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REVIEW

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Association between sleep bruxism and stress symptoms in adults: A systematic review and meta-analysis

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Abstract

To synthesise and critically review the association between sleep bruxism (SB) and stress symptoms in adults. A systematic review was performed. The search was completed using seven primary electronic databases in addition to a grey literature search. Two reviewers blindly selected studies based on pre-defined eligibility criteria. Risk of bias of the included articles was performed using the Joanna Briggs Institute Critical Appraisal Checklist for Analytical Cross-Sectional Studies. RevMan 5.4 was used to perform the meta-analysis. The quality of evidence was evaluated according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE). Ten studies were included for qualitative analysis, of which three were included for quantitative analysis. Three studies were evaluated to have low risk of bias, and seven were assessed with moderate risk of bias. Quality of evidence was classified as very low for all outcomes. Individuals with SB were found to have higher levels of some self-reported stress symptoms as assessed through questionnaires with a mean difference of 4.59 (95% CI 0.26-8.92). Biomarkers like epinephrine, norepinephrine, cortisol, adrenaline, dopamine, noradrenaline and prolidase enzyme levels also showed a positive association with SB. Although some associations were identified between probable SB and self-reported stress symptoms and biomarkers of stress in adults, given that the quality of evidence was found to be very low, caution should be exercised in interpreting these results. These findings suggest that additional and better designed studies are warranted in order to clarify the link between SB and stress.

KEYWORDS

evidence-based dentistry, sleep bruxism, stress symptoms, systematic review

1 | INTRODUCTION

Sleep bruxism (SB) can be defined as a masticatory muscle activity that occurs during sleep (characterised as rhythmic or non-rhythmic).[1] In healthy individuals, SB should not be considered as a disorder, but rather as a behaviour that can be a risk factor associated with certain clinical consequences. SB has a multifactorial aetiology,[1,2] that has been broadly classified into three groups of aetiological factors: biological factors,[3-5] psychological factors such as anxiety symptoms[6] and exogenous factors such as consumption of some medicines, caffeine, tobacco and/or alcohol.[7,8]

Baum[9] described stress as 'a negative emotional experience accompanied by predictable biochemical, physiological, cognitive and behavioural changes that are directed either towards altering

the stressful event or accommodating to its effects'. Moreover, the American Psychological Association[10] defines stress as the physiological or psychological response to internal or external stressors. These continuous stimuli can lead to an increase of some biomarkers, such as salivary cortisol, and can be manifested by the worsening of the systemic health of affected individuals.[11] Some examples of related symptoms are palpitations, sweating, dry mouth, shortness of breath, fidgeting, accelerated speech, augmentation of negative emotions (if already being experienced) and longer duration of stress-related fatigue. By eliciting these mind-body changes, stress contributes directly to psychological and physiological disorders and diseases that affect mental and physical health, thereby reducing quality of life.[12]

Previous studies in animals[13] as well as in humans[14-17] have associated SB with stress symptoms; however, not all studies have found this association.[18-20] Moreover, a literature review[21] was performed in 2009 about the role of psychological factors and bruxism. Most of the included studies did not assess SB through polysomnography (PSG), which is the standard test for detection of SB.[22] Additionally, bruxism was evaluated as a whole and not separated in relation to the circadian cycle, such as in awake versus sleep bruxism. A previous systematic review (SR)[23] was performed including primary studies that explored an association between bruxism and salivary cortisol to evaluate stress. Only two studies were included in that SR,[24,25] and there was no conclusive scientific evidence detected in that study.

The association between SB and multiple stress symptoms has not yet been consolidated in the literature. Therefore, the aim of this systematic review was to critically evaluate current evidence and answer the following focused question: 'Is there an association between sleep bruxism and stress symptoms among adults?'

2 | METHODS

2.1 | Protocol and registration

A study protocol was elaborated following the PRISMA-P[26] guidelines and registered at PROSPERO under the code CRD42020157471.

This SR was reported according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA).[27]

2.2 | Eligibility criteria

The acronym PECOS (Population, Exposition, Comparison, Outcomes and Studies) was used to formulate the focused question in this SR, in which the following are described: P) Adults with quantified stress; E) Presence of SB; C) Absence of SB; O) Association between SB and stress; and S) Observational studies. We therefore included studies that investigated the association between SB and stress symptoms in adults (18 years and older).

