Oral Diseases

WILEY

ORAL DISEASES
Leading in Oral, Maxillofacial, Head & Neck Medicine

ORIGINAL ARTICLE OPEN ACCESS

Periodontal Diseases

Electromyographic Assessment of Sleep Bruxism in Patients With Periodontitis: A Case–Control Study

Tommaso Gotti[1] | Isabella De Rubertis[1] | Ovidiu Ionut Saracutu[1] | Marco Ferrari[2] | Nicola Discepoli[1] | Daniele Manfredini[1]

[1]Department of Medical Biotechnologies, University of Siena, Siena, Italy | [2]Department of Medical Sciences, Surgery and Neurosciences, University of Siena, Siena, Italy

Correspondence: Ovidiu Ionut Saracutu (ovidiu.saracutu@unisi.it)

Received: 2 July 2025 | **Revised:** 12 December 2025 | **Accepted:** 23 December 2025

Keywords: bruxism | electromyography | full mouth bleeding score | periodontitis | sleep bruxism

ABSTRACT

Objective: The relationship between periodontitis and bruxism has always been a matter of debate. The aim of the present paper is to investigate the association between advanced stages of periodontitis (Stage III/IV) and the intensity and duration of sleep bruxism events, measured as bruxism work index (BWI) and bruxism time index (BTI) through surface electromyography.

Methods: Subjects were selected from patients regularly attending the School of Dentistry of the University of Siena, Siena, Italy, with the aim of having a test group of patients with periodontitis and a control group without periodontitis. Two calibrated operators performed the periodontal assessment. The sleep-time surface electromyographic activity of the left masseter muscle was registered through a portable device (dia-BRUXO, Biotech-Novations, Sanremo, Italy). Differences between cases and controls in the outcome variables concerning masseter activities were assessed.

Results: No significant difference was found between the two groups for the sleep bruxism work index and bruxism time index. Instead, a moderately negative significant correlation was found between the bruxism work index and the full mouth bleeding score.

Conclusion: Patients with advanced stages of periodontitis (Stage III and Stage IV) do not exhibit a higher frequency and intensity of sleep bruxism events compared to healthy individuals.

1 | Introduction

According to the latest updated international consensus, bruxism is an umbrella term for a spectrum of repetitive masticatory muscle activities (Verhoeff et al. 2025). These activities can have two different circadian manifestations, as they can occur during sleep (i.e., sleep bruxism [SB]) and/or during wakefulness (i.e., awake bruxism [AB]) (Lobbezoo et al. 2018). AB is defined as *a masticatory muscle activity during wakefulness that is characterized by repetitive or sustained tooth contact and/or by bracing or thrusting of the mandible and is not a movement disorder in otherwise healthy individuals*. SB *is considered a masticatory muscle activity during sleep that is characterized as rhythmic (phasic) or non-rhythmic (tonic) and is not a movement disorder or a sleep disorder in otherwise healthy individuals* (Lobbezoo et al. 2018). Five years after the consensus paper, a commentary note specified that bruxism cannot be considered a disorder by itself, but it is a sign of an underlying condition and, in turn, it may or may not be a factor associated with oral health outcomes (Manfredini, Ahlberg, Lavigne, Svensson, and Lobbezoo 2024).

Given these conceptual definitions, bruxism has been associated with various clinical outcomes, both harmful and potentially protective. The various bruxism activities, with different specificities, can represent a risk factor for tooth wear, tooth fracture, prosthodontic failures (Saracutu, Ferrari, et al. 2025), temporomandibular

disorders (TMDs) (Manfredini, Häggman-Henrikson, Al Jaghsi, et al. 2025; Manfredini and Lobbezoo 2021), facial pain, and headaches (Moreno-Hay and Bender 2024). Conversely, sleep arousal-related bruxism episodes, albeit not yet proven, were hypothesized to be a protective factor for certain medical conditions, such as obstructive sleep apnea (OSA) (Pollis et al. 2024), by preventing the collapse of the upper respiratory airways or gastroesophageal reflux disease (GERD) by stimulation of salivary production, buffering the gastric acids (Pollis et al. 2026).

Among the various potential clinical issues, the relationship between bruxism and periodontal diseases has always been a matter of controversy. Early speculative hypotheses by Karolyi and Ramfjord linked bruxism to periodontitis through occlusal trauma, a view that persists among some clinicians despite a lack of supporting evidence (Karolyi 1901). Such a hypothesis was later supported by some pioneer studies in an era when the etiology of both bruxism and periodontitis was far from being clear (Glickman and Smulow 1969; Glickman 1965). According to the European Federation of Periodontology (EFP), periodontitis is now defined as a *chronic inflammatory disease that is triggered by bacterial microorganisms and involves a severe chronic inflammation that causes the destruction of the tooth-supporting apparatus and can lead to tooth loss* (Caton et al. 2018). In the last two decades, the pathophysiology of the disease has been clearly elucidated as a complex biological process characterized by specific molecular pathways that lead to the activation of host-derived proteinases that induce loss of marginal periodontal ligament fibers and apical migration of the junctional epithelium (Tonetti et al. 2018). Within this complex pathway, bruxism-related masticatory muscle activities are not considered to have a role in the initiation or progression of the pathology. However, some clinicians still believe that occlusal trauma contributes to periodontitis, despite evidence showing no association between occlusal features and bruxism frequency (Ramfjord 1961; Manfredini, Landi, Tognini, et al. 2004; Manfredini, Landi, Romagnoli, and Bosco 2004; Landi et al. 2004).

As for periodontitis, a systematic review concluded that, whilst no investigation found a clear-cut association between the frequency of bruxism behaviors and the severity of periodontitis, the few available studies have major methodological limitations (Manfredini et al. 2015). Indeed, all the studies failed to provide information regarding the dose-effect response or the temporal relationship between masticatory muscle activities and periodontitis. This limitation is mainly related to the difficulties in the assessment of bruxism. Additionally, contradictory findings characterized more recent studies (Botelho et al. 2020). On one hand, some papers found that bruxism was associated with lower odds of periodontitis and severity of probing depth and clinical attachment loss (Nakayama et al. 2018), whilst other studies found that bruxers are associated with more than double the odds of periodontitis (Bilgin Çetin et al. 2021; Kato et al. 2018). Furthermore, a recent systematic review suggested that bruxism can be a risk factor for molar loss in patients undergoing periodontal maintenance therapy (Chen et al. 2024).

Such contrasting findings may be due to the subjective-based evaluation of bruxism, which is not suitable to provide specific details on the type of activity as well as its frequency and intensity (Saracutu, Manfredini, et al. 2025; Bracci et al. 2024). Thus, the best option is the assessment of bruxism via instrumental approaches (Manfredini et al. 2020). The STAB (Standardized Tool for the Assessment of Bruxism) is the first multidimensional, integrative tool for the assessment of bruxism (Manfredini, Ahlberg, Aarab, Bracci, et al. 2024; Manfredini, Ahlberg, Aarab, Bender, et al. 2024). Despite the emergence of EMG-based bruxism measures (e.g., BWI, BTI), no studies have investigated their relationship with periodontitis, leaving a key gap in the objective quantification of this association. The STAB proposes surface electromyography (EMG) as the strategy for quantifying bruxism-related masticatory muscle activities. More specifically, the various papers consider two possible strategies to assess bruxism via EMG. The most commonly used approach identifies bruxism events just by counting the EMG peaks exceeding 10% of the maximum voluntary contraction (MVC) (Manfredini, Ahlberg, Aarab, Bender, et al. 2024). This approach, based on a pioneer and frequently cited polysomnographic study by Lavigne et al. (1996) and frequently cited in the literature, provides the bruxism event count over a defined time span, but it does not provide any information on their intensity and duration (Manfredini et al. 2016). Such a strategy for categorizing patients into bruxers or non-bruxers just based on the number of SB events is not optimal (Manfredini et al. 2016; Kudo et al. 2023), as it did not correlate with clinical outcomes such as TMDs (Raphael et al. 2012), presumably due to the lack of quantification for the total muscle activity (Raphael et al. 2013). Thus, the adoption of the bruxism work index (BWI) and bruxism time index (BTI) was recommended (Manfredini, Ahlberg, Aarab, Bender, et al. 2024). The BWI has been defined as the percentage of muscle work during bruxism-related masticatory muscle activity (MMA) compared to the potential work that could be exerted if the highest peak of power registered during the 24 h had been kept unvaried during all the bruxism episodes. Conversely, the BTI is the percentage of time with bruxism-related MMA with respect to the total recording time (Colonna et al. 2022; Van Der Zaag et al. 2008). Such indexes have been recently used in the field of orthodontics to study the association between bruxism and the use of invisible aligners (Colonna et al. 2024).

