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A case–control study on the relationship between sleep bruxism and mental health conditions, depression and anxiety, in children

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This cross-sectional study aimed to examine the possible relationship between sleep bruxism, anxiety, depression, and demographic factors in children. Ninety-eight children(49 with bruxism and 49 controls) aged 6–17years were included in this case-control design. Parents completed bruxism questionnaires, and diagnoses were confirmed through intraoral examinations according to the American Academy of Sleep Medicine criteria. Psychological assessments were conducted using the Children's Depression Inventory and the Beck Anxiety Inventory. Statistical analyses were performed to explore associations between sleep bruxism, anxiety, depression, and demographic variables. No significant differences were observed across age groups; however, adolescents aged 13–17 with sleep bruxism had higher levels of anxiety and depression. Regression analysis indicated that a one-unit increase in anxiety scores may raise the likelihood of bruxism by 2.2 times in adolescents. Female adolescents with bruxism showed anxiety levels almost twice as high as males. No significant associations were identified between bruxism and demographic variables. Early dental referrals for children with elevated anxiety or depression scores may be considered given the potential association with sleep bruxism. Although this study does not demonstrate a direct link or causality, anxiety, depression, and bruxism may be interrelated. These findings underscore the need for interdisciplinary collaboration between psychiatry and dentistry to improve outcomes.

Keywords Anxiety, Children, Depression, Psychology, Sleep, Sleep bruxism

Abbreviations

AASM	American Academy of Sleep Medicine
BAI	Beck Anxiety Inventory
CDI	Children's Anxiety Inventory
CI	Confidence interval
FSH	Follicle-stimulating hormone
OR	Odds ratio
TMJ	Temporomandibular joint

Bruxism, according to the current consensus in the literature, is defined as a repetitive masticatory muscle activity involving clenching or grinding of the teeth, or bracing or thrusting of the mandible. This activity may occur during sleep (sleep bruxism) or while awake (awake bruxism), depending on the individual's circadian rhythm[1,2]. Sleep bruxism is observed more frequently in children and adolescents[3]. The prevalence of sleep bruxism ranges from 10.0% to 16.0% in adults and from 3.5% to 40.6% in children[4].

Sleep bruxism in children is a significant clinical condition, as tooth clenching and grinding is generally severe and persists for a long period[5]. According to the 2018 consensus by Lobbezoo et al., bruxism is not considered a disorder in healthy individuals but rather a risk factor for specific clinical outcomes[2]. Nonetheless, bruxism can lead to tooth wear, headaches, muscle pain, temporomandibular joint pain, and limited mouth opening. Therefore, identifying predisposing factors is crucial for early diagnosis[5].

The etiology of bruxism remains unclear and is considered multifactorial in origin[6]. Historically, peripheral factors have been considered the primary causal factors of bruxism. However, current literature provides no

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evidence supporting the role of occlusion in the development of bruxism[7]. Therefore, later studies have shifted their focus to pathophysiological factors, considering bruxism as part of the sleep arousal response[6]. Lifestyle factors such as excessive sugar consumption and prolonged screen time, which may contribute to dopaminergic system dysfunction in the central nervous system, as well as psychosocial factors such as anxiety and stress, have been highlighted as having a significant role in the etiology of bruxism[8]. Anxiety, a potential predisposing factor, is characterized by restlessness associated with the expectation of emotional danger and accompanying physiological arousal symptoms. While it is considered normal in children as part of their development, it may be classified as pathological when they are afraid of harm to themselves or others or when it causes impairments in academic or social functioning. Children with anxiety disorders experience emotional distress, such as excessive worry or fear, as well as physical complaints such as palpitations, difficulty breathing, excessive sweating, tremors, and dizziness[9].

Depression is a mood disorder characterized by the internalization of negative emotions accompanied by feelings of guilt, a lack of self-confidence, and pessimism. Depression, which can have significant effects on children's lives, may lead to a decrease in academic performance, deterioration in relationships with family and peers, and difficulties in concentration[10,11]. Children with depressive symptoms may exhibit overly sensitive, irritable, and exaggerated reactions such as shouting or crying[12]. The prevalence of depression has recently been reported to be 28.4% in adults and 21.3% in children[13,14]. In the etiology of bruxism, there is a consensus that psychological conditions, such as anxiety, stress, and depression, interact with physiological symptoms within a multifactorial structure.

Patients with psychiatric disorders are more prone to temporomandibular joint disorders and bruxism[15,16]. Additionally, awake bruxism has been supported in the psychiatric literature as being associated with depression[17,18]. Depression, stress, and anxiety are considered the most common psychological conditions associated with sleep bruxism[18]. A relationship between anxiety, depression, and bruxism has been reported[19–21], whereas other studies have not identified this relationship[22,23]. While studies examining the relationship between sleep bruxism and psychiatric conditions in children are limited, most have identified a correlation between sleep bruxism and anxiety or depression[24–26].

In addition to an individual's clinical and psychological characteristics, demographic features and family structures may also play a role in the development of bruxism. Parents' emotional states, attitudes toward the family, and marital status influence children's psychology[27]. One previous study reported an association between bruxism and the marital status of parents[28]. Some studies have reported that parents' educational level, professional life, and socioeconomic status affect children's quality of life and may be associated with their susceptibility to bruxism[23,29]. Furthermore, certain systemic diseases in children may influence bruxism, with conditions such as allergic rhinitis, asthma, and upper respiratory tract infections being associated with bruxism[30,31].

The relationships among psychological factors, demographic characteristics, and nocturnal bruxism were examined, as it is important to clarify the etiology, ensure accurate assessment of bruxism, implement appropriate management strategies, and achieve effective outcomes. To contribute to the limited body of literature concerning the pediatric population, this study aimed to assess the associations between sleep bruxism in children and anxiety and depression levels across different age groups and sexes and to evaluate the effects of demographic characteristics on sleep bruxism. Accordingly, two null hypotheses were formulated. The first null hypothesis posited that anxiety and depression levels are not associated with sleep bruxism in children. The second null hypothesis posited that the children's demographic characteristics did not affect sleep bruxism.

