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Protein supplement consumption is linked to time spent exercising and high-protein content foods: A multicentric observational study

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Abstract

The main aim of this study is to analyze if protein supplement consumption and food patterns vary across three geographical regions and secondly to identify possible factors that increase the likelihood of ingesting protein supplements.

A total of 916 responses from gym users of 3 countries (Italy, Turkey and UK) were entered for analysis. Questions were related to supplement consumption (protein and other supplements), food intake and training habits. A descriptive analysis, analysis of variance (ANOVA), and logistic regression were performed.

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No differences were found across groups regarding: prevalence of protein supplement consumption, typology of other ingested supplement and food intake. No relation was found between level of education ($r = .12$) or geographical region ($r = .16$) and protein consumption. The analysis showed that the coach is the main source of suggestion for the intake of protein supplements (52.3%). The logistic regression model highlighted that gym users who exercised more (OR 1.51, $p < 0.001$) and consumed higher quantities of chicken (OR 1.39, $p < 0.001$) eggs (OR 1.18, $p < 0.001$) and canned tuna (OR 1.15, $p < 0.05$) were more likely to use protein supplements.

Geographical area does not seem to influence the supplementation pattern. Time spent exercising and high protein foods are factors associated with protein supplement consumption.

Keywords: Psychology, Nutrition

1. Introduction

Several investigations were carried out with the aim of understanding the habits of athletes or regular gym users regarding the consumption of dietary supplements [1, 2, 3, 4]. These are defined as products taken orally that contain one or more ingredients that are intended to supplement one's diet and are not considered food [5].

It has been acknowledged that there are different reasons why males and females consume nutritional supplements. Males prevalently use them as a means of increasing strength, muscle mass and performance while females use them for health purposes, to recover from exercise or to lose weight [3, 6]. In general the prevalence of ingesting supplements is higher for males compared to females [4, 7].

Aside from gender, a factor which influences the prevalence or the typology of supplement use is the specific population analyzed. A nationwide survey from Japan [8] tried to clarify the prevalence of dietary supplement consumption among college students and found that on average almost 17% of the 9066 surveyed students declared the use of nutritional supplements. The mainly used supplements were vitamins/minerals followed by protein powders and weight loss products. A higher prevalence is generally found in gym users, with values ranging from 29.4% to 47.5% [1, 4, 7, 9, 10, 11]. Gym users (who are mainly resistance training practitioners) prevalently declare the use of protein supplements, followed by vitamins/minerals, branched chain amino acids and creatine a means to enhance performance or support intense training regimes [12]. Knapik et al. [3] in their research established that the prevalence for supplement consumption in professional athletes varies considerably. A survey conducted in elite players in the first Spanish basketball league [13] on a sample of 55 athletes, showed that 58% these athletes were supplement users and that vitamins

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and sport drinks were the most used dietary supplements. Other results from a group of elite track and field athletes [14] revealed a percentage consumption among this population of 86% with protein supplements, amino acids, caffeine and creatine being the most consumed supplements. Another survey conducted in 164 elite young German athletes practicing different sports (Endurance, racquet, ball, combat and other sports) showed that 80% of respondents used or had used dietary supplements with no differences between the typology of practised activity. Vitamins/minerals, followed by sport drinks were the most frequently used (around 77%), whereas protein and amino acid products were consumed with a frequency of around 30% [15].

Many athletes or recreational gym users declare using nutritional supplements, however, these products should be consumed only when the nutritional needs of each user are not satisfied by ones diet [5]. In particular, a daily protein intake ranging between 1.4–2.0 g protein/kg body weight/day, is recommended as a means of increasing lean body mass [6, 16]. Although the use of protein supplements has been seen to significantly enhance changes in muscle strength and size during prolonged resistance training in healthy adults [6, 16]. Therefore, the use of supplements should not be intended as a substitute for a healthy and appropriate diet, this latter defined as a nutritional regime that allows a person to sufficiently meet their energetic and nutritional needs [14].