In the field of periodontology, the only recent study on the relationship between bruxism and periodontitis, based on the use of EMG, adopted the protocol that identifies bruxism events as the EMG peaks exceeding a specific threshold of the maximum voluntary contraction (MVC) (Jung and Im 2022). The study found a positive association between bruxism and the severity of periodontitis (Kato et al. 2018). Conversely, no studies exist on the association between the severity of periodontitis and the new indexes proposed by the STAB, the BTI, and the BWI. In this view, the evaluation of the BTI and BWI on patients with periodontitis would allow to better understand how the reduced and unstable periodontal status can influence the intensity and the duration of the sleep bruxism events with respect to healthy individuals.

Within these premises, the present paper is to investigate the possible association between advanced stages of periodontitis (Stages III/IV) with the BTI and BWI, measured through surface EMG of the masseter muscle. The study aims to determine whether there is a statistically significant difference in BTI and BWI between patients with and without periodontitis, using EMG-based assessment.

2 | Materials and Methods

2.1 | Patients Recruitment

The patients were recruited in the period between June 2023 and December 2024. Subjects were selected from patients regularly attending the School of Dentistry of the University of Siena, Siena, Italy, with the aim of having a test group of patients with periodontitis and a control group without periodontal disease. Exclusion criteria were ongoing orthodontic treatment, wearing dentures, presence of temporomandibular disorders (TMD), or any other orofacial pains, use of drugs altering the masticatory muscle activities, diabetes, and presence of systemic or psychiatric diseases.

All individuals gave their informed consent in accordance with the Helsinki Declaration and understood that they were free to withdraw from the study at any time. The research protocol was approved by the Institutional Review Board of the Orofacial Pain Unit, University of Siena, Siena, Italy (#0087-2022).

The group of patients with periodontitis accessed the Unit of Periodontology for the first time. For them, the inclusion criteria were age between 28 and 50 years, ability to perform oral hygiene maneuvers, willingness to give informed consent to take part in the investigation, and a diagnosis of stage III or stage IV periodontitis at the first visit. The control group was enrolled in the Unit of Dental Hygiene and was composed of sex- and age-matched individuals, with a willingness to give informed consent to take part in the investigation and absence of any form of periodontal disease.

2.2 | Periodontal Assessment

Two calibrated operators (T.G. and I.D.) performed the periodontal assessment. The inter-examiner correlation coefficient ranged from 0.94 to 0.98 and between 0.91 and 0.99 for Probing Pocket Depth (PPD) and Clinical Attachment Loss (AL), respectively. Cases were defined according to the American Academy of Periodontology/European Federation of Periodontology 2017 guidelines (Caton et al. 2018), with a patient being a periodontitis case if interdental CAL is detectable at ≥ 2 non-adjacent teeth or buccal or oral CAL ≥ 3 mm with pocketing > 3 mm detectable in ≥ 2 teeth. After the diagnostic process, patients were informed about their periodontal status.

Subsequently, the full-mouth periodontal examination was performed using a manual UNC-15 periodontal probe (PCP15; Hu-Friedy, Chicago, IL, USA) at six sites per tooth (Lang et al. 1991). Residual roots and third molars were excluded from the examination. Probing pocket depth (PPD), gingival recession (REC), plaque (O'Leary et al. 1972), and Bleeding on Probing (BOP) (Ainamo and Bay 1975) were recorded on six sites per tooth. PPD was measured as the distance from the free gingival margin to the bottom of the pocket, and REC as the distance from the cementoenamel junction (CEJ) to the free gingival margin, assigning to it a negative sign if the gingival margin was located coronally to the CEJ. AL was calculated as the algebraic sum of REC and PPD of each site. Measurements were rounded to the lower whole millimeter. A Nabers probe was used to assess furcation involvement (FI) according to the Hamp classification (Hamp et al. 1975). Tooth mobility was assessed as well, according to the Miller Classification (Miller 1950). For each patient, the total number of teeth exhibiting increased mobility was recorded. Additionally, the highest mobility grade among these teeth was reported, representing the most severe diagnosis. Full mouth bleeding score (FMBS) and full mouth plaque score (FMPS) were calculated as the proportion of tooth surfaces bleeding and presenting plaque upon probing. Periodontitis' stage and grade were assigned according to the current classification (Tonetti et al. 2018). Smoking status was self-reported and recorded accordingly, with patients categorized as current smokers (S), former smokers (FS), or never smokers (NS). The presence of diabetes or other systemic comorbidities was verified through a review of the patients' medical records.

2.3 | Instrumental Assessment of Bruxism

After the periodontal assessment, patients received adequate instruction to perform the EMG data recording. The surface EMG activity of the left masseter muscle was registered through a portable surface EMG device (dia-BRUXO, Biotech-Novations, Sanremo, Italy; Saracutu, Pollis, et al. 2025). The advantage of using a portable EMG device relies on the possibility of performing the registration in the natural home environment rather than in a sleep laboratory, which can influence the usual sleep pattern of the patients (Ahlberg et al. 2008; Gallo et al. 1999). Given the absence of first-night impact on the masticatory muscle activity in previous studies, a single-night protocol was adopted (Hasegawa et al. 2013).

Considering that the patients of the test group were composed of individuals seeking periodontal treatment and coming for the first time to the attention of the University clinic, it was decided to perform the EMG monitoring of the masseter muscle before the start of the periodontal treatment to avoid the possible influence of the treatment on the masticatory muscle activity. The TMD Pain screener was adopted to exclude patients with TMD (Gonzalez et al. 2011), which can influence masticatory muscle activity.

The measurement was conducted by one investigator (T.G.) following the manufacturer's instructions. Surface EMG was carried out on the same day in which the periodontal assessment was performed. The investigator in charge of the bruxism assessment directly performed all the necessary procedures for the correct use of the device dia-BRUXO. After the application of the device, participants were requested to wear it for 24 h and instructed to keep a diary describing all the activities, with a special focus on sleep time and awake time.