Results

The study included 347 pediatric patients treated at the Child and Adolescent Psychiatry Clinic of the Erciyes University Faculty of Medicine. The STROBE checklist was used to report the results. A flowchart of the study population selection process is presented in Fig. 1.

A total of 98 patients participated in the study (girls, $n=28$ [28.6%]; boys, $n=70$ [71.4%]). We planned to have equal sex and age distributions in both the study and control groups; therefore, the groups were formed with 14 girls and 35 boys in each group, and the age distribution is shown in Table 1.

When evaluating the relationship between demographics and sleep bruxism according to age group, no statistically significant differences were observed between the study and control groups regarding school type, the presence of systemic diseases, medication use, the education levels of the mother and the father, the family income level, or parental marital status ($p>0.05$) (Table 2).

In the first-stage regression model, while the independent variables did not have a statistically significant effect on sleep bruxism, a one-unit increase in anxiety score increased the probability of sleep bruxism by 1.331 times ($p>0.05$). Cohen's d-values indicated a small effect size for anxiety and depression ($d=0.157$ and $d=0.104$, respectively) (Table 3).

The depression scale scores for the control and study groups are shown in Table 4. In the study group, those in the 13–17 age group were identified as being at risk for depression (CDI ≥ 19). Similarly, the 13–17 age group had the highest anxiety scale scores and was classified into the moderate-risk group (BAI ≥ 16). When anxiety and depression levels were assessed according to age group, no statistically significant difference in bruxism was observed between the two groups ($p>0.05$).

According to the regression analysis results in Table 5, in the 6–12-year age group, a one-point increase in anxiety score may increase the probability of sleep bruxism by 1.144 times, and a one-point increase in depression score may increase the probability of sleep bruxism by 1.091 times; however, this finding was not statistically significant. Cohen's d-values indicated a small effect size for both variables (anxiety, $d=0.070$; depression, $d=0.048$).

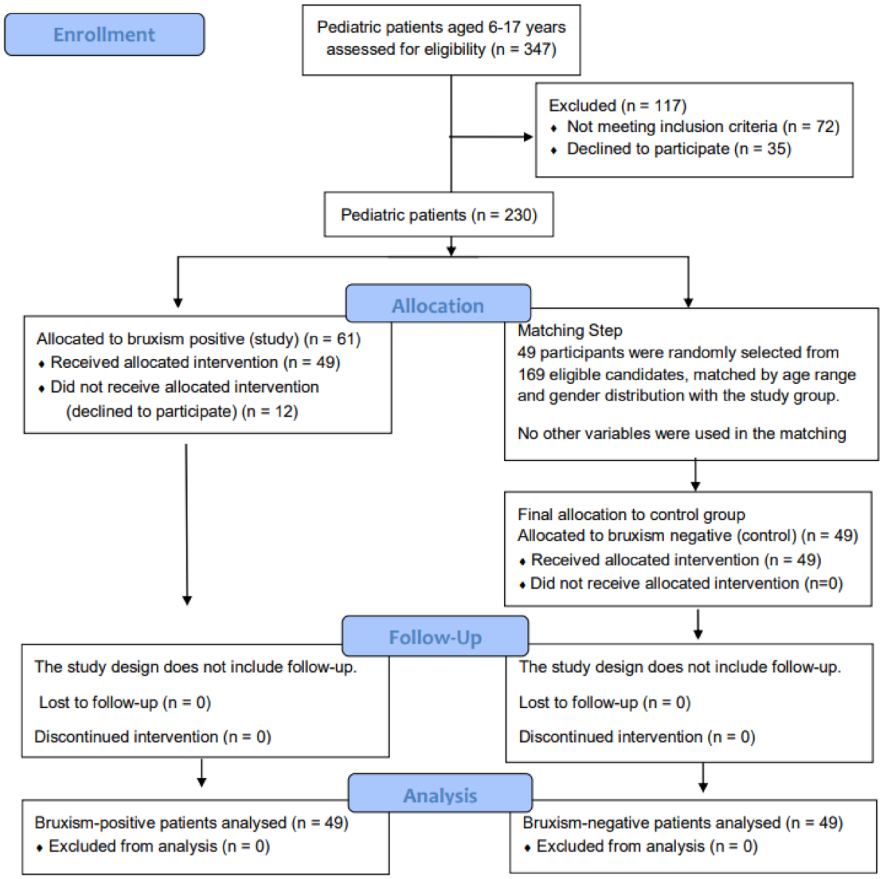


Fig. 1. Flowchart of the study population selection process.

	Ages 6–12		Ages 13–17	
Bruxism	Study group ($n=33$)	Control group ($n=33$)	Study group ($n=16$)	Control group ($n=16$)
Age distribution (mean ± SD)	9.36 ± 2.15	9.36 ± 2.15	14.56 ± 1.75	14.56 ± 1.75
Sex	26 boys 7 girls	24 boys 9 girls	9 boys 7 girls	11 boys 5 girls

Table 1. Patients' age (in years) and sex distributions. n, number; SD, standard deviation.

In the 13–17-year age group, while not statistically significant, a one-point increase in anxiety score may increase the probability of sleep bruxism by 2.002 times, and a one-point increase in depression score may increase the probability of sleep bruxism by 1.014 times ($p > 0.05$)(Table 5). Cohen's d-values for the 13–17-year age group indicated a medium effect size for anxiety ($d = 0.382$) and a small effect size for depression ($d = 0.010$).

The relationships between anxiety and depression levels and sleep bruxism in different age groups according to sex are shown in Table 6. When the mean anxiety scores of the BAI were examined, moderate anxiety was detected in both girls (24.9) and boys (19.1) aged 13–17 years with sleep bruxism. Regarding the mean CDI scores in our study, depression risk was identified only in girls in the 13–17-year age group (CDI ≥ 19). Anxiety and depression levels were greater in girls aged 13–17 years with sleep bruxism than in those without, but this difference was not statistically significant ($p > 0.05$).

