Sleep Medicine 137 (2026) 106898

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Genetic and environmental influence on sleep bruxism in preschoolers: A twin study

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ARTICLE INFO

Keywords:
Sleep bruxism
Preschool children
Twins
Multilevel analysis
Heritability

ABSTRACT

Objectives: To evaluate the influence of genetic and environmental factors associated with SB and to compare the coincidence of SB diagnoses among monozygotic (MZ) and dizygotic (DZ) preschool twin pairs.
Methods: This was a cross-sectional census study conducted with preschool twins aged 3–5 years enrolled in public and private schools in Teresina, Brazil. Data were collected through questionnaires (socioeconomic status, general health conditions, sleep aspects, and zygosity) answered by parents and through clinical examinations. SB was assessed by positive parental reports combined with the presence of tooth wear on more than three teeth. Coincidence was analyzed using tetrachoric correlation and multinomial regression. Heritability was calculated using Holzinger's formula. Multilevel logistic regression was performed to identify factors associated with SB at the individual and pair levels ($p < 0.05$).
Results: A total of 219 twin pairs (n = 438) participated in the study. The prevalence of SB was 18.9 %. Attending a private school (OR = 3.02; IC95 % = 1.27–7.13), being male (OR = 2.05; IC95 % = 1.07–3.93), having bronchitis (OR = 3.32; IC95 % = 1.32–8.34), snoring (OR = 2.46; IC95 % = 1.28–4.71), being five years old (OR = 3.00; IC95 % = 1.27–7.03), and being a DZ twin (OR = 2.27; IC95 % = 1.06–4.67) increased the likelihood of SB ($p < 0.05$). MZ twin pairs showed a very strong correlation for SB (rMZ = 0.943) and a higher likelihood of diagnostic coincidence. The heritability estimate was 94 %.
Conclusion: The very strong correlation for SB among MZ twin pairs and the high heritability suggest a genetic influence on the development of SB.

1. Introduction

Sleep bruxism (SB) is defined as masticatory muscle activity that occurs during sleep, which can be characterized as rhythmic (phasic) or non-rhythmic (tonic), and it is not considered a movement or sleep disorder [1]. The prevalence of this condition ranges from 3.5 % to 49.6 % in childhood and from 8 % to 31.4 % in adults [2].

Some clinical manifestations of SB include tooth tissue loss [3], jaw pain [4], headaches, and impaired sleep quality [5]. Considering this scenario, SB can affect well-being and negatively impact individuals' quality of life [6].

However, SB does not have a clearly defined etiology; it is known to be regulated by the central nervous system and may be influenced by multifactorial aspects [2], involving psychological, biological, extrinsic, and hereditary factors [7,8]. Moreover, in children, it may be associated with respiratory problems [9], stress, anxiety, and excessive screen time [10,11].

The influence of genetic patterns and heredity has been evaluated in

Abbreviations: CI, confidence interval; DZ, dizygotic; MZ, monozygotic; OR, Odds Ratio; rMZ and rDZ, tetrachoric correlation; SB, sleep bruxism; H^2, Heritability; SNPs, Single Nucleotide Polymorphisms..

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https://doi.org/10.1016/j.sleep.2025.106898
Received 15 September 2025; Received in revised form 31 October 2025; Accepted 3 November 2025
Available online 4 November 2025

the development of bruxism, and genetic polymorphisms may be associated with this behavior in children [12]. Twin studies allow for estimating the genetic influence on the development of traits and assessing the impact of environmental factors on individuals [13].

Although previous studies have investigated this condition in twins, they have not specifically assessed the deciduous dentition [14–16]. Furthermore, there is a lack of information on this topic in the American continent. Therefore, the aim of this study was to evaluate the influence of genetic and environmental factors associated with SB and to compare the diagnostic coincidence of SB between mono and dizygotic preschool-aged twins.

2. Materials and methods

2.1. Study design

This is a cross-sectional study reported in accordance with STROBE Statement.

2.2. Ethical considerations

This study was approved by the Research Ethics Committee (protocol: 4.541.438) and conducted in accordance with the ethical principles of the Declaration of Helsinki and Resolution 466/2012 of the Brazilian National Health Council. The research was authorized by the Municipal Department of Education and Culture of Teresina, as well as by the administrations of each private school individually. Parents or legal guardians who consented to the preschoolers' participation signed an informed consent form.

