SCIENTIFIC INVESTIGATIONS

Study of Associated Factors With Probable Sleep Bruxism Among Adolescents

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Study Objectives: To evaluate the prevalence of probable sleep bruxism (SB) and its association with sleep features, orthodontic fixed appliance wearing, and extraoral and intraoral clinical signs and symptoms in a population of adolescents.

Methods: Two hundred thirty-nine 12-year-old adolescents enrolled in private and public schools in Brumadinho, southeast Brazil, and their parents were invited to participate. They answered a questionnaire containing information regarding adolescents' sleep features and history of SB. Extraoral and intraoral examination was performed to identify some clinical signs (ie, absence of lip competence, presence of mouth breathing, clicks in the temporomandibular joint [TMJ], tooth wear) and symptoms (ie, pain in the masseter muscle upon palpation), and ongoing orthodontic treatment with fixed appliances. Parental report and clinical examination were used to determine probable SB. Descriptive statistics and logistic regression were performed to identify association of probable SB with independent variables.

Results: Of 239 adolescents initially selected, 231 (96.6%) participated in the study. Prevalence of probable SB was 16.9%. Adolescents who snored during sleep (odds ratio [OR] = 3.14; 95% confidence interval [CI] = 1.47–6.70), adolescents who did not have clicks in the TMJ (OR = 3.37; 95% CI = 1.11–10.15), and those who wore orthodontic appliances (OR = 2.72; 95% CI = 1.04–7.14) were more likely to be in the group with probable SB.

Conclusions: Snoring, absence of clicks in the TMJ, and fixed appliance wearing were associated with probable SB among adolescents. This study adds to the ongoing research on SB in adolescents and its associated factors.

Commentary: A commentary on this article appears in this issue on page 1281.

Keywords: adolescent, bruxism, epidemiology, orthodontic appliance, sleep, temporomandibular joint disorders

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BRIEF SUMMARY

Current Knowledge/Study Rationale: Knowledge regarding sleep bruxism (SB) and its associated factors among adolescents is still poor, especially because most studies are based only on self-report. Sleep habits and temporomandibular disorders are frequently associated factors; an association with orthodontic appliance use was hypothesized in a preliminary study.

Study Impact: This study presents further data on factors that may be associated with probable SB in 12-year-old adolescents; adolescents who snored during sleep, those who did not have clicks in the temporomandibular joint when opening and closing the mouth, and those wearing fixed orthodontic appliances had more chance of being in the group with probable SB. Further research is needed to refine these findings and find a possible biological explanation.

INTRODUCTION

Sleep bruxism (SB) is defined as a repetitive jaw-muscle activity that occurs during sleep, characterized by clenching or grinding the teeth and/or by bracing or thrusting of the mandible.¹ It can be categorized as: “possible,” based on self-report; “probable,” based on self-report plus a clinical examination, or “definite,” based on self-report, clinical examination, and polysomnographic recording.¹ According to previous studies, the prevalence of SB among adolescents ranges from 9.2% to 15.0% across different populations.^{2,3} However, such data are not definitive, because they are based on some studies that did not clearly discriminate between children and adolescents^{2,4,5} and, more importantly, on some

other studies that rely only on a self-reported approach to SB assessment.^{2,3,6,7}

SB is a multifactorial phenomenon^{8,9} that may have clinical consequences such as tooth wear, exacerbation of temporomandibular disorders (TMD), headaches, muscle ache, and dental filling fractures.^{10–12} Research is now focused on the associated factors that play a role in the pathophysiology of SB. Sleep features such as sleep duration and quality, environmental interference, and snoring are frequently associated with SB in youngsters.^{2,13,14} TMD have also been frequently reported in association with SB in adults,¹⁵ but their relationship in adolescents seems to be still controversial and unclear.^{16,17} Extraoral factors, such as lip incompetence (diagnosed when the individual cannot keep the upper and lower lips in contact or by doing it only if the

Figure 1—Clinical characteristics of tooth wear by attrition.