According to the regression analysis results in Table 7, neither depression nor anxiety had statistically significant effects on sleep bruxism. However, in the 6–12-year age group, a one-point increase in depression score in girls increased the probability of sleep bruxism by 1.430 times, with a small effect size ($d = 0.197$). For boys, a one-point increase in anxiety score increased the probability of bruxism by 1.295 times ($p > 0.05$), with a small effect size ($d = 0.142$).

For girls in the 13–17-year age group, a one-point increase in anxiety score increased the probability of bruxism by 1.967 times, and a one-point increase in depression score increased the probability of bruxism by 1.918 times. Cohen's d-values for the 13–17-year age group of girls indicated a medium effect size for both anxiety ($d = 0.373$) and depression ($d = 0.359$). For boys in the 13–17-year age group, a one-point increase in anxiety score increased the probability of bruxism by 2.210 times ($p > 0.05$), with a medium effect size ($d = 0.437$).

		Ages 6–12			Ages 13–17		
		Control group	Study group		Control group	Study group	
		n(%)	n(%)	*p*-value	n(%)	n(%)	*p*-value
School attended	Public school	29 (87.9%)	29 (87.9%)	0.646	16 (100%)	16 (100%)	–
	Private school	4 (12.1%)	4 (12.1%)		0 (0.0%)	0 (0.0%)	
Medical condition	None	28 (84.8%)	28 (84.8%)	0.633	11 (68.8%)	14 (87.5%)	0.197
	Present	5 (15.2%)	5 (15.2%)		5 (31.3%)	2 (12.5%)	
Medication use	None	18 (54.5%)	18 (54.5%)	0.597	8 (50.0%)	7 (43.8%)	0.5
	Present	15 (45.5%)	15 (45.5%)		8 (50.0%)	9 (56.3%)	
Mother's education	No education	0 (0.0%)	1 (3%)	0.295	0 (0.0%)	0 (0.0%)	0.58
	Primary school	20 (60.6%)	16 (48.5%)		10 (62.5%)	10 (62.5%)	
	High school	9 (27.3%)	11 (33.3%)		5 (31.3%)	6 (37.5%)	
	University	2 (6.1%)	5 (15.2%)		1 (6.3%)	0 (0.0%)	
	Postgraduate	2 (6.1%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	
Father's education	No education	0 (0.0%)	3 (9.1%)	0.412	1 (6.3%)	0 (0.0%)	0.716
	Primary school	16 (48.5%)	12 (36.4%)		6 (37.5%)	7 (43.8%)	
	High school	11 (33.3%)	12 (36.7%)		7 (43.8%)	6 (37.5%)	
	University	4 (12.1%)	3 (12.2%)		2 (12.5%)	3 (18.8%)	
	Postgraduate	2 (6.1%)	3 (%9.1)		0 (0.0%)	0 (0.0%)	
Family income	Low	11 (33.3%)	19 (57.6%)	0.187	9 (56.3%)	5 (31.3%)	0.164
	Medium	16 (48.5%)	8 (24.2%)		6 (37.5%)	11 (68.8%)	
	High	2 (6.1%)	2 (6.1%)		1 (6.3%)	0 (0.0%)	
	Very high	4 (12.1%)	4 (12.1%)		0 (0.0%)	0 (0.0%)	
Parents' marital status	Married	31 (93.9%)	30 (90.9%)	0.389	11 (68.8%)	15 (93.8%)	0.306
	Divorced	0 (0.0%)	2 (6.1%)		3 (%18.8)	1 (6.3%)	
	Deceased father or mother	1 (3.0%)	1 (3.0%)		1 (6.3%)	0 (0.0%)	
	Stepchild	1 (3.0%)	0 (0.0%)		1 (6.3%)	0 (0.0%)	

Table 2. Relationship between demographics and sleep Bruxism according to age group.

Bruxism (1/0)	B	*p*-value	OR	95% CI for EXP (B) (lower–upper)	Cohen's d	95% CI for Cohen's d (lower–upper)
Anxiety score	0.286	0.232	1.331	0.833–2.127	0.157	− 0.183 to 0.754
Depression score	0.107	0.847	1.113	0.375–3.300	0.104	− 0.970 to 1.190

Table 3. Regression analysis of the effects of anxiety and depression levels on sleep Bruxism using cohen's d effect size assessment. CI, confidence interval; OR, odds ratio.

Age (years)	Score	Bruxism	*n*	Mean	SD	Z	*p*-value
6–12	Anxiety scale score	Control group	33	9.18	8.244	1.066	0.286
		Study group	33	10.52	7.094		
	Depression scale score	Control group	33	12.94	6.154	-0.829	0.407
		Study group	33	12.33	7.676		
13–17	Anxiety scale score	Control group	16	14.19	10.666	1.471	0.149
		Study group	16	21.63	14.221		
	Depression scale score	Control group	16	15.63	8.148	0.212	0.224
		Study group	16	20.38	9.150		

Table 4. Relationship between the levels of anxiety, depression, and sleep Bruxism according to age group (in years). n, number; SD, standard deviation.

Discussion

Most studies lack detailed information on the diagnostic criteria and the reliability of such criteria for sleep bruxism. While the null hypotheses were statistically supported, the regression analysis indicated that anxiety and depression may affect sleep bruxism, particularly for children in the 13–17-year age group. Considering the hormonal changes in this age group, the observation of findings such as stress-induced sleep bruxism can

Age (years)	Bruxism(1/0)	B	*p*-value	OR	95% CI for EXP(B) (lower–upper)	Cohen's d	95% CI for Cohen's d (lower–upper)
6–12	Anxiety score	0.135	0.653	1.144	0.636–2.059	0.070	− 0.249 to 0.398
	Depression score	0.087	0.904	1.091	0.263–4.520	0.048	− 0.735 to 0.831
13–17	Anxiety score	0.694	0.129	2.002	0.817–4.909	0.382	− 0.111 to 0.877
	Depression score	0.014	0.988	1.014	0.171–6.014	0.010	− 0.974 to 0.989

Table 5. Regression analysis of the effects of anxiety and depression levels on sleep Bruxism according to age groups with cohen's d effect size assessment.

