

UPDATE

# Awake bruxism

*Bruxismo de la vigilia*

*Bruxismo da vigilia*

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## Abstract

Sleep bruxism has been extensively studied in recent decades, but considerable scientific controversy still persists in relation to awake bruxism. The present review focused on this topic, including 45 articles published between 2011 and 2020. International consensus propose advances in new diagnostic classifications, which include tools such as questionnaires, clinical examination, electromyography, polysomnography, momentary ecological evaluation and experience sampling methods. Awake bruxism is considered a behavioral problem, which can be treated by behavioral therapies. The momentary ecological evaluation allows capturing behavioral information in real time and is presented as a valuable tool for the diagnosis and evaluation of awake bruxism. Despite numerous advances presented in this review, studies are still required to explore this area of knowledge, especially in the pathophysiological mechanisms and their possible treatments.

**Keywords:** bruxism, ecological momentary assessment.

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## Resumen

El bruxismo del sueño ha sido extensamente estudiado en las últimas décadas pero aún persiste una considerable controversia científica en relación al bruxismo de la vigilia. El presente trabajo de revisión se focalizó en este tema, incluyendo 45 artículos publicados entre los años 2011 al año 2020. Los consensos internacionales plantean avances en nuevas clasificaciones diagnósticas, que contemplan herramientas como cuestionarios, examen clínico, electromiografía, polisomnografía, evaluación ecológica momentánea y métodos de muestreo de experiencias. Se considera al bruxismo de la vigilia un problema comportamental, pasible de ser tratado mediante terapias comportamentales que lo controlen. La evaluación ecológica momentánea permite capturar información comportamental en tiempo real y se presenta como una herramienta valiosa para el diagnóstico y evaluación del bruxismo de la vigilia. A pesar de numerosos avances presentados en esta revisión, aún se requieren estudios que exploren esta área del conocimiento, especialmente en los mecanismos fisiopatológicos y los posibles tratamientos.

**Palabras clave:** bruxismo, evaluación ecológica momentánea.

## Resumo

O bruxismo do sono tem sido amplamente estudado nas últimas décadas, mas ainda persiste considerável controvérsia científica em relação ao bruxismo de vigília. O presente trabalho de revisão focou nesse tema, incluindo 45 artigos publicados entre 2011 e 2020. Consensos internacionais propõem avanços em novas classificações diagnósticas, que incluem ferramentas como questionários, exame clínico, eletromiografia, polissonografia, avaliação ecológica momentânea e métodos de amostragem de experiência. O bruxismo de vigília é considerado um problema comportamental, que pode ser tratado por terapias comportamentais que o controlam. A avaliação ecológica momentânea permite capturar informações comportamentais em tempo real e se apresenta como uma ferramenta valiosa para o diagnóstico e avaliação do bruxismo em vigília. Apesar dos inúmeros avanços apresentados nesta revisão, ainda são necessários estudos para explorar essa área do conhecimento, principalmente nos mecanismos fisiopatológicos e possíveis tratamentos.

**Palavras-chave:** bruxismo, avaliação ecológica momentanea.

## Introduction

The ways in which bruxism is defined and classified have been numerous and have varied over time, ranging from authors who emphasize tooth contact, defining it as a habit of grinding or clenching,<sup>(1)</sup> to more recent approaches highlighting the muscle component involved.<sup>(2)</sup> This area of knowledge is currently highly controversial, especially concerning awake bruxism. This condition also has a high prevalence

