

A century of bruxism research in top-ranking medical journals

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Abstract

Background: Bruxism is a jaw-muscle activity characterized by teeth grinding and clenching. While many of its negative consequences (e.g., jaw-muscle pain, tooth fractures) are of particular interest to dentists, new insights underline the need for physicians to be knowledgeable about bruxism. In order to facilitate transfer of knowledge across disciplines, our objective was to assess what top-ranking medical journals have published on bruxism. Besides, we tested the insights described there against current science regarding the definition, assessment, epidemiology, etiology, consequences, comorbidities, and management of bruxism.

Results: In the past century, the four top-ranking medical journals have provided their readership with various bits and pieces of information on bruxism. While some of these insights have withstood the test of time, others are somewhat outdated. Further, the identified publications provide an incomplete picture of what physicians should know. The present article helps reduce this knowledge gap.

Conclusion: The role of the physician with regard to bruxism focuses mainly on its assessment and management, while insight into risk factors and comorbid conditions of bruxism is essential to high-level patient care. It is hoped that this article will contribute to improve the long-needed interdisciplinary collaboration between physicians and dentists regarding the assessment and management of bruxing patients.

Keywords

assessment, bruxism, comorbidities management, consequences, definition, dentistry, epidemiology, etiology, medicine

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Bruxism: Widely known but sufficiently understood?

Teeth grinding and clenching are oral behaviors of all times. In the Bible (Matthew 13), Jesus explains the parable of the weeds on the field as follows: *“As the weeds are pulled up and burned in the fire, so it will be at the end of the age. The Son of Man will send out his angels, and they will weed out of his kingdom everything that causes sin and all who do evil. They will throw them into the fiery furnace, where there will be weeping and gnashing of teeth.”* Among dentists such oral behaviors are known by the term “bruxism”, derived from the Greek “βρυγμός οδόντων” (*vrigmos ódodon*). Bruxism is especially known for its purported negative consequences, of particular interest to dentists. Apart from the piercing sounds it may produce during sleep, bruxism may be associated with conditions like pain in the masticatory muscles and temporomandibular joints, wearing down of the teeth, and fractures and failures of teeth and dental restorations. However, also headaches have been associated with bruxism,¹ showing that the behavior belongs to the medical domain as well. The involvement of psychosocial factors (e.g., anxiety) and lifestyle factors (e.g., alcohol intake) in the etiology of bruxism plus various possible comorbid conditions (e.g., sleep disorders like obstructive sleep apnea, insomnia, and REM behavior disorder; movement disorders like Parkinson’s disease) underline the need for physicians to be knowledgeable about bruxism.

The above suggests that the assessment and management of bruxism should be an interdisciplinary effort in which dentists and physicians work closely together. Unfortunately, it is a daily reality that medicine and dentistry continue to lack common insight and understanding, not only in terms of education and research but also concerning prevention and care provision.^{2,3} Consequently, not all physicians will have enough knowledge about the state-of-the-art management of their bruxing patients. If a physician checked the term “bruxism” in a reference like Dorland’s illustrated medical dictionary (W.B. Sanders Co., 1988), the following would be found: *“(...) an oral habit consisting of involuntary rhythmic or spasmodic nonfunctional gnashing, grinding, and clenching of teeth in other than chewing movements of the mandible, usually performed during sleep, which may lead to occlusal trauma. (...)”* However, a definition alone is not sufficient for physicians to base their up-to-date management strategies for bruxism on: they should thoroughly evaluate bruxism-related scientific articles, which prompts the question of what top-ranking general medicine journals like the British Medical Journal (BMJ), Journal of the American Medical Association (JAMA), New England Journal of Medicine (NEJM), and Lancet have published on this topic over the past century. Therefore, it was our aim to scrutinize BMJ, JAMA, NEJM, and Lancet on the topic of bruxism, and to test the

insights described there against current science regarding the definition, assessment, epidemiology, etiology, consequences, comorbidities, and management of bruxism. We expect that if dentists started communicating up-to-date knowledge regarding phenomena of interest to physicians, such as bruxism, by publishing in medical journals, physicians’ long-needed interdisciplinary collaboration with dentists, including management of bruxing patients, would naturally improve, ultimately benefitting our patients.