2.3. Study population and sample

This census-based study included all children aged 3–5 years, born from twin pregnancies, and enrolled in public and private preschools in the city of Teresina, Piauí, Brazil, in 2024, along with their parents or legal guardians.

According to the National System of Live Birth Information, 672 live births from twin pregnancies (336 twin pairs) were registered in the city of Teresina-PI between 2018 and 2021 [17].

The preschool population consists of 23,421 individuals, and the enrollment rate for this group is 98.8 % [18]. According to data from the National Institute for Educational Studies and Research Anísio Teixeira, there are 296 active preschool institutions in Teresina, located in both urban and rural areas [19].

2.4. Inclusion and exclusion criteria

This study included monozygotic and dizygotic twin pairs aged 3–5 years, enrolled in public and private preschools in Teresina, Piauí, with complete deciduous dentition, whose parents consented to participation through an informed consent form. Pairs were excluded if at least one twin used medications acting on the central nervous system (anticonvulsants, antipsychotics), had disabilities (cerebral palsy, hydrocephalus), syndromes and/or neurological conditions (Down syndrome, epileptic seizures), used fixed orthopedic appliances that prevented examination, or had incomplete questionnaires.

2.5. Calibration

Four examiners were trained and calibrated in three stages using image projection [20]./, conducted by a pediatric dentist experienced in epidemiological studies, and consisted of slide presentations outlining the clinical criteria for detecting tooth wear due to attrition [21] (duration: 2 h). In the second stage (duration: 2 h), images of tooth wear by attrition with varying severities were shown, along with images of other conditions such as erosive tooth wear for differential diagnosis. The examiners then made diagnoses according to the previously presented criteria. Next, the clinical form to be used was presented, and the clinical examination routine was explained [22]. After one week, the photographs were shown again, and the examiners were required to achieve at least 80 % accuracy to obtain favorable agreement.

Inter-examiner agreement was calculated using Cohen's *kappa* coefficient (examiner 1 = 0.865; examiner 2 = 0.800; examiner 3 = 0.931; examiner 4 = 0.931). After 15 days, the same clinical cases were presented again, and intra-examiner agreement was calculated (examiner 1 = 0.865; examiner 2 = 0.863; examiner 3 = 0.863; examiner 4 = 0.861).

2.6. Pilot study

A pilot study was conducted with 16 non-twin children and their guardians at the Children's Clinic of the Federal University of Piauí to evaluate the study methodology. No changes to the initially proposed methodology were necessary.

2.7. Data collection

Data collection was carried out in two phases between January and August 2024. First, parents or guardians completed a questionnaire covering socioeconomic and demographic aspects, general health conditions, and the habit of grinding teeth, as well as a zygosity questionnaire. In the second phase, the preschool children underwent clinical examinations, and the data were recorded on individual clinical forms developed for the study.

2.7.1. Non-clinical data

To locate the twins, all public and private preschools in Teresina, Piauí, were contacted (by phone or in person) to request authorization from the institution administrators. After authorization, a visit was made to the school, and socioeconomic and demographic questionnaires, health condition forms, questionnaires on sleep behavioral disorders and zygosity, as well as the informed consent form were delivered to be sent to the parents or guardians of the preschool children, requesting their authorization for inclusion in the study.

Socioeconomic, demographic, and general health conditions questionnaire to parents or guardians was developed by the authors based on items from previously published instruments. It included objective questions to obtain information about sex, age (in years), family income (categorized based on the Brazilian monthly minimum wage), mother's education level (in years of formal study), frequency of teeth grinding habits in children, sleep routine (restless sleep, headache upon waking, sleep environment, activities performed) and health problems (psychiatric, neurological and respiratory problems). In addition, parents were asked about the presence of sleep bruxism in themselves.

Zygosity was assessed using a questionnaire developed by Christeansen et al. (2003), translated into Brazilian Portuguese and adapted for use with parents or guardians by Ferreira et al. (2022) [23]. This questionnaire contains four questions and was answered by the children's guardians, covering physical similarities and identity confusion [24]. Twin pairs were classified as: a) monozygotic; b) dizygotic; or c) unknown zygosity.