Before the electrodes were placed, the skin was cleaned with a pad soaked in 70% ethyl alcohol. Male patients were required to shave before the start of the registration. EMG signals were detected by means of disposable bipolar electrodes with solid gel, AgAgCl sensors, and an interelectrode distance center-to-center of 22 mm. The detected signal is then processed by a three-stage analog circuit: an amplification circuit, an active bandpass filter (between 110 Hz and 550 Hz), and an RMS (root-mean-square) integrator, which finally adapts it for acquisition

within a high-performance processor. The analog information is digitalized in the processor by a 12-bit analog/digital converter (4096 discriminating levels), with data acquisition every 100 ms. The signal processing of the device (bandpass filtering 110–550 Hz, rectification, integration, or other processing) occurs entirely in the analog domain, before digitization. Thus, the data saved every 100 ms is not the raw EMG signal, but a pre-processed analog value, representative of the average EMG activity over the period (the data is already provided in RMS). In this way, these acquisitions are made every 100 ms of a single analog data point processed analogically, avoiding the loss of information that occurs with digital filtering. Figure 1 provides an example of a part of the EMG trace provided by the device after a registration. After its attachment, the device starts the registration of the signal for the next 24 h and stores the whole EMG trace resulting from data collection. The acquired signal can be treated in several ways for interpretation and data processing through the dedicated software released by the manufacturer (dia-BRUXO, Biotech-Novations, Sanremo, Italy). The BWI was calculated according to the formula:

$$\mathrm{BWI} = \frac{100 \times \sum_{i=1}^{n} x_i k_i}{\sum_{i=1}^{n} x_{\max} k_i}$$

where x_i is the EMG sample value (in μV), $x_{\max}$ is the maximum EMG value recorded (in μV), and k_i is the activation coefficient for the i-th sample.

The BTI was calculated according to the following formula:

$$\mathrm{BTI} = \frac{100 \times t \sum_{i=1}^{n} k_i}{1000 \times T}$$

where T is the total duration of EMG acquisition and $t = 100$ ms is the sampling interval of the device.

2.4 | Data Analysis

After 24 h had passed since the attachment of the device, patients were required to come back to the University clinic to detach it from the masseter muscle and download the collected data stored in the device through the dedicated software. The dia-BRUXO software allows downloading the whole EMG trace of the left masseter muscle and visualizing the whole muscle activity during sleep.

To download the data, the device must be connected to a computer with the installed software through the USB cable provided by the manufacturer. The software, when turned on, automatically recognizes if the device is connected to the computer. Upon connection, the investigator in charge of the instrumental assessment of bruxism (T.G.) downloaded the report generated by the software. Prior to the download, the software asks the operator to indicate the approximate time of sleeping and waking, which were taken from the diary that patients were instructed to write, along with the biographical information. The software requires a few minutes to generate a PDF report containing the biographical information of the patient, along with the BWI and the BTI for the indicated sleep time (Manfredini, Ahlberg, Aarab, Bender, et al. 2024; Colonna et al. 2022) and the whole EMG trace, indicating the continuous activity of the left masseter muscle every 100 milliseconds. To avoid a potential risk of bias, the statistician in charge of the statistical analysis was not involved in any part of the clinical procedures and therefore was blinded to group allocation.

2.5 | Study Outcomes and Power

The primary outcomes of the study were the comparison of the bruxism work index (BWI) and bruxism time index (BTI) between patients with periodontitis and periodontally healthy controls. Sample size calculation was performed assuming a moderate effect size (Cohen's $d = 0.5$), in line with the variability reported in previous EMG-based studies on bruxism activity (Vlăduțu et al. 2022). With an alpha level of 0.05, a power of 80%, and an estimated dropout rate of 10%, the required total sample size was approximately 40 participants. The sample size included was enough to find a mean 30% difference in the BTI and BWI between the two groups.

2.6 | Statistical Analysis

To perform the statistical analysis, the operator in charge of the EMG assessment of bruxism (T.G.) inserted all the data

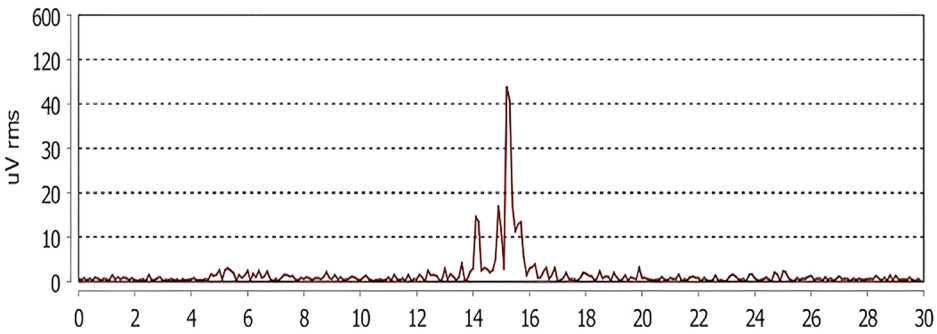

FIGURE 1 | Example of sleep bruxism trace detected by dia-BRUXO. The x-axis indicates the duration of the event in seconds, while the y-axis shows the intensity of the signal of the left masseter muscle in microvolts. The sleep bruxism event was detected between the 14th and 16th second of the registration, with an intensity that is higher than 40 microvolts.

regarding each patient in a unique Excel file. For each patient, data were added concerning the biographical characteristic, the periodontal status, specifying the % of sites with PPD ≥4 with BoP, the % of the FMBS and of the FMPS, and the BWI and BTI. Continuous data were reported as mean and standard deviation (SD), while categorical and dichotomic variables were expressed as absolute frequencies and percentages (%).

Intergroup comparisons were computed using the Fisher's exact test for categorical variables, and the Mann–Whitney U test for non-parametric numerical variables, including the BWI and BTI between subjects with and without periodontal disease. Spearman correlation test was used to measure the correlation existing between the BTI and BWI with the periodontal status of all participants, using as indicators the % of sites with PPD ≥4 with BoP, the % of the FMBS, and the % of FMPS. A significance level of 0.05 was adopted for all the statistical tests, and two-sided tests were applied. Data analyses were performed using SPSS 26.0 (IBM Corp., Chicago, IL, USA).

3 | Results

A total of 40 patients, 20 in each group, were enrolled (Figure 2). The mean age for participants without and with periodontitis was 47.55 ± 11.5 and 56.12 ± 7.8 years, respectively. Of the periodontitis group, 9 were males and 11 were females, while in the periodontally healthy group, 8 patients were males and 12 were females. All patients with periodontitis had an FMPS above 40%, while in the periodontally healthy group, all patients had an FMPS <20%. In the periodontitis group, 5 patients had diabetes, and 7 had comorbidities related to cardiovascular diseases (CVDs), while only 1 individual of the control group had diabetes, and 2 had CVDs. Of the total number of participants, 18 were never smokers (11 of the healthy group and 7 of the periodontitis group), 15 were current smokers (5 of the healthy group and 10 of the periodontitis group), and 7 were former smokers (4 of the healthy group and 3 of the periodontitis group). In the periodontitis group, 14 participants reported a history of periodontitis, while in the control group, there were only 6. Table 1 shows the characteristics of the participants. Regarding the clinical periodontal variables, the periodontitis group reported a significantly higher % of PPD >4 with BOP, PPD ≥5 mm, PPD ≥6 mm, mean PPD, mean AL, FMPS, FMBS, number of teeth lost due to periodontitis, and mobility compared to the control group. In the periodontitis group, 13 participants had stage III periodontitis, while 7 had stage IV periodontitis. Table 2 presents the clinical periodontal variables registered in the cohort. Table 3a reports the BTI and BWI values stratified for never smokers, current smokers, and former smokers. No statistically significant difference was found between the three groups (p-value >0.05; Table 3b). The mean values of the BWI and BTI for the periodontitis group were 0.081 ± 0.177 and 0.790 ± 0.783, while they were 0.059 ± 0.047 and 0.0950 ± 0.871 for the control group. No significant differences were found between the two groups of the BWI and BTI (p = 0.054 and p = 0.432; Table 4).

