Epidemiology of Bruxism in Adults: A Systematic Review of the Literature

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Aims: *To perform a systematic review of the literature dealing with the prevalence of bruxism in adult populations.* ***Methods:*** *A systematic search of the medical literature was performed to identify all peer-reviewed English-language papers dealing with the prevalence assessment of either awake or sleep bruxism at the general population level by the adoption of questionnaires, clinical assessments, and polysomnographic (PSG) or electromyographic (EMG) recordings. Quality assessment of the reviewed papers was performed according to the Methodological evaluation of Observational REsearch (MORE) checklist, which enables the identification of flaws in the external and internal validity. Cut-off criteria for an acceptable external validity were established to select studies for the discussion of prevalence data. For each included study, the sample features, diagnostic strategy, and prevalence of bruxism in relation to age, sex, and circadian rhythm, if available, were recorded.* ***Results:*** *Thirty-five publications were included in the review. Several methodological problems limited the external validity of findings in most studies, and prevalence data extraction was performed only on seven papers. Of those, only one paper had a flawless external validity, whilst internal validity was low in all the selected papers due to their self-reported bruxism diagnosis alone, mainly based on only one or two questionnaire items. No epidemiologic data were available from studies adopting other diagnostic strategies (eg, PSG, EMG). Generically identified "bruxism" was assessed in two studies reporting an 8% to 31.4% prevalence, awake bruxism was investigated in two studies describing a 22.1% to 31% prevalence, and prevalence of sleep bruxism was found to be more consistent across the three studies investigating the report of "frequent" bruxism (12.8% ± 3.1%). Bruxism activities were found to be unrelated to sex, and a decrease with age was described in elderly people.* ***Conclusion:*** *The present systematic review described variable prevalence data for bruxism activities. Findings must be interpreted with caution due to the poor methodological quality of the reviewed literature and to potential diagnostic bias related with having to rely on an individual's self-report of bruxism.* J OROFAC PAIN 2013;27:99–110. doi: 10.11607/jop.921

Key words: awake bruxism, bruxism, epidemiology, prevalence, sleep bruxism, systematic review

The study of bruxism has gained increasing interest over the past years, thereby focusing on aspects such as its definition, its etiology, the different motor activities characterizing bruxism (ie, grinding and clenching), its relationship with temporomandibular disorders (TMD), and its consequences on the natural dentition and dental implants.[1–11] Unfortunately, much remains unclear about these aspects, and knowledge of the epidemiologic characteristics of bruxism seems to be insufficient.

An accurate estimation of bruxism prevalence is complicated by the number of studies adopting different diagnostic strategies and investigating non-representative populations. The presence of comorbid conditions in selected populations, such as other physical or psychological diseases, may act as a confounding variable for the assessment of bruxism prevalence at the community level. Also, the nonlinear relationship between bruxism and tooth wear makes the adoption of dentally based diagnostic strategies unreliable in the absence of control for the other potential causes of tooth wear (eg, functional, endogenous, or exogenous factors).[12,13] Therefore, estimates are commonly based on findings from a few large-scale epidemiologic surveys, which suggest that self-reported tooth grinding during sleep has a prevalence of about 8% in general adult populations, with no sex differences and a decrease with age.[14,15] On the contrary, little information is available on the prevalence of awake bruxism.[16]

The literature on bruxism epidemiology has never been reviewed systematically, so definite conclusions on the issue are lacking. Hence, the aim of the present investigation was to perform a systematic review of the literature dealing with the prevalence of bruxism in adult populations.

Materials and Methods

On February 9, 2011, a systematic search of the medical literature was performed to identify all peer-reviewed papers in the English literature dealing with the prevalence of bruxism. Inclusion in the review was based on the type of study, viz, original studies describing the prevalence of awake and/or sleep bruxism at the general population level by the adoption of questionnaires, clinical assessments, and polysomnographic (PSG) and electromyographic (EMG) recordings. Studies performed on selected populations with comorbid medical conditions, such as TMD or psychiatric disorders, were excluded. The search strategy provided that two authors performed the first step and independently assessed the eligibility of papers for inclusion in the review. The other authors contributed to the expansion of the search strategy in the additional steps, and each of them also contributed with a handmade search in their own university library catalogue. The assessment of the studies' quality and data extraction from the selected studies was performed by the same two authors who performed the original search, and the strategies adopted for the quality assessment and for the data extraction were carefully checked by the other authors to minimize bias during the studies' review. In cases of disagreement, a decision was reached by consensus of the majority of authors.

Search Strategy and Literature Selection

As a first step, a search using Medical Subjects Headings (MeSH) terms in the National Library of Medicine's PubMed database was performed, and the following terms were used to identify a list of potential papers to be included in the review:

- Bruxism: A disorder characterized by grinding and clenching of the teeth.
- Prevalence: The total number of cases of a given disease in a specified population at a designated time. It is differentiated from incidence, which refers to the number of new cases in the population at a given time.