2.7.2. Clinical data

Before dental examination, teeth were cleaned using a toothbrush and fluoride toothpaste. Clinical examinations were conducted by previously trained and calibrated examiners, assisted by trained recorders responsible for filling out the forms. Each child was examined individually in a private classroom at the preschool, in a simplified position (examiner seated and the child's head resting on the examiner's lap). In order to do it, artificial light was used with a flashlight (Caerus, 12V, white light), a flat mouth mirror (Duflex, SS White, Rio de Janeiro, Brazil), a ball-ended probe as recommended by the World Health Organization (WHO-621, Trinity, Campo Mourão, Brazil), and a dry field

maintained with cotton rolls and/or sterile gauze pads.

The assessment of sleep bruxism was based on attrition tooth wear observed on clinical examination (clinically based) combined with parental reports of teeth grinding during sleep (subject-based) [1]. Tooth wear was analyzed on the surfaces involved in occlusion (canines and molars) (Smith and Knight, 1984). An adapted grading scale from 0 to 2 was used, where: grade 0 = sound tooth (no loss of enamel characteristics); grade 1 = loss of enamel surface characteristics; grade 2 = visible wear with dentin exposure [25,26]. Sleep bruxism was considered present when parents reported teeth grinding during sleep and tooth wear was observed on three or more teeth [27].

Children requiring dental treatment were referred to the Pediatric Dentistry Clinic at UFPI.

2.8. Statistical analysis

Statistical analysis was performed using Jamovi software version 2.6.19 (Jamovi, Sydney, Australia). Descriptive analyses were conducted to obtain absolute and relative frequencies of the data and to characterize monozygotic (MZ) and dizygotic (DZ) twins. Sleep bruxism, the dependent variable, was dichotomized as absence or presence of the condition. Pearson's chi-square and/or Fisher's exact tests were applied.

To assess the association of variables related to sleep bruxism (SB), univariate and multiple multilevel logistic regression analyses were conducted, considering two levels: child (1st level) and twin pair (2nd level). Initially, univariate multilevel regression was performed to evaluate the association between variables at both levels and SB. Odds ratios (OR) and their respective 95 % confidence intervals (95 % CI) were calculated. Variables with a significance level of $p \leq 0.20$ in the univariate analysis, as well as those with theoretical importance, were tested in the construction of the multiple model, where only variables with p-values <0.05 were retained. For all analyses, a significance level of 5 % ($p < 0.05$) was considered.

The diagnostic similarities of sleep bruxism (SB) in monozygotic (MZ) and dizygotic (DZ) twin pairs were evaluated by calculating the tetrachoric correlation (rMZ and rDZ). The correlation coefficient (r) ranges from −1 to +1 and is classified as negative (−) or positive (+), very weak ($|r|<0.20$), weak ($0.20\leq|r|<0.40$), moderate ($0.40\leq|r|<0.60$), strong ($0.60\leq|r|<0.80$), or very strong ($|r|\geq0.80$). Higher rMZ values compared to rDZ indicate a possible greater genetic effect on the presence of the condition [28].

Heritability (H^2) is the proportion of phenotypic variance that can be explained by genetic factors [13]. The calculation of H^2 for sleep bruxism (SB) was determined using Holzinger's formula (1929): (rMZ – rDZ)/(1 – rDZ). H^2 values range from 0 to 1, with values closer to 1 indicating a greater genetic influence on the condition [29].

The analysis of environmental factors simultaneously affecting the twin pair was conducted considering the coincidence of sleep bruxism (SB) diagnoses. This variable was categorized as: different diagnoses within the pair, no coincidence (1st case); both twins without SB, negative coincidence (2nd case); and both twins with SB, positive coincidence (3rd case). Bivariate and multivariate multinomial logistic regression analyses were performed, yielding odds ratios (OR) and 95 % confidence intervals (95 % CI).