Based on the new international consensus,[1] the assessment of SB can be classified through either a non-instrumental approach or an instrumental approach. The non-instrumental includes self-reporting (questionnaires and oral history) and clinical examination. The instrumental approach includes an electromyography (EMG) record that can also include audio and/or video recordings, through a PSG.[1] A grading system for SB assessment has been proposed based on the new international consensus. Further validation in clinical milieus is ongoing to support its use in differentiating behavioural and psychiatric disorder issues and if it is valid for use in causality assessments.[1,28,29] Such grading methodology has been used in other conditions such as neuropathic pain for classification of symptoms and test findings.[30,31] The first level of the SB grading is 'possible SB', based on positive self-report only. SB is considered 'probable' with a positive clinical inspection, with or without a positive self-report. 'Definite SB' grading is based on use of a positive instrumental assessment(s), as confirmatory test(s), with or without a positive self-report and/or a positive clinical inspection. The SB was graded based on available assessment information by the first author (HP).

In addition, stress symptoms were assessed through validated questionnaires, such as the Stress Questionnaire from the International Stress Management Association,[32] Perceived Stress Scale,[33] Manual of Student Stress Inventory (SSI)[34] and the Questionnaire WHO.[35]

Moreover, we also included studies that evaluated self-reported stress symptoms through biomarkers[36] such as cortisol, catecholamines, a-amylase and/or proinflammatory cytokines (interleukin (IL)-6, IL-1b levels) found in salivary, urine, blood and/or body fluids samples. The specificity and validity of these biomarkers was not assessed for the present review as it is a topic for another review.

Our exclusion criteria included the following: (a) studies that included individuals with comorbidities such as temporomandibular joint disorders, obstructive sleep apnoea, depression or other psychiatric disorders such as post-traumatic stress disorder, insomnia; anxiety; (b) studies that included subjects who use of psychotropics medications; (c) studies that evaluated awake bruxism (AB); (d) studies in which SB diagnostic criteria or stress criteria were not reported or not sufficiently described; (e) studies with no healthy control group; (f) studies that did not associate SB and stress; (g) reviews, letters, conference abstracts, personal opinions, case reports and laboratory research or abstracts with no full text available.

2.3 | Information sources and search strategy

Electronic search strategies were developed for EMBASE, Latin American and Caribbean Center on Health Sciences (LILACS), LIVIVO, PubMed, SCOPUS, Web of Science and PsycINFO. Additionally, a grey literature search was performed on Google Scholar, Open Grey and ProQuest. There was no time period restriction neither language. Furthermore, hand-searches were performed on the reference lists of included articles. Experts were also consulted in order to improve search findings, following the recommendations of Greenhalgh and Peacock.[37] More information concerning

truncation and word combinations are available in Table S1. All supplementary data will be available online. Reference management software (EndNote X7, Thomson Reuters) was used to exclude duplicates and organise references (Rayyan).[38]

2.4 | Study selection

A two-phase process was conducted by the same two reviewers to select studies. In phase-one, two reviewers (HP and JCR) independently screened the titles and abstracts of all identified references. Studies that did not fulfil the above noted eligibility criteria were excluded. In phase-two, the same two reviewers applied the eligibility criteria to the full text of the studies. A third reviewer (CM) was consulted in the event of unresolved rating disagreements between the two reviews following a consensus discussion.

2.5 | Data collection process and data items

The first reviewer (HP) collected and extracted the required information from the selected studies. A second reviewer (JCR) extracted the same information separately. Collected data were subsequently compared. Any unresolved disagreement was decided by the third reviewer (CM) if needed. The data collected consisted of: study characteristics (authors, year of publication, country), population characteristics (sample size, mean age of participants, gender), methods of disorder assessment and main findings.

2.6 | Risk of bias in individual studies

Risk of bias was assessed by using the Joanna Briggs Institute Critical Appraisal Checklist according to the design of the included studies. Separately, two reviewers (HP and JCR) performed the risk of bias evaluation and categorised the included articles as 'high risk' when the study bias rating 'yes' score was between 0% and 49%, 'moderate risk' when the study 'yes' score was between 50% and 69%, and 'low risk' when the study 'yes' score was above 70%. In cases of rating category discordance between the two reviewers, the third reviewer (CM) was consulted to resolve the disagreement. RevMan 5.4 (Review Manager 5.4, The Cochrane Collaboration) was used to generate relevant figures.

2.7 | External and internal validity

Clinical heterogeneity across studies was assessed by comparing variability across participants' characteristics (such as age and type of medication used). Methodological heterogeneity was evaluated by comparing variability in study design (such as diagnostic methods) and risk of bias in individual studies.

2.8 | Summary measures

The main outcome assessed was the association between SB and stress symptoms. The summary measure considered odds ratios (OR) in dichotomous variables, with 95% confidence intervals (CI). For continuous variables, the mean difference (MD) and median range (MR) were considered, also with 95% confidence intervals (CI).