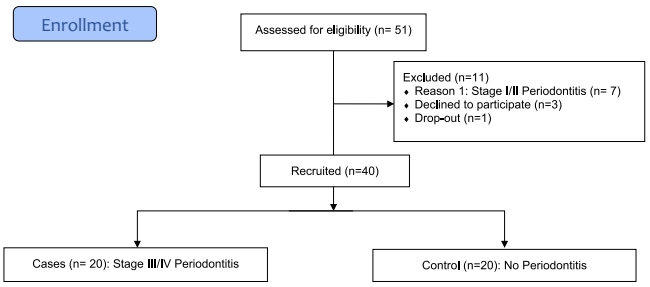

FIGURE 2 | CONSORT flow diagram.

Table 5 reports the results of the Spearman correlation between the BWI, the BTI, and the periodontal variables: % of sites with PPD ≥4 mm and BoP, the % of the FMBS, and the % of FMPS. No significant correlation (p >0.05) was found between the periodontal variables and the BWI and BTI with the exception for BoP. The analysis showed a negative, moderately significant correlation between the BWI and the percentage of sites with BoP (r = −0.041, p = 0.0012; Figure 3), but not with BTI (r = −0.21, p = 0.182).

TABLE 1 | Demographic characteristics of the patients with and without periodontitis.

Variables	Periodontally healthy group (n = 20)	Periodontitis group (n = 20)	p	Total (n = 40)
Gender (N [%])				
Males	8 (40)	9 (45)	1.00	17 (42.5)
Females	12 (60)	11 (55)		23 (57.5)
Age (years) (Mean [SD])	47.6 ± 11.5	56.1 ± 7.8	0.06	51.5 ± 10.6
Diabetes (N [%])	1 (5)	5 (25)	0.18	6 (15)
Other comorbidities (N [%])	2 (10)	7 (35)	0.13	9 (22.5)
Family history of periodontitis (N [%])	6 (30)	14 (70)	0.03	20 (50)
Smoking status (N [%])				
Current smokers	5 (25)	10 (50)	0.28	15 (37.5)
Former smokers	4 (20)	3 (15)		7 (17.5)
Never smokers	11 (55)	7 (35)		18 (45)

TABLE 2 | Clinical periodontal variables of the patients with and without periodontitis.

Variables	Periodontally healthy group ($n=20$)	Periodontitis group ($n=20$)	p
%PPD ≥ 4 mm with BOP (Mean ± SD)	1.1 ± 2.1	25.2 ± 1.6	< 0.001
%PPD ≥ 5 mm (Mean ± SD)	1.5 ± 0.6	14.8 ± 3.0	< 0.001
%PPD ≥ 6 mm (Mean ± SD)	0.4 ± 0.4	6.8 ± 1.6	< 0.001
Mean PPD (Mean ± SD)	2.4 ± 0.6	4.4 ± 0.8	0.0007
Mean AL (Mean ± SD)	2.5 ± 0.5	5.2 ± 0.7	0.00002
FMBS (Mean ± SD)	7.7 ± 4.8	37.6 ± 13.4	< 0.001
FMPS (Mean ± SD)	28.6 ± 20.8	55.5 ± 8.9	< 0.001
N of teeth lost due to peridontitis (Mean ± SD)	/	3.6 ± 1.6	
Mobility (*N* [%])			
Grade I	/	5 (25)	
Grade II	/	9 (45)	
Grade III	/	5 (25)	
N of teeth with mobility (Mean ± SD)	/	3.3 ± 1.5	
Periodontitis stage and grade (*N* [%])			
III A	/	2 (10)	
III B	/	5 (25)	
III C	/	6 (30)	
IV B	/	5 (25)	
IV C	/	2 (10)	
Periodontitis extent (*N* [%])			
Localized	/	2 (10)	
Generalized	/	18 (90)	

Abbreviations: AL, attachment loss; FMBS, full mouth bleeding score; FMPS, full mouth plaque score; N, number; PPD, probing pocket depth.

TABLE 3 | (a) Mean sleep BWI and BTI between current smokers, former smokers, and never smokers and (b) Comparison between the BTI and BWI indexed between never smokers, current smokers and former smokers (p-values).

Smoking status	BWI (Mean ± SD)		BTI (Mean ± SD)
(a)			
Never smokers ($n=18$)	0.057 ± 0.047		0.869 ± 0.719
Current smokers ($n=15$)	0.109 ± 0.200		0.939 ± 1.056
Former smokers ($n=7$)	0.024 ± 0.014		0.731 ± 0.512
Bruxism indexes	**NS vs. CS**	**NS vs. FS**	**CS vs. FS**
(b)			
BWI	0.731	0.155	0.860
BTI	0.759	0.717	0.833

Note: Mann–Whitney *U* test for comparison between the three groups.
Abbreviations: BTI, Bruxism time index; BWI, Bruxism work index; CS, Current Smokers; FS, Former Smokers; NS, Never Smokers; SD, Standard Deviation.

TABLE 4 | Mean sleep BWI and BTI for the periodontally healthy group and the periodontitis group.

	BWI						BTI					
	Mean ± SD	Median	IQR	95% Confidence interval	U	Z	Mean ± SD	Median	IQR	95% Confidence interval	U	Z
Periodontally healthy group ($n = 20$)	0.059 ± 0.047	0.0465	0.079	127.60–272.40	271.5	1.92	0.950 ± 0.871	0.649	1.031	127.55–272.45	229.5	0.785
Periodontal disease group ($n = 20$)	0.081 ± 0.177	0.020	0.051				0.790 ± 0.783	0.549	1.254			
p		0.054						0.432				

Note: Mann–Whitney *U* test for the comparison between the groups.
Abbreviations: BTI, Bruxism time index; BWI, Bruxism work index.

TABLE 5 | Correlation between the percentage of sites with PPD ≥ 4 with BoP, the % of the FMBS and the % of FMPS with the BWI and BTI recorded during sleep.

	BWI	BTI
%PPD ≥ 4 mm with BOP	−0.256	0.338
p	0.111	0.156
%FMBS	−0.410	−0.210
p	0.012*	0.182
%FMPS	0.005	0.123
p	0.976	0.449

Note: Spearman Correlation Analysis between bruxism work index, bruxism time index and periodontal variables.
Abbreviations: AL, attachment loss; BTI, bruxism time index; BWI, bruxism work index; FMBS, full mouth bleeding score; FMPS, full mouth plaque score; PPD, probing pocket depth.
*Statistically significant at $p < 0.05$.

4 | Discussion

The aim of the present investigation was to assess if a significant difference exists in the intensity and frequency of sleep bruxism activities between patients with and without periodontitis. To test such a hypothesis, a group of patients with stage III and stage IV periodontitis was recruited and compared with a control group of individuals without periodontitis. An instrumental assessment of sleep bruxism was performed through surface EMG, adopting the recently introduced BWI and BTI that were elaborated in the STAB (Manfredini, Ahlberg, Aarab, Bender, et al. 2024). This is the first study to use such indexes to assess bruxism in subjects affected by severe periodontitis. The statistical analysis showed no significant difference between BWI and BTI in the two groups. Based on these results, the null hypothesis could not be rejected.

As an interesting secondary finding, a negative significant correlation was found between BWI and FMBS of the whole population included in the study. Thus, the present study suggests that individuals with a higher level of inflammation of the periodontal tissues present a tendency to have a significantly lower intensity of bruxism episodes. Periodontitis was also correlated with a shorter duration of sleep bruxism episodes (BTI); however, such correlation was not statistically significant. These findings support the hypothesis that subjects with inflamed periodontium tend to exert a lower intensity of bruxism activities.