Age (years)	Sex	Score	Bruxism	*n*	Mean	SD	Z	*p*-value
6–12	Boys	Anxiety scale score	Control group	24	7.7	6.0	− 1.067	0.291
			Study group	26	9.6	6.8		
		Depression scale score	Control group	24	12.8	6.1	0.797	0.429
			Study group	26	11.3	7.0		
	Girls	Anxiety scale score	Control group	9	13.2	11.9	− 0.122	0.904
			Study group	7	13.9	7.7		
		Depression scale score	Control group	9	13.3	6.6	− 0.699	0.496
			Study Group	7	16.1	9.5		
13–17	Boys	Anxiety scale score	Control group	11	14.6	11.2	− 0.784	0.443
			Study group	9	19.1	14.3		
		Depression scale score	Control group	11	15.8	7.2	− 0.412	0.685
			Study group	9	17.1	6.6		
	Girls	Anxiety scale score	Control group	5	13.2	10.4	− 1.525	0.158
			Study group	7	24.9	14.5		
		Depression scale score	Control group	5	15.2	10.8	− 1.49	0.167
			Study group	7	24.6	10.7		

Table 6. Relationship between the levels of anxiety, depression, and sleep Bruxism according to sex across age groups. n, number; SD, standard deviation.

Ages (years)	Sex	Bruxism (1/0)	B	*P*	OR	95% CI for EXP(B) (Lower–Upper)	Cohen's d	95% CI for Cohen's d (lower–upper)
6–12	Girls	Anxiety score	− 0.025	0.964	0.975	0.333–2.854	− 0.013	− 0.606 to 0.578
		Depression score	0.357	0.774	1.430	0.124–16.446	0.197	− 1.149 to 1.543
	Boys	Anxiety score	0.259	0.484	1.295	0.628–2.674	0.142	− 0.256 to 0.542
		Depression score	− 0.010	0.992	0.991	0.169–5.805	− 0.005	− 0.981 to 0.969
13–17	Girls	Anxiety score	0.677	0.368	1.967	0.451–8.575	0.373	− 0.438 to 1.184
		Depression score	0.651	0.649	1.918	0.116–31.820	0.359	− 1.180 to 1.907
	Boys	Anxiety score	0.793	0.195	2.210	0.666–7.332	0.437	− 0.223 to 1.090
		Depression score	− 0.698	0.582	0.498	0.041–5.979	− 0.385	− 1.755 to 0.986

Table 7. Regression analysis of the effects of anxiety and depression levels on sleep Bruxism according to sex and age groups using cohen's d effect size assessment. CI, confidence interval; OR, odds ratio.

be considered reasonable. The inability to establish a definitive diagnosis or obtain statistical evidence may be attributed to the inadequacy of the diagnostic tools for bruxism and to the limitations of our study.

In dentistry, a diagnosis of bruxism is primarily based on clinical observations. However, diagnosing bruxism solely through clinical evaluation is challenging. Therefore, the following five primary methods are emphasized in the diagnosis of bruxism: questionnaire methods, clinical evaluation, the use of intraoral appliances, electromyographic analysis of masticatory muscles, and polysomnographic evaluation performed in sleep laboratories[32]. Among these, polysomnographic evaluation is considered the gold standard; however, it has several limitations, including challenges encountered when conducting studies in sleep laboratories, the high cost of equipment, and challenges in applying the results to large populations[33]. A clinical evaluation is based on anamnesis, tooth wear, tooth mobility, temporomandibular joint (TMJ) pain, headache, soft tissue changes, masticatory muscle pain, masseter muscle hypertrophy, and fatigue. However, none of these findings are specific to sleep bruxism[34]. Dental wear can result from various causes, and such wear may show individual differences, especially owing to increased occlusal contact during the primary dentition period, salivary composition, and

structural characteristics of teeth. Therefore, dental wear alone should not be used to diagnose sleep bruxism[32]. Studies have examined sleep bruxism during the primary, mixed, and permanent dentition periods; however, no study has evaluated psychometric and demographic data separately according to age group. The originality of our study lies in this aspect; therefore, age groups in this study were analyzed as distinct categories.

Various studies have proposed different anamnesis and examination criteria for the diagnosis of sleep bruxism. The AASM updated their most widely accepted criteria in 2014[35]. In our study, we initially used a questionnaire[36] that was simple to complete in daily practice and provided information quickly. The study groups were subsequently formed on the basis of the AASM's clinical diagnostic criteria. To ensure that the results of the study were unaffected, families were instructed not to alter their children's daily sleep routines or environments during the follow-up period. Tooth wear is the most common clinical manifestation of sleep bruxism[37]. Owing to the lower mineralization levels of primary teeth, tooth wear observed during the mixed dentition period has been reported to be more severe than during permanent dentition[38]. It has been suggested that canine teeth are subjected to greater loads because of their location in the transition zone between the anterior and posterior teeth within the dental arch and their critical function in occlusion[39]. In a study evaluating the etiological factors and prevalence of primary tooth wear, Rios et al.[40] reported that primary canine teeth exhibited the most common and severe wear and that there was a statistically significant association between bruxism and wear on canine teeth. Similarly, in a study conducted by Al Halabi et al.[41] involving children, sleep bruxism was associated with wear on primary canine teeth. While tooth wear is not an absolute diagnostic criterion for sleep bruxism, it is considered an important risk factor for tooth wear in children and adolescents[37]. Therefore, our clinical examination focused on evaluating tooth wear caused by sleep bruxism in primary canine teeth. Our findings are consistent with those of other studies that have reported primary canines being highly affected by wear associated with sleep bruxism.