Statistical heterogeneity was quantified using the I^2 test, and a value > 50% was considered as an indicator of substantial heterogeneity. According to the appropriate Cochrane Guidelines, a value greater than 50% is considered an indicator of substantial heterogeneity among studies. As a result, the random effect method was chosen to be the appropriate method for the mtea-analysis.[39] On the other hand, when I^2 was lower than 50%, the fixed effect model is recommended.[40] The software RevMan 5.4 (Review Manager 5.4, The Cochrane Collaboration) was used to perform all the meta-analyses and create figures.

2.9 | Confidence in cumulative evidence

A summary of the overall strength of evidence available was presented and categorised by groups analysed using 'Grading of Recommendations Assessment, Development and Evaluation' (GRADE). Summary of Findings (SoF) tables were produced with the aid of the GRADE online software (GRADEpro GTD, Copenhagen, Denmark) provided by the GRADE Working Group in association with the Cochrane Collaboration and Members of McMaster University.

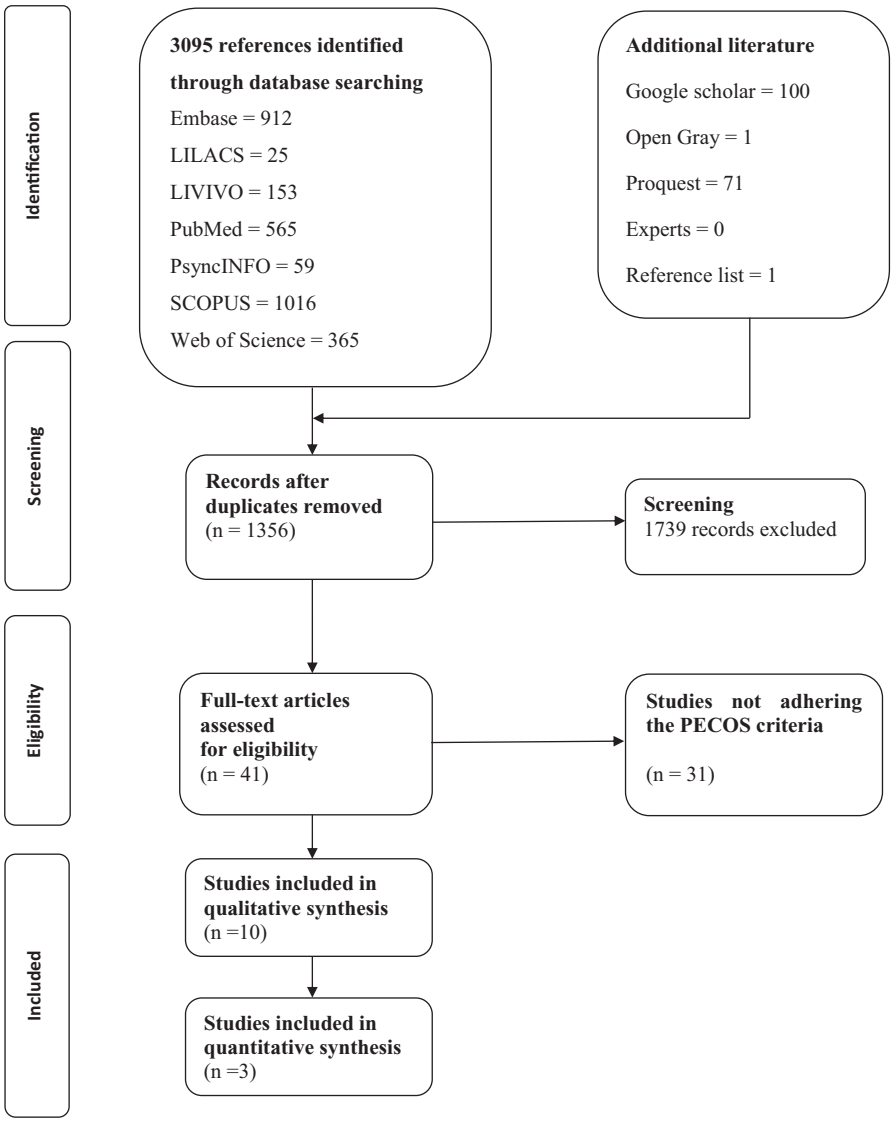
3 | RESULTS

3.1 | Study selection

In Phase 1, 3095 references were found within all searches. After duplicates were removed, 1147 were left for screening of title and abstract. After screening, 41 references were selected by both reviewers to Phase 2. After applying the eligibility criteria on full text, 31 more articles were excluded (please see Table S2 for exclusion details). Following careful article review, ten articles were finally included. (Figure 1) The search on main databases as well as the grey literature search was carried out on 16 September 2020, and ten articles were found through these databases.

