

Article

Frequency of Sleep Bruxism Behaviors in Healthy Young Adults over a Four-Night Recording Span in the Home Environment

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Abstract: Objectives: This study aimed to assess frequency and multiple-night variability of sleep bruxism (SB) as well as sleep-time masticatory muscle activities (sMMA) in the home environment in healthy young adults using a portable device that provides electrocardiographic (ECG) and surface electromyographic (EMG) recordings from the masticatory muscles. Methods: The study was performed on 27 subjects (11 males, 16 females; mean age 28.3 ± 1.7 years) selected from a sample of healthy young students. Evaluation was carried out for four nights to record data on masticatory muscle activities using a compact portable device that previously showed an excellent agreement with polysomnography (PSG) for the detection of SB events. The number of SB episodes per sleep hour (bruxism index), and the number of tonic, phasic and mixed sMMA events per hour were assessed. A descriptive evaluation of the frequency of each condition was performed on all individuals, and gender comparison was investigated. Results: Mean sleep duration over the four recording nights was 7 ± 1.3 h. The average SB index was 3.6 ± 1.2 . Most of the sMMA were tonic (49.9%) and phasic (44.1%). An ANOVA test showed the absence of significant differences between the four nights. No significant gender differences were detected for the SB index, phasic or tonic contractions; conversely, gender differences were detected for mixed sMMA events ($p < 0.05$). Conclusion: This investigation supports the concept that sMMA events are quite frequent in healthy adults. Differences over the four-night recording span were not significant. These data could be compared to subjects with underlying conditions that may lead to an additive bruxism activity and possible clinical consequences.

Keywords: sleep bruxism; masticatory muscle activity; compact portable device; surface electromyography



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1. Introduction

Bruxism is an oromandibular condition characterized by different activities of the jaw muscles (i.e., grinding or clenching of the teeth and/or thrusting or bracing of the mandible) and two distinct circadian manifestations, viz., awake bruxism (AB) and sleep bruxism (SB) [1]. Recently, a panel of experts proposed two distinct definitions for awake and for sleep bruxism; the latter is defined as a masticatory muscle activity during sleep that is characterized as rhythmic (phasic) or non-rhythmic (tonic) [1]. This would not be considered a disorder per se in otherwise healthy individuals, but it might be viewed as a protective and/or a risk factor for some clinical consequences [1–3].

Whilst polysomnography (PSG) has always been considered the standard of reference to evaluate the amount of jaw muscle activity associated with specific patterns of sleep arousals, several different non-instrumental and instrumental approaches may be used to assess SB, including clinical or self-reported/questionnaire-based protocols, clinical inspection and electromyographic (EMG) recordings [1,3–7]. In particular, a count of SB events can be assessed with measurement approaches to quantify the amount of sleep-time EMG activity [1].

Current knowledge on the epidemiology of SB reflects the adoption of different evaluation strategies, since the literature reports varied ranges of prevalence for both children/adolescents and adults. Prevalence rates in adults range from 8% to 16% for sleep bruxism [3]. In 2013, a comprehensive review of the topic cautioned about the interpretation and generalization of findings due to the poor methodological quality of the reviewed literature, with special regard to the amount of papers relying on single-item self-reporting to “diagnose” bruxism [8]. A large-scale polysomnography (PSG)-based epidemiological study underlines that the prevalence of SB was 7.4% when PSG was used as an exclusive criterion for diagnosis, whereas it was 5.5% when screened by questionnaires and confirmed by PSG [9].

As suggested by the consensus papers, an instrumental evaluation of muscle activity during sleep is the most appropriate approach to approximate a definite description of the epidemiology of SB behaviors [1]. Currently, a validated compact portable device has been proposed for the evaluation of SB, as an alternative to complete PSG, due to its high specificity and sensitivity [10–12].

Based on this, also, given the progressive diffusion of portable EMG recording devices that may lead to an increased number of research in this field over the next few years, there is a need to provide a picture of the frequency and clinical relevance of SB. The first step is the assessment of the frequency and natural variability of different SB activities in healthy individuals [3,13].