There could be different reasons for such findings. Patients with periodontitis have fewer teeth than subjects without periodontitis, and the lower number of dental elements can lead to reduced bite strength (Su et al. 2024), especially in subjects with loss of posterior support (Gibbs et al. 2002) and, subsequently, potentially reduced intensity of the masticatory muscle activities. Secondly, subjects with advanced stages of periodontitis suffer from tooth extrusion and hypermobility, which are features that tend to worsen the well-being of the patients (Agnese et al. 2025), masticatory dysfunction, and possibly induce patients to avoid contact between the two arches due to eventual discomfort. Thus, a potential self-protective attitude can be hypothesized. Moreover, no significant difference

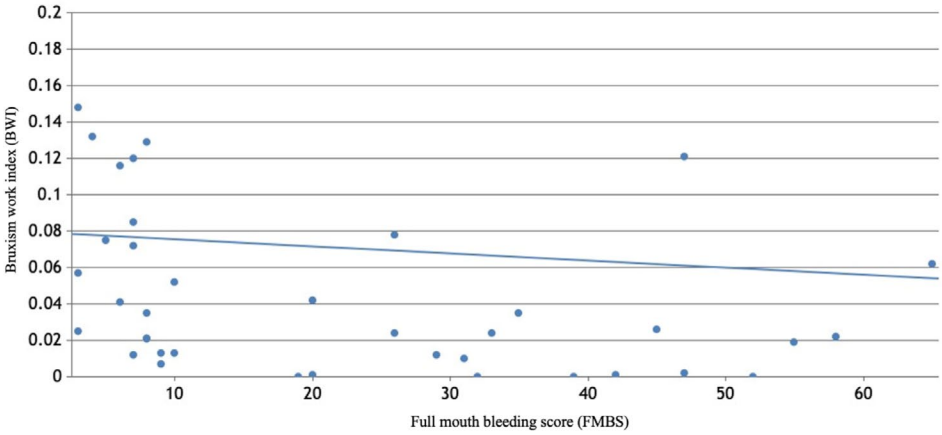

FIGURE 3 | Scatter plot of full mouth bleeding score (FMBS) (*x*-axis) and bruxism work index (BWI) (*y*-axis). Spearman's rank correlation: $\rho = [-0.410]$, $p = [0.012]$, $n = 40$.

was found between the BWI and BTI of smokers and never smokers. Such a finding is in line with the recent evidence showing that smoking has no direct impact on the frequency of SB (Ahlberg et al. 2024). Indeed, it could be seen as an indicator of underlying psychological distress (Pollis et al. 2025), which instead has a much higher impact on SB and may thus be the mediator between smoking and bruxism (Kurup et al. 2024; Ekman et al. 2023).

A systematic review published in 2015 showed that there was not enough evidence to suppose an association between bruxism and periodontitis, concluding that from a biological point of view, there is no rationale to state that bruxism can damage the healthy periodontium (Manfredini et al. 2015). In the subsequent years, a few other articles tried to shed more light on the topic. In 2019, Botelho et al. (2020) in a cross-sectional investigation, found even a negative association between the severity of periodontitis and the self-reported presence/absence of bruxism, which is in accordance with the results of the present study. In that investigation, patients with self-reported bruxism had significantly lower values of PPD, CAL, and BOP compared to patients who did not report bruxism (Botelho et al. 2020). In contrast with this paper, two cross-sectional studies published by Martinez-Canut et al. found instead a positive association between bruxism and tooth loss in patients undergoing periodontal maintenance therapy (Martinez-Canut et al. 2017; Martinez-Canut 2015). The reason for such discrepancy could be explained by the different methodologies adopted. Martinez-Canut et al. assessed bruxism by adopting the Tooth Wear Index proposed in 1990 by Ekfeldt et al. (Ekfeldt et al. 1990), supposing that the presence/absence of tooth wear should imply the presence/absence of bruxism. Such common belief, which largely characterized the early literature on bruxism, was shown to be incorrect by investigations performed using electromyography as well as by analyses of the differential diagnosis of tooth wear etiology. Indeed, a recent investigation found no correlation between the number of SB episodes per night and the degree of tooth wear (Manfredini et al. 2019). Additionally, a recent scoping review on the topic found a huge gap in the literature on the topic, with the absence of longitudinal studies proving a dose–response ratio between tooth wear and bruxism (Bronkhorst et al. 2024). Practice recommendations suggest, in case of the presence of extensive tooth wear, to investigate for the presence of medical conditions such as gastroesophageal reflux disease or eating disorders, along with the presence of an acidic diet (Leven and Ashley 2023; Wetselaar et al. 2020). In this regard, the recently proposed tooth wear evaluation system (TWES 2.0) recommends interesting strategies, looking for all the possible causes (Wetselaar et al. 2020).

Another limitation of the currently available studies is related to the old belief that bruxism is a behavior mostly manifesting as clenching and grinding of the teeth. The questionnaires used in the previously mentioned studies on a positive association between bruxism and periodontitis have been based on just two items, that is, asking patients if they are awake of clenching and/or grinding of the teeth during sleep or wakefulness. Nevertheless, it must also be considered that not all bruxism events necessarily involve tooth contact. In the last year, the importance of mandible bracing rapidly emerged as a behavior characterized by the isometric contraction of the masticatory muscle, without tooth contact, capable of overloading the temporomandibular joint and associated structures (Colonna et al. 2025; Câmara-Souza et al. 2023). As such, there could be a cluster of patients with bruxism behavior with a complete absence of tooth wear due to bruxism mostly manifesting through masticatory muscle activities without teeth contact.

The third important limitation of the available literature is the dichotomization of patients into two discrete categories, bruxers and non-bruxers, which is often still common for statistical purposes, albeit biologically unfounded, in light of the absence of clear-cut thresholds (Mungia et al. 2025). It is well known that bruxism is an umbrella term to indicate a spectrum of masticatory muscle activities that can be present in every individual up to a certain extent and whose clinical relevance is determined by its frequency and intensity (Manfredini, Ahlberg, Aarab, Bender, et al. 2024).

A recent EMG study was conducted on a group of 31 patients divided into subjects with no or mild periodontitis in comparison with subjects with moderate or severe periodontitis (Nakayama et al. 2018). The authors found an association between the duration of the masseter activity and patients with moderate and severe periodontitis. A direct comparison with such an investigation is complicated by two factors. Firstly, the authors adopted a different classification of periodontitis and did not

divide them according to the EFP grading and staging system (Glickman 1965), as we did in the present study. Instead, they adopted the consensus paper of the Center for Disease Control/American Association of Periodontology working group by Eke et al. in 2012 (Eke et al. 2012). Secondly, the paper adopted the criteria for the assessment of PSG/SB proposed by Lavigne et al. in 1996, which are not suitable for assessing the background masticatory muscle activity with the risk of underestimating the total intensity of bruxism-related muscle work during sleep (Manfredini, Ahlberg, Aarab, Bracci, et al. 2024).