In our study, we used the CDI, which is applicable for children aged 6–17 years. Oy[42] assessed the validity and reliability of this scale in Turkey. The BAI, which is applicable across a wide age range, was used to assess anxiety. Benjamin et al.[43] employed this scale in their study when they evaluated children aged 7–19 years for childhood anxiety and followed them up until the ages of 18–32 years. Therefore, we investigated the relationships between sleep bruxism, anxiety, and depression in patients aged 6–17 years. Additionally, unlike other psychometric evaluation studies, this study uniquely examined each parameter separately according to age group.

Because individuals' physical and psychological development are similar within specific periods, the developmental process is divided into stages, each characterized by distinct features and expressed through age groups. Child development is generally examined in the stages of infancy (0–2 years), early childhood (3–6 years), middle childhood (7–12 years), and adolescence (13–17 years)[27]. Adolescence is characterized by conflicts in close relationships, stubbornness, efforts to assert one's words and thoughts, sulking, anger, and depressive attitudes[44]. Furthermore, adolescents may exhibit high levels of depression and anxiety symptoms resulting from uncertainties, adjustment issues, and stress encountered in daily life[45]. One study reported that the prevalence of depression was lower in children aged 6–11 years compared with adolescents aged 12–17 years[46]. Similarly, in our study, the depression score (CDI ≥ 19) in the 13–17-year age group (43%) was higher than that in the 6–12-year age group (21%). Pubertal development influences the development of depression and anxiety in adolescents aged 12–17 years. Hormonal changes observed during the pubertal period are known to affect mood in both sexes[47]. It has been suggested that adrenal androgen concentrations in adolescent boys and men and estrogen levels owing to follicle-stimulating hormone (FSH) in adolescent girls and women are associated with negative mood[48,49]. Anxiety disorders observed in childhood are more commonly separated from specific phobias at younger ages, whereas social phobia becomes more prevalent with age[50]. An epidemiological study conducted on participants aged 4–14 years reported that specific phobia disorders were more common in children, whereas generalized anxiety disorders were more prevalent in adults[51]. Based on these differences between childhood and adolescence, we examined patients in two age groups, namely, 6–12 and 13–17 years.

In our study, no significant relationship was observed between the children's medical history and sleep bruxism when assessed within specific age groups. Cheifetz et al.[52] reported that children with bruxism had similar medical conditions to those without bruxism. However, in contrast to our findings, a Brazilian-based population study reported associations between bruxism and chronic health-related issues[53].

Limited financial and cultural resources may have a more pronounced effect on adolescents compared with adults or younger children. While social inequality and its consequences—such as the fear of falling behind peers—are anticipated to contribute to anxiety and depression related bruxism in adolescents, studies investigating sociodemographic factors have not identified any significant associations between parental education level, occupation, and sleep bruxism[54,55]. Consistent with these findings, we also did not identify any significant relationship between parental education level and sleep bruxism. Despite socioeconomic factors being considered key determinants of health, only a few studies have investigated their relationship with sleep bruxism[23,54,56]. Furthermore, the findings of studies examining the relationships between socioeconomic factors and sleep bruxism in children are conflicting[55]. In a study by Renner et al.[23] involving children aged 7–11 years in Brazil, high-income levels were reported to cause an increase in the prevalence of sleep bruxism. This relationship may be related to the number of daily activities performed by the children. In contrast, Ribeiro et al.[56] reported no effect of family income on sleep bruxism. Similarly, Gomes et al.[54] reported no relationship between socioeconomic factors and sleep bruxism. In line with these studies, our findings also indicated no significant difference between sleep bruxism and family income (grouped according to the 2021 data from the Turkish Statistical Institute)[57] or school type (public or private) in any age group.

In Turkey, private and public schools differ in terms of the number of class hours. Private schools offer extended hours along with extracurricular activities such as swimming, horseback riding, and gymnastics, which allow children to relax mentally, along with new-generation topics such as ecological farming, green chemistry, drama, and theater for cultural enrichment. Our hypothesis was based on the notion that more engaging lessons

spread throughout the school day may help alleviate children's stress. However, our data showed that, in line with most reported studies[58,59], no difference in bruxism was observed between children attending private and public schools of any age group or sex; however, very few children in our study attended private schools.

Two studies[60,61] reported no significant relationship between parental marital status (married or separated) and bruxism/sleep bruxism, whereas Leal et al.[28] reported an association between sleep bruxism and the marital status of parents/guardians. We investigated the relationship between parental marital status and sleep bruxism in children, but no significant relationship was observed.

Etiological theories have consistently emphasized the role of psychological factors and anxiety in bruxism[18]. Several studies investigated the relationships between anxiety, depression, and bruxism[20–24]. However, studies involving adults have shown significant inconsistencies. Some adult studies have reported that anxiety disorders and depression are more common in patients with sleep bruxism than in those without it[20,22,24]. A review by Polmann et al. in 2018[21] indicated that certain symptoms of anxiety disorders may be associated with sleep bruxism. Contrary to these studies, other investigations assessing the relationship between psychiatric disorders and bruxism have reported no differences in anxiety and depression levels between adult patients with and without bruxism[19–21]. Manfredini et al.[62] evaluated the relationship between anxiety and bruxism in patients with and without bruxism, but no significant differences were observed between the two groups in terms of anxiety psychopathology. Conversely, Manfredini and Lobbezoo[63] suggested that awake bruxism may be associated with psychosocial factors and psychopathological symptoms such as anxiety, stress, and depression. However, they concluded that there was no evidence linking sleep bruxism to psychosocial disorders. Two recent studies have suggested a potential association between anxiety and awake bruxism while indicating no such relationship with sleep bruxism[64,65].