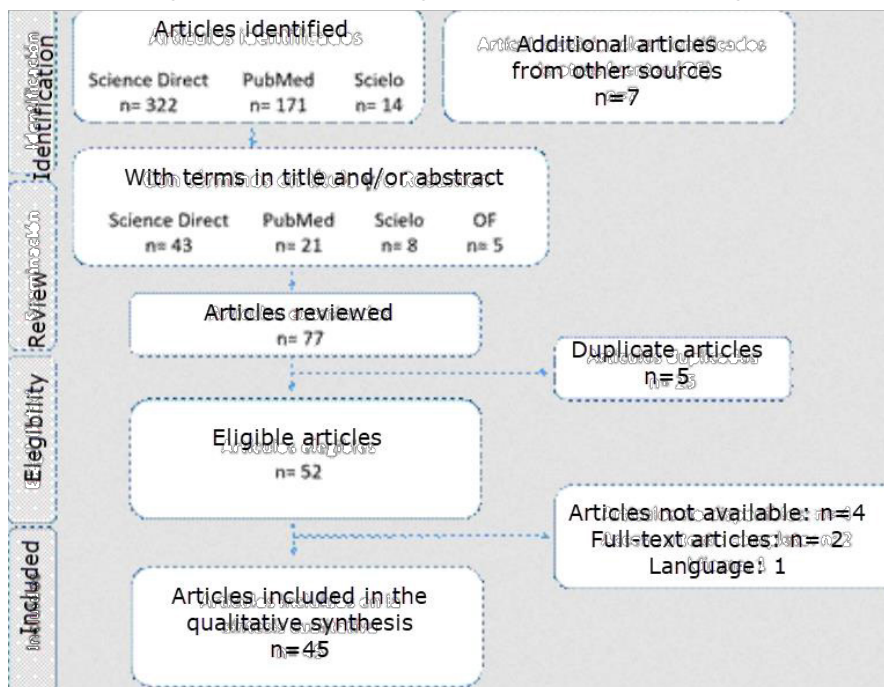
worldwide that ranges between 22% and 31% of the population.<sup>(3-5)</sup> A nationwide study was conducted in 2011 to determine the prevalence of bruxism and temporomandibular disorders (TMD). It showed that 55% of the population surveyed had at least one symptom, and 44% had at least one clinical sign, which led to the conclusion that these pathologies involve a series of variables that affect the health of the stomatognathic system and the quality of life of the people who suffer them.<sup>(6)</sup> Methodologi-

cal limitations, among other aspects, have hindered the production of high-impact papers. Previous publications show an inadequate and excessive use of systematic reviews in this area, whose scientific value is questionable due to the heterogeneity of the publications reviewed and can lead the reader to misleading, incomplete, or even erroneous conclusions.<sup>(7)</sup> It should also be noted that most of the published works focus on sleep bruxism. At the same time, there still exists uncertainty around the occurrence of the phenomenon during wakefulness. Given these variables, the high prevalence rate, and the degree of confusion and controversy involved, even among health professionals,<sup>(8,9)</sup> this study aimed to review the available knowledge on the phenomenon of awake bruxism, describe some of its essential characteristics, emphasizing the definition, classification, grading system, and diagnostic methods.

## Method

The study consisted of a narrative review conducted between November 2020 and February 2021. A search was conducted in databases such as PubMed, Scielo, ScienceDirect, and Timbó for articles published between 2011 and 2020, and reference texts on the subject reviewed. We used the Spanish descriptors “bruxismo de la vigilia,” “apretamiento diurno,” and the related terms in English (“awake bruxism”, “day-time clenching and/or grinding” and “diurnal clenching and/or grinding”). We included articles related to the subject under study and which contained the descriptors in the title or the abstract. The articles reviewed were research papers, reviews, and clinical cases with human studies, with full-text access published in Spanish or English. A total of 72 articles were found, and an additional 5 works from other sources were added. Of those (77), 32 were excluded according to the exclusion criteria in the flow-chart in Fig. 1. Therefore, 45 articles were included in this qualitative summary.

