



# Relationship between diabetes, hypertension and periodontal diseases: a systematic review of major clinical findings

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## Abstract

**Introduction:** In the scenario of periodontal diseases, chronic periodontitis is one of the most frequent periodontal diseases in the adult population with poor oral hygiene. The aggravating factors of the disease can be the occurrence of loss of bone structure, loss of attachment, and formation of a periodontal pocket, and even periodontitis can produce changes in systemic health, including stroke, renal failure, premature birth, diabetes, arterial hypertension, and coronary diseases.

**Objective:** A concise systematic review was carried out to elucidate through clinical studies the real relationship between periodontal diseases, diabetes, and arterial hypertension. **Methods:** The rules of the Systematic Review-PRISMA Platform. The research was carried out from May 2022 to July 2022 and developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 127 articles were found. In total, 57 articles were fully evaluated and 18 were included and evaluated in this systematic review. The symmetric funnel plot does not suggest a risk of bias. An association between periodontitis and arterial hypertension was evidenced. Community oral care services provided by dental hygienists can promote objective oral hygiene and subjective periodontal status in the local community and can help manage hypertension and diabetes. An association of diabetes with increasing age was observed for the lowest social class. A statistically significant association between diabetes was also observed concerning individuals with hypertension, hypercholesterolemia, and periodontal

disease. Yet, recent evidence suggests that periodontal disease causes hypertension. Diabetes mellitus is a factor that aggravates the periodontal disease. Periodontal treatment must be cautious and considered, and the periodontist must know the limitations, changes, and disorders that the diabetic patient may present. Any periodontal treatment should be performed once the diabetes is under control.

**Keywords:** Periodontal diseases. Diabetes. Arterial hypertension.

## Introduction

In the scenario of periodontal diseases (PD), chronic periodontitis is one of the most frequent periodontal diseases in the adult population with poor oral hygiene [1,2]. It is a disease caused by a bacterial biofilm, its primary cause being a bacterial infection whose main etiological agents (microorganisms) are *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, *Tannerella forsythia* [3], as well as other bacteria, be associated or not by iatrogenic factors, systemic diseases, diseases associated with immune dysfunction, smoking, obesity, among other causes [4,5]. Because of this, the inflammation of the supporting tissues results in large concentrations of neutrophil elastase that are released in the inflamed periodontium, which can act in the initial phases of tissue destruction and progression of periodontitis [5,6].

The aggravating factors of the disease can be the occurrence of loss of bone structure, loss of attachment, and formation of a periodontal pocket, and even periodontitis can produce changes in systemic health, including stroke, kidney failure, premature birth, diabetes, and coronary diseases [6,7]. Chronic

periodontitis has three stages of evolution: Mild (< 3 mm of marginal attachment loss), Moderate (> 3 mm of marginal attachment loss), and Severe ( $\geq$  5 mm of marginal attachment loss). It can also be Localized (< 30% of sites) and Generalized (>30% of sites). Changes in the volume of gingival fluid are directly related to the clinical picture of inflammation. Periodontal sites that had their gingival fluid volumes measured showed a positive relationship with the presence of supragingival plaque and inflammation [5,6], suggesting that the effectiveness of periodontal treatment can be measured by the use of biomarkers of neutrophil activity [3,4].

Bone defects may not heal with bone tissue filling and to facilitate repair/regeneration bone graft materials may be placed in the defects [8]. Several techniques seek regeneration of lost periodontal support tissues; flap surgery with the use of biomaterials, bone grafts (autogenous, allogeneic, xenogenous, heterogenous, alloplastic, or mixed), root surface biomodification, guided tissue regeneration, platelet-rich plasma, growth factors and tissue bioengineering, derivatives of the enamel matrix (hydroxyapatite), resorbable membranes [4-8].

In this scenario, diabetes mellitus (DM) is characterized as an inherited or acquired pathological condition of endocrine origin, which causes disturbances in the metabolism of carbohydrates, lipids, and proteins, causing a defective or deficient secretory response of insulin [5,6], caused by low production of insulin by the pancreas. Insulin is a hormone necessary for converting sugar, starch, and other elements into the energy we need in daily life.