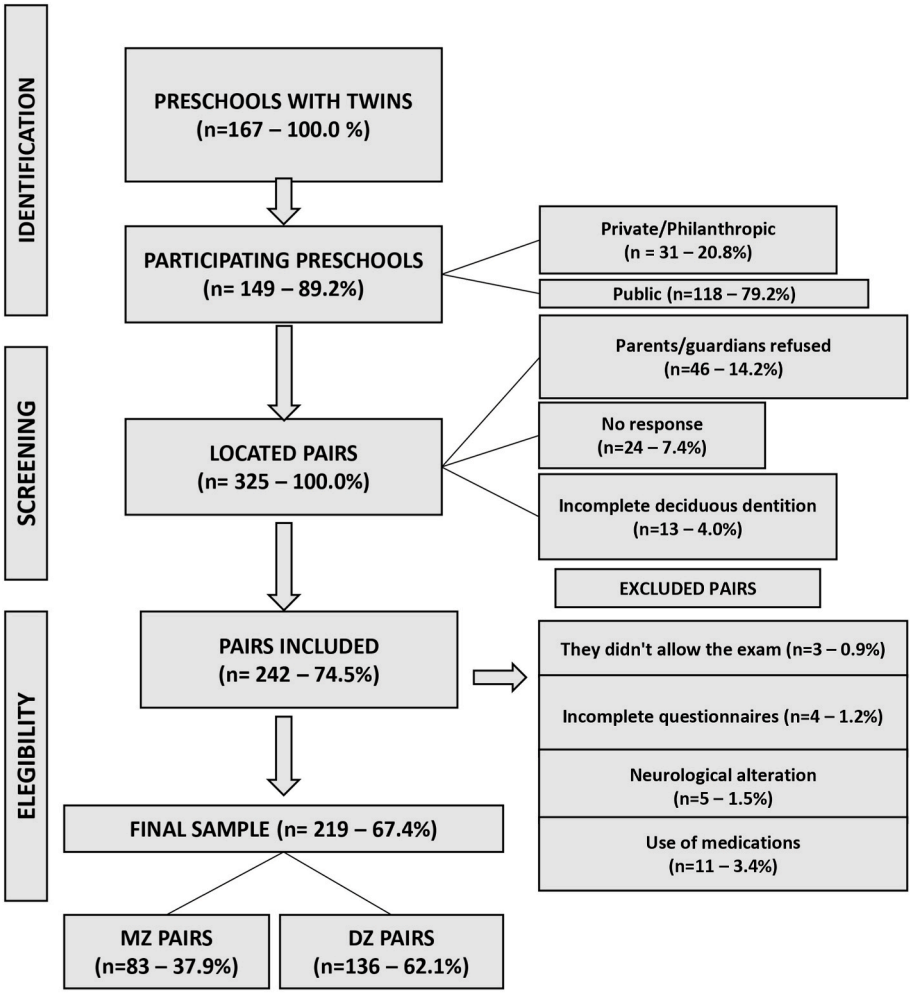

Fig. 1. Sample composition flowchart.

3. Results

In 2024, there were 296 preschools in Teresina, of which 194 were public and 102 were private. A total of 325 pairs of twins aged three to five years were identified and screened for eligibility. This study included 219 pairs of twins (438 preschoolers) enrolled in 149 preschools (118 public and 31 private), along with their parents/guardians (Fig. 1). The socioeconomic and demographic characteristics of the sample are described in Table 1. The prevalence of sleep bruxism (SB) among the twin preschoolers was 18.9 %, being higher in dizygotic (DZ) twins (p = 0.034). This group of twins also showed higher family income (p = 0.005) and higher maternal education level (p = 0.001).

In final adjusted multilevel model, sleep bruxism was associated with male child (OR = 2.05; 95 % CI = 1.07–3.93), attending a private school (OR = 3.02; 95 % CI = 1.27–7.13), having bronchitis (OR = 3.32; 95 % CI = 1.32–8.34), and snoring (OR = 2.46; 95 % CI = 1.28–4.71). Moreover, dizygotic (OR = 2.27; 95 % CI = 1.06–4.67) and five year-old child (OR = 3.00; 95 % CI = 1.27–7.03), also had a higher chance of having sleep bruxism (Table 2).

Monozygotic twin pairs showed a very strong positive correlation for the presence of SB (rMZ = 0.943; 95 % CI = 0.912–0.962). However, the same was not observed in dizygotic twins (rDZ = 0.0342; 95 % CI = −0.135 – 0.201) (p < 0.001). According to the heritability value, 94 % of the phenotypic differences between individuals can be explained by genetic factors (Table 3).

Descriptive analysis of the coincidence of SB diagnosis and factors related to twin pairs are presented in Table 4. In the final adjusted multinomial logistic regression model, it was observed that monozygotic twin pairs had a higher likelihood of positive coincidence (OR = 12.21; 95 % CI = 3.09–48.24) and negative coincidence (OR = 7.71; 95 % CI = 2.94–21.59) compared to dizygotic twin pairs. It was also observed that twin pairs whose father and/or mother did not report SB had a higher likelihood of negative coincidence (OR = 2.99; 95 % CI = 1.44–6.19) (Table 5).