Studies examining the relationships between sleep bruxism and anxiety and depression in children are limited. Oliveira et al.[25] reported a relationship between sleep bruxism and anxiety disorders in children aged 6–8 years. Restrepo et al.[26] reported that children aged 8–11 years with sleep bruxism were more anxious than those without. Consistent with these findings, Türkoğlu et al.[24] reported significantly higher rates of anxiety disorder and depression in children aged 8–17 years with sleep bruxism compared with those without. Some authors have shown that sleep bruxism symptoms decrease when anxiety and depression are treated using psychological techniques such as muscle relaxation and competence responses[66] or with the use of medication[67]. However, the efficacy of pharmacological treatments for sleep bruxism remains controversial. Long-term studies in children and adolescents are needed to evaluate the effects of psychopathological diagnoses and psychological therapy on sleep bruxism. Given that several studies conducted in children have reported this finding concerning the relationships between anxiety, depression, and sleep bruxism[24–26], we assumed that we might encounter higher rates of anxiety and depression in the group with sleep bruxism. However, in our study, no statistically significant difference was observed between the groups with and without sleep bruxism, even across the different age groups. Therefore, our first null hypothesis, which states that there is no relationship between sleep bruxism and anxiety or depression levels in children, was accepted. In most studies concerning this topic, limited information is available regarding the diagnostic criteria for sleep bruxism and their reliability. In our study, a questionnaire was initially used for diagnosis, followed by the application of the AASM diagnostic criteria during clinical examination. Unlike other studies, we specifically evaluated the wear on primary canine teeth to support the diagnosis of sleep bruxism. Consistent with the findings of another study, a high rate of wear, indicative of sleep bruxism, has been observed in primary canine teeth[40]. Alfano et al.[68] evaluated children aged 7–11 years with anxiety disorder using polysomnography, which provides a more objective evaluation, and reported no statistically significant difference between a group with anxiety and a control group in terms of sleep bruxism. Despite its cost and difficulty in obtaining equipment, polysomnography is the only method that can accurately detect sleep bruxism. Studies using this method are important for obtaining reliable detection and accurate results. Polysomnography is an effective method for accurately detecting sleep bruxism; however, we did not use this method because it is both expensive and time-consuming. We aimed to obtain more generalizable results using a large study sample; therefore, more economical and accessible data collection methods were used. Another possible reason why our results differed from those of studies conducted with patients visiting dental clinics was that our sample group was selected from patients attending psychiatric clinics. This selection may imply that both groups in our study had a greater predisposition to psychopathological conditions. This factor may be an important variable affecting the results. In our study, the relationships between anxiety, depression, and sleep bruxism were evaluated according to patient age. When the results were examined, it was observed that patients in the 13–17-year age group, classified as adolescents, had higher levels of depression and anxiety in those with sleep bruxism than in those without, but this difference was not statistically significant. When the relationships between anxiety, depression, and sleep bruxism were assessed according to sex, we observed that, in the 13–17-year age group, girls with sleep bruxism had higher anxiety and depression levels than those without sleep bruxism, but these differences were not statistically significant. Their anxiety scores were almost twice as high, indicating a medium effect size according to Cohen's *d*-value, but the absence of a statistically significant result may be attributed to our relatively small study sample size despite exceeding the figures in the power analysis. Moreover, in the regression analysis, it was concluded that each 1-unit increase in anxiety in children aged 13–17 years could have a 2.2 times greater effect on sleep bruxism, with a medium effect size. Hormone concentrations affect mood in both sexes. However, atypical depressive symptoms such as fatigue and increased appetite in girls before menstruation have been reported[47]. Additionally, the prevalence of depressive disorders decreases in boys after age 9, whereas it starts to rise in girls after age 12. The increase in sleep bruxism observed in girls in our study may also be attributed to depressive symptoms.

This study had several limitations. Clinical signs of sleep bruxism may reflect past issues rather than current conditions. Sleep bruxism may have started but not yet reached a clinically symptomatic level; therefore, it may not have been detected. No assessment of sleep bruxism severity was undertaken in the clinically diagnosed

patients. Test–retest procedures were not performed for the sleep bruxism questionnaire, which may affect the reliability of the responses. Sleep bruxism severity may vary among patients, which could have affected our interpretation of the results. Similarly, we did not grade anxiety or depression levels. During patient selection, no distinction was made between new and ongoing cases, and it is unclear how long patients had been receiving psychiatric treatment or when their anxiety and depression had started, how long the symptoms had persisted, or whether their anxiety was a state or trait. There was also a lack of inquiry into sleep disorders. Given that sleep disorders encompass a broad range of issues, we considered it necessary to address sleep disorders in a separate, more comprehensive study. While patient medication usage was questioned, we did not assess whether the medications were prescribed for psychiatric disorders, nor did we obtain data concerning the duration of their use. Some medications used to treat psychiatric disorders may trigger sleep bruxism, whereas others may reduce sleep bruxism. In addition, considering the potential insensitivity to pain resulting from medications the patients were taking, reporting of sleep bruxism symptoms may have been limited. While the division of age groups (6–12 and 13–17 years) was intended to account for developmental differences, it may have introduced certain biases. Older children and adolescents may exhibit more advanced cognitive and emotional processing abilities, potentially influencing their self-reported accuracy in psychological assessments. This difference in perception and expression of symptoms between age groups could have affected the reliability of the anxiety and depression scores, thereby affecting the interpretation of their association with sleep bruxism. Therefore, large-scale studies are needed to thoroughly evaluate patients' psychopathological conditions, medication use, lifestyle habits, family stressors, and influence of age-related cognitive differences.

This study, which evaluated patients admitted to a child psychiatry clinic and diagnosed with sleep bruxism, concluded that girls aged 13–17 years with depression scores of ≥ 20 could be considered for referral to a dentist for bruxism evaluation. We observed that anxiety was associated with higher odds of bruxism. Even among boys aged 13–17 with mild anxiety, the risk of bruxism was 2.2 times greater, with a medium effect size according to Cohen's *d*-values. We recommend that both girls and boys with mild anxiety be referred to a dentist to avoid the long-term effects of sleep bruxism.