orbicular muscle is contracted)¹⁸ and mouth breathing, can also be considered associated factors.¹⁹ In addition, a previous study evaluating the prevalence of SB before and during interceptive orthodontic treatment found an association between the type of orthodontic treatment and SB among children and adolescents.²⁰

Adolescence is a peculiar period of life, during which physical and behavioral changes occur, and individuals wish to be recognized and to assert themselves among their peers.²¹ The expectations and the uncertainty that typically take place during this period in life may work as a trigger for SB.²² Awareness of the determinants of SB may assist health professionals in the recognition of the condition among young individuals. However, the literature has acknowledged that the assessment of associated factors for SB among adolescents has been under-investigated thus far.²³

Therefore, the current study aimed to evaluate the prevalence of probable SB (ie, based on parental report plus clinical examination) among adolescents and to evaluate its association with a number of variables, including some sleep features and orthodontic fixed appliance wearing as well as some extraoral and intraoral signs/symptoms.

METHODS

Study Sample and Inclusion Criteria

The current study was carried out on 12-year-old adolescents enrolled at all schools (14 public and 2 private) in Brumadinho between August and December 2016. The city is located in southeast Brazil and has approximately 33,973 inhabitants (<http://www.censo2010.ibge.gov.br/>). A total of 538 12-year-old adolescents were enrolled in all 16 schools during the second semester of 2016.

The sample consisted of individuals aged 12 years, based on the recommendations of the World Health Organization (WHO) which considers it as the global indicator age group for international comparisons and surveillance of disease trends among adolescents (WHO 2015). Moreover, by this age, all permanent teeth except the third molars are usually erupted.

Adolescents' parents/caregivers were also invited to participate. Once they accepted, both the adolescents and the parents/

Figure 2—Clinical characteristics of tooth wear by erosion.

caregivers signed an informed consent form. All participants had to be literate, and no adolescents had cognitive disorders or syndromes. Information regarding adolescents' health was provided by their parents/caregivers, and confirmation of the adolescents' literacy was based on reports from teachers in the schools. Parents and adolescents who did not fill out all data correctly were excluded.

Sample Size Calculation

The minimum sample size was calculated by taking into account a 95% confidence interval (CI), a 5% standard error, and 15.3% prevalence of possible SB.²⁴ The calculation determined a minimum sample size of 199 adolescents. Considering the possible losses, the final sample size was increased by 20% to 239. Among the 538 adolescents enrolled in all schools in Brumadinho, 239 were randomly invited to participate in the study using a simple random selection process.

Ethical Issues

Ethical approval was obtained from the Human Research Ethics Committee of the Federal University of Minas Gerais, Brazil (protocol #54989816.3.0000.5142). All participants and parents/caregivers were informed through the consent form about the objectives of the study, examination procedures, and assurance of confidentiality.

Calibration Process

Two examiners were trained and calibrated by a researcher with clinical experience in this area. Calibration procedures concerned the identification of tooth wear and some clinical signs (ie, temporomandibular joint [TMJ] click and lip incompetence) and symptoms (ie, masseter muscle pain with palpation).

In a theoretical phase, photographs were used to discuss the criteria used to proceed with the differential diagnosis between tooth wear by attrition (loss of dental tissue by excessive attrition of one tooth against another)²⁵ (**Figure 1**) and by erosion (loss of dental tissue by extrinsic and intrinsic chemical sources without bacterial involvement)²⁶ (**Figure 2**). The kappa coefficient value for interexaminer agreement was 0.780, indicating substantial agreement.²⁷ Following the theoretical

phase, clinical examination to identify the presence or absence of tooth wear by attrition was then conducted. During the clinical calibration session, the two examiners were also calibrated for evaluation of the presence of pain in the masseter muscle upon palpation, lip incompetence, mouth breathing, and clicks/deflection in the TMJ when opening and closing the mouth.¹⁹ Seven adolescents were examined to assess interexaminer agreement. These individuals were re-examined after 2 weeks for the determination of intraexaminer agreement. The kappa coefficient values for both interexaminer and intraexaminer concordance showed substantial agreement for all the parameters under investigation (> 0.750).²⁷

Data Collection

The instruments used for data collection were self-administered questionnaires addressed to parents/caregivers and adolescents, and a clinical examination of adolescents performed by two researchers.