**Fig. 1. Search methodology and article selection strategy**



# Development

## Definition

The term “bruxism” evolved drastically in recent years, having been associated with dental clenching, being included among parasomnias, a predisposing or even protective factor against certain conditions. More recently, the focus has been placed on muscle contraction events. Many authors, however, focus on tooth contact as a sustained and invariable phenomenon. Therefore, they define it as the habit of involuntary spasmodic non-functional grinding or clenching of teeth that can cause dental trauma.<sup>(1)</sup> Others describe it as an oral habit possessing rhythmic activity of the orofacial muscles causing vigorous contact between the surfaces of the teeth.<sup>(10)</sup> They accordingly consider bruxism as a stereotyped movement disorder with tooth contact that can be secondary to central nervous system disorders (CNS), such as Parkinson’s disease, stroke and/or advanced dementia.<sup>(11,12)</sup> Functionally, it is also defined as a collective term for parafunctional movements outside the physiological range of chewing movements.<sup>(2,13)</sup> It can also cause various signs and symptoms, including masseter muscle hypertrophy, tooth wear, fracture or failure of restorations and dental implants, tooth sensitivity or pain, muscle or joint involvement, and temporomandibular joint (TMJ) disc displacements.<sup>(14)</sup> Therefore, tooth clenching is of great concern given its multiple clinical implications, such as destruction of tooth structure, fracture of dental rehabilitations, exacerbation of TMD, induction of temporalis muscle tension, and headache, which may also interfere with sleep.<sup>(15)</sup> Clinically, bruxism may be a risk factor leading to negative consequences, such as fatigue and muscle pain, and failures of dental restorations. However, it can also be associated with positive health outcomes, such as increasing salivation in patients with gastroesophageal reflux, thus reducing the risk of detrimental chemical tooth wear.<sup>(16)</sup> Recently, the definition of “brux-

ism” has been modified to unify the diffuse and heterogeneous criteria prevailing in the professional and research communities. Therefore, a recent international consensus of experts defined bruxism as “repetitive masticatory muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible.”<sup>(2,7)</sup> For this reason, most of the works published in the last five years base their research designs on this definition.<sup>(3,17-19)</sup> However, bruxism can be regarded as a sign of underlying disorders, and it can also represent a risk factor for clinical consequences, or it can be just a behavior without any pathological relevance.<sup>(20)</sup> Regardless, the 2018 definition highlights two important aspects. First, the focus has shifted to the muscle activity variable, specifying that bruxism does not necessarily involve tooth contact. Second, some authors consider that bruxism is not a pathological condition in healthy people.<sup>(7,16,21)</sup>

## Classification

For several decades, studies on bruxism focused on what happened during sleep. Consequently, various classifications addressed the condition from a general perspective and categorized it, according to its cause, into primary or secondary. The term “primary” refers to bruxism that occurs independently and is not associated with any other condition. In contrast, “secondary” refers to bruxism associated with a neurological disorder or an adverse drug effect.<sup>(22)</sup> Other classifications, for example, those based on the characteristics of tooth wear and mandibular dynamics (centric, eccentric), or according to the frequency of occurrence (mild, moderate, severe), have not been used in articles in recent years. Another classification resulting from the definition of SB, also used for AB, refers to the electromyographic characteristics of the contraction event and divides such events into tonic, phasic, or mixed.<sup>(23-25)</sup> Later on, this conception changed due to international expert consensus. Experts recommended that the sin-

gle definition of bruxism should no longer be used in favor of two separate definitions considering the circadian manifestations of the phenomenon: sleep and wakefulness.<sup>(2,18,19)</sup> Awake bruxism (AB) is a masticatory muscle activity occurring during wakefulness that is “characterized by a repetitive or sustained tooth contact and/or by bracing or thrusting the mandible,” and has special features.<sup>(7,16,20,26-28)</sup> Consequently, AB should not be considered as a movement disorder in healthy individuals, but rather a masticatory muscle activity during wakefulness which may or may not involve tooth contact.<sup>(4)</sup>

