Journal of Oral Rehabilitation

WILEY

JOURNAL OF ORAL REHABILITATION

ORIGINAL ARTICLE OPEN ACCESS

Comparison Between Ecological Momentary Assessment and Self-Report of Awake Bruxism Behaviours in a Group of Healthy Young Adults

Ovidiu Ionut Saracutu[1] | Daniele Manfredini[1] | Alessandro Bracci[2] | Matteo Val[1] | Marco Ferrari[1] | Anna Colonna[1]

[1]Orofacial Pain Unit, School of Dentistry, Department of Medical Biotechnologies, University of Siena, Siena, Italy | [2]Department of Neurosciences, School of Dentistry, University of Padova, Padova, Italy

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

Received: 20 February 2024 | **Revised:** 17 October 2024 | **Accepted:** 26 October 2024

Funding: The authors received no specific funding for this work.

Keywords: awake bruxism | bruxism | ecological momentary assessment | oral behaviour checklist | self-report | standardised tool for the assessment of bruxism

ABSTRACT

Objective: The aim of this investigation was to compare the self-reported frequency of awake bruxism (AB) behaviours by means of a validated single-observation point questionnaire (i.e., Oral Behaviour Checklist [OBC]) with the frequency reported in real-time with an Ecological Momentary Assessment (EMA) over 1 week.

Materials and Methods: One hundred healthy young adults took part in the study. The frequency of some activities belonging to the spectrum of AB behaviours (i.e., teeth contact, mandible bracing, teeth clenching, teeth grinding) was evaluated using the EMA approach with smartphone technology support over 1 week. The OBC questionnaire was used to evaluate the self-reported frequency of the same AB behaviours. Spearman's rank correlation coefficient was adopted to test the correlation between the average score of each OBC question considered (i.e., teeth contact, mandible bracing, teeth clenching, teeth grinding) and the average frequency of the corresponding EMA item.

Results: Statistical analysis showed a weak-to-moderate level of correlation between the two different AB assessment methods. Mandible bracing showed the highest level of correlation, while teeth grinding had the lowest one.

Conclusions: While the OBC represents a valid and easy-to-administer screening tool for evaluating bruxism behaviours, the EMA approach provides a more detailed real-time report on AB behaviours.

1 | Introduction

In 2013, an international group of experts defined bruxism as a masticatory muscle activity (MMA) with two distinct circadian manifestations: awake bruxism (AB) and sleep bruxism [1]. In 2018, a second consensus paper provided a specific definition of AB: *a masticatory muscle activity during wakefulness characterised by repetitive or sustained tooth contact and/or by bracing or thrusting of the mandible* [2]. In the current state of knowledge, bruxism is no longer considered a pathology nor a parafunction [3]. More specifically, AB is an umbrella term that comprehends different types of MMA, such as teeth contact, teeth clenching, mandible bracing, and teeth grinding [4].

The most recent systematic review on AB epidemiology reported a prevalence ranging from 22.1% to 31%. No difference was found for gender, while it was demonstrated that the prevalence of AB decreases with age [5, 6]. However, the

systematic review's authors suggested that data from such epidemiological studies must be taken cautiously due to the AB assessment method that was adopted in all studies. Indeed, most investigations evaluated AB by administering a questionnaire with a single dichotomous question, such as asking if the participant is aware of clenching or grinding the teeth during the day. Despite being cost-effective and easy to implement in clinical and research settings, such an approach does not evaluate bruxism in its continuum, as it should be done according to current strategies proposed by the latest scientific evidence [1, 4, 7–9].

To overcome such shortcomings, the STAB (Standardised Tool for the Assessment of Bruxism) was developed to provide the first non-stackable, multidimensional evaluation system for bruxism [10–12]. The STAB proposes a dual axis, multiple-domain approach for the identification of the bruxism status as well as the aetiology and clinical consequences, based on a combination of subject-based assessment (SBA), clinical-based assessment, and instrumentally based-assessment (IBA).

Among the SBA approaches, the authors proposed a series of items gathered from the Oral Behaviour Checklist (OBC) questionnaire [13]. The OBC questionnaire is based on a series of questions regarding the various AB conditions, asking the patient to indicate their frequency in the last month using a Likert-type 5-point scale. Such a self-report approach still represents the easiest and fastest way to collect data on AB behaviours, allowing researchers to perform studies in large sample sizes [14–16]. However, such an approach may be affected by recall bias since individuals might not be able to correctly recall the frequency and type of behaviour occurring in a monthly span [2]. Therefore, the STAB additionally includes the adoption of a smartphone-based Ecological Momentary Assessment (EMA) approach in the IBA section [17]. The EMA evaluation is not a novel concept. It was adopted for years in the field of behavioural medicine, while only in recent years has it been found to be applicable to the AB assessment [18–28].