The Medline search limits were set to papers on adults (+19 years) in the English language. (If the search retrieved papers including persons younger than 19, and those data could be separated from those of the older subjects, the papers were included in the review.) The combination of the two MeSH terms identified 81 publications; then, a keyword terms search was performed by using a combination of the term "bruxism" with the terms "prevalence," "incidence," "epidemiology," and/or "diagnosis." This strategy identified another 364 publications. After reading the abstracts, a total of 26 papers retrieved in full text were included in the review.[14,15,17–40]

As a next step, the same strategy was adopted to identify papers in the Scopus and Google Scholar databases, and two additional references were identified for inclusion in the review.[41,42]

The final steps consisted of a search within the reference lists of the selected articles and a handmade search within relevant English-language peer-reviewed journals in the fields of dentistry, TMD, and orofacial pain (*Journal of Dental Research*; *Journal of Orofacial Pain*; *Journal of Dentistry*; *Journal of Oral Rehabilitation*; *International Journal of Oral and Maxillofacial Surgery*; *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics*; *Journal of Oral and Maxillofacial Surgery*; *Journal of the American Dental Association*; *Acta Odontologica Scandinavica*; *Journal of Craniomandibular Practice*; and *Minerva Stomatologica*), within three journal publishers' website search engines (Elsevier, Wiley-Blackwell, and Springer) as well as within the authors' university library catalogues and personal collections. This final step provided six additional full-text papers plus one abstract communication for inclusion in the review.[43–49]

Hence, a total of 35 publications were found to be relevant to this systematic review's aim and were reviewed for qualitative assessment.

Quality Assessment

The methodological quality of the included studies was assessed according to the checklist for the Methodological evaluation of Observational REsearch (MORE).[50] The checklist contains six items to appraise the external validity, viz, the extent to which the results of a study can be generalized to the target population, and five items assessing the internal validity, viz, the extent to which the results of a study are correct for the subjects included in that study.[51] Appraisal of external validity according to the MORE checklist encompasses evaluation of sampling strategies, sampling bias, estimate bias, exclusion rate from the analysis, address bias, and subject flow, whilst appraisal of internal validity provides an assessment of the source of measure, definition of measure, validation of measures and reliability of the estimates, definition of outcomes in subpopulations, and reporting of prevalence. For each item, minor and major flaws in the study design were identified as well as poor reporting strategies.

In the attempt to increase the quality of this review and the consistency and generalizability of findings, only those studies with an acceptable external validity were selected for further evaluation of internal validity and data extraction. The cut-off criteria for selection were set as follows:

- Investigation should be performed on representative general populations (ie, studies were excluded if performed on convenient, workplace, or healthcare-recruited nongeneral population-based samples).
- Response/participation rate should be higher than 60% of the target population.
- Study design should assess potential sampling bias; viz, it should ensure that all members of the reference population have a known chance of selection.
- If the study sample includes subjects below 19 years of age, data reporting should clearly allow for discrimination between findings on adults and adolescents.
- Sampling strategy and response rate should be clearly reported.

Data Recorded from the Selected Studies

Papers satisfying the above criteria for an acceptable external validity were presented in detail as for their quality assessment and prevalence data. Due to the lack of consistency between strategies adopted in the various articles to report the prevalence of bruxism activities, the following assumptions were made for a better consistency of data presentation: *(1)* "bruxism awareness" based on self-report data was considered synonymous with "self-reported bruxism"; *(2)* "wake bruxism," "wake clenching," and "daily clenching" were all included under the category "awake bruxism prevalence"; and *(3)* "sleep bruxism," "sleep grinding," and "nocturnal bruxism" were all included under the category "sleep bruxism prevalence" (Fig 1).

Within these premises, for each of the included studies, the following data/information were recorded: size and demographic features of the sample (mean age [years], sex distribution [female-to-male ratio]); type of diagnostic approach (questionnaire, clinical, EMG, PSG); number of diagnostic items (N); presence of data analysis based on bruxism frequency, age, and sex comparison (yes/no); prevalence of bruxism (%), if available; prevalence of awake bruxism (%), if available; prevalence of sleep bruxism (%), if available; and sex- and age-related prevalence (%), if available.

Results

Overview

The reviewed papers covered a wide spectrum of populations of different age, sex, and ethnic background. Multiple studies were performed on subjects living in the USA, Sweden, Canada, Germany, UK, Turkey, Italy, Finland, and Japan. The sample size ranged from 100 to more than 13,000 subjects, and the mean age of participants, reported only in a minority of papers, varied between 19 and 66 years. A wide spectrum of sex distributions in the study populations was described. All studies except one relied on self-reported diagnoses alone, mainly based on one or two items. The prevalence of bruxism activities in both sexes was assessed in 18 studies, an age group comparison was performed in 10 studies, and the frequency of bruxism activities (ie, using terms like "sometimes," "seldom," "usually") was assessed in 6 studies.

Quality Assessment

Quality assessment showed that most studies had several methodological flaws. The external validity of findings was compromised by the very high percentage of papers with flaws in the sampling strategy (74.2% of papers had minor flaws and 17% major