Table 1
Socioeconomic and demographic characteristics of monozygotic and dizygotic twins (n = 438).

Variables	Zigosity		n (%)	p-value
	Monozygotic n (%)	Dizygotic n (%)		
Sex				0.089
Male	74 (33.9)	144 (66.1)	218 (49.8)	
Female	92 (41.8)	128 (58.2)	220 (50.2)	
Age				0.376
3	56 (39.4)	86 (60.6)	142 (32.4)	
4	48 (33.3)	96 (66.7)	144 (32.9)	
5	62 (40.8)	90 (59.2)	152 (34.7)	
Type of preschool				0.081
Public	138 (40.0)	207 (60.0)	345 (78.8)	
Private	28 (30.1)	65 (69.9)	93 (21.2)	
Answered the questionnaire				0.102
Mother	158 (38.9)	248 (61.1)	406 (92.8)	
Father	2 (12.5)	14 (87.5)	16 (3.6)	
Other	6 (37.5)	10 (37.5)	16 (3.6)	
Family income (minimum wages)[a]				**0.005**
≤2	136 (41.7)	190 (58.3)	326 (74.4)	
>2	30 (26.8)	82 (73.2)	112 (25.6)	
Maternal education (years of formal education)				**0.001**
≤12	54 (51.9)	50 (48.1)	104 (23.7)	
>12	112 (33.5)	222 (66.5)	334 (76.3)	
Other siblings				0.958
No	46 (37.7)	76 (62.3)	122 (27.9)	
Yes	120 (38.0)	196 (62.0)	316 (72.1)	
General health problems				0.208
No	148 (37.0)	252 (63.0)	400 (91.3)	
Yes	18 (47.4)	20 (52.6)	38 (8.7)	
Respiratory problems				0.186
No	137 (36.6)	237 (63.4)	374 (85.4)	
Yes	29 (45.3)	35 (54.7)	64 (14.6)	
Sleep in the same room as your parents				0.646
No	56 (33.7)	86 (31.6)	141 (32.4)	
Yes	110 (66.3)	186 (68.4)	296 (67.6)	
Sleep bruxism				**0.034**
No	143 (40.3)	212 (59.7)	355 (81.1)	
Yes	23 (27.7)	60 (72.3)	83 (18.9)	
Total	166 (100.0)	272 (100.0)	438 (100.0)	

Pearson'n Chi-square test.
[a]Minimum wage in 2024 = US$266,00. The average monthly salary of formal workers in Teresina is 2.6 times the minimum wage (IBGE, 2024).

4. Discussion

This was the first study conducted on the American continent that assessed sleep bruxism in the primary dentition of preschool twins, in addition to determining heritability and performing multilevel analysis. Previous studies with twin samples of similar age groups have evaluated SB; however, they did not estimate the proportion of genetic influence on this condition or discuss the associated environmental factors [15,16].

The prevalence of SB in this study (18.9 %) was higher than that observed in preschool twins of the same age group (13.5 %) [16]. However, in other studies with non-twin children, it was similar to that found by Gao et al. (2023) and lower than the prevalence rates reported in previous studies [7,9,30–32]. These differences may be due to the various locations in which the studies were conducted and the different diagnostic criteria applied for SB.

In the present study, although the prevalence of SB was higher among DZ individuals, MZ twin pairs showed greater chances of both negative and positive diagnostic coincidence. Previous studies have observed higher chances of similarities among identical twins and suggest the involvement of genetic effects in the development of SB [33–38].

The high correlation value in the MZ group and the heritability of this condition strengthen the hypothesis that a large percentage of individual differences related to SB can be explained by genetics [13]. Single Nucleotide Polymorphisms (SNPs) related to genes in serotonergic and dopaminergic pathways [39], as well as muscle metabolism genes, may be associated with bruxism in adults [12]. SNPs rs6313 and rs2770304 in the HTR2A gene, involved in low serotonin expression, have been associated with bruxism [40,41]. The serotonin pathway regulates the circadian cycle, maintains neuronal excitation, controls muscle tone, and is involved in the stress and anxiety response, which are factors that may predispose individuals to episodes of teeth grinding or clenching and help to understand its physiopathology [40,41].