3.2 | Study characteristics

Ten analytical cross-sectional studies were included. They were published in Brazil,[41-43] Greece,[24] Indonesia,[44] Turkey,[45] Lithuania,[46] Peru,[47] Poland[48] and the United States.[49] They were published between 1980 and 2020. Overall, 3149 participants



[1] Adapted from PRISMA.

FIGURE 1 Flow diagram of literature search and selection criteria (adapted from Preferred Reporting Items for Systematic Reviews and Meta-Analysis and generated using the software Review Manager 5.4, The Cochrane Collaboration)

were registered in these studies. The largest sample presented was 394[42] individuals and the smallest, 30.[49] In addition, only two of the included studies reported a priori calculations to estimate sample size.[46,47] Only three studies could be included for quantitative analysis.[24,46,48] Information regarding study characteristics can be found in Table 1.

Two studies[44,46] assessed possible SB using only questionnaires. SB assessment was considered probable in eight studies[24,41-43,45,47-49] using clinical examination, of which four used an instrumental approach (EMG) to detected SB. None of the articles reported a definitive assessment using the standard test polysomnography.

3.3 | Risk of bias within studies

Three studies[42,45,47] presented low risk of bias while seven articles were assessed with moderate[24,41,43,44,46,48,49] risk of bias. The question which most commonly elevated the risk of bias was 'Were confounding factors identified?'. Five studies identified at least one confounding factor such as coffee, tobacco, alcohol.[7] Further information about the criteria for grading the questions as 'yes' or 'no' can be found in the Checklist for Analytical Cross-Sectional Studies of the Joanna Briggs Institute.[50] More information about risk of bias can be found in Figure 2.

3.4 | Results of individual studies

The results of the analytical cross-sectional studies were scrutinised according the assessment method of stress symptoms. The evaluation of stress symptoms could be done through questionnaires that presented dichotomous or continuous results, and also through biomarkers.

Carvalho et al[41] analysed 81 police officers through self-report and clinical examination and found that 27 presented with probable SB. Nine participants presented with both conditions. The Stress

Symptoms Inventory (SSI) was used to estimate stress levels. A negative association was found through a chi-square test, with an OR of 0.02 (95% CI 0.01 to 0.10).

Carvalho et al[42] evaluated 395 policemen and 198 of them presented with probable SB. Approximately 27.34% of the individuals with SB also presented with stress symptoms. Stress symptoms were evaluated using the SSI. A chi-square test demonstrated that sleep bruxers had a 2.07 (95% CI 1.38 to 3.09) increased risk of stress symptoms than non-sleep bruxers.

Clark et al[49] recruited a sample of 30 adults from the Dental Center that were assessed by EMG for probable SB and biomarkers to evaluate stress symptoms. Three groups were classified according to EMG results: control, light muscle activity and heavy muscle activity. A positive association between the heavy muscle activity group and the other groups concerning stress was found using a Student *t* test. The mean difference between the heavy muscle activity and control groups was 4.27 (95% CI 3.96 to 4.58) with respect to the measured epinephrine biomarker and 19.17 (95% CI 17.33-21.01) for norepinephrine.

Indrasari et al[44] conducted a study with 214 individuals from an aircrew where 51 were assessed with possible SB. The Occupational Stress Indicator Management guide was chosen to evaluate stress symptoms. The mean difference between SB and non-SB was 2.10 (95% CI 0.39-3.81). A Mann-Whitney test was performed, and a significant association between SB and stress symptoms was found.

Jokubaukas et al[46] collected a sample of 102 participants with SB from a total 228 undergraduate dental students evaluated. SB was classified as probable and stress assessment was made using the Perceived Stress Scale (PSS). A chi-squared test and Fisher's exact test found a negative association between SB and stress. The mean difference between groups was 1.64 (95% CI −0.10-3.38).

Karakoulaki et al[24] used a portable device to detect SB along with a questionnaire in 45 individuals under treatment at a School of Dentistry. Twenty-five participants were classified with possible SB. Stress was evaluated via questionnaire (PSS) and biomarkers (cortisol and α-amylase). The mean difference regarding PSS was 10.72 (95% CI 5.95-15.49). Cortisol was found to have a mean difference of 0.10 (95% CI 0.06-0.14), and α-amylase showed a negative mean difference of 0.98 (95% CI −14.99-16.95). The Mann-Whitney test was used to compare those variables.

Marin et al[47] investigated 204 individuals from military aircrews and found that 62 presented probable SB. Only two individuals presented with both conditions. The World Health Organization (WHO) questionnaire was used to assess stress symptoms. Pearson's chi-square non-parametric test was used to carry out statistical analysis. This study found that SB sufferers had an 11.78 (95% CI 0.56-248.95) times higher risk of experiencing stress symptoms.