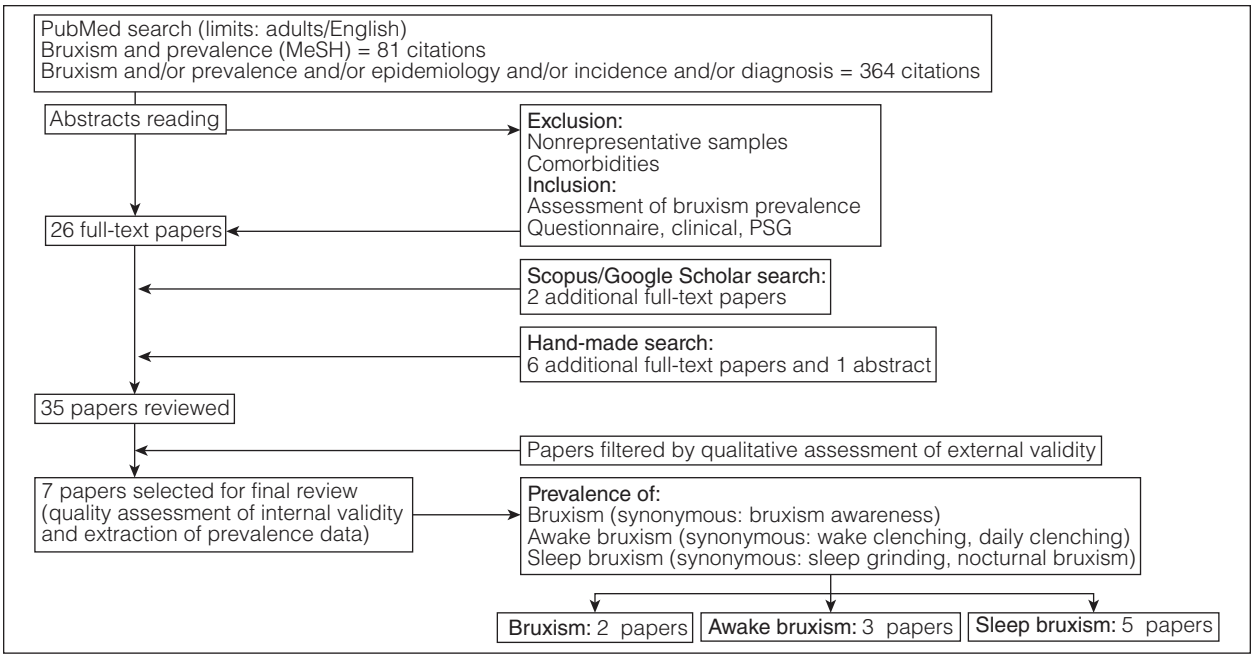

Fig 1 Literature search strategy. Different steps and criteria for selection of papers.

Table 1 Quality Assessment of the Reviewed Papers (n = 35) According to the MORE Guidelines, Based on the Assessment of Criteria for External Validity (Poor Reporting/Minor Flaws/Major Flaws)

	No. (%)
Sampling	
Poor reporting	
Poor reporting of sampling	2 (5.7)
Minor flaws	
Random sampling of general population restricted to geographic area	17 (48.5)
Convenient sample	9 (25.7)
Major flaws	
Population selected at workplace	1 (2.8)
Population selected at healthcare centers	5 (14.2)
Assessment of sampling bias	
Poor reporting	
Poor reporting of strategies adopted to ensure that all members of the reference population have a known chance of selection in the sample	13 (37.1)
Estimate bias	
Poor reporting	
Poor reporting of response rate in total sample	8 (22.8)
Major flaws	
< 40% response rate in the total sample or other subgroups	4 (11.4)
Exclusion rate from the analysis	
Poor reporting	
Not reported	35 (100)
Address bias	
Poor reporting	
Poor reporting of how sampling bias was addressed in the analysis	32 (91.4)
Subject flow	NA

MORE, Methodological evaluation of Observational Research.

Table 2 Quality Assessment: Studies Not Satisfying the Cut-off Criteria for an Acceptable External Validity

Study first author and year	Reason for exclusion based on quality assessment of external validity
Ahlberg, 2008[17]	Sampling: Nongeneral population–based recruitment (workplace)
Glaros, 1981[20]	Sampling: Nongeneral population–based recruitment (convenient sample)
Glass, 1993[21]	Estimate bias: Response rate in total sample < 40%
Goulet, 1993[44]	Evaluation of external validity not possible (abstract communication only)
Ingervall, 1980[22]	Sampling: Nongeneral population–based recruitment (healthcare) Estimate bias: Response rate not reported
Johansson, 2003[23]	Sampling: Nongeneral population–based recruitment (convenient sample)
Kobs, 2005[24]	Sampling: Sampling strategy not reported Estimate bias: Response rate not reported
Lavigne, 1994[14]	Estimate bias: Response rate not reported
Marklund, 2008[25]	Sampling: Nongeneral population–based recruitment (convenient sample)
Matsuka, 1996[46]	Estimate bias: Response rate not reported
McFarlane, 2001[26]	Sampling: Nongeneral population–based recruitment (healthcare) Estimate bias: Response rate in total sample < 40%
Melis, 2003[27]	Sampling: Sampling strategy not reported Estimate bias: Response rate not reported
Miyake, 2004[41]	Sampling: Nongeneral population–based recruitment (convenient sample)
Molina, 1997[28]	Sampling: Nongeneral population–based recruitment (healthcare)
Nekora-Azak, 2006[29]	Assessment of sampling bias: Not reported
Nekora-Azak, 2010[30]	Assessment of sampling bias: Not reported
Norheim, 1978[47]	Assessment of sampling bias: Not reported
Ow, 1995[48]	Sampling: Nongeneral population–based recruitment (convenient sample)
Pow, 2001[31]	Estimate bias: Response rate in total sample < 40%
Reding, 1966[32]	Sampling: Nongeneral population–based recruitment (convenient sample)
Rieder, 1983[33]	Sampling: Nongeneral population–based recruitment (healthcare)
Seligman, 1988[35]	Sampling: Nongeneral population–based recruitment (convenient sample)
Strausz, 2010[36]	Sampling: Nongeneral population–based recruitment (convenient sample)
Suwanprathes, 2010[37]	Estimate bias: Response rate not reported
Swanljung, 1979[49]	Assessment of sampling bias: Not reported
Velly, 2002[38]	Sampling: Nongeneral population–based recruitment (healthcare)
Zeithlofer, 2010[42]	Assessment of sampling bias: Not reported
Zulqairnan, 1998[39]	Sampling: Nongeneral population–based recruitment (convenient sample)

flaws, while an additional 5.7% had poor reporting of sampling strategy). Also, the exclusion rate of subjects from the prevalence analysis was not reported in any study, and there was a poor reporting of how sampling bias was addressed in the analysis in 91.4% of the studies (Table 1).