### **Prevalence**

Various papers state that the prevalence of bruxism ranges from 8% to 36%, in general.<sup>(5,13)</sup> However, most studies seem to agree that AB is more prevalent than SB when the circadian cycle is distinguished. According to data published in various studies, the prevalence of AB worldwide is between 22% and 31% of the population.<sup>(3-5)</sup> Several studies concluded that bruxism appears in over one third of the population, with a higher incidence in younger individuals, and decreases with age.<sup>(2,5,35)</sup> Consistently with the latter, a cross-sectional study that included 183 dental students estimated the prevalence of AB to be 36.5%.<sup>(33)</sup> Similarly, a descriptive cross-sectional study was conducted in Uruguay in 2011 to determine the prevalence of bruxism and TMD. This study found that temporomandibular disorders and bruxism are highly prevalent in our country. It showed that 55% of the population surveyed had at least one symptom, and 44% had at least one clinical sign, which led to the conclusion that these pathologies involve a series of variables that affect the health of the stomatognathic system, and the quality of life of the people who suffer them.<sup>(6)</sup>

### **Diagnostic evaluation**

The study of bruxism is still limited by differences in diagnostic criteria and instrument val-

idation in most research studies. For this reason, the consensus definition also introduced a diagnostic classification, according to which the validity of the diagnosis of bruxism can range from possible to definitive, based on the different approaches that can be used, for example, interviews, questionnaires, clinical examination, electromyography (EMG), polysomnography [PSG], ecological momentary assessment (EMA) or experience sampling methodology (ESM).<sup>(22,34)</sup> A bruxism assessment based on clinical variables depends on the findings associated with this condition, for example, extensive tooth attrition or muscle hypertrophy. Such findings occur variably, even in subjects with persistent chronic bruxism, and do not indicate the current status.<sup>(35)</sup> According to other authors, however, clinical features that are present both in SB and in AB, such as masticatory muscle hypertrophy, indentations on the tongue or lip and/or a linea alba on the inner cheek, can result from functional oromotor activities, such as swallowing, and are not necessarily indicative of bruxism.<sup>(36)</sup> Self-reports (SR) provide qualitative information about oral behaviors (presence/absence), which could be used to estimate frequencies.<sup>(37)</sup> Some authors have found positive correlations between AB questionnaire-based diagnoses and diagnoses based on history taking combined with a clinical examination,<sup>(38)</sup> while others claim that self-reported questionnaires are a common tool of limited validity in bruxism research<sup>(5,39)</sup> due to the lack of objective evaluation methods, non-functional tooth contact is mainly diagnosed using patient SR, through interviews and questionnaires. Nevertheless, the reliability of self-reported data is significantly limited by the patients' understanding of their unconscious behavior, which is consistent with the claim made by some authors that only 25% of patients with AB are aware of their condition.<sup>(40)</sup> These ways of identifying bruxism, however, have drawbacks. Some methods combine SR data with the clinical verification of the poten-



tial consequences of bruxism, including tooth wear, muscle hypertrophy, and tenderness. Even so, these kinds of signs mainly indicate chronic bruxism. Therefore, they are not well suited to identify acute episodes. Moreover, the causal link with parafunctional occlusion has not been confirmed since the loss of dental hard tissue is caused by physiological and non-physiological processes, which accumulate over the years.<sup>(13,41)</sup> It is worth emphasizing that modern concepts of bruxism indicate that, primarily, bruxism should be considered as a neuromuscular disorder of undetermined origin, identified by rhythmic jaw movements (RJM) during chewing, swallowing, and breathing, which are the result of neurophysiological and neurochemical changes.<sup>(42)</sup> Consequently, some research groups showed interest in recording and quantifying tooth contact. For this purpose, a study was developed in Japan to evaluate non-functional tooth contact in patients with TMD using an electronic system. According to this study, novel and reliable evaluations are necessary because “the reliability of self-reported data is considerably limited by the patients’ understanding of their unconscious behavior.” The researchers designed and installed a software program to send e-mails for 10 days, approximately every 20 minutes, to the subjects’ cell phones, asking whether their teeth were in contact. They concluded that, within the limitations of the study, patients with TMD had a higher frequency of non-functional tooth contact (11.7%) compared to healthy subjects (6.9%).<sup>(43)</sup> Following this evaluation strategy, a recent study introduced the concept of smartphone-based EMA to quantify AB frequency. This method has been used in several clinical fields, providing relevant real-time data collection during the day based on the natural environment of each individual.<sup>(29)</sup> The EMA was formulated to overcome the limitations of traditional quantitative methods used in various psychological studies. The common principle of many EMA techniques is that the patient re-