The EMA approach proved to be a reliable method to quantify and qualify the frequency of AB behaviours after compliance and comprehension are achieved [19–22]. Several studies on AB were performed on different categories of healthy individuals, such as preparatory college students [23], university students from different countries [24–26], and the general population [27, 28], using a dedicated smartphone-based EMA application [18].

Based on these premises, the present study aims to test the correlation between the score of the OBC questionnaire and the mean frequency of AB behaviours assessed by the EMA approach in a sample of healthy young adults.

2 | Materials and Methods

2.1 | Participants Recruitment

On 13 March 2019, 133 subjects were recruited among undergraduate students of the Dentistry and Dental Prosthodontics course at the University of Siena, Siena, Italy. A research study invitation email was sent to the students for enrollment into the study. Inclusion Criteria were the absence of any documented oral, systemic, psychiatric, or neurological disease. The temporomandibular disorder (TMD) pain screener was adopted to rule out temporomandibular disorders [29].

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. They were informed about the scope of the study and gave written consent before enrolment. The research protocol was approved by the Review Board of the Orofacial Pain Unit, University of Siena, Siena, Italy (#0033–2019).

2.2 | Experimental Design

After the participants signed the informed consent to participate in the study, they were invited to attend a 2-h seminar session. The leading researchers (O.I.S., A.C.) and the study coordinator (D.M.) gave participants information about the study protocol. In detail, in the first-hour, participants listened to an explanatory lesson regarding the new insights into the field of AB, with a special focus on the various AB behaviours (https://www.youtube.com/watch?v=xL79AcnpBCY). In the second part of the session, they received the OBC questionnaire. They also received an instruction sheet with the necessary information for downloading the research version of Bruxapp (BruxApp, World Medical Applications Srl, Italy), a smartphone-based application for the real-time report of AB behaviours. The instruction sheet also contained an ID code unique for each participant. After all, AB behaviour frequency was assessed both with the EMA approach (item A8.1 of the STAB) and with four AB items from the OBC (items A2.1, A2.2, A2.3, A2.4 of the STAB).

2.3 | Ecological Momentary Assessment

The app was pre-set with a specific number of notifications accompanied by an alert sound to be received at random times during the day. Upon receiving the alert sound, the participant was required to tap on the notification and select, among five possible current behaviours (i.e., relaxed jaw muscle, mandible bracing, teeth contact, teeth clenching, teeth grinding), the option that best fit with his/her current jaw condition. Moreover, participants were required to indicate the behaviour within 5 min after the alert sound to avoid recall bias. After 5 min, the notification disappears, and no answer can be reported. Participants were instructed to ignore the alert sounds received while performing physiological activities unrelated to the AB spectrum, such as speaking, eating, drinking, and yawning. They were required to perform the EMA protocol for 7 days. At the end of the week, the application automatically generates a report with a summary.

The app was set to send alerts from 08:00 to 12:00, 15:00 to 19:00, and 21:00 to 22:00 to reduce the probability of receiving an alert during meals. For the generated report to be valid, students were asked to answer to at least 60% of the daily alerts (12 out of 20). Such a threshold was chosen according to

recommendations from previous compliance studies [19, 20]. If a participant did not reach such a threshold, the app automatically extended his/her observation period for the days necessary to generate the seven-day report. The data from the days in which fewer than 12 alerts were answered were discarded. During the assessment period, participants did not have access to the data. After generating the report, the app automatically generated an anonymous CSV file that the participants were invited to share with the researchers involved in data collection (A.C., O.S.I., M.V.), along with the unique ID code. For any technical support, they could contact the study coordinators (A.B., D.M.) at any time.

2.4 | Self-Reported Awake Bruxism Assessment

For the assessment of self-report AB, the following four OBC items that are part of the STAB (items A2.1, A2.2, A2.3, A2.4) were considered [13];

- How often do you grind your teeth together during waking hours, based on the last month?
- How often do you clench your teeth together during waking hours, based on the last month?
- How often do you press, touch, or hold your teeth together other than while eating (i.e., contact between upper and lower teeth), based on the last month?
- How often do you hold, tighten, or tense your muscles without clenching or bringing teeth together, based on the last month?

Each item assessed the frequency of a specific AB behaviour, and the response option was based on a 5-point Linker scale as follows: "none of the time" (0), "a little of the time" (1), "some of the time" (2), "most of the time" (3), "all of the time" (4).

2.5 | Statistical Analysis

Statistical analysis was performed with Microsoft Office Excel 2021 (Los Angeles, CA, USA). A descriptive analysis of the AB conditions was performed, reporting mean, standard deviation, range, and coefficient of variation. Spearman's rank correlation coefficient was used to test the correlation between the average score of each OBC question considered (i.e., teeth contact, mandible bracing, teeth clenching, teeth grinding) and the average frequency of the corresponding EMA item. Gender comparison for the EMA assessed AB behaviours frequency was assessed via Student's *t*-test. The level of significance was set at $p < 0.05$.