Conclusions

Within the limitations of this study, the first null hypothesis was accepted, indicating no clear relationship between bruxism and mental health variables in the pediatric population. The attention of psychiatrists, as the first clinicians to encounter children with symptoms of anxiety and depression, should be focused on this issue. While statistically significant results could not be obtained, it may be beneficial to refer children with anxiety scores ≥ 8 to a dentist at an early stage, considering the potential risk of bruxism. It would be important for a psychiatrist to know that, among minors, children in the 13–17 age group are at risk of bruxism. However, it should be noted that this cross-sectional study identified only potential associations. Likewise, dentists may also be the first to encounter these children. Whenever signs of dental wear suggestive of bruxism are detected, dentists should consider informing parents that their child might be experiencing a psychological issue and a referral to a psychologist may be warranted. Therefore, both dentists and child psychiatrists should work in coordination to accurately diagnose bruxism and prevent its potential effects on oral health. It is predicted that child psychiatrists' ability to make the right decision without hesitation in such cases will provide much better clinical practice. It is possible to encourage common follow-up of correct clinical practices and avoid complications through increasing psychiatrists' awareness of bruxism. Practical tools, such as joint diagnostic and treatment indexes for psychiatrists and dentists, could streamline the identification and management of this condition.

Materials and methods

Study sample and procedures

This clinical study was conducted at two centers: the Child and Adolescent Psychiatry Clinic of the Erciyes University Faculty of Medicine and the Pedodontics Department of the Faculty of Dentistry. This study was approved by the Clinical Research Ethics Committee of Erciyes University Faculty of Medicine (Ethics Committee No. 2019/268). The study follows the WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Participants. İnformation concerning the study was provided to the patients and their parents/guardians, and informed consent forms were signed by the patients and their parents/guardians who volunteered to participate. The sample size was calculated using G*Power software. A power analysis of data from a previous study[24] revealed that the sample size for each group (study group and control group) should be at least 49. This value was determined with an effect size of 0.5, a significance level of 0.05, and a 0.90 power level.

The study sample group included 347 children aged 6–17 years who visited the Erciyes University Faculty of Medicine, Child Adolescent Psychiatry Outpatient Clinic, between January 2021 and May 2021, and issues concerning potential bias were addressed. Children who could cooperate with their parents and with the researchers, and those who agreed to participate were included (n = 302) in a preliminary study group for evaluation. In the first phase of the study, a questionnaire was administered to the children's parents/guardians through face-to-face interviews. In Part 1 of the questionnaire, data were collected in response to 14 questions concerning the family's socioeconomic status, the systemic medical history of the child, the parent's educational levels, and the family organization (Table 8). In Part 2 of the questionnaire, data were collected in response to the children's daytime and nighttime teeth clenching habits, in accordance with 2014 American Academy of Sleep Medicine (AASM) diagnostic criteria (Table 9)[35].

During intraoral examinations of patients referred to the Pedodontic Clinic of the Faculty of Dentistry of Erciyes University for clinical evaluation, 72 children with toothache, an inability to cooperate during the

Name of the child:
Contact phone number:
Child's age:
Child's sex:
Type of school the child attends? **a. Private School b. Public School**
What grade level is your child in?
Does your child have a current medical condition? **a. Yes b. No İf "yes" please explain:**
Is your child currently taking medication? **a. Yes b. No İf "yes" please explain:**
Mother's educational level **a. No education b. Primary school c. High school d. University e. Postgraduate**
Father's educational level **a. No education b. Primary school c. High school d. University e. Postgraduate**
Mother's occupation: Father's occupation:
Household income (monthly): **a. Low (≤314 Euros) b. Medium (315–629 Euros)** **c. High (630–1260 Euros) d. Very high (≥1260 Euros)**
Parental/marital status **a. Married b. Divorced c. Mother/father deceased d. Step-mother/father**

Table 8. Questionnaire part 1: Demographic, educational, and socioeconomic characteristics of the child and family.

Criteria A and B must be met	
A.	The presence of regular or frequent tooth-grinding sounds during sleep
B.	1. Abnormal tooth wear consistent with tooth grinding during sleep 2. Transient morning jaw muscle pain or fatigue, and/or temporal headache, and/or jaw locking upon waking, consistent with tooth grinding

Table 9. Diagnostic criteria for sleep bruxism (AASM 2014): individuals who Met criteria A and at least one criterion in B were considered Bruxism-positive[35].

examination, who were currently undergoing orthodontic treatment, or who had adenoid hypertrophy were excluded. To assess the relationships between bruxism and psychological factors more accurately, we excluded children with medical conditions such as allergic rhinitis, asthma, and upper respiratory tract diseases, as these conditions could contribute to bruxism. It was considered that physiological effects resulting from these conditions might lead to confusion in evaluating bruxism associated with psychological factors. The study continued with the clinical evaluation of 230 children. Clinical examinations were conducted by a single pediatric dentist with 6 years of clinical experience, blinded to the questionnaire results. During the oral examination, dental wear was assessed according to criteria B of the AASM[35]. An indication of sleep bruxism was recorded as the presence of wear areas in the form of shiny surfaces, protrusions, and grooves between surfaces in eccentric contact areas, including the buccal cusps of the upper jaw, lingual cusps of the lower jaw, cusps of the canines, and incisal edges of the incisors[69]. The results of the questionnaire and clinical evaluation according to criteria A and B in Table 9 indicated that children who met AASM criterion A and at least one of the criteria in B were considered bruxism positive. Among the 61 children who met these criteria, 49 (14 girls, 35 boys) agreed to participate in the study and formed a study group. For the control group (bruxism-negative), 49 children were randomly selected from among 169 whose parents had responded negatively to survey questions concerning both sleep and awake bruxism and who exhibited no intraoral findings indicative of sleep bruxism during the clinical examination, ensuring a match in age range and sex distribution with the study group. No other variables were used in the matching process. A formula created in Excel was used for randomization, and the investigators were blinded to who had been included or excluded. The methodology used to create the study and control groups is shown in Fig. 1. Owing to the distinction between children and adolescents in psychiatric assessments and between mixed dentition and permanent dentition at the age of 13 years, patients in the study and control groups were evaluated in two separate age ranges, namely, ages 6–12 and 13–17 years. Psychopathological signs and symptoms may vary owing to developmental and hormonal differences during childhood and adolescence[70]. Therefore, all evaluations were conducted comprehensively for patients within these two age ranges. All the obtained data were stored on a password-protected computer accessible only to the physicians involved in the study.