ports the outcome variable under study in real time, as in the case of the BruxApp® application. This application aims to re-educate patients by reminding them to relax their muscles and avoid tooth contact. It is based on a simple principle of data recording. The app emits a sound that alerts patients to focus on their jaw muscles and teeth position at random times during the day to allow for real-time reporting. This enables monitoring the patients’ oral behaviors in their natural environment. Also, repeated alerts at random intervals are potentially useful as an educational strategy to acquire awareness and reverse AB behaviors.<sup>(4)</sup> This instrument profits from the widespread use of smartphones and has many advantages for its application in AB assessment.<sup>(21)</sup> Its introduction in a research setting could allow for a better understanding of the condition’s epidemiology and relationship with various forms of bruxism, masticatory muscle pain, and TMJ pain.<sup>(4)</sup> Along the same lines, one study applied the EMA approach to provide information on the frequency of AB. The “positive alerts” to any AB behavior were measured over one week, and the average frequency was 28.3%.<sup>(44)</sup> A similar study using SR and EMA through a smartphone application, found 38.4% of “positive alerts” to AB behaviors over seven days, with tooth contact being the most frequent behavior (18.6% of alerts).<sup>(32)</sup> Another study on AB used BruxApp® in a population of 30 students to record the attitudinal conditions at the time of the alerts. Data were recorded over seven days, on two occasions, with a one-month interval between the two observation periods. Over the first seven days, the average frequency of relaxed jaw muscles reports at the study population level was 62%, and for tooth contact, it was 20%. One month later, the frequencies differed: relaxed jaw muscles increased to 74%, and tooth contact decreased to 11%, showing a potential self-awareness effect. Since the available literature is limited and inconsistent, comparing these findings with previous studies is

impossible.<sup>(16)</sup> instrumental assessment tools or real-time approaches are recommended to design a diagnostic classification of bruxism.<sup>(8)</sup> As part of this approach, technologies such as EMG and polysomnography can provide objective evidence of increased muscle activity associated with bruxism.<sup>(13)</sup> However, they require extensive equipment and are only suitable for a small group of subjects.<sup>(35)</sup> Furthermore, although AB is considered more prevalent, SB is the variant that has been studied the most, but diagnostic methods have reliability and validity weaknesses for detecting both conditions.<sup>(28)</sup> Given the focus on the muscular aspect of the condition, surface electromyography has gained ground because it provides detailed information on the motor activity of the jaw. This is an objective and reliable method to assess the intensity of muscle contractions and the duration of contraction episodes and can be used to measure the electrophysiological characteristics of spontaneous tooth clenching episodes during wakefulness, which could help to more accurately understand the effects of anxiety on the motor activity of the jaw and awake bruxism.<sup>(37,38)</sup> According to one study, in most cases, surveys on tooth clenching during wakefulness have been based on SR, which contained recall errors. Because electromyograms (EMGs) can record oral parafunctional behaviors such as clenching and grinding, ambulatory EMG recording with a portable device has been used to examine the state of the muscles under physiological and/or pathological conditions and has also been performed in laboratories. Daytime clenching behavior is identified mainly through subjective interviews in conjunction with clinical symptoms such as muscle pain or fatigue and tongue and/or oral mucosa indentations. However, little objective research has been conducted on clenching events. Therefore, little is known about the validity of self-reported clenching awareness during daytime activities.<sup>(25)</sup> Although the reference standard for the assessment of AB is real-time EMG, patients find