The present cross-sectional study is limited by the lack of follow-up. The study design showed that no significant difference is present between patients with stage III and stage IV periodontitis and patients without periodontitis for sleep BWI and BTI but does not allow the study of the effect of such reduced activity on periodontium. Moreover, FMBS was negatively correlated with a significantly lower sleep BWI. Smoking and diabetes were recorded and found to be evenly distributed between groups; however, their potential role as confounding factors cannot be fully excluded and should be addressed in larger prospective studies. Moreover, the interpretation of the present findings should take into account giving that the sample size calculation was conducted on a sample of healthy individuals, since no previous studies on the association between periodontitis and the bruxism work and time indexes exist. Additionally, no conclusion can be drawn as to whether such a reduced level of bruxism activity can still influence the evolution of periodontitis. For such purposes, an investigation with a prospective study design is needed. Secondly, the paper limits the analysis to sleep bruxism without considering the possible effect of the masticatory muscle activity occurring during wakefulness. Future studies should consider analyzing the 24-h bruxism activities in relation to periodontitis, given that AB and SB often tend to co-occur (Manfredini et al. 2025). Another limitation to consider is the fact that the data were software-generated and that they refer only to one masseter muscle. The study design can be improved by analyzing the BTI and BWI of both right and left masseter muscles. Moreover, given the impact of the psychological sphere on the frequency of sleep bruxism, future studies should consider performing a psychological assessment of participants, as it can be an important confounder. The use of the instrumentally assessed frequency of bruxism through the recently conceptualized BWI and BTI, with the specification of the exact formula for calculation, along with the use of the EFP classification for periodontitis, are, however, points of strength that will help standardize future studies on the topic.

5 | Conclusion

The present cross-sectional study showed that no significant difference is present between patients with advanced stages of periodontitis (Stage III and Stage IV) and patients without periodontitis for the sleep bruxism work index and the sleep bruxism time index. Moreover, the patient's level of full mouth bleeding score was negatively correlated with the bruxism work index, suggesting that the intensity of the bruxism-related masticatory muscle activities is negatively influenced by the degree of periodontal inflammation.

Author Contributions

Tommaso Gotti: writing – original draft, data curation, visualization, investigation, software. **Isabella De Rubertis:** writing – review and editing, data curation, formal analysis, investigation, visualization. **Ovidiu Ionut Saracutu:** writing – original draft, writing – review and editing, methodology, validation, data curation, formal analysis. **Marco Ferrari:** project administration, resources, validation, visualization, supervision. **Nicola Discepoli:** writing – review and editing, conceptualization, supervision, validation, visualization, methodology. **Daniele Manfredini:** writing – review and editing, conceptualization, methodology, validation, visualization, resources, supervision, project administration, investigation.

Funding

The authors have nothing to report.

Consent

All individuals gave their informed consent in accordance with the Helsinki Declaration and understood that they were free to withdraw from the study at any time. The research protocol was approved by the Institutional Review Board of the Orofacial Pain Unit, University of Siena, Siena, Italy (#0087-2022).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

Agnese, C. C. D., C. Schöffer, K. Z. Kantorski, F. B. Zanatta, C. Susin, and R. P. Antoniazzi. 2025. "Periodontitis and Oral Health-Related Quality of Life: A Systematic Review and Meta-Analysis." *Journal of Clinical Periodontology* 52, no. 3: 408–420. https://doi.org/10.1111/jcpe.14074.

Ahlberg, J., F. Lobbezoo, C. Hublin, M. Piirtola, and J. Kaprio. 2024. "Smoking Cessation Is Not Associated With a Decline in Reported Sleep Bruxism in Middle-Aged Finnish Twins: Data Revisited." *Journal of Oral Rehabilitation* 51, no. 1: 117–118. https://doi.org/10.1111/joor.13524.

Ahlberg, K., A. Savolainen, S. Paju, et al. 2008. "Bruxism and Sleep Efficiency Measured at Home With Wireless Devices." *Journal of Oral Rehabilitation* 35, no. 8: 567. https://doi.org/10.1111/j.1365-2842.2008.01875.x.

Ainamo, J., and I. Bay. 1975. "Problems and Proposals for Recording Gingivitis and Plaque." *International Dental Journal* 25, no. 4: 229–235.

Bilgin Çetin, M., Y. Sezgin, E. Maraş, and İ. A. Cebeci. 2021. "Association of Probable Bruxism With Periodontal Status: A Cross-Sectional Study in Patients Seeking Periodontal Care." *Journal of Periodontal Research* 56, no. 2: 370–378. https://doi.org/10.1111/jre.12829.

Botelho, J., V. Machado, L. Proença, et al. 2020. "Relationship Between Self-Reported Bruxism and Periodontal Status: Findings From a Cross-Sectional Study." *Journal of Periodontology* 91, no. 8: 1049–1056. https://doi.org/10.1002/JPER.19-0364.

Bracci, A., F. Lobbezoo, A. Colonna, et al. 2024. "Research Routes on Awake Bruxism Metrics: Implications of the Updated Bruxism

Definition and Evaluation Strategies." *Journal of Oral Rehabilitation* 51, no. 1: 150–161. https://doi.org/10.1111/joor.13514.

Bronkhorst, H., S. Kalaykova, M. C. Huysmans, B. Loomans, and T. Pereira-Cenci. 2024. "Tooth Wear and Bruxism: A Scoping Review." *Journal of Dentistry* 145: 104983. https://doi.org/10.1016/j.jdent.2024.104983.

Câmara-Souza, M. B., A. Bracci, A. Colonna, M. Ferrari, R. C. M. Rodrigues Garcia, and D. Manfredini. 2023. "Ecological Momentary Assessment of Awake Bruxism Frequency in Patients With Different Temporomandibular Disorders." *Journal of Clinical Medicine* 12, no. 2: 501. https://doi.org/10.3390/jcm12020501.

Caton, J. G., G. Armitage, T. Berglundh, et al. 2018. "A New Classification Scheme for Periodontal and Peri-Implant Diseases and Conditions - Introduction and Key Changes From the 1999 Classification." *Journal of Clinical Periodontology* 45, no. 20: S1–S8. https://doi.org/10.1111/jcpe.12935.

Chen, X., C. Xu, Y. Wu, and L. Zhao. 2024. "The Survival of Periodontally Treated Molars in Long-Term Maintenance: A Systematic Review and Meta-Analysis." *Journal of Clinical Periodontology* 51, no. 5: 631–651. https://doi.org/10.1111/jcpe.13951.

Colonna, A., A. Bracci, and D. Manfredini. 2025. "Bracing: The Hidden Side of the Moon." *Cranio* 43: 1–3. https://doi.org/10.1080/08869634.2025.2472087.

Colonna, A., F. Lobbezoo, G. Gravili, L. Lombardo, J. Ahlberg, and D. Manfredini. 2024. "Effects of Orthodontic Aligners on 24-Hour Masseter Muscle Activity: A Multiple-Day Electromyographic Study." *Cranio* 43, no. 5: 1–10. https://doi.org/10.1080/08869634.2024.2357054.

Colonna, A., L. Noveri, M. Ferrari, A. Bracci, and D. Manfredini. 2022. "Electromyographic Assessment of Masseter Muscle Activity: A Proposal for a 24 h Recording Device With Preliminary Data." *Journal of Clinical Medicine* 12, no. 1: 247. https://doi.org/10.3390/jcm12010247.

Eke, P. I., R. C. Page, L. Wei, G. Thornton-Evans, and R. J. Genco. 2012. "Update of the Case Definitions for Population-Based Surveillance of Periodontitis." *Journal of Periodontology* 83, no. 12: 1449–1454. https://doi.org/10.1902/jop.2012.110664.

Ekfeldt, A., A. Hugoson, T. Bergendal, and M. Helkimo. 1990. "An Individual Tooth Wear Index and an Analysis of Factors Correlated to Incisal and Occlusal Wear in an Adult Swedish Population." *Acta Odontologica Scandinavica* 48, no. 5: 343–349. https://doi.org/10.3109/00016359009033627.

Ekman, A., A. Tiisanoja, R. Näpänkangas, and K. Sipilä. 2023. "Association of Health-Related Factors With Self-Reported Sleep and Awake Bruxism in Northern Finland Birth Cohort 1966 – A Cross-Sectional Study." *Cranio* 43, no. 3: 510–520. https://doi.org/10.1080/08869634.2023.2198462.