3 | Results

Among the 133 students invited to participate in the study, 15 ignored the invitation. The remaining 118 met the inclusion criteria and attended the 2-h seminar. All of them completed the questionnaire and were instructed to perform the seven-day assessment of AB behaviours frequency via EMA. Eighteen further students did not reach the necessary alert response rate to be included in the study even after multiple days of prolonged observation period, and their data were discharged. This led to a final sample of 100 subjects (31 males and 69 females, mean age 22.5 years ±2.5, range 19–29) taking part in the study (Figure 1). Eleven participants did not reach the required threshold in the first instance and needed an extension of the observation period. All the other subjects did not need additional days to obtain seven valid assessment days.

The average EMA response rate was 76.1% ± 8.3%, without any statistically significant difference between genders (Table 1). Considering the individual frequency of each oral condition over 1 week, relaxed jaw muscles was the most frequent behaviour (77.3% ± 21.3%), followed by teeth contact (13.4% ± 15.7%), mandible bracing (6.9% ± 10.8%), teeth clenching (2.5% ± 4.6%), teeth grinding (0.4% ± 1.2%). Besides relaxed jaw muscles, teeth contact was the most reported AB behaviour. The coefficient of variation (CV) is expressed as the ratio between SD and mean for each of the 7 days of AB assessment (Table 1).

Table 2 summarises the results of the OBC questionnaire for each AB behaviour (i.e., teeth contact, mandible bracing, teeth clenching, teeth grinding). None of the time was the most indicated frequency (136 times), followed in order by a little of the time ($n = 97$), some of the time ($n = 95$), most of the time ($n = 62$), and all of the time ($n = 12$). The most chosen option was none of the time for teeth grinding ($n = 61$), while no participant indicated to perform mandible bracing and teeth grinding all of the time.

The level of correlation between the average score of each OBC item (i.e., teeth contact, mandible bracing, teeth

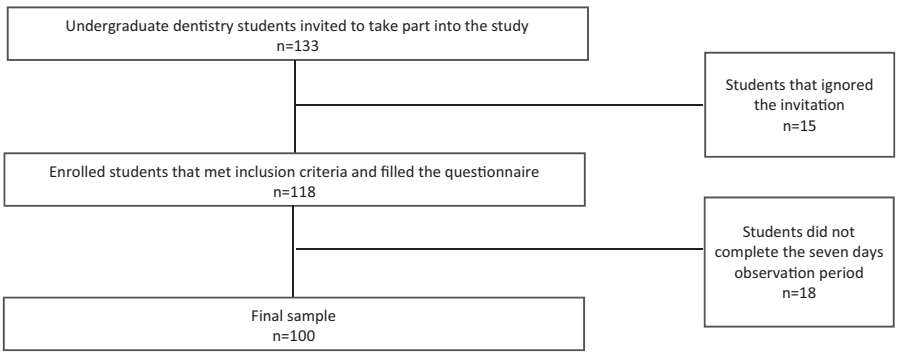

FIGURE 1 | Flowchart of volunteer selection.

TABLE 1 | Frequency data in percentage (mean, standard deviation, coefficient of variation) for the alert response rate and awake bruxism behaviours during the 7-days of observation.

Activity	D1	D2	D3	D4	D5	D6	D7	Mean	SD	Range	CV
Alert response rate	74.5	76.1	75.9	77.3	75.0	74.9	75.3	76.1	8.3	62.9–100	9.2
Relaxed jaw muscles	73.2	72.5	75.1	77.2	79.6	78.4	77.3	77.3	21.3	7.8–100	0.3
Teeth contact	15.5	13.8	13.5	12.3	11.5	12.8	12.8	13.4	15.7	0–80	1.2
Mandible bracing	7.8	8.8	7.7	6.9	5.7	5.4	7.0	6.9	10.8	0–62.5	1.6
Teeth clenching	2.0	3.6	3.6	2.2	2.2	2.1	2.2	2.5	4.6	0–18.4	1.8
Teeth grinding	0.6	0.5	0.5	0.3	0.1	0.1	0.6	0.4	1.2	0–4-4.3	3.0

Abbreviations: CV, Coefficient of variation; D, Day; SD, Standard deviation.

TABLE 2 | Number of times each condition was indicated (Oral Behaviour Checklist).