Searching for bruxism in the top-ranking medical journals and PubMed

In BMJ, JAMA, NEJM, and Lancet, the term “bruxism” was entered in the journals’ search engines, assessing all content in the main journals (i.e., disregarding the various specialty journals). An advanced search in BMJ on “title, abstract” yielded one article published in 1971. The search in JAMA resulted in five articles published between 1970 and 2008. A search on “title, abstract, extract” in NEJM yielded one article published in 1979. Finally, in the Lancet, an advanced search on “article title, abstract, keywords” yielded four articles published between 1894 and 1960. Thus, a total of 11 articles was identified.

After full-text reading, the oldest publication was excluded, because the search engine of the Lancet identified the author’s professional title (i.e., M.D. Brux., which is short for “M.D. Bruxelles” being the city where the author obtained his medical degree) instead of bruxism as our condition of interest.⁴ Assessment of the reference lists of the included 10 articles yielded one additional Lancet paper.⁵ The finally included 11 articles are summarized in Table 1. Together, they cover several aspects of the definition, assessment, epidemiology, etiology, consequences, comorbidities, and management of bruxism. The largest proportion of articles (4/11) was written by US-based authors, of 3/11 articles the country of origin of the author(s) was unknown, and 2/11 articles were written by UK-based authors. New Zealand and Sweden were each the country of origin for one of the included articles. The publication types were “Letter to the Editor, Correspondence” (5/11), “Medical News & Perspectives” (2/11), “Original Articles, Papers & Originals” (2/11), and “Annotation, Point of View” (2/11).

To test the insights on bruxism derived from the 11 included publications against the current state of science, a search was performed on July 18, 2023, in PubMed (National Library of Medicine) using the Medical Subject Headings (MeSH) term “Bruxism” as Major Topic, in combination with relevant subheadings. Bruxism topics assessed were: definition, assessment, epidemiology, etiology, consequences and comorbidities, and management. The search was conducted for articles of the past 10 years, with Article Type filter set to (Systematic) Review and

Table 1. Overview of publications in the British Medical Journal (BMJ), the Journal of the American Medical Association (JAMA), the New England Journal of Medicine (NEJM), and the Lancet as identified on the Journal's website using the search term "Bruxism".^a

Year	Author(s)	Ref. no.	Country, State	Journal	Publication type	Publication topic	Bruxism topic(s)	Conclusion
1915	Unknown	6	Unknown	Lancet	Annotation	Case series on teeth grinding in association with adenoid vegetations in children	Etiology	Teeth grinding is commonly observed in children with adenoid vegetations
1960	Every	5	New Zealand	Lancet	Point of View	Causes, consequences, and significance of extreme mandibular movements	Consequences	Extreme mandibular movements in the absence of food sharpens the teeth as to enable their use as effective tools and weapons
1960	Berlin and Dessner	7	Sweden	Lancet	Original Article	Clinical review on the association between bruxism and chronic headache	Definition, assessment, etiology, consequences, comorbidities, management	Bruxism is often associated with chronic headache
1960	Moss	8	UK	Lancet	Letter to the Editor	Comment on Berlin and Dessner (1960)	Management	Physiotherapeutic methods can be adopted to relieve bruxism-related headaches
1970	Magee	9	USA, MI	JAMA	Letter to the Editor	Case description of bruxism as an unusual side effect of levodopa	Etiology, consequences, management	Physicians should be vigilant regarding bruxism as a potential adverse reaction of levodopa
1971	Lewis et al.	10	UK	BMJ	Papers and Originals	Case descriptions of possible fenfluramine-provoked bruxism	Etiology	Bruxism seems to be provoked by fenfluramine intake
1976	Ingle	11	USA, DC	JAMA	Letter to the Editor	Aspects of diseases of the temporomandibular joint	Etiology, consequences, management	Anxiety and frustration may cause bruxism, which in turn may cause shortening of the masticatory muscles
1976	Morgan	12	USA, CA	JAMA	Letter to the Editor	Reply to Ingle (1976)	Etiology	Bruxism is not only caused by anxiety, but also by dental malocclusion and physical injury
1979	Hartmann	13	USA, MA	NEJM	Correspondence	Case descriptions of the association between alcohol intake and bruxism	Etiology	A definite association between alcohol intake and bruxism is suggested
1999	Lamberg	14	Unknown	JAMA	Medical News and Perspectives	Report of a symposium on pain and sleep	Epidemiology, etiology, consequences, management	Sleep bruxism is a common condition that should be managed with non-invasive approaches
2008	Lamberg	15	Unknown	JAMA	Medical News and Perspectives	Report of a conference on pediatric sleep disorders	Epidemiology, consequences, comorbidities, management	Sleep bruxism is highly prevalent in children and should be managed with non-invasive approaches

Ref. no.: Reference number; TMD: temporomandibular disorders.