Questionnaires

Parents/caregivers answered a questionnaire containing 16 questions regarding their demographic and socioeconomic characteristics (eg, date of birth, sex, address, educational level, and family's minimum wage) as well as information regarding the adolescents' sleep features (eg, sleep duration, sleeping position, history of drooling and snoring), medical history, history of audible tooth grinding at night, and history of muscle pain in the TMJ area.

Adolescents answered a survey with three questions, regarding their personal information (sex and date of birth) and history of tooth clenching during wakefulness (awake bruxism).

Clinical Examination

After answering the questions, the adolescents were clinically examined by one of the two calibrated examiners, whereas the other one wrote down the results and observations. Both researchers used appropriate equipment for individual protection during clinical examination. Extraoral and intraoral examination was performed in all participants to record the presence or absence of fixed orthodontic appliances, and to identify the presence of tooth wear by attrition on any tooth, pain in the masseter muscle upon palpation, TMJ clicks, lip incompetence, or mouth breathing. Tooth wear was recorded as "yes" or "no." "Yes" consisted of at least one tooth with any marked wear facets in the enamel or dentin on the occlusal/incisal and/or adjacent tooth surface, with a morphological change in shape with height reduction.^{28,29} "No" consisted of an absence of marked wear facets on any tooth surface.

Lip incompetence was diagnosed when the adolescent could not keep the upper and lower lips in contact or by doing it only if the orbicular muscle was contracted.¹⁸ Mouth breathing was evaluated using a mirror test.³⁰ Clicks in the TMJ were considered present when a clicking, popping, and/or snapping noise was audible during both opening and closing movements, detected with palpation during at least one of three repetitions of jaw opening and closing.³¹

Adolescents' weight and height were measured on a calibrated scale and portable stadiometer, and the body mass index

(BMI) was calculated as weight/height squared (kg/m^2). BMI was categorized as underweight, normal, or overweight, following the criteria proposed by the WHO (2007).

Probable Sleep Bruxism Assessment

The evaluation of probable SB followed the criteria proposed by an international consensus.¹ According to these criteria, SB diagnosis can be categorized as follows: "possible," based on patient's or parental report; "probable," based on patient's or parental report plus a clinical examination; or "definite," based on patient's or parental report, a clinical examination, and a polysomnographic recording.¹ "Probable SB" was observed through parents'/caregivers' self-report regarding the adolescents, along with the clinical examination of adolescents. The questionnaire used to assess SB was based on a previous study regarding information on sleep grinding/clenching.³² The questionnaire included the following questions:

- Sleep grinding: Are you aware of the fact that your son/daughter grinds his/her teeth during sleep?
- Sleep clenching: On morning awakening or awakening during the night, does your son/daughter have his/her jaws thrust or braced?

The questions could be answered with either "yes" or "no." Probable SB was considered present when parents/caregivers answered "yes" for at least one of those questions, in addition to the presence of tooth wear on any tooth, or pain in the masseter muscle upon palpation, identified in the clinical examination of adolescents.³²

Pilot Study

A pilot study involving 25 12-year-old adolescents (approximately 10% of the final sample) was performed at a private school in Belo Horizonte, southeast Brazil, to evaluate the proposed methodology. The subjects from the pilot study were not included in the main assessment, and the results from this pilot study revealed no need to change the proposed methodology in any way.

Statistical Analysis

All results were analyzed using the Statistical Package for the Social Sciences (SPSS for Windows, version 21.0, SPSS Inc., Chicago, Illinois, United States). Descriptive statistics were performed. Univariate and multivariate logistic regression was performed to evaluate the association between the dependent variable probable SB and the independent variables. All independent variables with $P < .20$ for the association with probable SB in the univariate logistic analysis were incorporated into the multivariate logistic regression model. For the multivariate model, statistical significance level was set at 5.0% ($P < .05$).

RESULTS

A total of 231 adolescents with their parents/caregivers participated in the current study (response rate: 96.6%). The 8 dropouts (3.4%) refused to participate or did not fill out all data correctly. Most adolescents were female (54.1%).