	None of the time = 0	A little of the time = 1	Some of the time = 2	Most of the time = 3	All of the time = 4
Teeth contact	26	17	30	16	11
Mandible bracing	30	29	25	16	0
Teeth clenching	17	30	27	25	1
Teeth grinding	61	21	13	5	0
Total	134	97	95	62	12

TABLE 3 | Spearman rank index correlation test between the OBC and the EMA.

	r	*p*
Teeth contact EMA/OBC	0.3	0.02
Mandible bracing EMA/OBC	0.55	< 0.001
Teeth clenching EMA/OBC	0.33	< 0.05
Teeth grinding EMA/OBC	0.23	0.015

Abbreviations: EMA, Ecological Momentary Assessment; OBC, Oral Behaviour Checklist.

clenching, teeth grinding) and the average frequency of the corresponding EMA question is reported in Table 3. A weak-to-medium level of correlation ($r = 0.3–0.55$) was found between the two different methods of AB assessment. Teeth grinding had the lowest level of correlation ($r = 0.23$), while mandible bracing had the highest ($r = 0.55$). All the results of the Spearman rank index correlation test were statistically significant ($p < 0.05$).

4 | Discussion

Self-reported approaches represent a universally accepted approach for assessing AB [4, 7]. Despite the self-report can affected by recall bias [2], various assessment methods proved to be easy to administer, cost-effective, and reliable [12]. Another possible strategy to assess and phenotype AB behaviours is represented by surface electromyography (EMG) [30], but such an approach is unfortunately partly limited by the costs and incomplete software development to interpret EMG traces based on the current bruxism definition. In addition, a feasible combination of EMG hardware and software is still lacking [31].

Based on that, the present cross-sectional observational study aimed to implement the knowledge on self-reported strategies by assessing the level of correlation between two methods included in the STAB, viz., the EMA approach (item A8.1 of the STAB) via a dedicated smartphone application (Bruxapp) and the single-recall point approach via the OBC (items A2.1, A2.2, A2.3, A2.4 of the STAB). Regarding the EMA, the main alert response rate during the 7 days of assessment was 76.1%, similar to other studies present in the literature [19, 20]. Besides relaxed jaw muscles, which was the most frequently reported condition (77.3%), teeth contact was the most common AB behaviour (13.4%), followed by mandible bracing (6.9%), teeth clenching (2.5%), and teeth grinding (0.4%). Such results are comparable with other studies conducted on undergraduate students [19, 20, 22–24] and the general population [28]. Statistical analysis showed a weak-to-moderate significant association between the frequency reported with EMA and the scores of the specific OBC questions. This can be explained by the participants' lack of awareness regarding masticatory muscle activity during wakefulness. Some subjects might become aware of their AB behaviours only thanks to the 7 days of self-monitoring through the EMA. This would imply that the strength of the association could be different if the OBC had been administered after the monitoring session. As such, a recent investigation found that the frequency of AB via EMA remained quite constant for 6 months [32]. Further studies should test the OBC consistency over time for the AB report and the possible impact of awareness training on its outcomes.

Due to the paucity of literature on the topic, a direct comparison with other papers is not always possible since most of the studies on EMA are focused on the frequency of AB behaviours and the compliance level [19–23, 25, 26]. Only three other investigations compared the OBC results with the EMA. In an Italian study on a sample of 151 participants recruited from the general population, the authors found a statistically significant association between the two assessment methods and a nonlinear association concerning mandible bracing [28]. This latter finding contrasts with the results of this study, which found the highest level of correlation between EMA and OBC for mandible bracing ($r = 0.55$). Such discrepancy might be explained by the different study samples. Undergraduate dentistry students have a dental background, which provides them with a more comprehensive understanding of bruxism, influencing the EMA and the OBC results. A second investigation on a smaller sample of college preparatory students in Brazil found a different but comparable level of correlation between the self-report and the EMA [24]. Conversely, a study conducted on Portuguese University students found very similar results to this study, as the level of the Pearson correlation test between the two assessment approaches was 0.5 for mandible bracing and 0.38 for teeth contact [26]. It is worth mentioning that in the latter study, the authors underwent different rounds of AB assessment before reaching such findings.

The main difference between the two approaches consists in the assessment's timing. The OBC strictly relies on the memory of the participant since he/she is required to answer a series of retrospective questions formulated as follows: "How often do you do each of the following activities, based on the last month?" [13]. In addition to the potential recall bias, it must also be remarked that the answer can be influenced by the moment of the day the questionnaire is filled out [33]. Conversely, the EMA approach assesses oral behaviours during different times of the day in natural settings, relying only on patient compliance and understanding of the conditions [27]. Thus, the two approaches might be indicated for different purposes. The OBC can serve as a screening tool in clinical settings, while the EMA can be prescribed by the clinician or the researcher when there is a suspect of high masticatory muscle activity to quantify and qualify the AB behaviours more reliably for potential treatment purposes.

Furthermore, with respect to recall strategies, the real-time assessment of AB can have other important functions. In the first stage, after the initial period of AB monitoring, the generated report can help patients become aware of their behaviours as part of cognitive-behavioural therapy (CBT), which is one of the strategies available for managing bruxism and TMDs [34, 35]. Secondly, smartphone-based applications can also be used for ecological momentary interventions (EMI) strategies [36]. In psychological care settings, the EMI approach has proved to be an effective method for inducing behavioural changes and promoting mental health through cognitive behavioural strategies [37]. When a patient receives an alert, he/she is invited to pay attention to his/her condition, focusing on the teeth's position and muscle tension, trying to reverse AB behaviours [38]. The efficacy of such a strategy in the field of AB has yet to be proved in a clinical setting [39].