^aYear of publication, author(s) and their affiliation (country state), journal, publication type and topic(s), bruxism topic, and bruxism-related conclusion(s).

Table 2. PubMed queries used to identify the most recent publications, mainly (systematic) reviews and meta-analyses that were published in the past 10 years, assessing the following bruxism topics: definition, assessment, epidemiology, etiology, consequences, comorbidities, and management.^a

Bruxism topic	PubMed query (Filter: Past 10 years)	No. of publications found	Most relevant publications identified after TiAb screening [Ref. no.]	Additional publications added after hand searching [Ref. no.]
Definition	Bruxism/classification[Majr] Additional filters: None	4	Lobbezoo et al., 2018 [16]	N/A
Assessment	Bruxism/diagnosis[Majr] Additional filters: review, systematic review, meta-analysis	19	Casett et al. [17]; Lavigne et al. [18]	Bracci et al. [19]; Lobbezoo et al. [20]; Manfredini et al. [21]
Epidemiology	Bruxism/epidemiology[Majr] Additional filters: review, systematic review, meta-analysis	19	Manfredini et al. [22]; Manfredini et al. [23]	Maluly et al. [24]
Etiology	Bruxism/etiology[Majr] Additional filters: review, systematic review, meta-analysis	48	Castroflorio et al. [25]; Kuhn and Türp [26]	Lobbezoo et al. [27]; Mayer et al. [28]; de Baat et al. [29]
Consequences	Bruxism/complications[Majr] Additional filters: review, systematic review, meta-analysis	25	Chrcanovic et al. [30]; Manfredini et al. [31]; Manfredini and Lobbezoo [32]	Wetselaar et al. [33]
Comorbidities	Bruxism/complications[Majr] Additional filters: review, systematic review, meta-analysis	25	Réus et al. [34]; Kuang et al. [35]; Pauletto et al. [36]	Verhoeff et al. [37]
Management	Bruxism/therapy[Majr] Additional filters: review, systematic review, meta-analysis	36	Manfredini et al. [38]; Jokubauskas and Baltrušaitytė [39]; Hardy and Bonsor [40]	Minakuchi et al. [41]

Ref. no.: reference number; N/A: not applicable.

^aThe number of publications found, the most relevant publications identified after Title and Abstract (TiAb) screening, as well as the additional publications added after hand searching are given.

Meta-Analysis. All languages were accepted. Since searches based on MeSH terms never yield the most recent publications, and some important publications may have been missed due to differing insights on how to label certain works, an additional hand search was performed by researchers (F.L. and M.C.V.).

Table 2 shows the number of publications found for each PubMed query (bruxism topic). The hand search yielded 10 additional publications. As step 1, F.L. and M.C.V. independently conducted a Title and Abstract (TiAb) screening of the publications found, followed by full-text assessment when needed, e.g. when TiAb screening did not provide sufficient insight into fulfillment of the following a priori formulated exclusion criteria:

- Studies with another article type than (Systematic) Review or Meta-Analysis
- (Systematic) reviews or meta-analyses: a. focusing only on a small part of the “bruxism” topic, or on a single aspect of bruxism in the presence of broader (systematic) reviews or meta-analyses covering that aspect; b. for which an equally fitting but more recent (systematic) review or meta-analysis was identified; or c. for which the hand search yielded a better alternative.

As step 2, the two researchers convened and discussed the divergences in their choices until reaching consensus. The results of this two-step assessment are also shown in Table 2.

Bruxism: What is the current state of science?

Insights into bruxism are described below per bruxism topic. Those topics derived from BMJ, JAMA, NEJM, and Lancet publications are summarized first, followed by a brief description of the current insights.