Of the 35 reviewed papers, 28 did not satisfy the cut-off criteria adopted for an acceptable external validity and were thus excluded from data extraction and discussion (Table 2). Of the remaining 7 papers, only 1 did not have any flaws compromising its external validity[15] (Table 3). The 7 papers were assessed for quality of internal validity, which also was shown to be a matter of concern due to the questionnaire-based approach to the diagnosis of bruxism (see Fig 1). In particular, problems were identified with respect to the reliability and validation of the measurement (poorly reported in all studies), to the major and minor flaws related with the absence of an evaluation on bruxism severity and frequency, and to the minor flaws concerning the source of measure for the prevalence (Table 3).

Bruxism Prevalence Data

The prevalence of bruxism, as defined above, was assessed by two out of the seven studies selected for data extraction, which reported an 8% prevalence of "frequent" bruxism[18] and 31.4% prevalence of bruxism irrespective of its frequency.[19] As for

Table 3 Quality Assessment of the Studies with an Acceptable External Validity

Study first author and year	Response rate (%)	External validity
Agerberg, 1972[43]	91.4	Minor flaw: Random sampling restricted to geographical area Poor reporting: address bias
Bernhardt, 2004[18]	71.3	Minor flaw: Random sampling restricted to geographical area Poor reporting: Address bias
Ciancaglini, 2001[19]	88	Minor flaw: Random sampling restricted to geographical area Poor reporting: Address bias
Jensen, 1993[45]	73.5	Minor flaw: Random sampling restricted to geographical area Poor reporting: Address bias
Ohayon, 2001[15]	68.1–89.4	
Santos-Silva, 2010[34]	85.1	Minor flaw: Random sampling restricted to geographical area
Winocur, 2011[40]	67	Minor flaw: Random sampling restricted to geographical area Poor reporting: Address bias

CI, confidence interval.

specific bruxism activities in relation to the circadian rhythm, awake bruxism was reported in two studies, describing a 22.1% prevalence of awake bruxism, as defined by the frequency term "often,"[45] and a 31% prevalence for any awake bruxism during the past 6 months.[40] Sleep bruxism's prevalence was reported in three studies, which described a 9.3% prevalence for sleep bruxism as frequent as three times a week,[34] 14% for "frequent" sleep bruxism,[40] and 15.3% for sleep bruxism as defined by the frequency term "often."[45] Two other studies assessed the prevalence of sleep bruxism,[15,43] one of which also investigated for awake bruxism,[43] but the overall data also included subjects under 19 years of age, so they could only be discussed with respect to the prevalence in the different age groups

Internal validity
Major flaw: Severity of bruxism not assessed in the study Minor flaw: Proxy report via questionnaires or interviews collected for the study Minor flaw: Frequency of bruxism not assessed in the study Minor flaw: Point prevalence Poor reporting: Omitted 95% CI for prevalence data Poor reporting: No information on validation of measurement Poor reporting: No information on reliability of measurement
Major flaw: Severity of bruxism not assessed in the study Minor flaw: Proxy report via questionnaires or interviews collected for the study Minor flaw: Frequency of bruxism not assessed in the study (* "frequency" used as cut-off for bruxism positivity) Minor flaw: Point prevalence Poor reporting: Omitted 95% CI for prevalence data Poor reporting: No information on validation of measurement Poor reporting: No information on reliability of measurement
Major flaw: Severity of bruxism not assessed in the study Minor flaw: Proxy report via questionnaires or interviews collected for the study Minor flaw: Frequency of bruxism not assessed in the study Minor flaw: Point prevalence Poor reporting: No information on validation of measurement Poor reporting: No information on reliability of measurement
Major flaw: Severity of bruxism not assessed in the study Minor flaw: Proxy report via questionnaires or interviews collected for the study Minor flaw: Frequency of bruxism not assessed in the study (* word "often" used as cut-off for bruxism positivity) Minor flaw: Point prevalence Poor reporting: Omitted 95% CI for prevalence data Poor reporting: No information on validation of measurement Poor reporting: No information on reliability of measurement
Major flaw: Severity of bruxism not assessed in the study Minor flaw: Proxy report via questionnaires or interviews collected for the study Minor flaw: Frequency of bruxism not assessed in the study Minor flaw: Point prevalence Poor reporting: No information on validation of measurement Poor reporting: No information on reliability of measurement
Major flaw: Severity of bruxism not assessed in the study Minor flaw: Proxy report via questionnaires or interviews collected for the study Minor flaw: Frequency of bruxism not assessed in the study (* temporal cut-off "three times a week" used as cut-off for bruxism positivity) Minor flaw: Point prevalence Poor reporting: No information on validation of measurement Poor reporting: No information on reliability of measurement
Major flaw: Severity of bruxism not assessed in the study Minor flaw: Proxy report via questionnaires or interviews collected for the study Minor flaw: Frequency of bruxism not assessed in the study Minor flaw: Point prevalence Poor reporting: Omitted 95% CI for prevalence data Poor reporting: No information on validation of measurement Poor reporting: No information on reliability of measurement

and/or awake bruxism. Very few studies reported prevalence data with respect to sex (Table 4). Given the heterogeneity of frequency criteria adopted to report bruxism as a whole and awake bruxism, a consistent prevalence estimate could be drawn only for frequent sleep bruxism (12.8% ± 3.1%).