Although supplement consumers are usually more careful about their nutritional intake [17], there is a tendency in these users to exceed the nutritional recommendations, and therefore such excessive supplement consumption may be a health threat [18]. In some cases there have also been reports of contaminations by toxic agents or substances prohibited by the anti-doping agencies within nutritional supplements, without these substances being indicated in the product label [19]. Despite the possible side effects of consuming an unintended substance, protein supplements are frequently used in clinical populations with positive effects such as reduced hospitalization and fewer complications compared to patients who do not use such supplements [20].

Other element often reported by researchers as contributing factor of supplement usage is the level of education and the training experience [18, 21]. Higher levels of education, that may imply a greater awareness of the role of nutrition in good health are usually linked to higher consumptions [18]. Likewise, training experience seems to promote a higher consumption of nutritional supplements [21], especially in individuals with over a year of gym practice who exercise more than twice a week.

Given the different prevalences reported worldwide and the different contributing factors that may be involved in the decision making process of dietary supplement consumption, the main aim of this study is to gather information regarding supplement consumption, in particular protein supplements and food intake and identify such consumption patterns in gym users from three different geographical regions across Europe. Secondly we will try to identify any possible factor or habit that could influence the use of protein supplements, in commercial gym users.

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2. Methods

2.1. Participants

Surveys were conducted from a representative number of commercial gyms located in Italy (Palermo), Turkey (Ankara) and United Kingdom (UK, Medway). The gyms were identified using the closed envelope method and then randomly selected. More than one gym was selected for each location. The survey was administered to people attending strength, team or aerobic activities within the selected gym (Weightlifting, functional fitness, indoor cycling, calisthenics, Step Aerobics and other indoor gym activities). To reduce heterogeneity of the sample, people attending outdoor aerobic activities were excluded. Based on such inclusion/exclusion criteria a total number of 916 participants (704 males and 212 females, age 26.7 $\pm$ 7.8 years old, weight 76.3 $\pm$ 12.3 kg and height 176 $\pm$ 8 cm) were selected. These were 354 from Italy (307 males and 47 females), 352 from Turkey (222 males and 130 females) and 210 from the UK (175 males and 35 female).

2.2. Questionnaire procedure

In order to evaluate the frequency of dietary supplement consumption and weekly food intake a questionnaire was adopted, as previously reported [9, 22, 23]. Common and commercial names were used to describe and define the foods and the nutritional supplements included within the definition of supplement: product intended to supplement the diet and that contains one or more dietary ingredients. The completion of the questionnaire was considered as consent to participate in the study. According to the Italian and Turkish regulations, ethical approval was not required for this study. The ethics committee of the University of Greenwich approved the study (approval number: fE&S/uREC/14/2.3.31).

Nonetheless, the study was undertaken in accordance with the deontological norms laid down in the Helsinki Declaration and the European Union recommendations for Good Clinical Practice. The questionnaire was administered by the same investigator, for each geographical area, using the face-to-face interview method in order to reduce bias from a self-administered questionnaire [24].

2.3. Food and supplement consumption, type and frequency of physical activity, source of information

The weekly supplement and food intake, the type and frequency of physical activity and the source where the participants obtained orientation on supplement use were asked in the questionnaire. The frequency of each food was reported from 0 to 7 according to each participant weekly consumption. 0 was considered when the participant never consumed a food and 7 when the participant consumed a food every day. The type of practised activity within: gym activity, team activities, indoor aerobic

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activities, the combination of gym and aerobic activities and "other" were asked. Concomitantly, weekly training frequency was reported. If a participant reported the use of protein supplements a question regarding the source of information was asked. The possible answers as source of information were: The coach, myself, internet, a physician, a nutritionist, a friend or other.

2.4. Statistical analysis

Data analysis was performed using the EpiInfo software version 7.2.2.6 (CDC, Atlanta, GA, US) for frequency distribution and descriptive analysis and SPSS 20 for inferential analysis.

Frequency distribution of food consumption, protein users, type of physical activity and source of information were performed. A D'Agostino-Pearson Test was used to test for normality of distributions. Differences were assessed by a two-way ANOVA to compare replicate means by row for parametric assessment. Differences were assessed by a Friedman test to compare replicate means by row for non-parametric assessment. Pearson partial correlations were used to evaluate any association between protein consumption and the demographic characteristics of the sample. A logistic regression model was created to understand the associations between protein consumption and other variables related to protein consumption.

