REVIEW ARTICLE

http://dx.doi.org/10.15331/jdsm.7278

Is There an Association With Periodontitis and Obstructive Sleep Apnea? A Systematic Review

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Study Objectives: Investigate whether there is an association between periodontitis and obstructive sleep apnea (OSA).

Methods: An electronic search was performed on PubMed, LILACS, and Cochrane Library without any time or language restrictions and it was undertaken until January 31, 2021. The following keywords were used: ("obstructive *sleep apnea*" and "*periodontitis*"; "*treatment of periodontitis*" and "obstructive *sleep apnea*"). Only studies that used laboratory-based polysomnography to evaluate the OSA were included. For the diagnostic of periodontitis, only studies that used evaluation of pocket depth and clinical attachment loss were included. This review was registered with the identification number CRD42021236096, in the PROSPERO International Prospective Register of Systematic Reviews hosted by the National Institute for Health Research, University of York, Centre for Reviews and Dissemination.

Results: The search strategy resulted in six papers. Only case-control and cross-sectional studies were included. The studies included evaluated the association between periodontitis and OSA and one study assessed the concentrations of a number of salivary cytokines in patients with OSA syndrome and those without OSA syndrome. The reported prevalence of periodontitis ranged between 17.5% and 77% to 96.4% in patients with OSA.

Conclusion: Most of the included studies support the hypothesis that an association exists between periodontitis and OSA; however, more intervention studies are needed.

Clinical Implications: OSA may be a potential risk factor for periodontal disease; however, randomized controlled clinical trials with longer follow-up times are needed.

Keywords: obstructive sleep apnea, periodontitis, periodontal treatment

Citation: Rocha Rodrigues V, Falardo Ramos S. Is there an association with periodontitis and obstructive sleep apnea? A systematic review. *J Dent Sleep Med*. 2023;10(1)

INTRODUCTION

Periodontitis is a multifactorial infection that results in connective tissue destruction, alveolar bone resorption, and eventually tooth loss.[1] Periodontal disease is one of the most prevalent chronic inflammatory diseases worldwide.

The association between periodontitis and systemic diseases has been studied over several years. The association has been made mainly with diabetes mellitus, cardiovascular diseases, and rheumatoid arthritis. [2]

In recent years, there has been growing interest in periodontitis and obstructive sleep apnea (OSA). These two diseases have similar risk factors, such as age, sex, and smoking. [2.] Furthermore, the inflammatory mediators play a role in both diseases. These two conditions are associated with similar systemic inflammatory responses and involve common inflammatory mediators such as intrerleukin-1B, interleukin-6, tumor necrosis factor-alpha, and C-reactive protein. [3]

OSA comprises episodes of partial or complete occlusion of the upper airways during sleep and causes cessation of breathing and resulting in hypoxia, hypercapnia, and sleep fragmentation. [3]

OSA has also been linked to several systemic conditions including, cardiovascular disease, [4,5] stroke, [6] endocrine diseases (such as diabetes), and hypertension. [7]

The severity of OSA is based the on the apnea–hypopnea index (AHI), which is the total number of apnea and hypopnea episodes that occur during sleep divided by the hours of sleep, It is a summary measure used for sleep-disordered breathing. "In adults, an AHI of less than 5 events per hour is considered normal. Mild OSA is defined as an AHI ≥5 to 15 events per hour, moderate OSA> 15 to 30 events per hour, and severe OSA as> 30 events per hour". [8]

The purpose of this review is to evaluate the association between periodontal disease and OSA.

MATERIALS AND METHODS

Study Registration

The review was registered with the identification number CRD42021236096, in the PROSPERO International Prospective Register of Systematic Reviews hosted by the National Institute for Health Research, University of York, Centre for Reviews and Dissemination.

Research and Study Selection

An electronic search without time or language restrictions was undertaken between January 31, 2021 in the following database: PubMed, LILACS, and Cochrane Library using the following keywords and MeSH terms: ("Obstructive Sleep Apnea" and Periodontitis"; and "Treatment of Periodontitis").

Design of the Included Studies, Eligibility Criteria and Patient, Intervention, Comparison, Outcome (PICO) Question

The methodology used to perform this study was based on the study published by Al-Jewair et al.[3] However, in this systematic review only cross-sectional and case-control studies were included, and for the diagnostic of OSA only articles that used polysomnography were included. For the diagnostic of periodontitis, only the studies that included evaluation of probing pocket depth and clinical attachment level were included.