The present study presents some limitations. The sample comprised undergraduate dentistry students representing a specific population. Thus, the level of compliance with using a smartphone-based application in the general population might be lower since it requires a series of interactions from the participants during the day, which might not be possible for individuals with certain work occupations. Moreover, it is known that dentistry university students are more prone to anxiety and psychological distress compared to the general population [40–42]. Considering the determinant impact of psyche on the frequency of AB behaviour [43–45], the AB frequency assessed in this study could be higher than in healthy adults. The mean frequencies of AB did not show any significant difference between the 7 days of monitoring; however, a wide range was found. Given the impact of psyche on the frequency of AB behaviours [46], further studies should confirm if the fluctuations of AB behaviours could be explained by the daily variation in the level of psychological distress assessed via questionnaires. Another limitation is represented by the fact that no clinical examination was performed to look for signs of bruxism, such as the presence of linea alba on checks mucosa and muscle hypertrophy.

However, this study adds important findings to further refine the different methods of AB assessment, as part of the needed research to cross-correlate the different approaches proposed in the STAB [12]. Ideally, these data should be included in a protocol with the wake-time analysis of the masseter and temporalis muscle EMG recordings [30, 47]. In contrast to the past, such analysis should be based on evaluating bruxism activity in its continuum, as the EMA approach, rather than by adopting specific cut-off points [9]. Interestingly, the present study based the self-reported evaluation on a 5-point Likert scale and not on a single-point evaluation system, as in most epidemiological studies on AB [6]. Such an approach allows clinicians to obtain a tentative quantitative report based on the patient's awareness of his/her behaviours, which could eventually be compared with the results of the EMA. However, patients might not be able to report with enough accuracy the frequency of AB conditions, leading to an underestimation of a potentially harmful behaviour [48]. Matching the two assessment methods could provide clinicians and patients with a more realistic picture of the AB behaviour frequency compared to the patient's initial beliefs as part of CBT, a first-line strategy for managing AB [49–51].

5 | Conclusions

In a sample of healthy young adults, the correlation between the self-reported OBC and the smartphone-based EMA approach was weak-to-moderate. Mandible bracing behaviour had a higher level of correlation. Such findings suggest a different use of the two assessment methods. The OBC could be adopted as a first screening tool for a general overview of the possible presence of AB behaviours; on the other hand, the EMA approach should be prescribed when a more detailed evaluation of AB behaviours is needed, as its results, collected in the natural environment and in real-time, are less affected by recall bias.

Author Contributions

O.I.S. contributed to the collection of the data, data processing, and writing of the original draft. D.M. has been involved in the conceptualization, methodology, supervision, reviewing, and editing of the original draft. A.B. conceptualised the study and contributed to data collection. M.V. contributed to data collection. M.F. co-supervised the investigation, organised session details, and revised the manuscript. A.C. took part in the collection of the data, data processing, and editing of the original draft.

Disclosure

A.B. took part as a shareholder of the WMA srl Company for the development of software for smartphones.

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.

Peer Review

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/joor.13895.

References

1. F. Lobbezoo, J. Ahlberg, A. G. Glaros, et al., "Bruxism Defined and Graded: An International Consensus," *Journal of Oral Rehabilitation* 40, no. 1 (2013): 2–4, https://doi.org/10.1111/joor.12011.

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

3. D. Manfredini, J. Ahlberg, G. J. Lavigne, P. Svensson, and F. Lobbezoo, "Five Years After the 2018 Consensus Definitions of Sleep and Awake Bruxism: An Explanatory Note," *Journal of Oral Rehabilitation* 51 (2023): 623–624, https://doi.org/10.1111/joor.13626.

4. A. Bracci, F. Lobbezoo, B. Häggman-Henrikson, et al., "International Network for Orofacial Pain and Related Disorders Methodology INfORM. Current Knowledge and Future Perspectives on Awake Bruxism Assessment: Expert Consensus Recommendations," *Journal of Clinical Medicine* 11, no. 17 (2022): 5083, https://doi.org/10.3390/jcm11175083.

5. D. Manfredini, E. Winocur, L. Guarda-Nardini, D. Paesani, and F. Lobbezoo, "Epidemiology of Bruxism in Adults: A Systematic Review of the Literature," *Journal of Orofacial Pain* 27, no. 2 (2013): 99–110, https://doi.org/10.11607/jop.921.

6. J. M. D. Oliveira, P. Pauletto, C. Massignan, et al., "Prevalence of Awake Bruxism: A Systematic Review," *Journal of Dentistry* 138 (2023): 104715, https://doi.org/10.1016/j.jdent.2023.104715.