According to the International Diabetes Federation, there are 366 million carriers in 2011, with an expectation of 552 million by 2030. In Brazil, there are 12.4 million, ranking 5th in the number of carriers in the world. Periodontal disease is an inflammation (chronic or acute) that affects the supporting structures of the tooth and is influenced by certain local or systemic conditions. The mechanisms by which diabetes can contribute to the development of periodontal disease include vascular changes, neutrophil dysfunction, reduction in collagen synthesis and maturation, activation of collagenase increment, the persistence of hyperglycemic indices, genetic predisposition, addition to changes in the gingival microbiota [7,8].

Furthermore, arterial hypertension (AH) and periodontitis are two highly prevalent conditions worldwide with a significant impact on cardiovascular disease (CVD) complications. Studies have shown that poor periodontal health is associated with an increased prevalence of hypertension and may influence PD control. Risk factors such as advanced age, male gender, non-white ethnicity, smoking,

overweight/obesity, diabetes, low socioeconomic status, and low education have been considered the common denominators that support this relationship. However, recent evidence indicates that the association between periodontitis and hypertension is independent of common risk factors [9].

Therefore, the present study aimed to carry out a concise systematic review to elucidate through clinical studies the real relationship between periodontal diseases, diabetes, and arterial hypertension.

## Methods

### Study Design

The rules of the Systematic Review-PRISMA Platform (Transparent reporting of systematic reviews and meta-analysis-[HTTP://www.prisma-statement.org/](http://www.prisma-statement.org/)) were followed.

### Data sources and research strategy

The search strategies for this systematic review were based on the keywords (MeSH Terms): "*Periodontal diseases. Diabetes. Arterial hypertension*". The research was carried out in May 2022 to July 2022 and developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. Also, a combination of the keywords with the booleans "OR", "AND", and the operator "NOT" were used to target the scientific articles of interest.

### Study Quality and Bias Risk

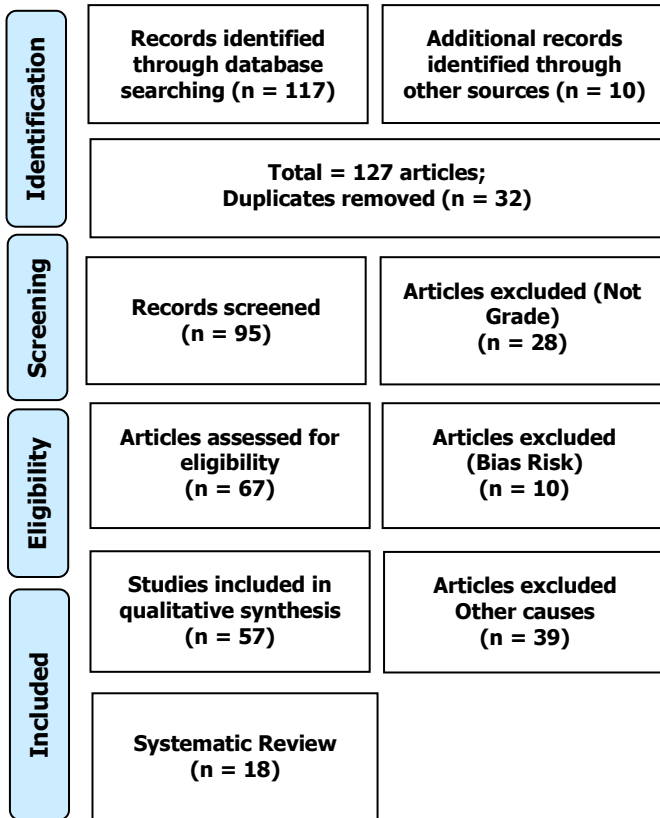
The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument.

## Results and Discussion

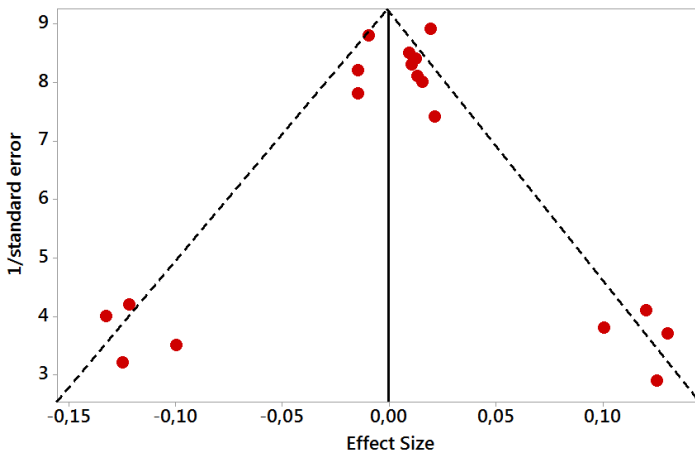
A total of 127 articles were found. Initially, duplication of articles was excluded. After this process, the abstracts were evaluated and a new exclusion was performed, removing the articles that did not address the theme of this article. In total, 57 articles were fully evaluated and 18 were included and evaluated in this systematic review (**Figure 1**).