This systematic review utilized the meta-analyses of observational studies in epidemiology (MOOSE) guidelines statement and checklist.

Risk of Bias in Individuals and Across Studies

For the assessment of nonrandomized studies and the risk of bias, the Newcastle-Ottawa Scale (NOS) was used by the authors of this study.

The Newcastle-Ottawa Scale (NOS) assesses the quality of nonrandomized studies included in a systematic review and/or meta-analyses and evaluates three elements. A score ranging from 0 to 9 was allocated to each study, and those with a score of 6 or higher were considered to be high-quality studies.

For the three case-control studies, two of them [2,9] were categorized with low risk of bias (scored 8-9). One study[10] was categorized at medium risk of bias. For the three cross-sectional studies, [8, 11,12] two of them [8,12] were categorized with high risk of bias (scored ≤5). The third study [8] was categorized as having low risk of bias (scored 8-9).

RESULTS

Literature Search

The study selection process is summarized in Figure. 1. An electronic search was performed on PubMed, LILACS, and Cochrane Library without any time or language restrictions and it was undertaken until January 31, 2021. Records were also identified through other sources (such as professional organization websites, cited references) using the following keywords: ("obstructive sleep apnea" and "periodontitis"; "treatment of periodontitis" and "obstructive sleep apnea"). Only studies that used laboratory-based polysomnography to evaluate the OSA were included. For the diagnostic of periodontitis, only studies that used evaluation of pocket depth and clinical attachment loss were included. The search strategy resulted in six papers. All data were extracted by the study authors, independently and in duplicate operating with data extraction forms.

All the data collected were loaded to Review Manager software and checked. The following factors were noted:

a. Type of study, year of publication, population, age, and sex that were included
b. Diagnostic of periodontitis and OSA
c. Results
d. Risk of bias

After reading the title or abstract, 96 articles were excluded (interreader agreement $\kappa = 0.944 \pm 0.056$ for kappa calculation) and the following site was used https://www.graphpad.com/quickcalcs/kappa1.cfm. Any disagreement was resolved by discussion.

All of the authors of the included studies were contacted and asked if they have more information or unpublished material. None of the authors have replied.

Articles between selected records and full-text articles were excluded by study title and abstract, because they do not meet the objectives of the systematic review and they were not control or cohort studies.

The full-text reports of the remaining 10 articles led to the exclusion of 4 because they did not meet the inclusion criteria. The diagnostic for OSA were self-reported using the Berlin questionnaire (Bq), the Epworth Sleepiness Scale (ESS), [13,14] and the STOP-Bang questionnaire [14,15] and were applied to determine the risk for OSA syndrome. The study [16] was excluded because 1 year later the author published a similar article. [10]

Study Design and Follow-Up

Of the selected studies, all were cross-sectional and case-control studies.

DISCUSSION

The aim of this review was to investigate the association between periodontal disease and OSA.

Five of the six studies [2, 8, 9, 11, 12] evaluated the association between periodontal disease and OSA, and one study [10] assessed the concentrations of a number of salivary cytokines in patients with OSA syndrome and those without OSA syndrome (Table 1).

The reported prevalence of periodontitis ranged between 17.5 and 77% to 96,4% in patients with OSA [2, 8, 9, 11, 12]

Gunaratnam et al., [12] reported a 77% prevalence of periodontitis in patients with OSA. The prevalence of periodontitis in a group of patients with OSA is greater than the national average.

Also, in three studies, [9, 11, 12] the prevalence of periodontitis was higher in the OSA group (96.4%) than in the control group (75%) (P <0.001).

Five studies found a significant relationship between periodontitis and OSA. [2, 8, 9, 11, 12]. On the contrary, one cross-sectional study [8] failed to show significant differences in the clinical attachment level between the OSA groups.

The study by Seo et al., [11] revealed that there is a significant association between OSA and periodontitis. The authors state that OSA may be a risk factor for periodontitis and the treatment can prevent the progression of periodontitis. They concluded that periodontitis was more frequent in patients with OAS than in individuals without OAS (17.5%).

Another study, [9] after adjusting for socioeconomic factors, concluded that patients with OSA were 1.75 times more likely (95% CI = 1.67–1.88; P <0.001) than control patients to have periodontitis. (33.8% versus 22.6%, P <0.001).