In both groups, the patients' psychological status assessments were conducted by a specialist psychiatrist at the Child and Adolescent Psychiatry Clinic through interviews with the children and their families. During the

Dependent variable	Bruxism	0, none
		1, present
Independent variable	Anxiety	0 = 0–7, minimal
		1 = 8–15, mild
		2 = 16–25, moderate
		3 = 26+, severe
Independent variable	Depression	0 = 0–19
		1 = 20+

Table 10. Categorical variables in the regression analysis.

interviews, the Children's Depression Inventory (CDI)[71] and the Beck Anxiety Inventory (BAI)[72] were used to determine the risk of depression and anxiety, respectively, in the children. For interviews with children aged < 12 years, at least one parent was required to be present during the session to better understand the child's emotional and psychological state and ensure an accurate evaluation. The analysis was also performed in a single-blinded manner to minimize bias in the results.

The CDI uses a self-reported scale to assess the severity of children's depressive symptoms. Applicable to children aged 6–17 years, this scale can be completed by a child either through self-reading or having someone else read it aloud. Evaluating the preceding two weeks, the CDI consists of 27 items, each offering three response options. Each child was asked to select the statement that best described them, with each item ranging in scores from 0 to 2 based on symptom severity, leading to a maximum possible score of 54. Higher total scores indicate greater severity of depressive symptoms. Oy[42] conducted a Turkish validity and reliability study of the CDI, which established a cutoff score of 19. Oy reported test-retest reliability of the CDI to be 0.70 and internal consistency to be 0.80. However, these scales are not diagnostic tools; rather, they are used in epidemiological studies. A score of ≥ 19 indicates that an individual is at risk of depression.

The BAI is a Likert-type self-report scale used to measure anxiety severity in children and adults. This scale consists of 21 items, with each item ranging in scores between 0 and 3, with the total score ranging from 0 to 63. A high total score indicates an individual's anxiety level. The scores obtained on the scale were evaluated as follows:

- 0–7 points: minimal anxiety or normal.
- 8–15 points: mild anxiety.
- 16–25 points: moderate anxiety.
- 26–63 points: severe anxiety.

In accordance with this scoring system, medical treatment is generally recommended for individuals with scores > 16 points. This inventory was developed by Beck et al.[42] in 1988 and adapted to Turkish by Ulusoy[73] in 1993. Ulusoy reported a Cronbach's alpha of 0.92 for internal consistency and a test–retest reliability coefficient of 0.75, indicating that the Turkish version of the BAI demonstrates high reliability. During the development of the Turkish version of BAİ cutoff points were analyzed, and it was determined that scores of ≥ 17 could distinguish anxiety that may require treatment with 90% accuracy. For this reason, discrimination was made on a 16-point scale by remaining faithful to the original scale, and discussions and comments were made in accordance with the Turkish version of the cutoff point, according to the population in which the study was conducted.

Statistical analysis

The statistical analyses of the findings obtained in the study were performed using SPSS 22.0 software. The statistical significance was set at $p < 0.05$. The parameters considered were the mean (M), standard deviation (± SD), and 95% confidence intervals (CIs). A chi-square test was used to determine the relationships between sleep bruxism and children's demographic characteristics. Kolmogorov–Smirnov and Shapiro–Wilk tests were used to examine whether the anxiety and depression scale scores followed a normal distribution. A Mann–Whitney U test was used to evaluate whether anxiety and depression levels in different age groups significantly differed on the basis of the presence of sleep bruxism. Logistic regression analysis results are presented with odds ratios (ORs) and 95% CIs. In addition to *p*-values, effect size (Cohen's *d*) calculations were performed for each independent variable. It has been suggested that a value of ≤ 0.2 should be considered a small effect, a value between 0.2 and 0.5 should be considered a medium effect, and a value of ≥ 0.8 should be considered a large effect[74]. The 95% CIs for effect size values are also reported to assess the reliability of our results. Categorical classifications of the variables used in the logistic regression analysis are presented in Table 10. Differences were considered statistically significant in the analyses.

Logistic regression modeling was conducted in the following three distinct stages:

Stage 1: All patients were evaluated as either having bruxism or not, and the effects of independent variables on the presence of bruxism were examined.

Stage 2: To examine the effects of independent variables on the dependent variables according to age group, the participants were divided into two age groups (6–12 and 13–17 years), and a separate logistic regression model was created for each age group.

Stage 3: This stage involved the incorporation of sex as a variable, with separate logistic regression models run for each sex within each age group. This stage sought to investigate the effect of the independent variables on the dependent variables for each sex across age groups.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available owing to ethical restrictions but are available from the corresponding author upon reasonable request.

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Conceptualization, E.B., M.A., Ş.S. ; methodology, E.B., M.A., Ş.S. ; software, E.B.; validation, E.B., M.A., Ş.S., P, D. ; formal analysis, E.B.; investigation, E.B.; resources, E.B.; data curation, E.B.; writing—original draft preparation, E.B., P.D.; writing—review and editing, E.B., M.A., Ş.S., P.D.; visualization, E.B., P, D. ; supervision, E.B., Ş.S., P.D.; project administration, E.B.; funding acquisition, E.B. All authors have read and agreed to the published version of the manuscript.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki and approved by the Clinical Research Ethics Committee of Erciyes University Faculty of Medicine (Ethics Committee No. 2019/268). Informed consent was obtained from all participants involved in this study.

Competing interests
The authors declare no competing interests.

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