In this context, the rs10193179 polymorphism, linked to the Myosin IIIB gene, has been associated with SB; this variant is associated with higher levels of SP5 gene expression. In mice, this gene is associated with increased grip strength and hyperactivity, mechanisms that are part of the pathophysiology of SB [42]. Furthermore, the ACTN3 gene, which encodes proteins expressed in muscle fibers, can be affected by SNPs rs678397, rs1671064, and rs1815739 [12]. Since SB involves masticatory muscle movements occurring during sleep, these polymorphisms in the ACTN3 gene have been associated with SB in a study conducted with children [12]. It is important to emphasize that genetic factors do not act in isolation and environmental factors should also be considered [28].

Twin pairs whose father and/or mother did not report teeth grinding during sleep had a higher chance of negative diagnostic coincidence for SB. A systematic review with meta-analysis reported that when parents have bruxism, the likelihood of their child having bruxism is higher, which may be attributed to autosomal dominant inheritance [43]. Beyond this hereditary factor, the family environment can also influence aspects of SB; for example, maternal anxiety may increase the chances of children exhibiting this behavior [11,44].

Regarding individual factors, being male and five years old increased the risk of SB. The literature is controversial about the influence of sex

Table 2
Multilevel model of factors associated with sleep bruxism in preschool twins (n = 438).

	Sleep bruxism		Unadjusted OR (95 % CI)	p	Adjusted OR (95 % CI)	p
	Present	Absent				
Variables related to the 1st level - child (n=438 individuals)	**n%**	**n%**				
Type of preschool						
Public	57 (16.5)	288 (83.5)	1		1	
Private	26 (28.0)	67 (72.0)	**2.33 (1.05–5.13)**	**0.036**	**3.02 (1.27–7.13)**	**0.012**
Sex						
Female	32 (14.5)	188 (85.5)	1		1	
Male	51 (23.4)	167 (76.6)	**2.41 (1.20–4.83)**	**0.013**	**2.05 (1.07–3.93)**	**0.030**
General health problems						
No	73 (18.3)	327 (81.8)	1			
Yes	10 (26.3)	28 (73.7)	1.78 (0.62–5.10)	0.282		
Psychological problem						
No	78 (19.2)	329 (80.8)	1			
Yes	5 (16.1)	26 (83.9)	0.69 (0.19–2.46)	0.578		
Respiratory problem						
No	62 (16.6)	312 (83.4)	1			
Yes	21 (32.8)	43 (67.2)	**2.72 (1.20–6.13)**	**0.016**		
Bronchitis						
No	64 (16.4)	327 (83.6)	1		1	
Yes	19 (40.4)	28 (59.6)	**4.34 (1.72–10.94)**	**0.002**	**3.32 (1.32–8.34)**	**0.010**
Sinusitis						
No	57 (16.1)	296 (83.9)	1			
Yes	26 (30.6)	59 (69.4)	**2.73 (1.26–5.93)**	**0.011**		
Snore						
No	30 (13.3)	196 (86.7)	1		1	
Yes	53 (25.0)	159 (75.0)	**2.53 (1.31–4.90)**	**0.006**	**2.46 (1.28–4.71)**	**0.006**
Practice activity						
No	41 (16.8)	203 (83.2)	1		1	
Artistic/Sports	17 (16.0)	89 (84.0)	0.88 (0.38–2.02)	0.764	0.21 (0.20–1.32)	0.173
Domestic	25 (28.4)	63 (71.6)	**2.34 (1.01–5.44)**	**0.047**	1.91 (0.85–4.29)	0.116
Variables related to the 2nd level - pair (n=438 individuals)						
Age (in years)						
3	16 (11.3)	126 (88.7)	1		1	
4	28 (19.4)	116 (80.6)	1.95 (0.82–4.63)	0.126	1.71 (0.70–4.14)	0.231
5	39 (25.7)	113 (74.3)	**3.11 (1.33–7.27)**	**0.009**	**3.00 (1.27–7.03)**	**0.012**
Maternal education (years of formal education)						
<12 anos	9 (8.7)	95 (91.3)	1			
≥12 anos	74 (22.2)	260 (77.8)	**3.33 (1.33–8.34)**	**0.010**		
Zigosity						
Monozygotic	23 (13.9)	143 (86.1)	1		1	
Dizygotic	60 (22.1)	212 (77.9)	**2.28 (1.05–4.93)**	**0.036**	**2.27 (1.06–4.67)**	**0.034**
Father and/or mother with SB						
No	43 (13.6)	273 (86.4)	1			
Yes	40 (32.8)	82 (67.2)	**4.05 (1.92–8.56)**	**<0.001**		
Total	**83 (18.9)**	**355 (81.1)**				

OR: *odds ratio*; 95 % CI = 95 % Confidence Interval.