Furthermore, all the clinical periodontal parameters, including index of plaque and gingival index, bleeding on probing, probing pocket depth, and clinical attachment loss, were significantly higher in the OSA group than in the control group. [9, 11, 12]

Conversely, another study evaluating the association between periodontal disease severity and OSA severity found no association between OSA and periodontitis. [8] The only parameter with a significant association was the plaque index. [8]

Other studies were able to detect greater numbers of periodontally relevant pathogenic microorganisms in patients with the most severe OSA. [10] The differences in microbial ecology, which might influence onset and/or progression of periodontitis, may be explained by a low-grade inflammation associated with OSA together with intermittent decrease in oxygenation. The drying of the oral cavity may also prevent self-cleaning ability of the oral mucosa and result in increased bacterial colonization. [16 ,17]

The findings in this systematic review need to be interpreted with caution because the quality of the evidence was low in many studies. The assessment of periodontal disease and definitions used differed among the studies, which may have resulted in overestimation or underestimation of the disease prevalence. Also, the AHI index for OSA ascertainment varied among the studies. More randomized controlled clinical trials with longer follow-up times are needed to provide clear recommendations on this association.

CONCLUSIONS

There is insufficient evidence on the association of periodontal disease and OSA. Most of the included studies support the hypothesis that an association exists between periodontitis and OSA; however, more intervention studies are needed to confirm a cause-effect relationship between periodontitis and OSA.

REFERENCES

1. Drisko C. Nonsurgical periodontal therapy. *Periodontol 2000*. 2002;25(1):77-88.
2. Gamsiz-Isik H, Kiyan E, Bingol Z, Baser U, Ademoglu E, Yalcin F. Does obstructive sleep apnea increase the risk for periodontal disease? A case-control study. *J Periodontol*. 2016
3. Al-Jewair T, Al-Jasser R, Almas K. Periodontitis and obstructive sleep apnea's bidirectional relationship: a systematic review and meta-analysis. *Sleep Breath.* 2015;19(4):1111-1120.
4. Mooe T, Rabben T, Wiklund U, Franklin KA, Eriksson P. Sleep-disordered breathing in women: occurrence and association with coronary artery disease. *Am J Med*.1996;101:251–256.
5. Mooe T, Rabben T, Wiklund U, Franklin KA, Eriksson P. Sleep-disordered breathing in men with coronary artery disease. *Chest*.1996;109:659–663.
6. Capampangan DJ, Wellik KE, Parish JM, et al. Is obstructive sleep apnea an independent risk factor for stroke? A critically appraised topic. *Neurologist.* 2010;16:269 273.
7. Mahmood K, Akhter N, Eldeirawi K, et al. Prevalence of type 2 diabetes in patients with obstructive sleep apnea in a multi-ethnic sample. *J Clin Sleep Med*.2009; 5:215–221.
8. Loke W, Girvan T, Ingmundson P, Verrett R, Schoolfield J, Mealey BL. Investigating the association between obstructive sleep apnea (OSA) and periodontitis. *J Periodontol*. 2014; 9:1–15.
9. Keller JJ, Wu CS, Chen YH, Lin HC. Association between obstructive sleep apnea and chronic periodontitis: a population-based study. *J Clin Periodontol*. 2013; 40:111–117.
10. Nizam N, Basoglu OK, Tasbakan MS, Nalbantsoy A, Buduneli N. Is there an association between obstructive sleep apnea syndrome and periodontal inflammation? *Clin Oral Invest*. 2016;20(4):659-668.
11. Seo WH, Cho ER, Thomas RJ, et al. The association between periodontitis and obstructive sleep apnea: a preliminary study. *J Periodontal Res*. 2013; 48:500–506.
12. Gunaratnam K, Taylor B, Curtis B, Cistulli P. Obstructive sleep apnoea and periodontitis: a novel association? *Sleep Breath*. 2009;13:233–239.
13. Sales-Peres SH, Groppo FC, Rojas LV, de C Sales-Peres M, Sales-Peres A. A periodontal status in morbidly obese patients with and without obstructive sleep apnea syndrome risk: a cross-sectional

study. *J Periodontol.* 2016;87(7):772–782.

14. Sanders *et al.,* Periodontitis and sleep disordered breathing in the Hispanic Community Health Study/Study of Latinos. *SLEEP*. 2015;38(8):1195-1203.