**Figure 2** presents the results of the risk of bias in the studies using the Funnel Plot, through the calculation of the Effect Size (Cohen's Test). The sample size was determined indirectly by the inverse of the standard error. The number of clinical studies evaluated was n=18. The graph showed symmetric behavior, not suggesting a significant risk of bias in studies with small sample sizes, which are shown at the bottom of the graph.

**Figure 1.** Flow Chart of Study Eligibility (Systematic Review).



**Figure 2.** The symmetric funnel plot does not suggest a risk of bias between the small sample size studies that are shown at the bottom of the graph (N = 18 studies).



Based on the studies addressed in this study, an association between periodontitis and arterial hypertension was evidenced. One study investigated the hypothesis that periodontal health is linked to incident arterial hypertension, with 32,285 participants (mean age: 45.79 ± 13.87 years); 78.5% were women. Two thousand one hundred and sixteen incident cases of high blood pressure were identified during an average follow-up of 8 years. The presence of unreplaced missing teeth (hazard ratio: 1.13; 95%CI: 1.03-1.23)

was significantly associated with a higher risk of incident arterial hypertension, while a regular annual visit to the dentist was associated with a lower risk (hazard ratio: 0.88; 95% CI: 0.80-0.97). Therefore, self-reported periodontitis was associated with incident arterial hypertension over 8 years. The present results highlight the importance of considering periodontal health when assessing an individual's risk of arterial hypertension [10].

In addition, a study evaluated the effects of a community oral hygiene service on general and periodontal health indicators of patients with hypertension and type 2 diabetes mellitus who visit a community health center in Korea. A total of 151 participants (45% male), with a mean age of 63 ± 8.4 years, were included in the study; these included patients with hypertension (62%), diabetes (12%), and hypertension and diabetes (26%). A lower frequency of subjective edema was reported in the fourth session (37.9%) compared to the first (55.6%). In addition, significantly fewer cases of calculus and bleeding were observed (p < 0.05), and significantly more patients reported having no gingival problems in the fourth session (43.1% vs. 27.2%; p < 0.05) than in the first session. Therefore, community oral hygiene services provided by dental hygienists can promote objective oral hygiene and subjective periodontal status in the local community and can help control hypertension and diabetes [11].

In this context, it is imperative to know the association of diabetes with hypercholesterolemia, hypertension, periodontal disease (PD), and sociodemographic variables. Thus, a descriptive cross-sectional study with individualized secondary data provided by the 2021 National Health Survey used data from 14,584 surveys conducted in the Spanish population ≥ 40 years of age. The prevalence of diabetes in this population (n = 14,584) was 12.21%, similar to 11.49% in a Spanish population (2009) aged 55 to 642 years. In the analysis of subjects who reported having diabetes (n = 1,781), statistically, significant associations were observed with the study variables. An association of diabetes with increasing age is observed for the lowest social class. A statistically significant association between diabetes was also observed concerning individuals with hypertension, hypercholesterolemia, and PD [12].

In this sense, the authors Flor LS and Campos MR confirm these results, as they observed associations of diabetes (p < 0.001) with age ≥ 40 years, hypercholesterolemia, arterial hypertension, and in individuals with less than 5 years of schooling [13]. PD is a chronic inflammatory process that can affect the systemic health of patients with diabetes. Stanko P and

Izakovicova Holla L observed a possible bidirectional relationship between both diseases [14]. It has also been observed that when moderate to severe periodontitis is treated, the glycemic level improves and when the glycemic level is controlled, periodontitis improves [15]. So, is diabetes a risk factor for PD and other diseases, or do the periodontal bacteria and inflammatory factors in periodontitis cause these diseases, or is it a fluke? [16].