Table 1—Descriptive analysis of the sample according to sleep bruxism occurrence.

Variables	Probable Sleep Bruxism	
	Present (%)	Absent (%)
Sex		
Female	21 (53.8)	104 (54.2)
Male	18 (46.2)	88 (45.8)
Possible awake bruxism reported by adolescents		
Yes	14 (35.9)	41 (21.5)
No	25 (64.1)	150 (78.5)
Sleep duration per night		
Less than 8 hours	09 (23.1)	43 (22.5)
More than 8 hours	30 (76.9)	148 (77.5)
Adolescent's sleep position		
Prone	04 (10.2)	35 (18.3)
Lateral	17 (43.6)	97 (50.8)
Supine	03 (07.7)	11 (05.8)
Various positions/agitated sleep	15 (38.5)	48 (25.1)
Adolescent snores during sleep		
Yes	20 (51.3)	50 (73.7)
No	19 (48.7)	140 (26.3)
Adolescent drool on the pillow		
Yes	23 (59.0)	77 (40.1)
No	16 (41.0)	115 (59.9)
BMI		
Overweight	0 (0.0)	08 (04.2)
Normal	28 (71.8)	130 (68.1)
Underweight	11 (28.2)	53 (27.7)
Adolescent complained about muscular pain in the TMJ region		
Yes	12 (30.8)	33 (17.2)
No	27 (69.2)	159 (82.8)
Lips seal		
Yes	37 (94.9)	180 (93.8)
No	02 (05.1)	12 (06.3)
Mouth breather		
Yes	03 (07.7)	09 (04.7)
No	36 (92.3)	183 (95.3)
Clicks in TMJ when opening and closing the mouth		
Yes	05 (12.8)	46 (24.0)
No	34 (87.2)	146 (76.0)
Wearing fixed orthodontic appliances		
Yes	08 (20.5)	23 (12.0)
No	31 (79.5)	169 (88.0)

Values in parenthesis refer to the percentage between columns. Not all participants answered all questions. BMI = body mass index, TMJ = temporomandibular joint.

Mean age of parents/caregivers was 39.9 years (standard deviation = 8.53), and most questionnaires were completed by mothers (82.1%), followed by fathers (11.8%) and individuals with other relationships to the adolescent (6.1%). Prevalence of probable SB was 16.9%, whereas 23.9% of adolescents reported possible awake bruxism.

History of tooth grinding and clenching during sleep was reported by 17.7% of parents/caregivers. Tooth wear on any tooth was identified in 84.4% of adolescents, and 13.4% presented pain in the masseter muscle upon palpation during clinical examination. Among the 201 adolescents who presented with tooth wear and pain on the masseter muscle upon palpation, 80.1% did not report history of sleep clenching or grinding. Most adolescents slept more than 8 hours per night (68.7%),

according to their parents/caregivers. The most frequent sleeping position was lateral (49.6%), followed by various positions/agitated sleep (27.4%), prone (17.0%), and supine (6.1%). A total of 30.6% adolescents snored, and 43.4% drooled during sleep. Overweight was identified in 3.5% of adolescents.

Complaints of muscle pain in the face area were reported by 19.5% of adolescents. Clinical examination confirmed that 13.4% of the adolescents wore fixed orthodontic appliances. Mouth breathers were only 5.2% of the sample, and absence of lip seal was observed in only 6.1%. Clicks in the TMJ when opening and closing the mouth were present in 51 adolescents (22.1%). Among the adolescents with probable SB, 51.3% snored, and 59.0% drooled on the pillow during sleep. The descriptive statistics of the sample are presented in **Table 1**.

Table 2—Univariate and multivariate logistic regressions between independent variables and probable sleep bruxism among 12-year-old adolescents.