Ozcan-Kucuk et al[45] assessed a total of 51 subjects with probable SB and 70 healthy individuals. Prolidase enzyme levels were evaluated to assess stress symptoms. The independent *t* test showed a positive association between SB and stress symptoms. Female sleep bruxers had a median range of 0.98 (0.49-2.33) and 0.97 (0.77-1.34) as median range for male SB subjects.

Saczuk et al[48] analysed 60 adults who came to consultation to a Laboratory of Masticatory Dysfunctions using a portable device, and 35 were found to have probable SB. The PSS was used to evaluate stress. The Mann-Whitney test was used to carry out the primary analysis. A negative mean difference was found between groups 3.00 (95% CI −0.07-6.07).

Seraidarian et al[43] evaluated possible SB in 40 men found in general population through questionnaire,[51] and 20 were found to have SB. Catecholamines (adrenalin, noradrenalin and dopamine) were used to assess stress levels. The Mann-Whitney test showed a positive association between all three catecholamines and SB. The mean difference for adrenaline, dopamine and noradrenaline were respectively: 75.90 (95% CI 59.99-91.81), 277.90 (95% CI 220.97-334.83) and 125.73 (95% 108.91-142.55).

3.5 | Synthesis of results

3.5.1 | Stress assessed by questionnaire

A meta-analysis was performed for continuous outcomes in three studies by using mean difference and the inverse variance analysis method.[24,46,48] A positive association was found ($P < .001$), and the mean difference was 4.59 (95% CI 0.26-8.92) between bruxers and non-bruxers. However, a considerable level of heterogeneity was discovered through I^2 and Tau^2 tests, indicating that the included studies were particularly heterogeneous in their reported effect size. Further details of these data can be found in Figure 3.

For dichotomous outcomes, relative frequencies, absolute frequencies and p-values were collected from the studies as outcomes measurements. Moreover, since different approaches were used to evaluate stress symptoms, the data appeared to have wide variation and the samples had different degrees of SB classification (eg possible, probable). Of note, the included studies were considered clinically, methodologically and statistically heterogeneous. Therefore, quantitative data were not directly comparable, and therefore, a meta-analysis was deemed inappropriate for dichotomous results.

3.5.2 | Stress assessed by biomarkers

Four studies[24,43,45,49] used biomarkers to evaluate stress symptoms. Epinephrine, norepinephrine, cortisol, α-amylase, adrenaline, dopamine, noradrenaline and prolidase enzyme levels were used. A quantitative analysis could not be performed since each study used one different biomarker. All biomarkers analysed in this SR were found to have significantly higher levels in sleep bruxers than non-bruxers. Only α-amylase did not show a positive association with SB. Meta-analysis was not performed due to high levels of clinical, methodological and statistical heterogeneity.

TABLE 1 Summary of overall descriptive characteristics of included studies (n = 10)

Author (Y) country	Sample (n)	Groups (n)	Age (mean ± SD or range in years)	SB diagnostic methods and classification[a]	Stress diagnostic method
Carvalho et al (2008a) Brazil	81	SB 27 NB 54	22-46 y	1) Clinical examination	Questionnaire SSI
Carvalho et al (2008b) Brazil	394	SB 198 NB 196	35.5	1) Questionnaire 2) Clinical examination	Questionnaire SSI
Clark et al (1980) United States	30	SB 20 NB 10	Light muscle activity: 21-40 Heavy muscle activity: 19-49 NB: 19-29	1) EMG	Biomarkers
Indrasari et al (2017) Indonesia	214	SB 51 NB 163	19-57 y	1) Questionnaire	Sloan and Cooper's questionnair
Jokubaukas et al (2019) Lithuania	228	SB 102 NB 126	22.67 ± 2.27	1) Questionnaire	Questionnaire PSS
Karakoulaki et al (2015) Greece	45	25 SB 20 NB	34.5 ± 6.4	1) Questionnaire 2) EMG (BiteStrip)	Questionnaire PSS Biomarkers
Marin et al (2007) Peru	204	62 SB 142 NB	31-41	1) Questionnaire 2) Clinical examination	Questionnaire WHO
Ozcan-Kucuk et al (2020) Turkey	121	51 SB 70 NB	SB9.13 ± 10.74 NB 26.84 ± 7.75	1) Clinical examination	Biomarkers
Saczuk et al (2019) Poland	60	35 SB 25 NB	SB 29.9 ± 8.35 NB 35 ± 10.9	1) Self-report 2) Clinical examination 3) EMG (BiteStrip)	Questionnaire PSS
Seraidarian et al (2009) Brazil	40	20 SB 20 NB		1) Clinical examination	Biomarkers

Note: Abbreviations: EMG, electromyography; NB, no bruxism; OSI, Oxidative Stress Index; Questionnaire PSS, Perceived Stress Scale; Questionnaire WHO, World Health Organisation; SB, sleep bruxism; SSI, stress symptoms inventory.