7. A. Bracci, F. Lobbezoo, A. Colonna, et al., "Research Routes on Awake Bruxism Metrics: Implications of the Updated Bruxism Definition and Evaluation Strategies," *Journal of Oral Rehabilitation* 51, no. 1 (2024): 150–161, https://doi.org/10.1111/joor.13514.

8. D. Manfredini, A. Colonna, A. Bracci, and F. Lobbezo, "Bruxism: A Summary of Current Knowledge on Aetiology, Assessment and Management," *Journal of Oral Surgery* 13 (2020): 358–370.

9. D. Manfredini, J. Ahlberg, P. Wetselaar, P. Svensson, and F. Lobbezoo, "The Bruxism Construct: From Cut-Off Points to a Continuum Spectrum," *Journal of Oral Rehabilitation* 46, no. 11 (2019): 991–997, https://doi.org/10.1111/joor.12833.

10. D. Manfredini, J. Ahlberg, G. Aarab, et al., "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 (2020): 549–556, https://doi.org/10.1111/joor.12938.

11. D. Manfredini, J. Ahlberg, G. Aarab, et al., "The Development of the Standardised Tool for the Assessment of Bruxism (STAB): An International Road Map," *Journal of Oral Rehabilitation* 51 (2022): 15–28, https://doi.org/10.1111/joor.13380.

12. D. Manfredini, J. Ahlberg, G. Aarab, et al., "Standardised Tool for the Assessment of Bruxism," *Journal of Oral Rehabilitation* 51 (2023): 29–58, https://doi.org/10.1111/joor.13411.

13. M. R. Markiewicz, R. Ohrbach, and W. D. McCall, Jr., "Oral Behaviors Checklist: Reliability of Performance in Targeted Waking-State Behaviors," *Journal of Orofacial Pain* 20, no. 4 (2006): 306–316.

14. O. S. Huhtela, R. Näpänkangas, T. Joensuu, A. Raustia, K. Kunttu, and K. Sipilä, "Self-Reported Bruxism and Symptoms of Temporomandibular Disorders in Finnish University Students," *Journal of Oral & Facial Pain and Headache* 30, no. 4 (2016): 311–317, https://doi.org/10.11607/ofph.1674.

15. I. Sierwald, M. T. John, O. Schierz, et al., "Association of Temporomandibular Disorder Pain With Awake and Sleep Bruxism in Adults," *Journal of Orofacial Orthopedics* 76, no. 4 (2015): 305–317, https://doi.org/10.1007/s00056-015-0293-5.

16. A. Ekman, J. Rousu, R. Näpänkangas, R. Kuoppala, A. Raustia, and K. Sipilä, "Association of Self-Reported Bruxism With Temporomandibular Disorders—Northern Finland Birth Cohort (NFBC) 1966 Study," *Cranio* 41, no. 3 (2023): 212–217, https://doi.org/10.1080/08869634.2020.1853306.

17. S. Shiffman, A. A. Stone, and M. R. Hufford, "Ecological Momentary Assessment," *Annual Review of Clinical Psychology* 4 (2008): 1–32, https://doi.org/10.1146/annurev.clinpsy.3.022806.091415.

18. D. Manfredini, A. Bracci, and G. Djukic, "BruxApp: The Ecological Momentary Assessment of Awake Bruxism," *Minerva Stomatologica* 65, no. 4 (2016): 252–255.

19. A. Zani, F. Lobbezoo, A. Bracci, J. Ahlberg, and D. Manfredini, "Ecological Momentary Assessment and Intervention Principles for the Study of Awake Bruxism Behaviors, Part 1: General Principles and Preliminary Data on Healthy Young Italian Adults," *Frontiers in Neurology* 1, no. 10 (2019): 169, https://doi.org/10.3389/fneur.2019.00169.

20. A. Colonna, L. Lombardo, G. Siciliani, et al., "Smartphone-Based Application for EMA Assessment of Awake Bruxism: Compliance Evaluation in a Sample of Healthy Young Adults," *Clinical Oral Investigations* 24, no. 4 (2020): 1395–1400, https://doi.org/10.1007/s00784-019-03098-2.

21. N. C. Pereira, P. V. P. Oltramari, P. C. R. Conti, et al., "Frequency of Awake Bruxism Behaviour in Orthodontic Patients: Randomised Clinical Trial: Awake Bruxism Behaviour in Orthodontic Patients," *Journal of Oral Rehabilitation* 48, no. 4 (2021): 422–429, https://doi.org/10.1111/joor.13130.

22. A. Zani, F. Lobbezoo, A. Bracci, et al., "Smartphone-Based Evaluation of Awake Bruxism Behaviours in a Sample of Healthy Young Adults: Findings From Two University Centres," *Journal of Oral Rehabilitation* 48, no. 9 (2021): 989–995, https://doi.org/10.1111/joor.13212.