3. Results

Descriptive characteristics of the sample are described in Table 1. Characteristics of protein and non-protein users for the three geographical regions are described in Table 2.

Table 1. Descriptive caracheteristics of the samples.

	Italy			**Turkey**			**Uk**		
	Tot.	**M**	**F**	**Tot.**	**M**	**F**	**Tot.**	**M**	**F**
Age (years)	29.3 ± 10.3	29.1 ± 10.3	30.8 ± 10.2	24.9 ± 4.9	24.9 ± 4.9	24.7 ± 5.0	25.6 ± 5.3	26.1 ± 5.43	23.6 ± 3.9
Heigh (Cm)	175.2 ± 8.45	176.7 ± 7.8	165.6 ± 5.8	174.8 ± 7.8	77.4 ± 9.4	168.1 ± 5.2	181.1 ± 7.8	183.6 ± 6.3	170.3 ± 4.5
Weight (Kg)	74.2 ± 13.05	76.7 ± 11.9	58.2 ± 7.5	70.1 ± 12.8	178.8 ± 6.2	57.7 ± 6.9	78.3 ± 10.05	81.6 ± 7.3	62.2 ± 5.4
Gender (n)	354	307	47	352	222	130	210	175	35
Education (years)	12.3 ± 3	12.2 ± 3.1	12.9 ± 3.1	14.1 ± 1.9	14.1 ± 2	14.2 ± 1.9	15.8 ± 1.6	15.9 ± 1.6	15.6 ± 1.7
Weekly exercise (h)	3.67 ± 0.95	3.68 ± 0.95	3.61 ± 0.95	3.81 ± 0.99	4.03 ± 1.04	3.44 ± 0.76	4.29 ± 0.81	4.35 ± 0.80	3.94 ± 0.78

Values are expressed as means ± st.dv. Tot. = Total; M = Male; F= Female.

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Table 2. Descriptive characteristics of the protein and non-protein users.

	Users (%)	Non-users (%)	W/Freq (Days)
Tot	302 (33.0)	614 (67.0)	4.5 ± 1.2
Male	287 (94.7)	417 (68.0)	4.5 ± 1.2
Female	15 (5.0)	197 (32.1)	3.5 ± 0.8
Italy	102 (28.8)	252 (71.2)	4.1 ± 1.2
Turkey	91 (25.9)	261 (74.1)	4.7 ± 1.3
UK	109 (51.9)	101 (48.1)	4.6 ± 1.3

Tot (n = 916); Male (n = 704); Female (n = 212); Ita (n = 354); Turk (n = 352); Uk (n = 210); W/Freq = mean weekly frequency.
Users = Protein users; Non-Users = Non protein users; W/Freq: Frequency of protein consumption.
Data are expressed as absolute values and (relative percentages) and as means ± st.dv for W/Freq.

Correlations showed a low association between the protein users and the geographical area ($r = 0.16$) and also a low coefficient between the users and their level of education ($r = 0.12$).

No differences were identified between the percentage values of the other dietary supplements associated with the protein intake across the three groups ($p = 0.46$) (Fig. 1).

The data indicates that the geographical location of the gym users does not affect their choice of using a protein supplement in combination with other supplements. The trend shown for the three groups is that the protein users ingest such supplement either alone or in combination with other supplements (different than creatine or amino acids).

No significant difference was found between the type of physical activity practised among the three groups ($p = 0.32$) (Fig. 2). Resistance training gym activity was the preferred activity amongst protein users across the three geographical regions.

No significant differences were found between the source of information across the three geographical regions ($p = 0.91$) (Fig. 3). Coaches were identified as the main person suggesting the use of protein supplements, followed by each user's personal choice. A very low percentage of users reported a physician or a nutritionist as the person who suggested the use of a protein supplement.

The analysis of variance of the dietary patterns between the Italian, Turkish and UK population did not demonstrate significant differences across the three groups for any food (Table 3).