[a]Based on an expert consensus (Lobbezoo et al, 2013).[1]

Results (Mean ± SD, or other pertinent findings)				Main conclusion
SB and stress 9 NB and stress 52			$P < .05$	Association between SB and emotional stress was found.
SB and stress 108 NB and stress 72			$P < .05$	Emotional stress was found to be associated with SB.
Light muscle activity and stress Epinephrine: 6.44 ± 0.97 Norepinephrine 28.15 ± 3.78 **Heavy muscle activity and stress** Epinephrine: 10.26 ± 0.48 Norepinephrine 39.08 ± 3.42 **NB and stress** Epinephrine: 5.99 ± 0.51 Norepinephrine: 19.91 ± 2.44			$P > 00.5$ $P < .05$ $P > .05$	The difference between the heavy muscle activity group and the other two groups was significant.
SB and home stress 23.39 ± 5.50 NB and home stress 21.29 ± 5.24			$P > .05$	There is no association between SB and home stress.
SB and stress 21.43 ± 6.56 NB and stress 19.79 ± 6.77			$P > .05$	No association between SB and perceived stress was found.
SB and PSS 34.52 ± 7.98 NB and PSS 23.80 ± 8.21 SB and cortisol 0.37 ± 0.08 NB and cortisol 0.27 ± 0.06 SB and α-amylase 39.74 ± 31.86 NB and α-amylase: 38.76 ± 22.70			$P < .05$ $P < .05$ $P < .05$	A positive association was found between perceived stress and cortisol levels of stress.
SB and stress 2 NB and NB and stress 0			$P < .05$	A significant association was found between SB and work stress.
	SB	**NB**	$P < .05$	OSI and SB was found to have a positive statistical association
Female	0.98 (0.49 - 2.33)	0.77 (0.56 - 1.3)	$P < .05$	
Male	0.97 (0.77 - 1.34)	0.83 (0.53 - 1.54)		
SB and stress (18.0 ± 6.74) NB and stress (15.0 ± 5.36)			$P < .05$	Perceived stress showed a positive association with SB.
SB and adrenaline (111.41 ± 32.98) NB and adrenaline (35.51 ± 15.19) SB and dopamine (479.6 ± 77.7) NB and dopamine (201.7 ± 104.1) SB and noradrenaline (274.45 ± 26.77) NB and noradrenaline (148.72 ± 27.50)			$P < .05$ $P < .05$ $P < .05$	A statistically significant positive correlation was found between catecholamine levels and the presence of SB.

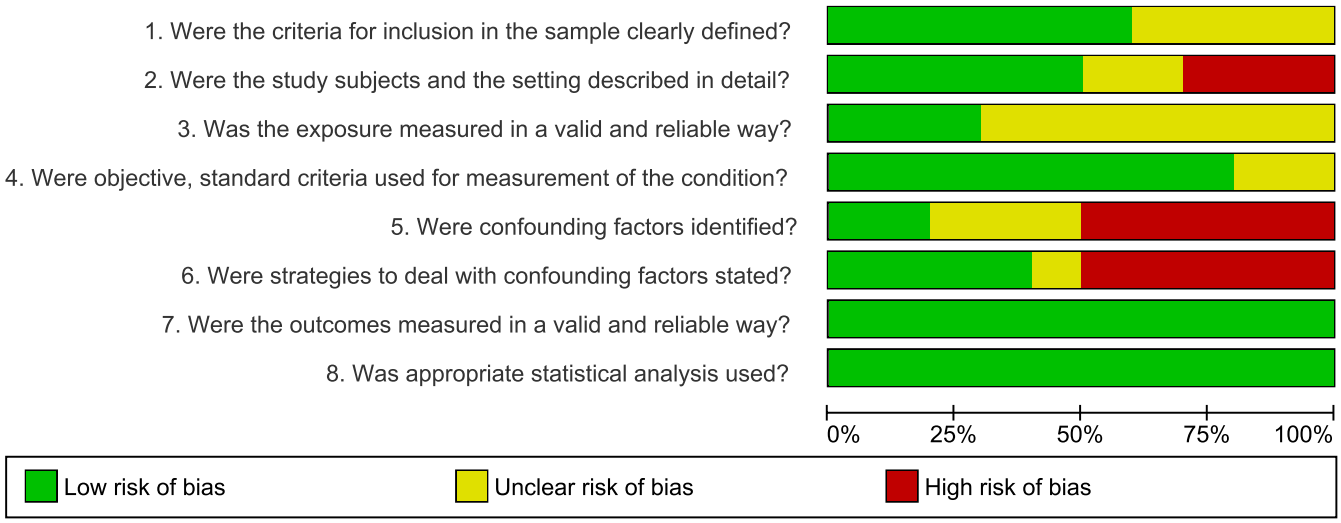


FIGURE 2 Risk of bias summary, assessed by Joanna Briggs Institute Critical Appraisal Checklist for Analytical Cross-Sectional Studies: author's judgments for each included study (generated using the software Review Manager 5.4, The Cochrane Collaboration) [Colour figure can be viewed at wileyonlinelibrary.com]