23. A. Colonna, A. Bracci, J. Ahlberg, et al., "Ecological Momentary Assessment of Awake Bruxism Behaviors: A Scoping Review of Findings From Smartphone-Based Studies in Healthy Young Adults," *Journal of Clinical Medicine* 12, no. 5 (2023): 1904, https://doi.org/10.3390/jcm12051904.

24. M. B. Câmara-Souza, A. G. Carvalho, O. M. C. Figueredo, A. Bracci, D. Manfredini, and R. C. M. Rodrigues Garcia, "Awake Bruxism Frequency and Psychosocial Factors in College Preparatory Students," *Cranio* 41, no. 2 (2023): 178–184, https://doi.org/10.1080/08869634.2020.1829289.

25. A. Bracci, G. Djukic, L. Favero, L. Salmaso, L. Guarda-Nardini, and D. Manfredini, "Frequency of Awake Bruxism Behaviours in the Natural Environment. A 7-Day, Multiple-Point Observation of Real-Time Report in Healthy Young Adults," *Journal of Oral Rehabilitation* 45, no. 6 (2018): 423–429, https://doi.org/10.1111/joor.12627.

26. R. Dias, R. Vaz, M. J. Rodrigues, J. M. Serra-Negra, A. Bracci, and D. Manfredini, "Utility of Smartphone-Based Real-Time Report (Ecological Momentary Assessment) in the Assessment and Monitoring of Awake Bruxism: A Multiple-Week Interval Study in a Portuguese Population of University Students," *Journal of Oral Rehabilitation* 48, no. 12 (2021): 1307–1313, https://doi.org/10.1111/joor.13259.

27. A. Emodi-Perlman, D. Manfredini, T. Shalev, et al., "Awake Bruxism-Single-Point Self-Report Versus Ecological Momentary Assessment," *Journal of Clinical Medicine* 10, no. 8 (2021): 1699, https://doi.org/10.3390/jcm10081699.

28. R. Bucci, D. Manfredini, F. Lenci, V. Simeon, A. Bracci, and A. Michelotti, "Comparison Between Ecological Momentary Assessment and Questionnaire for Assessing the Frequency of Waking-Time Non-Functional Oral Behaviours," *Journal of Clinical Medicine* 11, no. 19 (2022): 5880, https://doi.org/10.3390/jcm11195880.

29. Y. M. Gonzalez, E. Schiffman, S. M. Gordon, et al., "Development of a PHQ-4 and Effective Temporomandibular Disorder Pain Screening Questionnaire: Reliability and Validity," *Journal of the American Dental Association (1939)* 142, no. 10 (2011): 1183–1191, https://doi.org/10.14219/jada.archive.2011.0088.

30. T. Yamaguchi, S. Mikami, M. Maeda, et al., "Portable and Wearable Electromyographic Devices for the Assessment of Sleep Bruxism and Awake Bruxism: A Literature Review," *Cranio* 41, no. 1 (2023): 69–77, https://doi.org/10.1080/08869634.2020.1815392.

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

32. A. Colonna, F. Lobbezoo, A. Bracci, M. Ferrari, M. Val, and D. Manfredini, "Long-Term Study on the Fluctuation of Self-Reported Awake Bruxism in a Cohort of Healthy Young Adults," *Journal of Oral Rehabilitation* (2024), https://doi.org/10.1111/joor.13872.

33. S. E. Kaplan and R. Ohrbach, "Self-Report of Waking-State Oral Parafunctional Behaviors in the Natural Environment," *Journal of Oral & Facial Pain and Headache* 30, no. 2 (2016): 107–119, https://doi.org/10.11607/ofph.1592.

34. N. K. Hwangbo, K. C. Woo, and S. T. Kim, "Evaluation of Clinical Symptoms Improvement by Cognitive Behavioral Therapy Using a Smartphone Application in Patients With Temporomandibular Disorder," *Healthcare (Basel)* 11, no. 10 (2023): 1443, https://doi.org/10.3390/healthcare11101443.

35. M. D. Litt, D. M. Shafer, and D. L. Kreutzer, "Brief Cognitive-Behavioral Treatment for TMD Pain: Long-Term Outcomes and Moderators of Treatment," *Pain* 151, no. 1 (2010): 110–116, https://doi.org/10.1016/j.pain.2010.06.030.

36. K. P. Dao, K. De Cocker, H. L. Tong, A. B. Kocaballi, C. Chow, and L. Laranjo, "Smartphone-Delivered Ecological Momentary Interventions Based on Ecological Momentary Assessments to Promote Health Behaviors: Systematic Review and Adapted Checklist for Reporting Ecological Momentary Assessment and Intervention Studies," *JMIR mHealth and uHealth* 9, no. 11 (2021): e22890, https://doi.org/10.2196/22890.