Variables	Univariate analysis OR (95% CI)	P	Multivariate analysis OR (95% CI)	P
Adolescent sex Female Male	1 0.987 (0.495–1.969)	.971	–	–
Region that lives Urban area Countryside	1 0.814 (0.408–1.625)	.560	–	–
Adolescent complained about headache frequently (reported by parents) No Yes	1 1.388 (0.696–2.77)	.352	–	–
Adolescent complained about headache frequently (reported by adolescents) No Yes	1 1.211 (0.601–2.448)	.591	–	–
Lip seal No Yes	1 1.233 (0.265–5.743)	.789	–	–
Mouth breather No Yes	1 1.694 (0.437–6.567)	.445	–	–
Adolescent drool on the pillow No Yes	1 2.147 (1.066–4.325)	.032	–	–
Adolescent sleep in various positions/agitated sleep No Yes	1 1.862 (0.903–3.838)	.092	1 1.810 (0.809–4.048)	.148
Adolescent snores during sleep No Yes	1 2.947 (1.455–5.971)	.003	1 3.148 (1.478–6.704)	.003
Adolescent complained about muscular pain in the TMJ region No Yes	1 2.141 (0.985–4.655)	.055	1 1.902 (0.805–4.493)	.143
Possible awake bruxism reported by adolescent No Yes	1 2.049 (0.978–4.293)	.057	1 1.793 (0.814–3.950)	.147
Clicks in TMJ when opening and closing the mouth No Yes	2.142 (0.792–5.798) 1	.134	3.370 (1.118–10.157) 1	.031
Wearing fixed orthodontic appliance No Yes	1 1.896 (0.778–4.622)	.159	1 2.729 (1.043–7.142)	.041

CI = confidence interval, OR = odds ratio, TMJ = temporomandibular joint.

The univariate logistic analysis, comparing statistical differences between groups (with and without probable SB) and independent variables, and multivariate logistic regressions are shown in **Table 2**. The variables “Adolescent drools on the pillow,” “Adolescent sleeps in various positions,” “Adolescent snores during sleep,” “Adolescent complains about muscular pain in the TMJ region,” “Possible awake bruxism reported by adolescent,” “Clicks in TMJ when opening and closing the mouth” and “Wearing fixed orthodontic appliance” showed $P < .20$ in the association (univariate analysis) with probable SB and were included in the multivariate analysis. The variable “Adolescent drools on the pillow” did not remain in the final model. The final model shows that adolescents who snored during sleep (odds ratio [OR] = 3.14; CI = 1.47–6.70), those who

did not have TMJ clicks when opening and closing the mouth (OR = 3.37; CI = 1.18–10.15) and those wearing fixed orthodontic appliances (OR = 2.72; CI = 1.04–7.14) had more chance of being in the group with probable SB ($P < .05$).

DISCUSSION

The current study aimed to evaluate the prevalence of SB and factors associated with it among 12-year-old adolescents. The prevalence of probable SB is close to the prevalence of possible SB reported in the literature.^{2,7} A study conducted on 7- to 17-year-old individuals found a 15% prevalence of possible SB,² and a study evaluating 12- to 18-year-old adolescents found a

14.8% prevalence of possible SB.⁷ SB prevalence among adolescents is considered lower when compared with studies involving children^{14,33} and young adults.^{34,35} Most studies on SB in adolescents relied only on individuals' self-report^{2,3,6,7} whereas others have also included children in their study samples.^{2,4,5} Thus, this investigation, which included only 12-year-old adolescents and adopted a combined self-report plus clinical assessment approach to SB diagnosis (ie, "probable" bruxism), could have some further points of strengths with respect to the available knowledge.

The presence of SB was tested for association with several variables. Results concerning the association between SB and sleep characteristics are in accordance with data published elsewhere.^{14,36} In a study carried out in Hong Kong, it was observed that children who snored were 3.2 times more likely to be in the group of individuals with SB.³⁶ Research in southeastern Brazil also evaluated the association between possible SB and sleep characteristics among children/adolescents aged between 4 and 15 years. The findings showed that most children with SB snored during sleep and drooled on the pillow, and that those who snored were 8.2 times more likely to be in the group of individuals with SB.¹⁴ Despite the lack of association between SB and lip incompetence and mouth breathing in the current study, the literature has recognized that SB is frequently associated with other sleep-related breathing disorders, such as mouth breathing and sleep apnea.²³ Indeed, SB is a sleep phenomenon that rarely occurs in isolation. Studies have advocated that SB may be associated with nocturnal breathing disorders^{2,37} and even with more severe conditions, such as obstructive sleep apnea syndrome, which may manifest indirectly with daytime sleepiness and fatigue.³⁸