Within the above premise, the twofold aim of the present study was to: 1. Assess the frequency and variability of sleep bruxism in a sample of healthy young adults who underwent home EMG/electrocardiographic (ECG) recordings with a portable device during four consecutive nights, and 2. Set a possible comparison standpoint for future studies.

2. Materials and Methods

The sample consisted of 30 otherwise healthy young adults attending the Post-Graduate School of Orthodontics, University of Ferrara, Ferrara, Italy (20 February 2019).

The research protocol was approved by the Institutional Review Board of the Post-graduate School of Orthodontics, University of Ferrara, Ferrara, Italy. All individuals gave their informed consent in accordance with the Helsinki Declaration.

Participants were all Caucasians in good general health, and the exclusion criteria were any documented psychiatric, neurological, systemic (e.g., rheumatologic) or sleep diseases and/or the presence of temporomandibular disorders (TMD) pain, as screened with the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) guidelines [14].

Each participant underwent an instrumental in-home evaluation with a portable device (Bruxoff[®], OT Bioelettronica, Torino, Italy) that provided a concurrent recording of heart frequency as well as EMG signals from both the masseter muscles. This device was selected due to its high specificity (91.6%) and sensitivity (92.3%) for SB assessment when the diagnostic cut-off was set at four SB episodes per hour [12], as proposed by PSG/SB criteria [5,15]. Technical details concerning the recording procedure and the device have been explained elsewhere [12,16].

The study design provided four consecutive recording nights (at least four hours of sleep per night). None of the subjects was under medication at the time of recording and all individuals were requested to avoid assuming potential sleep-altering substances or drugs (e.g., caffeine, nicotine, alcohol) within the hours immediately before the recordings.

For each recording night, the SB index and the number of tonic, phasic and mixed sleep-time masticatory muscle activities (sMMA) events per hour were calculated.

The subjects were educated to perform three maximum voluntary clenching activities (MVC) on teeth lasting three seconds each and separated by 10 s of rest. The highest of the MVC measures was used for normalizing the EMG values as a percent of MVC. The SB events (i.e., masseter contractions exceeding 10% of MCV amplitude and preceded by a 20% increase in heart rate), as well as the overthreshold masseter contractions that were not preceded by a heart rate increase, were also scored (and from here on referred to as

“sMMA”) [5]. The Bruxmeter software (Bruxmeter[®]) automatically scored the number of tonic, phasic and mixed sMMA events per hour and the number of SB episodes per hour of sleep (SB index) [12].

Statistical Analysis

The data were collected in a database and all statistical procedures were executed using Excel software (Microsoft Corporation, Redmond, WA, USA).

A descriptive analysis of each variable was performed and an analysis of variance (ANOVA) was used to assess significant differences between the average values of the four recording nights for all outcome variables.

Gender comparison was performed using Student's *t*-test.

The level of significance was set at $p < 0.05$.

3. Results

Within the initial study sample of 30 subjects, three individuals were excluded from the data analysis due to technical problems during the recording procedure. Thus, data are reported on a sample of 27 individuals (11 males, 16 females; mean age 28.3 ± 1.7 years).

Mean sleep duration was 7.0 ± 1.3 h during the four nights. No considerable sleep interruptions that might have influenced outcomes were reported by any subjects.

The average SB index over the four recording nights was 3.6 ± 1.2 (range 0–9).

The mean number of phasic, tonic and mixed events/hour was 2.1 ± 1.5 , 2.4 ± 2.3 and 0.3 ± 0.4 respectively (Table 1).

Table 1. Descriptive statistics of outcome variables during the four recording nights.

Outcome Variable	Average Values (SD)	Range
SB index	3.6 (1.2)	0–9
Phasic sMMA events per hour	2.1 (1.5)	0.1–6.7
Tonic sMMA events per hour	2.4 (2.3)	0–12
Mixed sMMA events per hour	0.3 (0.4)	0–1.2

SD, standard deviation; SB, sleep bruxism; sMMA, sleep-time masseter muscle activities.