Table 3
Heritability and correlations of sleep bruxism (SB) in monozygotic (MZ) and dizygotic (DZ) twin pairs.

	Zigosity		p	Total
	Monozygotic rMZ (IC95 %)	Dizygotic rDZ (IC95 %)		
n pairs (%)	**83 (37.9)**	**136 (62.1)**		**219 (100.0)**
Presence of SB	0.943 (0.912–0.962)	0.0342 (−0.135–0.201)	**<0.001**	
Heritability (H^2) – presence of SB	–	–		0.940

rMZ – tetrachoric correlation in the monozygotic group; rDZ – tetrachoric correlation in the dizygotic group; CI 95 %–95 % confidence interval.

on the presence of this behavior. Contrary to this result, a cross-sectional study observed that being female was associated with SB [45]. However, other studies found a stronger association with male children [5,32,44,46]. Concerning the age group with higher prevalence, this corroborates a study that found an association with the age range of five to seven years [47]. This may suggest that the physiological factors characterizing SB can be influenced by changes in brain activities of children during their development [47].

In the present study, preschool twins with bronchitis and who snore during sleep had a higher prevalence of SB, corroborating the literature [9,11,43,47]. Respiratory problems that cause airway obstruction reduce the amount of oxygen available to the individual, consequently activating the central nervous system and favoring episodes of SB [43]. Additionally, snoring associated with masticatory muscle activity during sleep may occur during obstructive sleep apnea episodes with the purpose of restoring airway patency [11,47,48]. Based on these results and evidence from other studies, a possible influence of these factors on the child's sleep is suggested.

Table 4
Descriptive analysis of diagnostic coincidence of SB and related factors in twin pairs (n = 219).

Variables	Coincidence			n (%)	p value
	No coincidence n (%)	Negative coincidence n (%)	Positive coincidence n (%)		
Zigosity					**<0,001**
Monozygotic	5 (6.0)	69 (83.1)	9 (10.8)	83 (37.9)	
Dizygotic	47 (34.6)	82 (60.3)	7 (5.1)	136 (62.1)	
Age					0.095
3	21 (27.6)	46 (60.5)	9 (11.8)	76 (34.7)	
4	16 (22.2)	50 (69.4)	6 (8.3)	72 (32.9)	
5	15 (21.1)	55 (77.5)	1 (1.4)	71 (32.4)	
Family income (minimum wages)[a]					0.263
≤2	36 (22.1)	117 (71.8)	10 (6.1)	163 (74.4)	
>2	16 (28.6)	34 (60.7)	6 (10.7)	56 (25.6)	
Maternal education (years of formal education)					**0.020**
<12	6 (11.5)	44 (84.6)	2 (3.8)	52 (23.7)	
≥12	46 (27.5)	107 (64.1)	14 (8.4)	167 (76.3)	
Father and/or mother with SB					**<0.001**
No	30 (19.0)	121 (76.6)	7 (4.4)	158 (72.1)	
Yes	22 (36.1)	30 (49.2)	9 (14.8)	61 (27.9)	
Total	**52 (23.7)**	**151 (8.9)**	**16 (7.3)**	**219 (100.0)**	

Multinomial logistic regression.
[a]Minimun wage in 2024 = US$266,00.

Table 5
Factors associated with diagnostic coincidence of SB in twin pairs (n = 219).