it difficult to comply when they need to undergo recordings of craniomandibular muscle activity for extended periods. This is key for understanding this condition's epidemiological characteristics and clinical management.<sup>(18,45)</sup> The expert consensus mentioned above<sup>(7)</sup> suggested that a definitive diagnosis of AB should be based on electromyographic recordings or, as an alternative due to the limitations of compliance during wakefulness, could be supported using EMA. The latter is described as a simple method to collect data on patients' self-reported AB, consisting of adopting a smartphone-based EMA protocol.<sup>(4)</sup> Finally, an advance of a study that aims to develop a bruxism assessment tool, which will have to undergo a rigorous validation process to create a potential scoring system, has been published recently. Its general structure will be based on a multimodular system that has two clear-cut main axes: an evaluation Axis A, including subject-based, clinically based, and instrumentally based assessments, and an aetiological/risk factors Axis B. In addition, existing and validated questionnaires should be used for all items.<sup>(8)</sup>

### Grading

A diagnostic grading system has been proposed for clinical and research purposes based on an appraisal of the advantages and limitations of the available diagnostic tools. Such a strategy recommends that any study should specify the diagnosis of sleep or awake bruxism as "possible," "probable," and "definitive" based on the diagnostic approach used.<sup>(18)</sup> Thus, self-reported approaches would only be sufficient for a "possible" diagnosis of both circadian manifestations of bruxism. In contrast, if a clinical evaluation with positive signs of the condition is included, a "probable SB or AB" diagnosis could be established.<sup>(4,29)</sup> Similarly, Baad Hansen<sup>(2)</sup> concludes that since a bruxism diagnostic classification system was proposed in 2013, it is acknowledged that commonly used methods such as SR and clinical examination can, at

best, only lead to a suggestion of probable bruxism. Instrumental approaches are required for definitive bruxism assessments.<sup>(50)</sup> Despite the rationale provided by several authors for incorporating more reliable methods, most studies use SR assessed only by questionnaires, which is a clear weakness.<sup>(35)</sup> In contrast, achieving a definitive diagnosis requires instrumental approaches such as the use of PSG (for SB) or EMG (for AB), which are costly and difficult to disseminate. This, unfortunately, makes their use impossible in an epidemiological study.<sup>(3)</sup> Likewise, it is difficult to establish a definitive diagnosis of AB due to the difficulties in obtaining continuous electromyographic recordings of the activity of the mandibular muscles during wakefulness. This is where EMA seems to play a prominent role because it enables real-time reporting of the condition under study.<sup>(18)</sup> This procedure, also known as “ESM,” requires a real-time report of the condition under study (for example, AB behaviors). Based on that, it could be helpful to assess the frequency of all conditions (teeth clenching, jaw clenching, teeth grinding, tooth contact habits) that are potentially part of the spectrum of AB behaviors, in a natural setting. To pursue that goal, smartphone technology provides an ideal platform for adopting EMA-based on-time evaluations at multiple daily recording points over multiple-day spans.<sup>(34,44)</sup> In summary, the classification system suggests that the diagnosis is “possible” when based on a positive SR only, “probable” when positive clinical findings are found (with or without a positive SR), and “definitive” based on predefined parameters in an instrumental assessment (with or without a positive SR and/or positive clinical findings).<sup>(8,22,51)</sup>

## Discussion

Although bruxism is a worldwide phenomenon that has attracted the interest of research groups, data regarding its prevalence may not be accu-

