REVIEW

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The interrelationship between periodontal disease and diabetes mellitus – a review of the literature.

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Abstract
Introduction. Periodontal disease is a chronic inflammatory condition that affects the supporting structures of the teeth, whereas diabetes mellitus is a metabolic disorder characterized by persistent hyperglycemia. Evidence indicates a bidirectional relationship between these two conditions: periodontal disease may negatively influence glycemic control and contribute to increased HbA1c levels, while diabetes can intensify periodontal inflammation. **Aim of the study.** This paper explores the association between periodontal disease and diabetes mellitus focusing on the ways in which these two chronic conditions interact and influence one another. The study examines how metabolic control affects periodontal status and considers the potential role of periodontal therapy in the evolution of diabetes. In addition, it aims to evaluate the prevalence and severity of periodontal disease among patients with diabetes and to identify the metabolic and behavioral factors that may contribute to this relationship. **Material and Methods.** This review of the literature shows that patients with diabetes mellitus, regardless of type, have a higher prevalence and more severe forms of periodontal disease compared to people without diabetes. Relevant literature was identified through a search of electronic databases including PubMed, ResearchGate, and Google Scholar using the following keywords: "periodontal disease", "diabetes mellitus", "HbA1c and periodontitis". **Results.** The initial search yielded 278 articles. Following the application of predefined inclusion criteria and a stepwise selection process, as well as the review of available full-text publications, 19 studies fulfilled the eligibility requirements and were ultimately included in the present analysis. **Conclusions.** The analyzed data support the presence of a clear bidirectional relationship between diabetes mellitus and periodontal disease. Effective metabolic control, together with proper oral hygiene, plays an important role in slowing the progression of both conditions. These findings highlight the importance of a coordinated approach between dental and medical care.

Keywords: periodontitis, periodontal disease, diabetes mellitus, HbA1c and periodontitis, glycemic control, bidirectional relationship.

Introduction

Diabetes mellitus is a metabolic disorder defined by persistently elevated blood glucose levels. This condition arises as a result of insufficient insulin secretion, decreased tissue sensitivity to insulin or a combination of both mechanisms [1]. This disease has a polygenic etiology, being influenced by environmental factors and characterized by hormonal dysfunction of the pancreas. Diabetes mellitus is one of the most common chronic noncommunicable diseases worldwide with an ever-increasing prevalence [2]. Approximately 537 million people worldwide suffer from diabetes, according to the latest statistics from the International Diabetes Federation and experts estimate a significant increase in the coming decades [1,2].

Periodontal disease is a chronic inflammatory condition of the periodontium caused by the interaction between the host's immune response and the presence of subgingival bacterial biofilm [3]. In its early stages, it manifests as gingivitis, a reversible inflammation of the gums. If left untreated, it can progress to periodontitis, a condition characterized by loss of periodontal attachment, the appearance of periodontal pockets, and bone resorption [4]. Periodontal disease is common in the adult population worldwide, with a prevalence of 20-50%. Its incidence increases with age and is higher in people exposed to risk factors such as smoking or poor metabolic control. Due to its high frequency and consequences on oral and systemic health, periodontal disease is considered an important public health issue [5].

Data from the literature indicate a clear association between diabetes mellitus and periodontitis, which is often described as the "sixth complication" of diabetes [6]. The relationship between the two conditions is bidirectional: poor glycemic control promotes the worsening of periodontal lesions and persistent periodontal inflammation correlates with higher HbA1c values. According to a meta-analysis published in 2018, diabetes increases the likelihood of periodontitis occurrence or progression by approximately 86% [7].

Classification of diabetes mellitus types

According to the classification proposed by the World Health Organization (2022), diabetes mellitus is divided into four main categories: type 1 diabetes mellitus (juvenile onset, insulin-dependent), type 2 (adult onset, associated with insulin resistance), gestational diabetes and other specific or secondary forms, such as drug-induced diabetes or diabetes associated with pancreatic diseases [8].