Gallo, L. M., S. S. Gross, and S. Palla. 1999. "Nocturnal Masseter EMG Activity of Healthy Subjects in a Natural Environment." *Journal of Dental Research* 78, no. 8: 1436–1444. https://doi.org/10.1177/00220345990780080901.

Gibbs, C. H., K. J. Anusavice, H. M. Young, J. S. Jones, and J. F. Esquivel-Upshaw. 2002. "Maximum Clenching Force of Patients With Moderate Loss of Posterior Tooth Support: A Pilot Study." *Journal of Prosthetic Dentistry* 88, no. 5: 498–502. https://doi.org/10.1067/mpr.2002.129062.

Glickman, I. 1965. "Clinical Significance of Trauma From Occlusion." *Journal of the American Dental Association* 70: 607–618. https://doi.org/10.14219/jada.archive.1965.0261.

Glickman, I., and J. B. Smulow. 1969. "The Combined Effects of Inflammation and Trauma From Occlusion in Periodontitis." *International Dental Journal* 19, no. 3: 393–407.

Gonzalez, Y. M., E. Schiffman, S. M. Gordon, et al. 2011. "Development of a Brief and Effective Temporomandibular Disorder Pain Screening Questionnaire: Reliability and Validity." *Journal of the American Dental Association* 142, no. 10: 1183. https://doi.org/10.14219/jada.archive.2011.0088.

Hamp, S. E., S.-. E. Hamp, S. Nyman, and J. Lindhe. 1975. "Periodontal Treatment of Multirooted Teeth. Results After 5 Years." *Journal of Clinical Periodontology* 2, no. 3: 126–135. https://doi.org/10.1111/j.1600-051x.1975.tb01734.x.

Hasegawa, Y., G. Lavigne, P. Rompré, T. Kato, M. Urade, and N. Huynh. 2013. "Is There a First Night Effect on Sleep Bruxism? A Sleep Laboratory Study." *Journal of Clinical Sleep Medicine* 9, no. 11: 1139. https://doi.org/10.5664/jcsm.3152.

Jung, J. K., and Y. G. Im. 2022. "Can the Subject Reliably Reproduce Maximum Voluntary Contraction of Temporalis and Masseter Muscles in Surface EMG?" *Cranio* 43, no. 3: 380–389. https://doi.org/10.1080/08869634.2022.2142234.

Karolyi, M. 1901. "Beobachtungen iiber Pyorrhea alveolaris." *Osterreichisch-Ungarische Vierteljahrsschrift Fur Zahnheilkunde* 5: 279–295.

Kato, S., D. Ekuni, S. Kawakami, A. H. Mude, M. Morita, and S. Minagi. 2018. "Relationship Between Severity of Periodontitis and Masseter Muscle Activity During Waking and Sleeping Hours." *Archives of Oral Biology* 90: 13–18. https://doi.org/10.1016/j.archoralbio.2018.02.021.

Kudo, A., T. Yamaguchi, S. Mikami, et al. 2023. "Frequency Distribution of the Number and Amplitude of Electromyographic Waveforms of the Masseter Muscle During Sleep in Patients With a Clinical Diagnosis of Sleep Bruxism." *Cranio* 43: 1–13. https://doi.org/10.1080/08869634.2023.2222640.

Kurup, S., A. Perez-Pino, and M. Litt. 2024. "The Association Between Temporomandibular Disorders Signs and Symptoms, Bruxism, and Health Variables: A Cross-Sectional Study." *Cranio* 43: 1083–1109. https://doi.org/10.1080/08869634.2024.2425918.

Landi, N., D. Manfredini, F. Tognini, M. Romagnoli, and M. Bosco. 2004. "Quantification of the Relative Risk of Multiple Occlusal Variables for Muscle Disorders of the Stomatognathic System." *Journal of Prosthetic Dentistry* 92, no. 2: 190–195. https://doi.org/10.1016/j.prosdent.2004.05.013.

Lang, N. P., S. Nyman, C. Senn, and A. Joss. 1991. "Bleeding on Probing as It Relates to Probing Pressure and Gingival Health." *Journal of Clinical Periodontology* 18, no. 4: 257–261. https://doi.org/10.1111/j.1600-051x.1991.tb00424.x.

Lavigne, G. J., P. H. Rompré, and J. Y. Montplaisir. 1996. "Sleep Bruxism: Validity of Clinical Research Diagnostic Criteria in a Controlled Polysomnographic Study." *Journal of Dental Research* 75, no. 1: 546–552. https://doi.org/10.1177/00220345960750010601.

Leven, A. J., and M. Ashley. 2023. "Epidemiology, Aetiology and Prevention of Tooth Wear." *British Dental Journal* 234, no. 6: 439–444. https://doi.org/10.1038/s41415-023-5624-0.

Lobbezoo, F., J. Ahlberg, K. G. Raphael, et al. 2018. "International Consensus on the Assessment of Bruxism: Report of a Work in Progress." *Journal of Oral Rehabilitation* 45, no. 11: 837–844. https://doi.org/10.1111/joor.12663.

Manfredini, A., O. I. Saracutu, M. Ferrari, M. Pollis, and D. Manfredini. 2025. "Sleep Bruxism Self-Report and Awake Bruxism: An Ecological Momentary Assessment." *Oral Diseases*. https://doi.org/10.1111/odi.15400.

Manfredini, D., J. Ahlberg, G. Aarab, et al. 2020. "Towards a Standardized Tool for the Assessment of Bruxism (STAB)-Overview and General Remarks of a Multidimensional Bruxism Evaluation System." *Journal of Oral Rehabilitation* 47, no. 5: 549–556. https://doi.org/10.1111/joor.12938.

Manfredini, D., J. Ahlberg, G. Aarab, et al. 2024. "Standardised Tool for the Assessment of Bruxism." *Journal of Oral Rehabilitation* 51, no. 1: 29–58. https://doi.org/10.1111/joor.13411.

Manfredini, D., J. Ahlberg, G. Aarab, et al. 2024. "The Development of the Standardised Tool for the Assessment of Bruxism (STAB): An International Road Map." *Journal of Oral Rehabilitation* 51, no. 1: 15–28. https://doi.org/10.1111/joor.13380.

Manfredini, D., J. Ahlberg, G. J. Lavigne, P. Svensson, and F. Lobbezoo. 2024. "Five Years After the 2018 Consensus Definitions of Sleep and Awake Bruxism: An Explanatory Note." *Journal of Oral Rehabilitation* 51, no. 3: 623–624. https://doi.org/10.1111/joor.13626.

Manfredini, D., J. Ahlberg, R. Mura, and F. Lobbezoo. 2015. "Bruxism Is Unlikely to Cause Damage to the Periodontium: Findings From a Systematic Literature Assessment." *Journal of Periodontology* 86, no. 4: 546–555. https://doi.org/10.1902/jop.2014.140539.

Manfredini, D., A. De Laat, E. Winocur, and J. Ahlberg. 2016. "Why Not Stop Looking at Bruxism as a Black/White Condition? Aetiology Could Be Unrelated to Clinical Consequences." *Journal of Oral Rehabilitation* 43, no. 10: 799–801. https://doi.org/10.1111/joor.12426.

Manfredini, D., B. Häggman-Henrikson, A. Al Jaghsi, et al. 2025. "Temporomandibular Disorders: INfORM/IADR Key Points for Good Clinical Practice Based on Standard of Care." *Cranio* 43, no. 1: 1–5. https://doi.org/10.1080/08869634.2024.2405298.