Definition

In their clinical review on the association between bruxism and chronic headache, Berlin and Dessner⁷ define bruxism as “*a habitual unconscious clenching or grinding of the teeth to no physiological purpose.*”

Nowadays, since there is increasing evidence that bruxism may actually serve a physiological goal (see Consequences), Lobbezoo et al.¹⁶ defined bruxism as jaw-muscle activity that can occur both during sleep (sleep bruxism) and wakefulness (awake bruxism). The international consensus definitions for (generic) bruxism, as well as for sleep and awake bruxism separately, are as follows:¹⁶

- Bruxism is a repetitive jaw-muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible. Bruxism has two distinct circadian manifestations: it can occur during sleep (indicated as sleep bruxism) or during wakefulness (indicated as awake bruxism).
- Sleep bruxism is 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.
- Awake bruxism is 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.

Importantly, many older studies report on generic bruxism, while a distinction between the sleep and awake chronotypes is currently deemed essential, from both a research and a clinical perspective.

Assessment

Berlin and Dessner⁷ state that the case history is essential to establish the presence of bruxism, although they focus on bruxism’s purported negative consequences and comorbid conditions (e.g., tenderness in the masticatory system, headaches) rather than on the behavior itself. In addition, they state that clinical observations of the actual behavior and/or its extra-oral (e.g., hypertrophic masticatory muscles) and intra-oral (e.g., mechanical tooth wear, soft tissue lesions) signs can be used in the assessment of bruxism.⁷

Currently, Lobbezoo et al.¹⁶ distinguish three probability levels for the assessment of bruxism to determine the

likelihood that a certain assessment of bruxism actually yields a valid outcome:

- Possible bruxism is based on a positive self-report only.
- Probable bruxism is based on a positive clinical inspection, with or without a positive self-report.
- Definite bruxism is based on a positive instrumental assessment, with or without a positive self-report and/or a positive clinical inspection.

In this context, the recent development of the Standardized Tool for the Assessment of Bruxism (STAB) is of special interest.²¹ This comprehensive instrument enables the assessment of bruxism at all probability levels, but with an emphasis on the possible and probable levels. In addition, the recent development of the Bruxism Screener (BruxScreen) represents an important step forwards, because this brief assessment tool is suitable for usage in everyday clinical settings.²⁰ For the definite probability level, Casett et al.¹⁷ reported that portable EMG recorders show better accuracy for the assessment of sleep bruxism than self-report questionnaires and clinical observations. Still, better metrics need to be developed for sleep bruxism¹⁸ as well as for awake bruxism,¹⁹ especially regarding their clinical relevance. Last, it should be noted that since bruxism is by definition a jaw-muscle activity and not a disorder, the term “diagnosis” does not apply to its assessment.¹⁶

Epidemiology

In two conference reports, the epidemiology of sleep bruxism is described to occur in 6–8% of adults,¹⁴ while 14% of children is reportedly affected.¹⁵

More recently, Manfredini et al.^{22,23} published two systematic reviews on this topic: one focusing on children and another one on adults. Regarding sleep bruxism in children, a prevalence range of 3.5–40.6% was found.²² For bruxism in adults,²³ most included studies were questionnaire-based, thus reporting on possible bruxism. For generic, sleep, and awake bruxism, prevalence data of 8.0–31.4%, 12.8 ± 3.1%, and 22.1–31.0%, respectively, were found. Men and women showed comparable prevalence, while a decline in bruxism was observed with aging. Based on polysomnographic data, Maluly et al.²⁴ reported a definite sleep bruxism prevalence in adults of 7.4%, only slightly lower than the mean prevalence of possible sleep bruxism reported by Manfredini et al.²³

Etiology

Eight of the 11 identified publications deal with the aspect of etiology, from which it can be gathered that adenoid vegetations,⁶ occlusal disharmonies,^{7,12,13} side-effects of medications like levodopa⁹ and fenfluramine,¹⁰ physical trauma,¹² genetics,¹³ emotional tension and

anxiety,^{7,11,12,14} and alcohol intake¹³ are key factors in the etiology of bruxism.