15. Ahmad NE, Sanders AE, Sheats R, Brame JL, Essick GK. Obstructive sleep apnea in association with periodontitis: a case-control study. *J Dent Hyg*. 2013;87(4):188–199.

16. Nizam N. Basoglu O, Tasbakan M, Nalbantsoy A, Buduneli N. Salivary cytokines and the association between obstructive sleep apnea syndrome and periodontal disease. *J Periodontol*. 2014;l;85(7):251-258.

17. Alexander AG. Habitual mouth breathing and its effect on gingival health. *Parodontologie*. 1970; 24:49–55

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted April 22, 2021
Submitted in final revised form May 26, 2022
Accepted for publication October 6, 2022

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DISCLOSURE STATEMENT

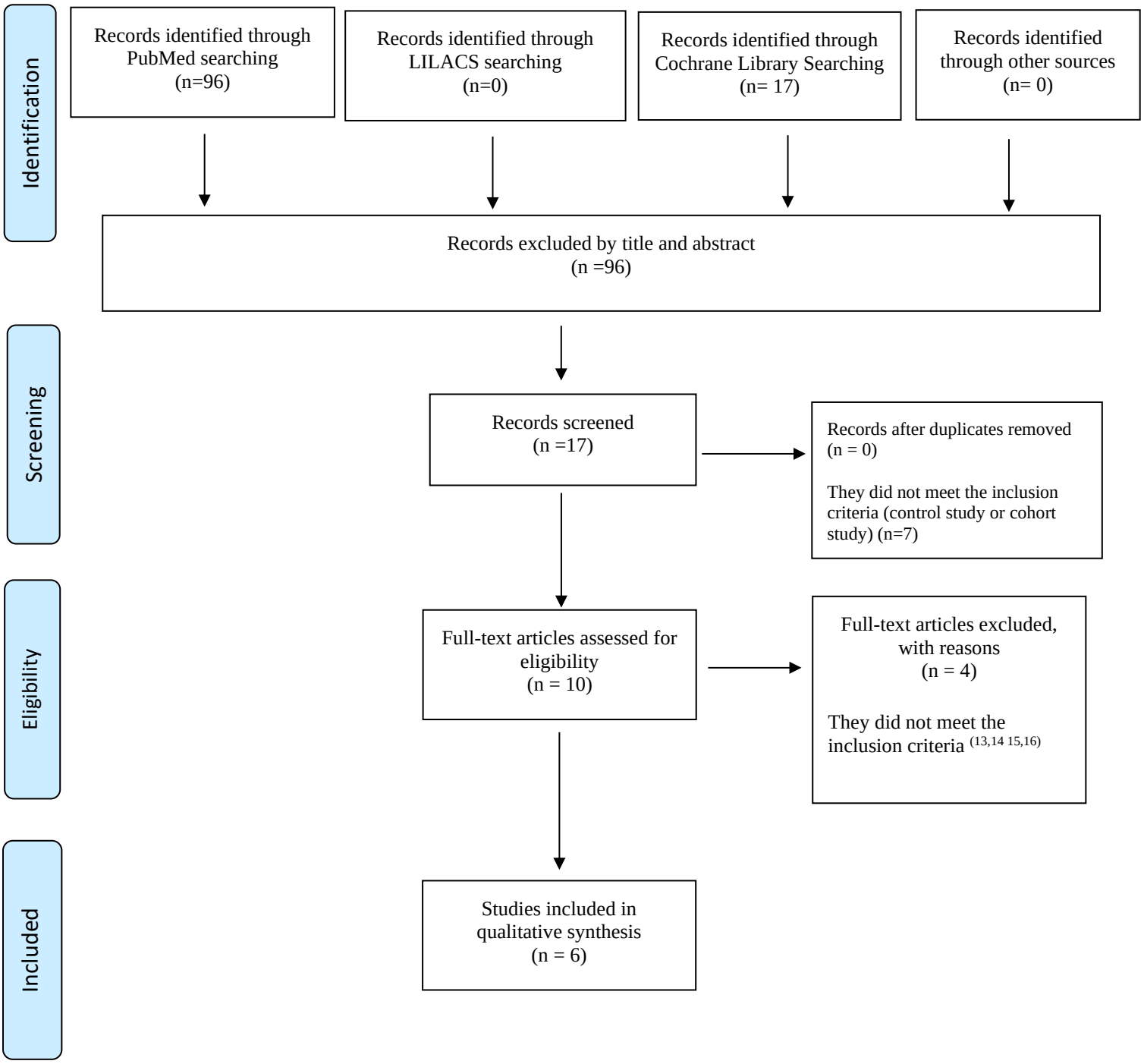
The authors report no conflicts of interest.