37. M. A. Marciniak, L. Shanahan, J. Rohde, et al., "Standalone Smartphone Cognitive Behavioral Therapy-Based Ecological Momentary Interventions to Increase Mental Health: Narrative Review," *JMIR mHealth and uHealth* 8, no. 11 (2020): e19836, https://doi.org/10.2196/19836.

38. M. A. Osiewicz, F. Lobbezoo, A. Bracci, J. Ahlberg, J. Pytko-Polończyk, and D. Manfredini, "Ecological Momentary Assessment and Intervention Principles for the Study of Awake Bruxism Behaviors, Part 2: Development of a Smartphone Application for a Multicenter Investigation and Chronological Translation for the Polish Version," *Frontiers in Neurology* 10 (2019): 170, https://doi.org/10.3389/fneur.2019.00170.

39. J. C. Rosen, "Self-Monitoring in the Treatment of Diurnal Bruxism," *Journal of Behavior Therapy and Experimental Psychiatry* 12, no. 4 (1981): 347–350, https://doi.org/10.1016/0005-7916(81)90077-x.

40. D. Knipe, C. Maughan, J. Gilbert, D. Dymock, P. Moran, and D. Gunnell, "Mental Health in Medical, Dentistry and Veterinary Students: Cross-Sectional Online Survey," *BJPsych Open* 4, no. 6 (2018): 441–446, https://doi.org/10.1192/bjo.2018.61.

41. S. Basudan, N. Binanzan, and A. Alhassan, "Depression, Anxiety and Stress in Dental Students," *International Journal of Medical Education* 8 (2017): 179–186, https://doi.org/10.5116/ijme.5910.b961.

42. I. G. Franzoi, F. D'Ovidio, G. Costa, A. d'Errico, and A. Granieri, "Self-Rated Health and Psychological Distress Among Emerging Adults in Italy: A Comparison Between Data on University Students, Young Workers and Working Students Collected Through the 2005 and 2013 National Health Surveys," *International Journal of Environmental Research and Public Health* 18, no. 12 (2021): 6403, https://doi.org/10.3390/ijerph18126403.

43. D. Manfredini, N. Landi, F. Fantoni, M. Segù, and M. Bosco, "Anxiety Symptoms in Clinically Diagnosed Bruxers," *Journal of Oral Rehabilitation* 32, no. 8 (2005): 584–588, https://doi.org/10.1111/j.1365-2842.2005.01462.x.

44. D. Manfredini, A. Ciapparelli, L. Dell'Osso, and M. Bosco, "Mood Disorders in Subjects With Bruxing Behavior," *Journal of Dentistry* 33, no. 6 (2005): 485–490, https://doi.org/10.1016/j.jdent.2004.11.010.

45. D. Manfredini and F. Lobbezoo, "Role of Psychosocial Factors in the Etiology of Bruxism," *Journal of Orofacial Pain* 23, no. 2 (2009): 153–166.

46. O. I. Saracutu, D. Manfredini, A. Bracci, E. Ferrari Cagidiaco, M. Ferrari, and A. Colonna, "Awake Bruxism Behaviors Frequency in a Group of Healthy Young Adults With Different Psychological Scores," *Cranio* (2024), https://doi.org/10.1080/08869634.2024.2357199.

47. S. Prasad, M. Paulin, R. D. Cannon, S. Palla, and M. Farella, "Smartphone-Assisted Monitoring of Masticatory Muscle Activity in Freely Moving Individuals," *Clinical Oral Investigations* 23, no. 9 (2019): 3601–3611, https://doi.org/10.1007/s00784-018-2785-3.

48. R. E. Goldstein and C. W. Auclair, "The Clinical Management of Awake Bruxism," *Journal of the American Dental Association (1939)* 148, no. 6 (2017): 387–391, https://doi.org/10.1016/j.adaj.2017.03.005.

49. M. E. Mesko, B. Hutton, J. A. Skupien, R. Sarkis-Onofre, D. Moher, and T. Pereira-Cenci, "Therapies for Bruxism: A Systematic Review and Network Meta-Analysis (Protocol)," *Systematic Reviews* 6, no. 1 (2017): 4, https://doi.org/10.1186/s13643-016-0397-z.

50. B. A. Thompson, B. W. Blount, and T. S. Krumholz, "Treatment Approaches to Bruxism," *American Family Physician* 49, no. 7 (1994): 1617–1622.

51. C. G. De la Torre, D. Manfredini, C. M. Grillo, L. Guarda-Nardini, L. Machado Gonçalves, and C. M. Rizzatti Barbosa, "Therapeutic Effectiveness of a Combined Counseling Plus Stabilization Appliance Treatment for Myofascial Pain of the Jaw Muscles: A Pilot Study," *Cranio* 35, no. 3 (2017): 180–186, https://doi.org/10.1080/08869634.2016.1168071.