The logistic regression analysis predicting the likelihood of being a protein supplement user (vs. not being a supplement user) was significant, χ^2 (6) = 75.54, $p < 0.001$ (Table 4). Training frequency increased the likelihood of being a protein supplement user (OR = 1.51, 95% CI: 1.30−1.77, $p < 0.001$) while age, gender or the

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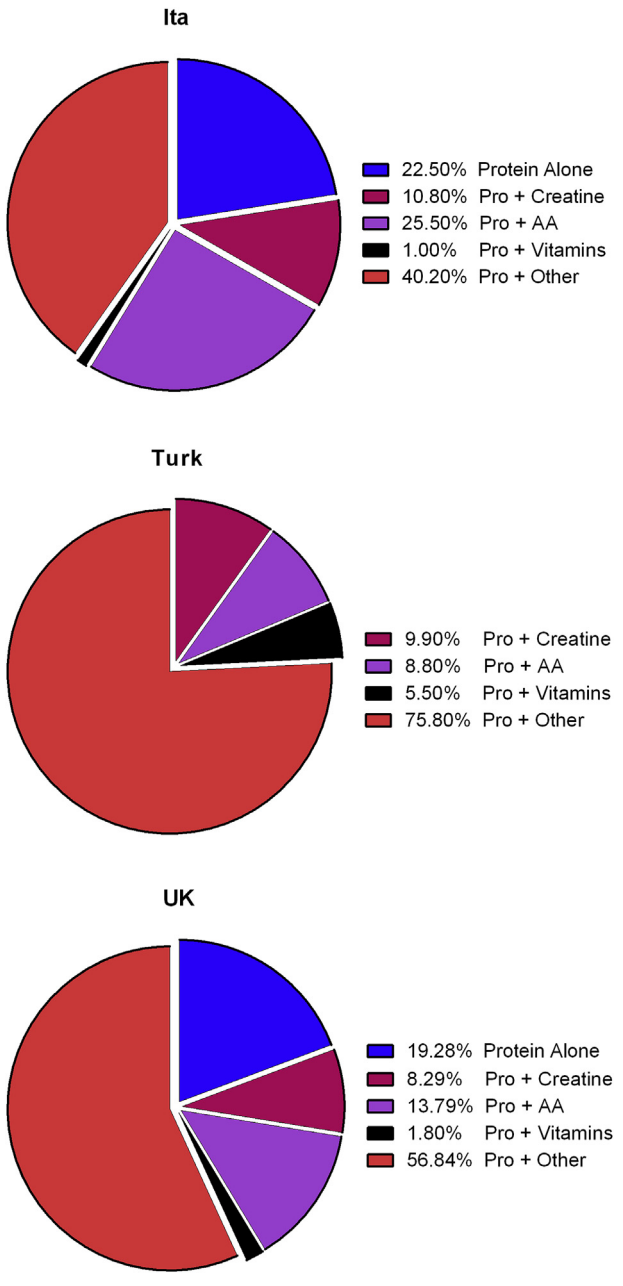

Fig. 1. Percentage of users stratified by geographical region who use protein supplements in association with other supplement.

level of education did not. A second model linking the nutritional habits to the likelihood of being a protein supplement user (vs. not being a supplement user) highlighted that a higher intake of chicken (OR = 1.39, 95% CI: 1.23−1.57, $p < 0.001$), eggs (OR = 1.18, 95% CI: 1.06−1.30, $p < 0.001$) and canned tuna (OR = 1.15, 95% CI: 1.03−1.28, $p < 0.05$) were moderately linked to a higher likelihood of using protein supplements.