rate because the diagnostic methods used in most studies were questionnaire-based SR, and some of them included clinical signs. However, according to the expert consensus,<sup>(7)</sup> these methods result in what is classified as a diagnosis of possible or probable bruxism. Despite this, a descriptive cross-sectional study was conducted in Uruguay in 2011 with a large and representative sample. This research analyzed different variables based on questionnaires and clinical examinations. Active bruxism was more prevalent in the capital city than outside the capital, where the high prevalence rate of TMD and bruxism among the Uruguayan population was evident.<sup>(6)</sup> This study did not distinguish between the different circadian manifestations of the condition. Other studies report that although sleep bruxism has been studied the most, awake bruxism is more prevalent. Several authors show, based on various studies, that the prevalence of AB is higher than that of SB.<sup>(10,29,30)</sup> It was also found that AB predominates among young people and decreases with age.<sup>(2,5,31,32)</sup> Regarding the bruxism prevalence results, Riva et al.,<sup>(6)</sup> used an instrument that led to results of a “possible” or “probable” active bruxism based on a clinical examination and guided questionnaire, and failed to obtain data for a definitive diagnosis, according to the recommendations of the 2018 expert consensus.<sup>(7)</sup> Similarly, Melo et al.<sup>(28)</sup> state that, since the diagnostic methods for arriving at these results are inaccurate, additional studies are recommended to explore these issues in greater depth.<sup>(28)</sup> Regarding the definition of bruxism, although a 2013 international expert consensus defined bruxism as “a repetitive masticatory muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible,”<sup>(2)</sup> there still exist controversy around this point in studies. Thus, some authors<sup>(1,10)</sup> base their studies on the definition that tooth contact is an essential factor. In contrast, authors such as Manfredini et al.,<sup>(18)</sup> Nakayama et al.,<sup>(19)</sup> Winocur et al.,<sup>(3)</sup>



Saito-Murakami et al.,<sup>(20)</sup> used the concepts published in the consensus as references for their studies. Years later, the experts mentioned above, who promoted the 2013 consensus, published and updated the consensus, highlighting two important aspects of bruxism. One specifies that bruxism does not necessarily involve tooth contact since the focus has been definitively shifted to muscle activity. This current approach, which not only emphasizes the “classical” bruxism activities (clenching or grinding of the teeth), is consistent with the expert opinion that anatomical factors like certain characteristics of dental occlusion do not cause bruxism. Thus, bruxism should not be considered a disorder but rather a behavior that can be a risk and/or even a protective factor for certain clinical consequences.<sup>(3)</sup> Due to the expert consensus, bruxism is classified according to the circadian component into sleep or awake bruxism. This is the most commonly used classification and is mentioned by various authors.<sup>(2,18,19)</sup> No less important, several authors classify bruxism events into tonic, phasic, or mixed based on the electromyographic characteristics of this condition.<sup>(24-26,63)</sup> So far, most of the available data on the prevalence of AB have been obtained by retrospective SR at a single observation point. This approach requires participants to recall the frequency of a habit over the period covered by the report (for example, days, weeks, months, and years) and provide a generic response. The resulting answers may be biased and, therefore, include reporting errors.<sup>(16)</sup> Lobbezoo et al.<sup>(7)</sup> report that it is important to further the understanding that SR has limitations and shortcomings in general. Therefore, additional research is needed to improve non-instrumental assessment tools for bruxism. For now, however, self-assessment of awake bruxism remains the primary tool used in bruxism research and clinical practice. According to the American Academy of Sleep Medicine AB is usually identified by the patient due to the limitations in validated objective methods. In contrast to this situa-