The distribution of contraction types was comparable between the four recording nights (Table 2) and the ANOVA test (Table 3) shows that there are no statistically significant differences in any of the SB event types between the four recording nights.

Table 2. Percentage distribution of phasic, tonic, and mixed sMMA events over each recording night.

Night #	% Phasic sMMA Events (s.d)	% Tonic sMMA Events (s.d)	% Mixed sMMA Events (s.d)
1	42.5 (20.5)	51.6 (36.5)	5.9 (6.1)
2	49.3 (26.8)	44.4 (40.5)	6.3 (5.6)
3	45.2 (27.8)	50.3 (39.3)	4.5 (4.7)
4	39.3 (22.8)	53.4 (33.6)	7.2 (7.5)
Mean	44.1 (24.5)	49.9 (37.5)	6.0 (6.0)

sMMA, sleep-time masseter muscle activities.

Table 3. Average values of outcome variables (s.d. in parenthesis) over each recording night and the ANOVA test for significant differences. (statistical significance: $p < 0.05$).

Outcome Variable	Night 1	Night 2	Night 3	Night 4	Sig.
SB Index	3.4 (2.2)	2.9 (1.6)	4.2 (2.1)	4.0 (1.9)	0.084
Phasic sMMA events per hour	2.2 (1.2)	2.3 (1.6)	2.2 (2.0)	1.8 (1.2)	0.758
Tonic sMMA events per hour	2.7 (2.2)	2.1 (2.4)	2.5 (2.9)	2.5 (1.8)	0.790
Mixed sMMA events per hour	0.3 (0.4)	0.3 (0.3)	0.2 (0.3)	0.4 (0.4)	0.711

SB, sleep bruxism; sMMA, sleep-time masseter muscle activities.

No significant differences were found regarding gender comparison in any outcomes except for mixed sMMA events ($p < 0.05$) (Table 4).

Table 4. Descriptive statistics pertaining to the variables for male and female (mean value, standard deviation, range) and differences between gender assessed using Student's *t*-test for each variable (statistical significance: $p < 0.05$).

Outcome Variable	Male		Female		<i>t</i> -Test
	Mean (SD)	Range (Min-Max)	Mean (SD)	Range (Min-Max)	
SB Index	4.1 (2.1)	0.0–9.0	3.3 (1.8)	0.0–8.5	0.058 NS
Phasic sMMA events per hour	1.9 (1.5)	0.1–6.7	2.3 (1.6)	0.1–6.7	0.213 NS
Tonic sMMA events per hour	2.1 (2.1)	0.1–10.5	2.7 (2.4)	0.0–12.0	0.174 NS
Mixed sMMA events per hour	0.2 (0.3)	0.0–0.8	0.4 (0.4)	0.0–1.2	0.024 S

SD, standard deviation; SB, sleep bruxism; sMMA, sleep-time masseter muscle activities; S: significant ($p < 0.05$); NS: not significant.

4. Discussion

Several history reports and clinical signs and symptoms have been suggested as markers of SB (e.g., report of sleep teeth grinding sounds, shiny spots on restorations, masseter muscles hypertrophy, transient jaw muscle pain in the morning, tooth wear etc.) although none of these has been directly and consistently associated with ongoing SB [6]. However, the presence of at least one of the above clinical symptoms or signs, together with the bed partner's report of tooth grinding during sleep, has been used to propose screening criteria for PSG-based SB assessment [5,15].

These criteria were very useful in the research setting, but their validity for recognizing clinically relevant SB has been questioned. In particular, the peculiar study populations recruited for research purposes and the focus on the number of SB events, instead of the full spectrum of sMMA activities, emerged as shortcomings to address for further refining of the SB epidemiology [13]. Within this premise, the present investigation provided information on the frequency of sleep bruxism behaviors by EMG/ECG recordings with a validated portable device [10,12], with the aim of collecting data on the frequency and natural variability of SB in healthy individuals.