Manfredini, D., N. Landi, M. Romagnoli, and M. Bosco. 2004. "Psychic and Occlusal Factors in Bruxers." *Australian Dental Journal* 49, no. 2: 84–89. https://doi.org/10.1111/j.1834-7819.2004.tb00055.x.

Manfredini, D., N. Landi, F. Tognini, G. Montagnani, and M. Bosco. 2004. "Occlusal Features Are Not a Reliable Predictor of Bruxism." *Minerva Stomatologica* 53, no. 5: 231–239.

Manfredini, D., and F. Lobbezoo. 2021. "Sleep Bruxism and Temporomandibular Disorders: A Scoping Review of the Literature." *Journal of Dentistry* 111: 103711. https://doi.org/10.1016/j.jdent.2021.103711.

Manfredini, D., L. Lombardo, A. Visentin, A. Arreghini, and G. Siciliani. 2019. "Correlation Between Sleep-Time Masseter Muscle Activity and Tooth Wear: An Electromyographic Study." *Journal of Oral & Facial Pain and Headache* 33, no. 2: 199–204. https://doi.org/10.11607/ofph.2081.

Martinez-Canut, P. 2015. "Predictors of Tooth Loss due to Periodontal Disease in Patients Following Long-Term Periodontal Maintenance." *Journal of Clinical Periodontology* 42, no. 12: 1115–1125. https://doi.org/10.1111/jcpe.12475.

Martinez-Canut, P., A. Llobell, and A. Romero. 2017. "Predictors of Long-Term Outcomes in Patients Undergoing Periodontal Maintenance." *Journal of Clinical Periodontology* 44, no. 6: 620–631. https://doi.org/10.1111/jcpe.12730.

Miller, S. C. 1950. *Textbook of Periodontia Oral Medicine*, 420–470. Blakinston.

Moreno-Hay, I., and S. D. Bender. 2024. "Bruxism and Oro-Facial Pain Not Related to Temporomandibular Disorder Conditions: Comorbidities or Risk Factors?" *Journal of Oral Rehabilitation* 51, no. 1: 196–201. https://doi.org/10.1111/joor.13581.

Mungia, R., F. Lobbezoo, E. Funkhouser, et al. 2025. "Dental Practitioner Approaches to Bruxism: Preliminary Findings From the National Dental Practice-Based Research Network." *Cranio* 43, no. 3: 480–488. https://doi.org/10.1080/08869634.2023.2192173.

Nakayama, R., A. Nishiyama, and M. Shimada. 2018. "Bruxism-Related Signs and Periodontal Disease: A Preliminary Study." *Open Dentistry Journal* 12, no. 1: 400–405. https://doi.org/10.2174/1874210601812010400.

O'Leary, T. J., R. B. Drake, and J. E. Naylor. 1972. "The Plaque Control Record." *Journal of Periodontology* 43, no. 1: 38. https://doi.org/10.1902/jop.1972.43.1.38.

Pollis, M., F. Lobbezoo, A. Colonna, and D. Manfredini. 2024. "Relationship Between Sleep Bruxism and Obstructive Sleep Apnoea: A Population-Based Survey." *Australian Dental Journal* 69, no. 1: S101–S107. https://doi.org/10.1111/adj.13036.

Pollis, M., F. Lobbezoo, O. I. Saracutu, A. Colonna, and D. Manfredini. 2025. "Psychological Distress: A Mediating Factor in the Relationship Between Sleep Bruxism and Tobacco Smoking." *Journal of Oral Rehabilitation* 52: 13978. https://doi.org/10.1111/joor.13978.

Pollis, M., F. Lobbezoo, M. Val, M. Ferrari, and D. Manfredini. 2026. "Sleep Bruxism and GERD Correlation in a General Population Convenience Sample." *Cranio* 44, no. 1: 52–58. https://doi.org/10.1080/08869634.2024.2443697.

Ramfjord, S. P. 1961. "Bruxism, a Clinical and Electromyographic Study." *Journal of the American Dental Association* 62, no. 1: 21–44. https://doi.org/10.14219/jada.archive.1961.0002.

Raphael, K. G., M. N. Janal, D. A. Sirois, et al. 2013. "Masticatory Muscle Sleep Background Electromyographic Activity Is Elevated in Myofascial Temporomandibular Disorder Patients." *Journal of Oral Rehabilitation* 40, no. 12: 883–891. https://doi.org/10.1111/joor.12112.

Raphael, K. G., D. A. Sirois, M. N. Janal, et al. 2012. "Sleep Bruxism and Myofascial Temporomandibular Disorders: A Laboratory-Based Polysomnographic Investigation." *Journal of the American Dental Association* 143, no. 11: 1223–1231. https://doi.org/10.14219/jada.archive.2012.0068.

Saracutu, O. I., M. Ferrari, M. Pollis, D. Manfredini, and E. F. Cagidiaco. 2025. "The Outcome of Prosthodontic Treatments in Individuals With Bruxism and Different Restoration Material. A Scoping Literature Review." *Cranio* 1: 1–13. https://doi.org/10.1080/08869634.2025.2477964.

Saracutu, O. I., D. Manfredini, A. Bracci, M. Val, M. Ferrari, and A. Colonna. 2025. "Comparison Between Ecological Momentary Assessment and Self-Report of Awake Bruxism Behaviours in a Group of Healthy Young Adults." *Journal of Oral Rehabilitation* 52, no. 3: 289–295. https://doi.org/10.1111/joor.13895.

Saracutu, O. I., M. Pollis, L. Bulferi Bulferetti, et al. 2025. "Comparison Between Two Different Registration Protocols for the Count of Sleep Bruxism Events in a Sample of Healthy Individuals." *Clinical Oral Investigations* 29, no. 7: 365. https://doi.org/10.1007/s00784-025-06394-2.

Su, J. N., Y. H. Pan, O. Dorj, et al. 2024. "Association Between Oral Health Status and Occlusal Bite Force in Young Adults." *Journal of Dental Sciences* 19, no. 2: 1182–1189. https://doi.org/10.1016/j.jds.2023.11.005.

Tonetti, M. S., H. Greenwell, and K. S. Kornman. 2018. "Staging and Grading of Periodontitis: Framework and Proposal of a New Classification and Case Definition." *Journal of Periodontology* 89, no. Suppl 1: S159–S172. https://doi.org/10.1002/JPER.18-0006.

Van Der Zaag, J., F. Lobbezoo, C. M. Visscher, H. L. Hamburger, and M. Naeije. 2008. "Time-Variant Nature of Sleep Bruxism Outcome Variables Using Ambulatory Polysomnography: Implications for Recognition and Therapy Evaluation." *Journal of Oral Rehabilitation* 35, no. 8: 577–584. https://doi.org/10.1111/j.1365-2842.2008.01893.x.

Verhoeff, M. C., F. Lobbezoo, J. Ahlberg, et al. 2025. "Updating the Bruxism Definitions: Report of an International Consensus Meeting." *Journal of Oral Rehabilitation* 52, no. 9: 13985. https://doi.org/10.1111/joor.13985.

Vlăduțu, D. E., M. Ionescu, R. Mercuț, et al. 2022. "Ecological Momentary Assessment of Masseter Muscle Activity in Patients With Bruxism." *International Journal of Environmental Research and Public Health* 20, no. 1: 581. https://doi.org/10.3390/ijerph20010581.

Wetselaar, P., M. J. M. Wetselaar-Glas, L. D. Katzer, and M. O. Ahlers. 2020. "Diagnosing Tooth Wear, a New Taxonomy Based on the Revised Version of the Tooth Wear Evaluation System (TWES 2.0)." *Journal of Oral Rehabilitation* 47, no. 6: 703–712. https://doi.org/10.1111/joor.12972.