However, the above enumeration is not complete nor fully accurate in light of the current evidence. There is broad consensus that the role of disharmonies in dental occlusion and articulation in the etiology of bruxism is negligible, if at all present.²⁷ And yet, evidence is increasing for contributions of biological and lifestyle factors like arousals from sleep, genetics, certain neurotransmitters (dopamine, serotonin, noradrenalin, histamine), coffee consumption, alcohol intake, smoking, heroin usage, and use of anticonvulsants, phenethylamines, and SSRIs.^{25,26,28,29} Last, there is strong evidence for the role of psychological factors like emotional stress, anxiety, and maladaptive coping in the etiology of bruxism.^{26,28}

Consequences

Identified as fatigue, tenderness, or shortening of the masticatory muscles but nowadays known as temporomandibular disorders (TMD), several authors describe this condition as one of the potential consequences of bruxism.^{7,11,14} In addition, mechanical tooth wear has been identified as a possible negative outcome of, especially, grinding behavior; both in adults^{9,14} and in children.¹⁵ Interestingly, Every⁵ interprets bruxism-related tooth wear positively, the wear process being a means to sharpen the teeth (“thegosis”) as to enable their use as effective tools and weapons.

From the above summary, it could be gathered that in the four top-ranking medical journals the bruxism topic “consequences” is limited to TMD and mechanical tooth wear. However, bruxism has been associated with many more possible consequences, both negative and positive. On the negative side, TMD has indeed been associated with bruxism behavior, albeit with evidence based mainly on self-report studies.³² For other possible negative consequences, e.g. mechanical tooth wear,³³ dental implant fractures and failures,³⁰ and damage to periodontal tissues,³¹ the evidence basis is still weak due to the so-far insufficient methods used to assess bruxism. Importantly, on the positive side there is growing insight that bruxism may be a protective factor for certain health outcomes, such as being the ending episode of respiratory arousals from sleep, so as to prevent upper-airway collapse or restore its patency while asleep; or protecting against the risk of detrimental chemical tooth wear by increasing salivation in case of gastroesophageal reflux.¹⁶ This actually represents a real paradigm shift in our appreciation of the consequences of bruxism, and has major consequences for decisions about its management.

Comorbidities

Comorbid conditions of bruxism are discussed in 2 out of the 11 identified publications. Berlin and Dessner⁷ describe

chronic headache in association with bruxism. Besides, Lamberg¹⁵ reports on obstructive sleep apnea in association with sleep bruxism in children.

Recent literature corroborates these observations, at least in part, and additionally suggests several other conditions as being related to bruxism. Réus et al.³⁴ state that patients with awake bruxism have a significantly increased chance of having tension-type headaches, while no such association was observed for sleep bruxism or migraine in the articles included in their systematic review. A comprehensive systematic review on the associations between sleep bruxism and other sleep disorders suggests such associations with obstructive sleep apnea, restless leg syndrome, periodic limb movement during sleep, sleep-related gastroesophageal reflux, insomnia, Parkinson’s disease, REM behavior disorder, and sleep-related epilepsy.³⁵ The associations between bruxism on the one hand and obstructive sleep apnea and Parkinson’s disease on the other were partly confirmed in two recent scoping reviews.^{36,37}

Management

The management of bruxism is discussed in 6 out of the 11 identified publications. Muscle relaxants¹⁴ and clonazepam¹⁵ have been suggested for sleep bruxism in adults and children, respectively. Physical and behavioral approaches, like physiotherapy, relaxation, biofeedback, and sleep hygiene instructions, have been described as well.^{8,14,15} Finally, occlusal splints have been suggested, either for muscle relaxation⁷ or for protection against mechanical tooth wear,^{9,14,15} while Berlin and Dessner⁷ advice against the irreversible reshaping of the dental occlusion. Ingle¹¹ simply states that “*treatment should be most conservative.*”

While the above overview includes several sound management strategies, those suggested for bruxism are nowadays more comprehensive, but also more complex, than suggested above. First, while some classes of medication are known to be causally related to the occurrence and/or worsening of bruxism,²⁹ several drugs have been suggested for its management (rabeprazole, L-tryptophan, levodopa, bromocriptine, amitriptyline, clonazepam, propranolol, clonidine, gabapentin, pramipexole, and botulinum toxin type A), but there is still insufficient evidence on their safety and effectiveness.⁴¹ Therefore, these drugs are not recommended for usage in everyday clinical practice. Second, biofeedback (notably contingent electrical stimulation) is shown to be effective in reducing sleep bruxism in the short term, although there is still no evidence for this technique’s long-term effects.^{39,41} Third, evidence for the effectiveness of occlusal splints in the treatment of bruxism is still insufficient.^{40,41} In their comprehensive systematic review of the literature, Manfredini et al.³⁸ state that there is not enough evidence to define a standard of reference approach for the treatment of bruxism, although oral appliances may be useful thanks to their protective role against progression of mechanical tooth

wear. Importantly, since bruxism may also be associated with positive health outcomes, its management should be based on a weighted compromise between its negative and positive consequences.