Table 1. Evidence-Based Studies of Association Between Periodontal Disease and Obstructive Sleep Apnea

Author	Aim	Study/ Sample	Evaluated Parameters	Diagnosis or risk for OSA	Results	Conclusion
Loke et al. 2015	Investigated whether OSA has any association with periodontitis	-Cross-sectional -A total of 100 patients were included	PD, GR CAL, BOP and PI	Polysomnography	Moderate to severe periodontitis was verified in 73% Between the AHI groups, no significant differences were found in the prevalence of periodontitis. After adjusting for age, they found a significant association between the AHI severity categories and % of sites with plaque,	The author did not find significant association. Only found a significant association with the % of plaque
Seo et al. 2012	Evaluate the prevalence of periodontitis in patients with OSA.	-Cross-sectional -Total of 687 participants	PD, GR, CAL, BOP, GI and PI	Polysomnography	According to the results 17.5% of the participants had periodontitis.	The authors found a significant relationship between OSA and periodontitis
Keller et al. 2012	Assess the association between OSA and periodontitis	-Population based case-control -Study population: 29,284 sampled	PD, BOP, radiographic and tooth mobility	Polysomnography	There was a significant difference in the prevalence of periodontitis between cases and controls (33.8% *versus* 22.6%, $P < 0.001$).	The authors found an association between OSA and periodontitis
Gunaratnam et al. 2009	Assess the association between OSA and periodontitis	-Cross-sectional -Study population: 66 (54 men and 12 women)	PD, GR, CAL, BOP, GI and PI	Polysomnography	The prevalence of periodontitis ranged between 77%–79%,	OSA is associated with periodontitis.
Gamsiz-Isik et al. 2016	Evaluate if periodontitis is more prevalence in patients with OSA when compared with control patients	-Case-control -Study population: 163 individuals: 83 individuals (18 females; 65 males) with OSA and 80 non-OSA individuals (23 females; 57 males) as controls.	PD, CAL, BOP, GI and PI	Polysomnography	Periodontitis in the OSA group was detected in 96.4% and was significantly higher than in the control group 75%, ($P<0.001$).	Higher prevalence of periodontitis and higher levels of GCF, IL-1β and serum CRP in OSA patients.
Nizam et al. 2015	Evaluate the association between OSA and periodontitis through saliva, biomarkers, and subgingival bacteria.	-A preliminary case–control study -Study population: 52 patients were grouped according to the severity of OSA: 13 participants served as control patients, 17 patients had mild-to-moderate OSA, and 22 severe OSA.	PD, CAL, BOP Serum, saliva, and subgingival plaque samples were collected Salivary, serum concentrations of (IL-6, TNF-α, and RANKL)	Polysomnography	The different cytokines were detected with higher concentration in the OSA groups, but there was no statistical significance.	OSA appeared to correlate with increasing periodontal disease severity.

AHI - apnea-hypopnea index; BOP – Bleeding on Probing; CAL- Clinical attachment level; CRP- C-reactive protein; CP-Chronic Periodontitis; GCF- Gingival crevicular fluid; GI- Gingival index; GR- Gingival Recession; IL-6 – interleukin 6; IL-1β- Interleukin 1 beta; OSA- Obstructive sleep apnea; PD- Probing depth; PI- Plaque index; RANKL, receptor activator of nuclear factor kappa B ligand; TNF-α - tumor necrosis factor alpha;

Figure 1


Identification
Records identified through PubMed searching (n=96)
Records identified through LILACS searching (n=0)
Records identified through Cochrane Library Searching (n= 17)
Records identified through other sources (n= 0)
Records excluded by title and abstract (n =96)
Screening
Records screened (n =17)
Records after duplicates removed (n = 0)
They did not meet the inclusion criteria (control study or cohort study) (n=7)
Eligibility
Full-text articles assessed for eligibility (n = 10)
Full-text articles excluded, with reasons (n = 4)
They did not meet the inclusion criteria (13,14 15,16)
Included
Studies included in qualitative synthesis (n = 6)