The current investigation also found an association between probable SB and the absence of clicks in the TMJ when opening and closing the mouth. This result was unexpected and is in contrast with the findings of a previous study, in which adolescents with TMJ clicking were 3.7 times more likely to be in the group of adolescents with severe SB.¹⁶ In a 20-year follow-up study with Swedish individuals, reports of tooth clenching and nocturnal tooth grinding during childhood were strongly correlated with TMJ clicking 20 years later,³⁹ and children who reported tooth grinding at night and presented moderate to severe tooth wear were more likely to report TMJ clicking 20 years later.⁴⁰ Children's report of TMJ clicking and the presence of clinical TMJ clicking were also associated with individuals' report of TMJ clicking 20 years later.⁴⁰ Although the prevalence of TMD symptoms is high among children and adolescents and seems to increase over time, its association with SB and tooth wear has been found only in adulthood.^{39,40} It seems that the role of SB in TMD development depends on time, and it may be one of many factors related to TMD etiology.⁴¹ Both conditions present intermittence of the symptoms over time,⁴⁰ and both conditions have a multifactorial etiology, with the involvement of psychological, physiological, and genetic factors.⁴¹ This heterogeneity may be a shortcoming for assessment of the relationship between the two conditions, and the result presented herein should be included as a component of the framework of the complex bruxism–TMD relationship. Further studies

investigating this complex relationship among adolescents are encouraged.

The current study found a positive association between fixed appliance wearing and the presence of probable SB. In the adjusted model of the logistic regression analysis, adolescents wearing fixed appliances were 2.7 times more likely to be in the group of individuals with SB. Parents/caregivers report a cessation of SB among children and adolescents when interceptive orthodontic treatment takes place, also possibly due to natural stabilization of sleep structure.²⁰ As for our findings, given the neutrality of occlusion as far as its relationship with bruxism is concerned,⁴² a possible explanation is that fixed orthodontic therapy is associated with a negative effect on oral health-related quality of life.^{43–45} Orthodontic patients also have expectations regarding how they will be treated, the amount of pain they will feel, and how efficient the treatment will be.⁴⁶ This period of uncertainty and anticipation might have an effect on SB reporting due to a sort of anxious expectation, which is a factor that has been associated with bruxism in adults.⁴⁷

This study has some limitations that should be taken into account. First, the retrospective nature of the evaluation might have influenced the results by recall bias, as data collection depended on participants' ability to retrieve past event information. Second, the cross-sectional design precludes any inference of causality.⁴⁸ Third, the small percentage of adolescents (13.4%) wearing fixed appliances might have influenced the generalization of results concerning its association with probable SB. Finally, there is a need to compare these findings with future studies performed with polysomnography (PSG), which remains the gold standard for SB assessment.⁴⁹ Unfortunately, PSG is likely to be more suitable for small sample studies because of its high cost and limited availability.¹ In addition, validated PSG recording criteria exist for adults⁴⁹ but not for children or adolescents, and even in adults they are undergoing critical appraisals.⁵⁰ Thus, in studies on young individuals, the use of self-report or parents'/caregivers' reports^{2,3,6,7} and clinical examination¹ could still be recommended for assessing SB.^{2,3,6,7}

Knowledge regarding SB is of great interest to researchers and clinicians in several medical fields.¹ The associated factors that have been retrieved in the current study can be easily identified during clinical examination. Thus, physicians, dentists, and other health care deliverers play an important role in identifying and informing patients about SB and its associated factors. Longitudinal research on adolescents is needed to understand the clinical relevance of the depicted association, especially in light of increasing evidence that bruxism is not necessarily a disorder.

ABBREVIATIONS

BMI, body mass index
SB, sleep bruxism
TMD, temporomandibular disorders
TMJ, temporomandibular joint
WHO, World Health Organization

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