The age distribution of the prevalence of bruxism, awake bruxism, and sleep bruxism was reported only in three investigations, and a between-study comparison was not possible due to the different presentation of data with respect to age stratification. In general, prevalence peaks in subjects under 40 years of age were common to all investigations. Also, a common trend for a prevalence decrease with age was observed (Table 5).

Table 4 Data Extraction from Selected Studies Investigating the Prevalence of Bruxism, Awake Bruxism, and Sleep Bruxism

Study first author and year	Country	Size	Mean age, y (range)	Females (%)	Diagnostic approach
Agerberg, 1972[43]*	Sweden	1,106	15–74	51.6	Unspecified self-reporting
Bernhardt, 2004[18]	Germany	2,529	20–79	52	1 self-reported item for "frequent" bruxism
Ciancaglini, 2001[19]	Italy	483	44.9 (18–75)	62.1	1 self-reported item: "Would you say that you have any clenching and/or grinding of the teeth?"
Jensen, 1993[45]	Denmark	735	25–64	NA	1 self-reported item: "Do you often press (or grind) your teeth (during sleep)?"
Ohayon, 2001[15]*	UK, Germany, Italy	13,057	15–100	52	2 self-reported items: Teeth grinding plus at least one of tooth wear, muscle stiffness, or loud grinding
Santos-Silva, 2010[34]†	Brasil	1,101	280	53.6	1 unspecified self-reported item using "three times a week" as cutoff
Winocur, 2011[40]	Israel	402	35 (18–70)	62.4	3 self-reported items: Grinding and/or worn dentition plus one of six "symptoms" ("frequently" for sleep bruxism; no specification for awake bruxism)

NA, data not available.
*Some papers also assessed subjects under 19 years of age. Despite the limits set for the literature search, they were included in the review because of their data on adults, as presented in the table on the prevalence in different age groups.
†Data of the 2007 cohort of the study.

Discussion

Several structured and systematic reviews dealing with various aspects of the bruxism literature have recently been performed.[8–10,52,53] A common suggestion from those reviews is that an improvement of the knowledge on bruxism prevalence and epidemiology should be helpful to clarify some aspects of its clinical characteristics.

A major concern of many researchers dealing with pain medicine is the poor external validity of findings coming from studies on selected non-representative populations.[54] So, in the design phase of this research, efforts were made to review as many papers as possible, for example, by setting no limits on the geographical distribution of papers, or the publication time, and to maximize the external validity of findings by establishing cut-off criteria for inclusion in the final review. Nonetheless, from a methodological viewpoint, it must be noted that the search of the literature on the prevalence of bruxism was complicated by the need for screening a high number of questionnaire-based papers not having bruxism assessment as their main outcome variable; thus, despite the comprehensive search strategy adopted for paper selection and retrieval, one cannot exclude the possible exclusion of some papers that could not be detected due to their low specificity for the assessment of the prevalence of bruxism or due to the language limitations of the search strategy.

As for the quality of the reviewed papers, several flaws compromising the external validity of findings were shown, and only 7 out of 35 papers satisfied the criteria adopted to identify an acceptable external validity. Almost half of the reviewed papers were studies based on non-representative samples, recruiting either convenient samples or populations of subjects at workplaces or healthcare centers, whilst others had poorly representative samples due to a low participation rate or did not even report the sampling strategies. Such flaws affected the external validity of the findings and the consistency of prevalence data.

Therefore, data extraction was performed only from the seven papers with minimal flaws in their external validity. Of those, only one paper did not have any flaws or poor reporting strategies compromising its external validity,[15] whilst no papers had a flawless internal validity. Most internal flaws were due to the fact that the totality of data was derived from studies based on self-reported questionnaires, mainly containing a single bruxism item within a comprehensive history questionnaire, so that the within-study specificity and between-study homogeneity of criteria to diagnose bruxism was a matter of concern. A variety of findings and strategies adopted to report prevalence data were shown. Only a minority of papers investigated the prevalence of specific bruxism activities, viz, clenching and grinding. Also, lack of homogeneity was reported for the terms used in the questionnaire items.

Given the above considerations on the quality assessment, this review's findings must be interpreted with caution. Also, in an attempt to increase the

	Bruxism (%) (M/F)	Awake bruxism (%) (M/F)	Sleep bruxism (%) (M/F)
	–	–	–
	8	–	–
	31.4 (29.4/33.3)	–	–
	–	22.1 (15.8/28.9)	15.3 (12/18.9)
	–	–	–
	–	–	9.3 (8/10.6)
	–	31 (36/28)	14 (15/13)

Table 5 Summary of Findings from Studies Assessing Age Patterns for the Prevalence of Bruxism, Awake Bruxism, and Sleep Bruxism

Study first author and year	Age groups (y)	Bruxism (%)	Awake bruxism (%)	Sleep bruxism (%)
Agerberg, 1972[43]	25–34		19	15
	35–44		20	9
	45–54		29	5
	55–64		24	4
	65–74		19	2
Ciancaglini, 2001[19]	< 30	34.6	–	–
	31–40	33.8		
	41–50	29.5		
	51–60	29.4		
	> 60	26.9		
Ohayon, 2001[15]	19–24	–	–	5.8
	25–44			5.8
	45–64			4.7
	> 64			1.1

strength and consistency of the findings, some assumptions related with the different terms adopted to indicate bruxism and its relation with circadian rhythm in the different studies were forcedly made, the effects of which on the internal consistency of this review's findings on the prevalence of bruxism have to be assessed in future research.