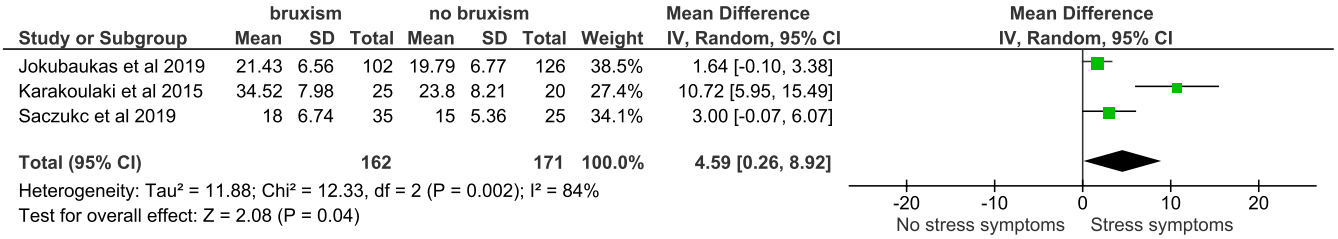


FIGURE 3 Forest plot, associating sleep bruxism and stress symptoms evaluated through the Perceived Stress Scale (generated using the software Review Manager 5.4, The Cochrane Collaboration) [Colour figure can be viewed at wileyonlinelibrary.com]

3.6 | Confidence in cumulative evidence

Confidence in cumulative evidence was performed for stress assessment markers. Confidence was found to be very low according to the GRADE criteria. Imprecision was judged to be serious since different tools for stress assessment were used across studies. Adding to that, some concerns regarding SB detection were present given that no standardised method was used across studies. The risk of bias was also evaluated for continuous and biomarker outcomes. Most of the studies did not report whether confounders were identified nor did they report how confounders were dealt with. As well, all studies used convenience sampling, a method that is not ideal. Most of studies did not report the process of researcher method calibration. Inconsistency was considered serious given that divergent results were found using both questionnaires as outcomes. Supplementary information relevant to these issues can be accessed in Table 2.

3.7 | External and internal validity of findings

Internal validity was highly affected in this SR, since neither SB nor stress were assessed through standardised tests. External validity was limited due to the use of convenience sampling in most studies. Almost all participants were selected from convenience samples (universities, clinics and hospitals), only one study selected their participants from the general population; however, only men were included.[43] As well, studies were collected from four different continents: America, Europe, Asia and Oceania (since Indonesia is a transcontinental nation). Caution should be taken when extrapolating the results of this SR from a worldwide population.

4 | DISCUSSION

4.1 | Summary of evidence

Results from this SR suggest a positive association between SB and stress symptoms. However, caution should be exercised in this interpretation due to the moderate risk of bias of almost all studies and the very low quality of evidence to support the assessed outcomes. Possible SB was positively associated with stress symptoms in two studies[44,46] that evaluated SB through questionnaires. All included studies[24,41-43,45,47-49] that evaluated probable SB showed a positive association with a measured stress symptom.

TABLE 2 Grading of recommendations assessment, development and evaluation summary of findings table

Certainty assessment						No of patients		Certainty
No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	SB	Stress	Absolute (95% CI)
Questionnaire (continuous)								
5	Observational study	serious[a]	serious[b]	not serious	serious	268/949 (28.2%)	681/949 (71.8%)	⨁◯◯◯ VERY LOW
Questionnaire (dichotomous)								
3	Observational study	not serious[a]	serious[b]	not serious	serious[c]	287/679 (42.3%)	392/679 (57.7%)	⨁◯◯◯ VERY LOW
Biomarkers								
4	Observational study	serious[c]	serious[b]	not serious	not serious	173/355 (48.7%)	182/355 (51.3%)	⨁◯◯◯ VERY LOW

Abbreviation: CI, Confidence interval.

[a]Risk of Bias was considered serious because most of the studies did not state whether confounders were identified and how to deal with them.

[b]Stress symptoms were assessed through different tools.