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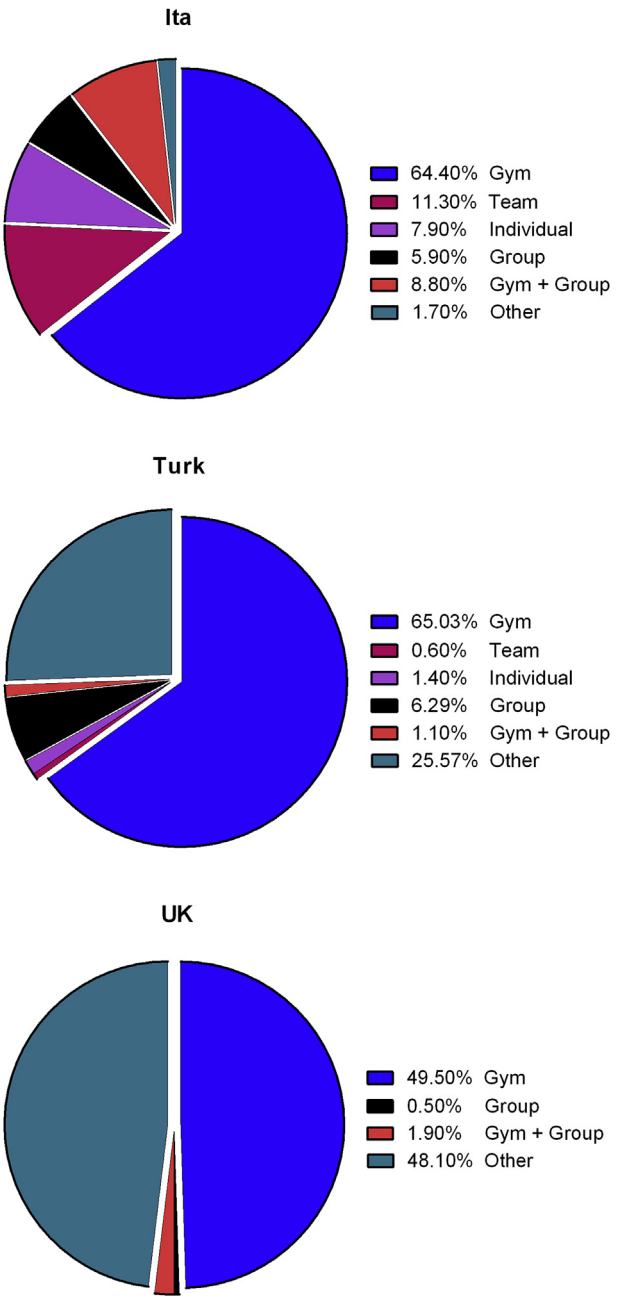

Fig. 2. Percentage of practised physical activity stratified by geographical region.

4. Discussion

The main results regarding protein consumption have highlighted a uniformity amongst supplementation with a percentage intake in line with that expressed in other studies in different geographical locations [1, 4, 7, 9, 10, 11]. Whilst the statistical difference was not significant across groups, it is worth mentioning that the UK population reported a consumption of 51.9%. Such relatively higher

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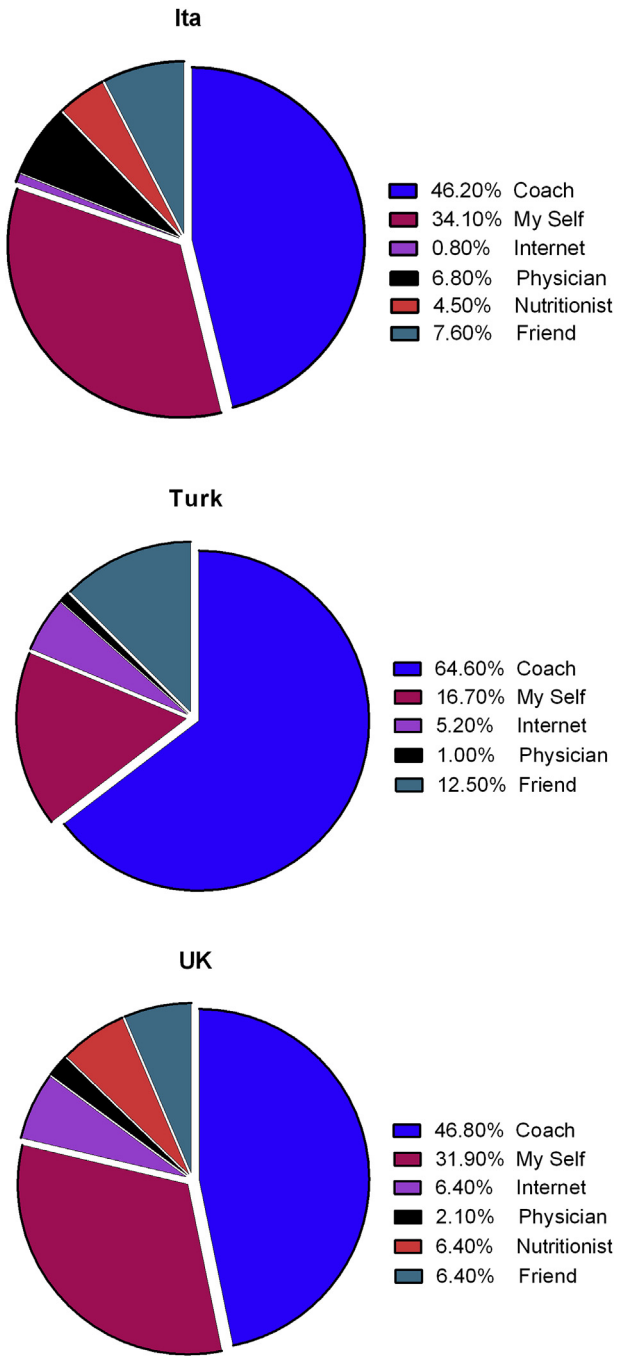