Bruxism: What is the physician's role?

In the past century, the four top-ranking medical journals have provided their readership with various bits and pieces of information on the topic of bruxism. While some of these insights have withstood the test of time, others are somewhat outdated by now. Further, the 11 identified publications provide an incomplete picture of what physicians should know about bruxism. The present article helps reduce this knowledge gap. Based on the identified publications that have touched upon bruxism since 1915, physicians have been informed that bruxism does not serve a physiological purpose, while there is increasing evidence that bruxism may actually serve several physiological goals. No information is provided in the identified publications on how bruxism can (or should) be assessed in a reliable and valid manner, while recently both comprehensive and brief instruments have been developed for its standardized assessment. While the identified publications provided some prevalence data on bruxism in the general children's and adult population, the outcomes of recent systematic reviews and meta-analyses have provided strong figures for generic bruxism as well as for awake and sleep bruxism separately. The four top-ranking medical journals did report on several possible etiological factors of bruxism, although the role of occlusal disharmonies is now firmly refuted. Of importance for physicians is the strong evidence for the role of psychological factors in the etiology of bruxism. As for bruxism's consequences, the focus has almost entirely been on TMD and mechanical tooth wear, while other possible negative outcomes have not been described; neither have the possible positive consequences (i.e., preventing upper-airway collapse or restoring its patency while asleep; increasing salivation in case of gastroesophageal reflux) that are nowadays increasingly being reported in association with bruxism. The number of observed comorbid conditions of bruxism, many of which belong to the medical domain, is climbing. Last, while the management of bruxism is reported in the identified publications, current strategies are more comprehensive and at the same time more complex due to its multifactorial etiology, its multiple comorbidities, and the complicated balance between its negative and positive consequences. New insights into this topic are published frequently, but the evidence for effective and safe strategies remains incomplete.

From the above, it is hoped that physicians will take an interest in bruxism, given its many medical aspects which may need to be dealt with in close collaboration with dentists. For example, polysomnography, which is needed to confirm definite sleep bruxism, is a hospital-based

procedure, or, when done ambulatory, is performed under a physician's responsibility. A variety of risk factors for bruxism have also been identified in the biopsychosocial domain, underlining the need for physicians' knowledgeability on this topic. Since bruxism is increasingly associated with positive health outcomes, physicians become an essential part of the interdisciplinary patient-centered decision-making process as to whether to treat a bruxer. More comorbidities with bruxism are being found, hence physicians are expected to be knowledgeable about the co-occurrence of bruxism with their patients' other medical conditions. Last, physicians would be involved in carefully weighing the pros and cons of managing bruxism.

Conclusion

Although the four top-ranking medical journals have published 11 articles that touch upon bruxism over the past century, no comprehensive information on the condition has been presented to the journals' readership so far. This article summarizes the current insights into the definition, assessment, epidemiology, etiology, consequences, comorbidities, and management of bruxism. The role of the physician with regard to bruxism focuses mainly on the condition's assessment and management, while insight into the risk factors and comorbid conditions of bruxism is essential to high-level patient care. It is hoped that this article will contribute to improve the long-needed interdisciplinary collaboration between physicians and dentists regarding the assessment and management of our bruxing patients.

Article highlights

- This article summarizes current insights into the definition, assessment, epidemiology, etiology, consequences, comorbidities, and management of bruxism.
- The role of the physician with regard to bruxism focuses not only on the condition's assessment and management, but also on its risk factors, protective factors, and comorbid conditions.

Author contributions

Prof. Lobbezoo and Dr. Verhoeff conceptualized and drafted the manuscript. All authors critically revised the manuscript and approved the final version. All authors are personally accountable for all aspects of the work.

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