tion, multiple research studies on SB, even some randomized clinical trials (RCT), evaluate different therapies for reducing muscle activity during sleep. Some authors claim that only a quarter of patients with AB are aware of the condition.<sup>(40)</sup> While it is recognized that instrumental approaches such as EMG and PSG are required to reach a definitive diagnosis,<sup>(7,21,34)</sup> Reissman et al.<sup>(35)</sup> argue that these studies require extensive equipment and are therefore only suitable for a small group of subjects. In addition, this gold standard assessment is currently only available for SB, not AB.<sup>(16)</sup> They also noted that using such tests in a large-scale epidemiological study is not feasible. They added that SR is a common tool in large population studies, serving as a justification for most studies using this instrument in their designs. In addition, no definitive criteria had been established for AB, and no information is available on the need to identify the presence of bruxism, as in some individuals, it can be a relatively harmless behavior without any clinical consequences.<sup>(8)</sup> However, the evaluation of bruxism based on clinical examination is widespread in the research. It depends on the findings associated with bruxism, for example, extensive tooth attrition or muscle hypertrophy. Such findings, however, occur variably, even in subjects with persistent chronic bruxism, and do not indicate the current status.<sup>(35)</sup> Regarding oral behaviors, EMA has already demonstrated its reliability in the research setting. Still, it should be noted that EMA-based data on AB are fragmented and limited to a few investigations of selected behaviors, such as teeth clenching and tooth contact habits. On the other hand, EMA protocols based on smartphones typically require participants to complete assessments at predetermined time intervals or windows, either in response to specific states or events or in response to an auditory signal programmed by the researchers. Thus, smartphones provide an ideal platform for real-time reports at multiple daily recording points over

multiple-day spans. While the instrument holds great promise, treatment adherence may be a methodological challenge. For this reason, a recent study evaluated compliance with the use of a smartphone-based application for the assessment of EMA over one week and found an average response compliance rate of 67.8%. Based on these results, it was concluded that the EMA-based strategy could have an interesting potential and that the results can be used for comparison purposes in future studies.<sup>(34)</sup> However, a precise definition of AB behaviors and calibration of examiners presenting this strategy to patients is needed to provide stronger evidence.<sup>(21)</sup> In brief, most research studies have focused on SB. At the same time, knowledge of AB is fragmented due to the difficulties obtaining hour-long EMG during wakefulness<sup>(45)</sup> and the subsequent availability of information (mainly based on retrospective self-report at a single observation point). There are few epidemiological data on AB, and findings are not easy to summarize due to the adoption of different assessment strategies.<sup>(34)</sup> In addition to these difficulties, some methodological aspects are under discussion, and a consensus has not been reached, such as those that study the threshold in the EMG channels above which masticatory muscle activity is considered a true activity burst or event. Regardless of the method, this value should be recorded before recording activity during wakefulness.<sup>(7)</sup> These are determined concerning MCV, or as the number of times it exceeds the basal level of muscle activity. There is controversy on this point among different authors regarding the percentage of MCV that should be used as a cut-off value (10% MCV,<sup>(24)</sup> 20%,<sup>(26)</sup> or even 30%<sup>(3)</sup>). However, the ability of the recording instruments to

differentiate parafunctional (bruxism) and functional (swallowing, phonation, etc.) EMG events is essential, and this is the methodological weakness that recent studies should emphasize.<sup>(25)</sup> Although the grading system proposed by Lobbezoo et al.<sup>(45)</sup> aims to improve and standardize the management of this type of phenomenon, the authors themselves recognize that this classification system was merely a suggestion and could even be difficult to adapt to current knowledge, due to the poor clinical validity of the cut-off points to assess the presence or absence of clinically relevant SB and AB. They also state that the purpose of the meetings was to outline a path towards a future comprehensive publication on a standardized tool for the assessment of bruxism (STAB).<sup>(45)</sup>

## Conclusions

According to current scientific evidence, awake bruxism should be considered an oromandibular muscular behavior that requires a specific instrumental approach to achieve a definitive diagnosis.

The use and combination of self-reporting, clinical, and instrumental diagnostic tools allow bruxism to be graded as possible, probable or definitive.

The introduction of the principles of ecological momentary assessment to the study of bruxism is a valuable tool for assessing awake bruxism, preferably in combination with self-report instruments.

Further research is needed to develop a reliable, valid, and accessible clinical assessment tool. Moreover, the study of bruxism poses new challenges, both in the area of research and in professional practice.

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**Conflict of interest:**

I declare that I have no commercial or associational interest that would present a conflict of interest with the submitted work.

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1. Conception and design of study
2. Acquisition of data
3. Data analysis
4. Discussion of results
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LIF has contributed in 1, 2, 3, 4, 5 y 6.

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