Fig. 3. Percentage of the different sources of information which suggest the use of protein supplements stratified by geographical region.

percentage is however in line with other studies assessing protein products intake in the United Kingdom [25]. In line with previous studies, in all three countries, males declared a higher protein consumption compared to females [26, 27].

When the protein supplement users were asked if they took such supplements in association with other supplements, the majority declared they consumed them alone

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Table 3. Percentages and comparison of food consumption of the different geographical regions.

Foods Frequency per week	Italy								Turkey								UK								p
	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	
Milk	20.6	4.8	5.1	7.6	2.0	59.6	0.0	0.0	0.6	0.0	0.9	2.6	7.7	14.2	7.1	26.7	1.0	0.0	1.4	4.3	12.9	23.8	11.9	44.8	0.15
Cheese	17.8	13.3	22.9	21.8	6.5	17.8	0.0	0.0	0.3	0.6	4.8	11.9	28.7	33.5	16.2	4.0	4.3	1.4	1.4	9.0	20.0	26.2	9.5	28.1	0.96
Chicken	1.4	9.3	24.6	30.5	13.8	20.1	0.0	0.3	2.8	12.2	12.2	16.5	27.0	20.2	8.8	0.3	1.0	0.0	1.4	12.9	25.7	27.1	9.5	22.4	0.06
Eggs	12.7	31.6	31.4	12.7	4.0	7.6	0.0	0.0	5.7	11.4	6.0	12.2	17.6	25.0	16.8	5.4	2.4	0.5	3.3	11.9	16.7	19.0	15.7	30.5	0.98
Vegetables	3.4	5.9	10.2	13.3	6.8	60.5	0.0	0.0	1.1	7.1	23.3	27.6	18.5	11.6	7.7	2.3	0.5	0.5	2.4	9.5	12.9	24.8	13.3	36.2	0.53
Bakery	26.0	16.1	11.6	8.2	4.8	33.3	0.0	0.0	21.0	32.1	15.9	12.5	9.4	5.1	3.1	0.9	14.8	6.7	7.6	19.5	15.7	21.9	5.2	8.6	0.12
Cold cuts	26.6	19.2	18.6	15.3	6.5	13.8	0.0	0.0	23.0	36.9	18.5	11.4	6.3	3.4	0.6	0.0	17.6	9.5	7.6	21.9	15.2	20.0	2.9	4.8	0.99
Yogurt	37.3	7.6	11.3	13.0	4.8	24.0	0.0	0.0	0.3	2.0	8.2	19.6	27.3	28.1	11.6	2.8	6.2	11.0	13.3	17.6	20.0	15.7	5.7	10.0	0.98
Meat	6.8	15.5	30.8	29.7	7.6	9.6	0.0	0.0	1.4	1.7	10.2	8.8	18.5	21.0	22.2	16.2	1.9	5.7	8.6	21.0	17.1	20.5	9.5	15.7	0.99
Fish	10.2	30.5	36.7	17.2	4.0	1.4	0.0	0.0	22.7	56.3	15.1	5.4	0.6	0.0	0.0	0.0	3.8	16.7	30.5	29.0	12.4	6.7	0.5	0.5	0.33
Nuts	54.0	14.4	13.6	5.9	3.4	8.8	0.0	0.0	23.9	47.7	16.2	9.1	2.8	0.3	0.0	0.0	22.9	15.2	25.7	14.8	10.5	7.1	1.9	1.9	0.23
Snacks	55.9	12.1	9.3	8.5	3.7	10.2	0.0	0.0	25.0	33.5	14.5	15.1	8.2	3.1	0.6	0.0	35.7	16.2	15.2	18.1	4.8	7.1	1.0	1.9	0.18
Canned tuna	23.7	20.6	27.1	14.7	5.4	8.5	0.0	0.0	16.5	34.7	20.7	19.0	5.4	3.4	0.3	0.0	38.1	26.7	11.9	11.0	8.1	3.3	0.5	0.5	0.99
Legumes	11.6	18.6	29.7	21.5	9.6	9.0	0.0	0.0	0.9	5.7	17.0	27.0	25.0	18.2	5.7	0.6	4.3	6.2	8.1	16.2	13.3	21.0	12.9	18.1	0.99