Still, recent evidence suggests that PD causes hypertension, which is a precursor to the development of other systemic diseases. A longitudinal cohort study looked at the effect of hypertension and PD on the risk of subsequent systemic disease. The mean age of the study population was 55.4 years and 130,220 (53.3%) participants were female. At baseline, 131,566 (53.8%) participants were hypertensive and 4.5% reported PD. The incidence rates of all systemic diseases were higher in hypertensive than non-hypertensive participants of the same PD status. In hypertensive subjects, an additive effect was observed for PD on the risks of CVD and respiratory disease compared with healthy hypertensive controls. Hypertensive patients with PD present exacerbated risks of several systemic diseases [17].

Also, the authors Kasbohm et al 2017 [18] characterized periodontitis as inflammation of the gingival tissue, and its main risk factor is socioeconomic factors, sex, age, smoking, and diabetes, but the periodontal disease also has a genetic background. An extensive longitudinal survey (Third National Health and Nutrition Examination Survey, NHANES III) evidenced the degree of glycemic control as the most important variable in determining the risk for periodontal diseases in diabetics. Adults with poor glycemic control had 2.9 times more periodontitis than non-diabetics. On the other hand, diabetics with good control did not present a significant increase in risk when compared to non-diabetics.

Besides, Albandar (2000) [19] knowing that periodontal disease has a higher prevalence and severity in diabetic individuals when compared to non-diabetic individuals and that the impact of periodontal disease in these individuals on daily life is not reported in the literature, the objective of this study was to evaluate the impact of this disease on the quality of life of patients with diabetes mellitus. A prospective, parallel, and the comparative longitudinal clinical study was carried out between type 2 diabetics and non-diabetics with moderate generalized chronic periodontitis. The study period was 6 months. Conventional periodontal scaling and root planing were performed and the response to this treatment was compared between groups at 3 and 6 months, measuring plaque index, probing bleeding,

probing depth, clinical attachment level, and gingival recession. In diabetic patients, clinical response was related to HbA1c and blood glucose measurements at 3 and 6 months [20].

Severe periodontal disease often coexists with severe diabetes mellitus. Diabetes is a risk factor for severe periodontal disease. A model is presented whereby severe periodontal disease increases the severity of diabetes mellitus and complicates metabolic control [21]. The established correlation between diabetes and periodontal disease and the increasing prevalence of type II diabetes in the general population indicate that dentists are likely to treat an increasing number of diabetic patients. Although there is little scientific evidence to support the concept, it has generally been accepted that treatment for periodontal disease in diabetic patients can reduce insulin requirements and improve metabolic balance [22].

Besides, the authors Persson et al. (2003) [23] in a study evaluating periodontal conditions and systemic diseases, focusing on diabetes mellitus, observed that the percentage of periodontal sites with pockets larger than 5 mm corresponded to 21.1% of the sample in patients with non-insulin diabetes dependents.

Association between large periodontal destruction and diabetes mellitus has been reported in the literature [24-26]. Usually, periodontitis is caused by the biofilm and exacerbated by the systemic condition. It is considered that the patterns of periodontal disease are related to the present microbiota and are modified by the systemic situation. Some authors found that with mechanical periodontal therapy (scaling) and antibiotic therapy, there was a reduction in glycosylated hemoglobin (14bA1 c) and a reduction in the need for insulin [12,24-26]. With diabetes under control, the patient can be treated in the same way as a healthy person. However, stress must be controlled, because due to the action of endogenous adrenaline, blood glucose levels may rise [8,11].

## Conclusion

An association between periodontitis and arterial hypertension was evidenced. Community oral care services provided by dental hygienists can promote objective oral hygiene and subjective periodontal status in the local community and can help manage hypertension and diabetes. An association of diabetes with increasing age was observed for the lowest social class. A statistically significant association between diabetes was also observed concerning individuals with hypertension, hypercholesterolemia, and periodontal disease. Yet, recent evidence suggests that periodontal disease causes hypertension. Diabetes mellitus is a



factor that aggravates the periodontal disease. Periodontal treatment must be cautious and considered, and the periodontist must know the limitations, changes, and disorders that the diabetic patient may present. Any periodontal treatment should be performed once the diabetes is under control.

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Not applicable.

### Informed consent

Not applicable.

### Data sharing statement

No additional data are available.

### Conflict of interest

The authors declare no conflict of interest.

### Similarity check

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