Studies adopting the generic term "bruxism" found a prevalence of 8% for frequent bruxism,[18] and 31.4% for bruxism independent of its frequency.[19] The two studies assessing the prevalence of awake bruxism found a 22.1% prevalence in subjects who answered that they often have bruxism while awake[45] and 31% in subjects answering positively to the generic question on their awake bruxism during the past 6 months.[40] Data on sleep bruxism were drawn from three studies,[34,40,45] and the reported prevalence range (9.3% to 15.3%) was more consistent, likely due to their common aim to investigate frequent sleep bruxism. Bruxism was not found to be a disorder related to sex, since sex differences were not relevant for any of the bruxism activities, even though a female-to-male ratio was reported only in a few studies. As for the age-related findings, a common trend for a prevalence decrease with age was described in all studies investigating the age pattern of bruxism report. It should be pointed out that a clearer picture of the age-related distribution will be achieved with the integration of these data with those derived from similar reviews in children and adolescents.

The importance of the above-described data lies in the systematic search from which they were derived. These findings may represent the best available estimate for the prevalence of bruxism and may be used to reappraise some statements based on individual papers, but it cannot be forgotten that several flaws compromising the internal validity of the papers included in the final review were identified. As commonly observed for the entire bruxism literature, the data should be interpreted with caution because of some critical problems in bruxism diagnosis. Several approaches have been proposed in the literature to diagnose bruxism, based on the attempt to identify signs and symptoms to be used as proxies for bruxism. Among these, the assessment of tooth wear failed to prove a reliable diagnostic tool, because of the high rate of false positive findings related with the high prevalence of tooth wear in populations of nonbruxing subjects.[55–57] Also, the controversial relationship between bruxism and pain makes a clinical assessment based on pain items unreliable and influenced by the clinicians' preconceived ideas.[10,16] At present, validated diagnostic criteria exist only for sleep bruxism and should be based on PSG recordings,[58] thus requiring the recording of jaw muscle activities and of multiple channels characterizing sleep in a controlled laboratory setting. No definite criteria are available yet for clenching activities during wakefulness. Recently, some diagnostic strategies based on multichannel ambulatory EMG recordings have been proposed,[59] but costs and availability still limit their translation into the clinical setting. So, a combination of an interview and a thorough clinical assessment comprising an intraoral examination (eg,

assessment of tooth wear and its differential diagnosis, hyperkeratosis of the oral mucosa, line alba in the cheeks, teeth impression in the tongue or lips, tooth or implant fracture) and an extraoral examination (eg, assessment of jaw muscle hypertrophy, temporomandibular pain) performed by an expert examiner should be viewed as the most widespread approach for establishing a diagnosis of bruxism, and its pros and cons have been extensively discussed in several papers.[55,60,61] Notwithstanding that, the large majority of the data on the prevalence of bruxism in the present review came from studies including a single-item, questionnaire-based assessment, with subsequent problems of internal validity of the studies. As stated above, the data should be interpreted with caution, also in light of previous suggestions that the bruxism literature is full of contradictory findings between studies based on self-report and those adopting a PSG and/or EMG-based bruxism diagnosis.[8,10]

Future epidemiologic studies should carefully take into account the sampling strategies and avoid the selection of non-representative populations, which in the present review were interpreted as flaws in the methodological quality assessment and caused the exclusion of most investigations from the final review. Such flaws might have been a potential source of bias in the generalization of the prevalence of bruxism at the general population level, as suggested by the very high variability of prevalence findings in the papers not included in the final review, with bruxism ranging from 7.6% to 37%,[28,41] awake bruxism from 2.7% to 57.3%,[25,49] and sleep bruxism from 4.1% to 59.2%.[25,48]

No information was gathered on the current/past occurrence and on the different frequencies of bruxism activities, because none of the studies with an acceptable external validity was designed to address these issues.

In view of the above considerations, it seems that much has yet to be done before full knowledge on the prevalence of bruxism can be achieved. The bruxism literature is likely to undergo a critical reappraisal as soon as an accurate and reliable diagnostic approach will be defined. To this aim, it is recommended that strategies to perform investigations on this phenomenon, possibly based on a diagnostic grading, are discussed in the near future on the basis of the shortcomings revealed in this systematic review.

Conclusions

The present systematic review assessed the literature on the prevalence of bruxism. Quality assessment of the reviewed literature pointed out several methodological flaws that hampered the external validity of findings, so that 28 out of the 35 reviewed papers had problems with the poor or uncertain representativeness of the study samples. Nonetheless, the 7 studies included in the final review because of their acceptable external validity had problems with their internal validity, mainly due to the fact that data were derived from questionnaire-based studies, since no epidemiologic data are available from studies adopting other diagnostic strategies (eg, PSG, EMG). As for the reported prevalence, generically identified "bruxism" was assessed in 2 studies, reporting an 8% to 31.4% prevalence, awake bruxism was investigated in 2 studies describing a 22.1% to 31% prevalence, and sleep bruxism's prevalence was found to be more consistent across the 3 studies investigating the report of "frequent" bruxism (12.8% ± 3.1%). Bruxism activities were found to be unrelated to sex, and a decrease with age was described in elderly people.

However, it should be noted that findings from this review must be interpreted with caution due to the methodological problems affecting the validity of most papers. In particular, findings are subjected to the same critical appraisal characterizing previous structured and systematic reviews of the bruxism literature due to potential diagnostic bias related to the need to rely on an individual's self-report of bruxism.