The data under the frequency per week are expressed as a percentage for the whole weekly frequency for each food. 0 indicates never consumed while 7 indicates consumed every day. Italy (n = 354); Turkey (n = 352); UK (n = 210); p = Comparison between nations for each food.

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Table 4. Results of the logistic regression model with factors potentially influencing protein consumption.

	B	SE	OR	95%CI		p
				Lower	Upper	
Users vs. non-users						
Gender	-0.13	0.18	0.87	0.62	1.24	0.45
Age	-0.01	0.01	0.99	0.97	1.01	0.45
Level of Education	0.05	0.03	1.05	0.98	1.11	0.14
Training Frequency	0.41	0.08	1.51	1.30	1.76	0.00
Constant	-2.68	0.62	0.07			0.00

Logistic regression analysis between protein users and non-protein users. B= Unstandardized regression weight; SE = Error of B; OR = Odd Ratio; 95%CI = Confidence Intervals of the OR (95%).
Model statistics: Model $\chi^2(6) = 75.54$, $p < 0.001$ Pseudo-$R^2 = 0.07$ (Cox & Snell), 0.11 (Nagelkerke).

or in association with other supplements (rather than vitamins, amino acids or creatine, that are usually indicated as a high prevalence nutritional supplement). The analysis of variance did not highlight any difference between the three groups. Studies from different populations usually report that vitamins or minerals are the most consumed nutritional supplement [28]. However, these studies focused on the prevalence of a specific supplement and did not report whether other supplements were taken in combination. Braun et al. [15] has attempted to identify the prevalence of supplement use in elite young Germany athletes, and their results have demonstrated that on average three different supplements were consumed by each individual athlete [15]. However, the nutritional needs and the reasons for which an elite athlete decides to use a supplement are likely to be different from those of a recreational resistance training user. Despite the relatively higher nutritional needs of elite athletes, Goston and Correia [11] reported that gym users (in a Brazilian population) consume on average five different products on a daily base, with protein supplements or amino acids being the most used products (58%). Dickinson et al. [28] reported the results of a series of surveys on supplement consumption in the USA over a five year period. Around 30% of the screened population reported to use a variety of supplements. However the main aim of the study was to understand the consumption of multivitamin supplements and the authors did not specify which supplements were intended with the term "variety". Therefore it is not possible to state if these were protein supplements or not [28,29].

Higher education has often been linked to a higher consumption of nutritional supplements [8,17,30,31]. In contrast, the present results did not show any association with the level of education across the three countries. In a multiethnic study by Foote et al. [17] where 100,196 people were interviewed to identify factors associated with supplement consumption, results provided evidence that age, education, physical activity and healthy habits are linked to a higher consumption of nutritional

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supplements. The results arose from a questionnaire investigating the consumption of 7 specific substances (Vitamin A, C and E, beta-carotene, selenium, calcium, iron and selenium), a multivitamin or any supplement, and did not provide specific information regarding protein supplements [17]. It could be possible that the use of vitamins, which is usually linked with health purposes, increases in people with higher education who are more conscious of health related issues. Either the use of protein supplements is majorly linked to the typology of practised activity [11] or alternatively our contrasting results could be explained by the limited sample analyzed.