Coincidences (ref: non-coincidents pairs)								
	Positive (n = 16)		Positive (n = 16)		Negative (n = 151)		Negative (n = 151)	
	Unadjusted OR (95 % CI)	p	Adjusted OR (95 % CI)	p	Unadjusted OR (95 % CI)	p	Adjusted OR (95 % CI)	p
Zigosity								
Monozygotic	**12.08 (3.12–46.66)**	**< 0.001**	**12.21 (3.09–48.24)**	**< 0.001**	**7.70 (2.90–20.43)**	**< 0.001**	**7.97 (2.94–21.59)**	**< 0.001**
Dizygotic	**1**		**1**		**1**		**1**	
Age								
3	0.15 (0.01–1.36)	0.093	0.16 (0.01–1.53)	0.114	1.67 (0.77–3.61)	0.189	1.71 (0.74–3.96)	0.204
4	0.87 (0.25–2.96)	0.831	1.12 (0.31–4.05)	0.860	1.42 (0.66–3.06)	0.361	1.60 (0.70–3.66)	0.260
5	1		1		1		1	
Family income (minimum wages)[a]								
≤2	1				1			
>2	1.35 (0.41–4.35)	0.616			0.65 (0.32–1.31)	0.235		
Maternal education (years of formal education)								
<12	1				**1**			
≥12	0.91 (0.16–5.03)	0.917			**0.31 (0.12–0.79)**	**0.014**		
Father and/or mother with SB								
No	0.57 (0.18–1.76)	0.330	0.59 (0.18–1.96)	0.388	**2.95 (1.49–5.83)**	**0.002**	**2.99 (1.44–6.19)**	**0.003**
Yes	1		1		**1**		**1**	

Ref: Reference level; OR: odds ratio; 95 % CI = 95 % confidence interval.
[a] Minimum wage in 2024 = US$266,00.

Attending a private preschool was also associated with SB, a result similar to that found by Córtese et al. (2024), but different from a study with Colombian children [10]. This may be explained by the fact that children attending private schools mostly belong to families with higher socioeconomic status, which may be related to an environment with more activities, demands, and pressures compared to children from lower-income families [49].

This study has a cross-sectional design and presents memory bias and data collection instrument bias as some of its limitations. However, protocols for cross-sectional studies were followed, validated questionnaires were used, and examiners were previously trained and calibrated. The heritability calculation using formulas simplifies the evaluation performed, suggesting the use of more complex analyses to assess factors that may also determine phenotypic variance.

The sample is census-based, aiming to provide reliable data on the twin population of Teresina. Additionally, a low non-response rate was achieved. The SB assessment was performed through clinical examination combined with parental reports. Despite the low accuracy of the subject-based assessment, most preschool twins and their parents slept in the same room, increasing the reliability of the reports. Statistical analysis was robustly conducted to evaluate factors associated both with the individual and the pair using multilevel regression.

The results of this study indicate that genetics has a strong influence on the development of SB. Based on this knowledge, it is possible to provide more targeted monitoring and management of this behavior in children and their families, since it is not possible to dissociate genetic characteristics from the environment in which the individual is embedded. Therefore, it is important that parents or guardians have self-awareness by recognizing the clinical consequences of SB (tooth wear, headaches, and facial pain) in themselves and consequently in their children. In this way, the etiological factors associated with this condition can be identified, and appropriate multidisciplinary management can be provided to minimize these consequences.

5. Conclusion

A very strong correlation for the presence of SB in MZ twins and high heritability suggest a genetic influence in the development of SB. Male individuals, enrolled in private preschools, aged five years, with bronchitis, who snore during sleep, and DZ twins have a higher chance of

having SB. MZ pairs have a greater chance of coincidents diagnoses. Pairs whose parents do not have SB, who show a higher chance of negative diagnostic coincidence.

CRediT authorship contribution statement

Maria Eduarda Matos Sousa: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Francisca Aline da Silva Matias-Santos:** Writing – review & editing, Methodology, Investigation, Data curation. **Letícia Caminha Aguiar Lopes:** Writing – review & editing, Methodology, Investigation, Data curation. **Viviane Oliveira do Nascimento:** Writing – review & editing, Methodology, Investigation, Data curation. **Lúcia de Fátima Almeida de Deus Moura:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Fausto Medeiros Mendes:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Marcoeli Silva Moura:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Marina de Deus Moura Lima:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Cacilda Castelo Branco Lima:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization.

Nonfinancial disclosure

None.

Financial disclosure

None.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We acknowledge the Fundação de Amparo à Pesquisa do Piauí (FAPEPI), Universidade Federal do Piauí (UFPI), and the Postgraduate Program in Dentistry at the Federal University of Piauí (PPGO - UFPI) for their support in developing the research.

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