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References

1. American Academy of Sleep Medicine. International Classification of Sleep Disorders, ed 2, 2005.
2. De Leeuw R (ed). American Academy of Orofacial Pain. Orofacial Pain: Guidelines for Assessment, Diagnosis and Management, ed 4. Chicago: Quintessence, 2008.
3. Lobbezoo F, Hamburger HL, Naeije M. Etiology of bruxism. In: Paesani DA (ed). Bruxism: Theory and Practice. Berlin: Quintessence, 2010:53–66.
4. Manfredini D. The role of emotional factors in the etiology of bruxism. In: Paesani DA (ed). Bruxism: Theory and Practice. Berlin: Quintessence, 2010:87–98.
5. Macaluso GM, Guerra P, Di Giovanni G, Boselli M, Parrino L, Terzano MG. Sleep bruxism is a disorder related to periodic arousal during sleep. J Dent Res 1998;77:565–573.
6. Kato T, Thie NM, Montplaisir JY, Lavigne GJ. Bruxism and orofacial movements during sleep. Dent Clin North Am 2001;45:657–684.
7. Lavigne GJ, Khoury S, Abe S, Yamaguchi T, Raphael K. Bruxism physiology and pathology: An overview for clinicians. J Oral Rehabil 2008;35:476–494.

8. Manfredini D, Lobbezoo F. Role of psychosocial factors in the etiology of bruxism. J Orofac Pain 2009;23:153–166.
9. Svensson P, Jadidi F, Arima T, Baad-Hansen L, Sessle BJ. Relationships between craniofacial pain and bruxism. J Oral Rehabil 2008;35:524–547.
10. Manfredini D, Lobbezoo F. Relationship between bruxism and temporomandibular disorders: A systematic review of literature from 1998 to 2008. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109:e26–e50.
11. Lobbezoo F, van der Zaag J, Naeije M. Bruxism: Its multiple causes and its effects on dental implants. An updated review. J Oral Rehabil 2006;33:293–300.
12. Lobbezoo F, Aarab G, van der Zaag J. Definitions, epidemiology, and etiology of sleep bruxism. In: Lavigne GJ, Cistulli PA, Smith MT (eds). Sleep Medicine for Dentists. A Practical Overview. Chicago: Quintessence, 2009:95–100.
13. Paesani DA. Tooth wear. In: Paesani DA (ed). Bruxism: Theory and Practice. Berlin: Quintessence, 2010:123–148.
14. Lavigne GJ, Montplaisir JY. Restless leg syndrome and sleep bruxism: Prevalence and associations among Canadians. Sleep 1994;17:739–743.
15. Ohayon MM, Li KK, Guilleminault C. Risk factors for sleep bruxism in the general population. Chest 2001;119:53–61.
16. Paesani DA. Introduction to bruxism. In: Paesani DA (ed). Bruxism: Theory and Practice. Berlin: Quintessence, 2010:3–20.
17. Ahlberg K, Jahkola A, Savolainen A, et al. Associations of reported bruxism with insomnia and insufficient sleep symptoms among media personnel with or without irregular shift work. Head Face Med 2008 Feb 28;4:4.
18. Bernhardt O, Gesch D, Splieth C, et al. Risk factors of high occlusal wear scores in a population-based sample: Results of the Study of Health in Pomerania (SHIP). Int J Prosthodont 2004;17:333–339.
19. Ciancaglini R, Gherlone E, Radaelli G. The relationship of bruxism with craniofacial pain and symptoms from the masticatory system in the adult population. J Oral Rehabil 2001;28:842–848.
20. Glaros AG. Incidence of diurnal and nocturnal bruxism. J Prosthet Dent 1981;45:545–549.
21. Glass EG, McGlynn FD, Glaros AG, Melton K, Romans K. Prevalence of temporomandibular disorder symptoms in a major metropolitan area. J Craniomandib Pract 1993;11:217–220.
22. Ingervall B, Mohlin B, Thilander B. Prevalence of symptoms of functional disturbances of the masticatory system in Swedish men. J Oral Rehabil 1980;7:185–197.
23. Johansson A, Unell L, Carlsson GE, Söderfeldt B, Halling A. Gender difference in symptoms related to temporomandibular disorders in a population of 50-year-old subjects. J Orofac Pain 2003;17:29–35.
24. Kobs G, Bernhardt O, Kocher T, Meyer G. Oral parafunctions and positive clinical examination findings. Stomatologija 2005;7:81–83.
25. Marklund S, Wanman A. Incidence and prevalence of myofascial pain in the jaw-face region. A one-year prospective study on dental students. Acta Odontol Scand 2008;66:113–121.
26. McFarlane TV, Gray RJM, Kincey J, Worthington HV. Factors associated with the temporomandibular disorder, pain dysfunction syndrome (PDS): Manchester case-control study. Oral Dis 2001;7:321–330.
27. Melis M, Abou-Atme YS. Prevalence of bruxism awareness in a Sardinian population. J Craniomandib Pract 2003;21:144–151.
28. Molina OF, dos Santos Jr. J, Nelson SJ, Grossman E. Prevalence of modalities of headaches and bruxism among patients with craniomandibular disorders. J Craniomandib Pract 1997;15:314–325.
29. Nekora-Azak A, Evlioglu G, Ordulu M, Issever H. Prevalence of symptoms associated with temporomandibular disorders in a Turkish population. J Oral Rehabil 2006;33:81–84.
30. Nekora-Azak A, Yengin E, Evlioglu G, Ceyhan A, Ocak O, Issever H. Prevalence of bruxism awareness in Istanbul, Turkey. J Craniomandib Pract 2010;28:122–127.
31. Pow EHN, Leung KCM, McMillan AS. Prevalence of symptoms associated with temporomandibular disorders in Hong Kong Chinese. J Orofac Pain 2001;15:228–234.
32. Reding GR, Rubright WC, Zimmerman SO. Incidence of bruxism. J Dent Res 1966;45:1198–1204.
33. Rieder CE, Martinoff JT, Wilcox SA. The prevalence of mandibular dysfunction. Part I: Sex and age distribution of related signs and symptoms. J Prosthet Dent 1983; 50:81–88.
34. Santos-Silva R, Bittencourt LRA, Nogueira Pires ML, et al. Increasing trends of sleep complaints in the city of Sao Paulo, Brazil. Sleep Med 2010;11:520–524.
35. Seligman DA, Pullinger AG, Solberg WK. The prevalence of dental attrition and its association with factors of age, gender, occlusion, and TMJ symptomatology. J Dent Res 1988;67:1323–1333.
36. Strausz T, Ahlberg J, Lobbezoo F, et al. Awareness of tooth grinding and clenching from adolescence to young adulthood: A nine-year follow up study. J Oral Rehabil 2010;37:497–500.
37. Suwanprathes P, Won C, Komoltri C, Nana A, Kotchabhakdi N, Guilleminault C. Epidemiology of sleep-related complaints associated with sleep-disordered breathing in Bangkok, Thailand. Sleep Med 2010;11:1025–1030.
38. Velly AM, Gornitski M, Philippe P. A case-control study of temporomandibular disorders: Symptomatic disc displacement. J Oral Rehabil 2002;29:408–416.
39. Zulqairnan BJ, Khan N, Khattab S. Self-reported symptoms of temporomandibular dysfunction in a female university student population in Saudi Arabia. J Oral Rehabil 1998;25:946–953.
40. Winocur E, Uziel N, Lisha T, Goldsmith C, Eli I. Self-reported bruxism—Associations with perceived stress, motivation for control, dental anxiety and gagging. J Oral Rehabil 2011;38:3–11.
41. Miyake R, Ohkubo R, Takehara J, Morita M. Oral parafunctions and association with symptoms of temporomandibular disorders in Japanese university students. J Oral Rehabil 2004;31:518–523.
42. Zeithlofer J, Seidel S, Klösch G, et al. Sleep habits and sleep complaints in Austria: Current self-reported data on sleep behaviour, sleep disturbances and their treatment. Acta Neurol Scand 2010;122:398–403.
43. Agerberg G, Carlsson GE. Functional disorders of the masticatory system. I: Distribution of symptoms according to age and sex as judged from investigation by questionnaire. Acta Odontol Scand 1972;30:597–613.
44. Goulet JP, Lund JP, Montplaisir J, Lavigne GJ. Daily clenching, nocturnal bruxism, and stress and their association with TMD symptoms [abstract]. J Orofac Pain 1993;7:120.
45. Jensen R, Rasmussen BK, Lous I, Olesen J. Prevalence of oromandibular dysfunction in a general population. J Orofac Pain 1993;7:175–182.
46. Matsuka K, Yatani H, Kuboki T, Yamashita A. Temporomandibular disorders in the adult population of Okayama City, Japan. J Craniomandib Pract 1996;14:158–162.