Results show that in a population of healthy young adults, the average SB index over four consecutive recording nights was 3.6 ± 1.2 . The majority of sMMA were tonic (49.9%) and phasic (44.1%), whilst mixed sMMA events (6%) were less frequent, in accordance with a previous study [17]. As regards gender comparison, no significant differences were found in any outcomes except for mixed sMMA events. These results are partially in accordance with the literature on self-reported bruxism, which did not report any statistically significant gender differences [8,18]. However, non-instrumental findings of a slightly higher report of SB in females are worthy of further examination.

As for SB frequency fluctuation, no statistically significant differences for any study variables during the four nights were detected. This suggests the absence of a first night effect (FNE), which is likely due to the smaller size of the device with respect to that used in another recent investigation reporting a potential FNE in the evaluation of SB [19] or to the peculiar sample of healthy individuals with respect to another study reporting a possible FNE in subjects with SB [20].

Our findings are open to interesting observations both for research and clinical purposes.

The average values for the SB index over the four recording nights (i.e., 3.6 events/h) are very similar to the cutoff threshold that has always been accepted to mark high frequency SB (i.e., 4 events/h). Our results are in line with the previous investigations, which reported average SB index values of 4.5 ± 2.6 [21] and 3.3 ± 1.7 [17] events/h in a

sample of asymptomatic volunteers, and suggest that getting deeper into the knowledge of SB epidemiology is a fundamental step to understanding the clinical relevance and the relationship with purported etiological factors and consequences. In short, the controversial findings on the relationship between SB and clinical consequences (e.g., orofacial pain, temporomandibular joint disorders, tooth wear) may be partly due to the adoption of screening PSG/SB criteria that are too low for discriminating severe bruxers from the general population.

This investigation has its main limitations in the limited sample size and the case series design, without any control groups of individuals with purported risk factors (e.g., psychological factors, drugs, respiratory disturbances) or potential consequences of SB. On the other hand, it represents one of the very few attempts to monitor sleep time jaw muscle activity on multiple nights, thus making it hard to expand similar observation periods to large populations. As such, these findings in a population of healthy asymptomatic subjects further support the need for a possible reconceptualisation of SB researches, replacing a yes/no approach to SB assessment based on predefined thresholds for putative disease with an assessment based on the continuum of jaw muscle activities [1,3,13,22]. In particular, future investigations should assess the relative importance of clenching and grinding episodes also in terms of muscle work [3,23].

Moreover, notwithstanding that quantitative recordings are the standard requisite for a definite SB assessment, some authors underline that the complexity of phenomena leading to muscle fatigue and pain would require an implementation of evaluation strategies [3,13]. Based on this, the possible developments of future studies on the topic, also by the use of validated portable devices, are quite intuitive and comprise the recruitment of a larger sample over a longer period and an evaluation of the additive contribution of associated factors for a better comprehension of the possible clinical consequences. The concurrent use of other sleep monitoring devices (e.g., actigraphy) may be useful to help in discriminating SB from motor phenomena related with body movement.

In short, as recommended by the recent literature, our results provided the first step for the assessment of the frequency and natural variability of different SB activities in healthy individuals, suggesting that a revision of currently adopted PSG/SB criteria is needed for a proper evaluation of SB clinical relevance.

5. Conclusions

Within the limits of the present study, which was designed to evaluate sleep bruxism behaviors in a sample of healthy young adults using a portable EMG/ECG device, findings suggest that sMMA events associated with heart-rate increase are quite frequent. The average sleep bruxism index over the four recording nights was 3.6 ± 1.2 . Any significant fluctuation was found for the study variables during the four nights, thus suggesting the absence of a first night effect in the home environment.

These data could be compared to subjects with underlying conditions that may be associated with additive bruxism activity and possible clinical consequences.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflict of interest.

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