[c]Divergent results were found within the studies.

Stress symptoms are present in our daily life tasks. The presence of stress per se will not automatically cause a disorder or disease. However, an extended exposure to stressors might cause the organism to experience a phase of exhaustion associated with adverse effects.[52]

Catecholamines, cortisol and alfa-amylase levels were assessed through biomarkers in four of the included SB studies. Catecholamines are similar hormones and neurotransmitters with several functions, such as control of motoneuron activity, regulation of sleep and modulation of heart rate.[53] They are regulated through the hypothalamic-adrenal axis, which releases catecholamines in the presence of a stress trigger. In our SR, dopamine, serotonin, adrenalin, noradrenalin and prolidase levels were evaluated. All included studies that associated catecholamines with SB found higher levels in sleep bruxers than in non-sleep bruxers. This association has been also found in a paediatric sample.[54] Further, it has been suggested that neurotransmitters might be involved in the origin of jaw movements.[5] Moreover, two studies that associated sleep bruxism with cortisol found higher levels of cortisol in the case group sample. Cortisol, also known as hydrocortisone, is a hormone that is also regulated by the hypothalamic-adrenal axis, as is the case with the neurotransmitters listed above. Cortisol levels also change according to the circadian rhythm.[55] Higher levels of cortisol also increase vigilance and hypervigilance,[56] among other conditions.

A-amylase has been known as a biomarker for acute stress. However, the use of this biomarker has generated some conflicting findings in the published literature.[57] The negative association found in this SR should be considered with caution given that SB is unlikely to develop from a single episode of stress.

Three[24,46,48] articles evaluated *perceived* stress in their sample via questionnaires. Perceived stress is 'feelings or thoughts that an individual has about how much stress they are under at a given point in time or over a given time period'.[58] A meta-analysis was performed that found an overall positive association between SB and perceived stress.

4.2 | Limitations

Our SR identified only analytical cross-sectional studies, a limitation that precludes any causal inferences between SB and stress symptoms.[59] Longitudinal studies that include therapeutic interventions, clinical trials including those that encompass long-term follow-up periods would better support findings associated with directionality and are more likely to provide a higher quality of evidence.[60]

Moreover, there are some comorbidities that may influence the variables of our SR, such as the presence of some anxiety symptoms[6] and the use of some psychotropic medications.[8] Studies that included participants with these conditions were excluded. It is important to note that there is no assurance that these conditions were not present but unreported by study participants.

All questionnaires assessed self-reported stress and studies did not report the presence of a trained psychological professional in the evaluation and analysis process. There are a number of advantages associated with self-report evaluation, however caution should be taken while interpreting the results in this context. Even when

interviewees meant to be honest, their self-reports may be subject to biases for a variety of reasons. Some limitations such as self-deception and poor memory have been found to be related to this issue.[61]

Moreover, is not possible to assess how the presence of awake bruxism could affect the sleep bruxism activity in this study. A person with undetected awake bruxism may show inaccurate results when evaluated for probable sleep bruxism, since the clinical signs and symptoms for both conditions are similar. [62]

5 | CONCLUSIONS

Based on current published literature, a positive association between probable SB and stress symptoms appears to exist, but caution should be exercised due to the moderate risk of bias and the very low quality of evidence included in this SR to support the association. Stronger methodological and standardised prospective studies (ie participants selection from general population, standardise clinical and test protocols with long-term follow-up) are needed to increase the quality of evidence in order to confirm this possible association and to help clarify the direction of the association between these variables.

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CONFLICT OF INTEREST

Authors have no conflicts of interest to declare.

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DDS Helena Polmann worked on study conceptualisation, design, data collection, data analysis, drafted the initial manuscript, and approved the final manuscript as submitted. DDS Jéssica Conti Réus worked on study conceptualisation, design, data collection, data analysis, drafted the initial manuscript, and approved the final manuscript as submitted. Dr Carla Massignan worked on study conceptualisation, data analysis and critically reviewed the manuscript, and approved the final manuscript as submitted. Dr Junia Maria Serra-Negra worked on study conceptualisation, data analysis and critically reviewed the manuscript, and approved the final manuscript as submitted. Dr Bruce D. Dick worked on study conceptualisation, data analysis and critically reviewed the manuscript, and approved the final manuscript as submitted. Dr Carlos Flores-Mir worked on study conceptualisation, data analysis and critically reviewed the manuscript, and approved the final manuscript as submitted. Dr Gilles J. Lavigne worked on study conceptualisation, data analysis and critically reviewed the manuscript, and approved the final manuscript as submitted. Dr Graziela De Luca Canto worked on study conceptualisation, data analysis and critically reviewed the manuscript, and approved the final manuscript as submitted.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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