The source of information is in line with other published studies, which also identified the coach as the principal person suggesting the use of protein supplements, followed by each person's personal choice [1, 11,32]. Given this finding, education by influential figures in the athlete's or gym user's life, such as coaches and family members, is of fundamental importance. In short, uneducated trainers may provide inaccurate, inappropriate or potentially harmful advice [1,32]. Interestingly, a very low percentage of users reported the physician (3.3%) or a nutritionist (3.6%) as their primary source of information, which could lead the protein users to being unaware of the potential risks and side effects associated with an excessive consumption of a protein supplement [7].

The three analyzed samples did not show any significant difference regarding the nutritional habits. However, it has to be noted that the three counties analyzed are geographically far from each other and each of them possesses different cultural backgrounds. As such, it could therefore be possible that foods that may be prevalent in each specific country have not been taken into account. Another explanation that could explain our results is that all the gathered information regarding supplement consumption has been retrieved from gyms across the three countries and therefore from physically active populations, whereby nutritional habits according to the practised activity might be similar as for the aforementioned supplementing prevalence. There are however no elements that allow us to provide a definitive answer. The linear logistic regression however revealed that individuals with a higher consumption of chicken, eggs and canned tuna (foods with a high protein content [33]) also exhibited a higher consumption of protein supplements. Hartmann et al. [7] have investigated the reasons that induce a person to use a protein supplement and they revealed that 84% of males and 54% of females used protein supplements in order to increase muscle mass. Moreover, the main reason that pushed such users to consume these supplements was that they believed that these had a well-being and positive health effect [7].

This is in agreement with previous study cases and larger studies that reported a high frequency of protein supplement consumption among bodybuilders [34, 35, 36]. Protein supplementation has been seen to have an anti-sarcopenic stimulus and may also help young and aging persons participating in resistance training activities

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to increase strength and lean body mass [6]. In order to maximize skeletal muscle recovery and growth it has been suggested that athletes have an increased dietary need of daily protein ingestion with recommended amounts ranging between 1.4−2.0 g protein/kg body weight/day (g/kg/d) [6, 16]. However, there is currently no evidence that doses above 3.0 g/kg/d will provide further benefits in individuals doing resistance training. While it is possible for physically active individuals to obtain their daily protein requirements through the consumption of whole foods, supplementation is a practical and easy way of ensuring intake of adequate and quality protein sources [16,37]. Therefore our results provide evidence gym users have inadequate knowledge regarding their nutritional needs.

A limitation to the present study was the administration of the questionnaire. Even though the researchers applied the face-to-face method it is not possible to know exactly how many people responded correctly or provided inaccurate information (Acquiescence bias). However, the results provided seem to be in line with those of other studies. Another drawback was the limited number of female participants compared to the male population analyzed. Notwithstanding the results have been analyzed through percentages in order to normalize the findings, it will be necessary to increase the sampled population to effectively estimate the consumption of protein supplements in females.

The results of the present study confirm that males use protein supplements more than females and that the geographical area and the level of education are not determining factors for the use of protein supplements. Results also highlight the importance of the coach as the main person suggesting the use of protein supplements. Given the current evidence of protein over-supplementation in recreational gym users this demonstrates the need for coaches to be adequately trained in order to provide accurate nutritional advice. A higher training frequency and a diet richer in protein foods are factors responsible for increasing the odds of resistance trainers being protein supplement users notwithstanding that this population does not have such a nutritional need.

Declarations

Author contribution statement

Ewan Thomas: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Bettina Karsten, Antonio Paoli, Antonio Palma, Antonino Bianco: Conceived and designed the experiments; Wrote the paper.

Fatma Nese Sahin: Conceived and designed the experiments.

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Goktug Ertetik, Vincenza Leonardi: Performed the experiments.

Francesco Martines: Contributed reagents, materials, analysis tools or data.

Paulo Gentil: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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