47. Norheim PW, Dahl BL. Some self-reported symptoms of temporomandibular joint dysfunction in a population in northern Norway. J Oral Rehabil 1978;5:63–68.
48. Ow RKK, Loh T, Neo J, Khoo J. Symptoms of craniomandibular disorder among elderly people. J Oral Rehabil 1995;22:413–419.
49. Swanljung O, Rantanen T. Functional disorders of the masticatory system in southwest Finland. Comm Dent Oral Epidemiol 1979;7:177–182.
50. Shamliyan TA, Kane RL, Ansari MT, et al. Development quality criteria to evaluate nontherapeutic studies of incidence, prevalence, or risk factors of chronic diseases: Pilot study of new checklists. J Clin Epidemiol 2011;64:637–657.
51. Aschengrau A, Seage GR. Essentials of Epidemiology in Public Health. Sudbury, Jones & Bartlett, 2003.
52. Restrepo C, Gomez S, Manrique R. Treatment of bruxism in children: A systematic review. Quintessence Int 2009;40:849–855.
53. Lobbezoo F, Ahlberg J, Manfredini D, Winocur E. Are bruxism and the bite casually related? J Oral Rehabil 2012;39:489–501.
54. Palla S, Farella M. External validity: A forgotten issue? J Orofac Pain 2009;23:297–298.
55. Koyano K, Tsukiyama Y, Ichiki R, Kuwata T. Assessment of bruxism in the clinic. J Oral Rehabil 2008;35:495–508.
56. Schierz O, John MT, Schroeder E, Lobbezoo F. Association between anterior tooth wear and temporomandibular disorder pain in a German population. J Prosthet Dent 2007;97:305–309.
57. Abe S, Yamaguchi T, Romprè PH, De Grandmont P, Chen YJ, Lavigne GJ. Tooth wear in young subjects: A discriminator between sleep bruxers and controls? Int J Prosthod 2009;22:342–350.
58. Lavigne GJ, Rompré PH, Montplaisir JY. Sleep bruxism: Validity of clinical research diagnostic criteria in a controlled polysomnographic study. J Dent Res 1996;75:546–552.
59. Manfredini D, Fabbri A, Peretta R, Guarda-Nardini L, Lobbezoo F. Influence of psychological symptoms on home-recorded sleep-time masticatory muscles activity in healthy subjects. J Oral Rehabil 2011;38:902–911.
60. Marbach JJ, Raphael KG, Janal MN, Hirschkorn-Roth R. Reliability of clinician judgment of bruxism. J Oral Rehabil 2003;30:113–118.
61. Van der Meulen MJ, Lobbezoo F, Aartman IHA, Naeije M. Self-reported oral parafunctions and TMD pain intensity. J Orofac Pain 2006;20:31–35.