Type 1 diabetes mellitus is an autoimmune disease with absolute insulin deficiency caused by the destruction of pancreatic β-cells. It frequently occurs in young people, has a sudden onset and requires permanent insulin therapy; lack of treatment leads to diabetic ketoacidosis [9].

Type 2 diabetes mellitus is the most common form of diabetes, characterized by decreased tissue sensitivity to insulin and insufficient insulin secretion [9]. It is associated with obesity, sedentary lifestyle, and genetic predisposition, it has an insidious onset and is diagnosed by hyperglycemia or elevated HbA1c levels. Treatment includes: lifestyle changes, oral medication and in advanced stages, insulin [10].

Gestational diabetes is characterized by glucose intolerance that first appears during pregnancy. This type of diabetes is caused by insulin resistance induced by placental hormones. Although often asymptomatic, it can be associated with maternal-fetal complications and affected women are at increased risk of developing type 2 diabetes later in life [10].

Other forms of diabetes are: genetic, autoimmune or secondary such as MODY, LADA, and secondary diabetes associated with endocrine or pancreatic diseases or drug treatments [11]. MODY (Maturity-Onset Diabetes of the Young) is a monogenic form characterized by a deficiency in insulin secretion but with preserved sensitivity. LADA (Latent Autoimmune Diabetes in Adults) is an autoimmune form with slow progression [11].

Periodontal disease is a chronic inflammation of the tissues supporting the teeth, caused by bacterial plaque. If left untreated, it leads to the destruction of the periodontal ligament and alveolar bone, causing tooth mobility and loss through immune-mediated inflammatory mechanisms [12]. In addition to periodontopathogenic bacteria, such as Porphyromonas gingivalis, which play an essential role in triggering inflammation, oral microbiota imbalance also contributes significantly to the progression of the disease [13]. At the same time, it is the host's exaggerated immune response that ultimately causes tissue destruction. Risk factors that can influence the stage or even induce the onset of the disease include: poor oral hygiene, tobacco use, chronic stress, genetic susceptibility, certain systemic diseases such as diabetes mellitus [13].

Classification of periodontal diseases

Periodontal health is characterized by the absence of support loss and clinically normal gums. Gingivitis is a reversible inflammation of the gums, mainly caused by bacterial plaque, but it can also occur in a medicinal or systemic context [14].

Periodontitis is a chronic inflammatory disease that causes loss of attachment and destruction of the alveolar bone. According to the 2018 classification of the European Federation of Periodontology, it is classified by staging (severity and complexity) and grading (rate of progression and risk factors). Clinically, it manifests as bleeding on probing, periodontal pockets, and bone resorption [14].

Periodontal manifestations of systemic diseases include general conditions that influence the periodontium, as well as acquired conditions such as periodontal abscesses,

endo-periodontal lesions, mucogingival deformities, trauma and complications associated with dental restorations [15].

The mechanisms of action of diabetes mellitus that promote the onset and progression of periodontal disease are as follows:

1. Altered oral microbiome (subgingival dysbiosis)

Diabetes mellitus alters the oral microbiome, favoring pathogenic bacteria such as Fusobacterium and Actinobacteria and reducing microbial diversity. This dysbiosis increases the inflammatory potential of subgingival biofilm, which explains the increased susceptibility of diabetic patients to periodontitis [16].

2. Exacerbated inflammation

The hyperglycemia characteristic of diabetes mellitus stimulates the production of proinflammatory cytokines and reduces the secretion of anti-inflammatory cytokines. These changes lead to chronic inflammation in the periodontium and progressive tissue damage. Adipokines such as leptin (proinflammatory) and adiponectin (anti-inflammatory) are also imbalanced in diabetes contributing to systemic and local inflammation [16]. Periodontitis is also a source of systemic inflammation, creating a vicious cycle that worsens glycemic control. Inflamed periodontal tissues release proinflammatory cytokines into the circulation [16]. These stimulate the liver to produce C-reactive protein and other acute phase proteins. Systemic inflammation can interfere with insulin action at the cellular level, contributing to insulin resistance [17].

3. Immune response disorder

Diabetes affects immune system function reducing the bactericidal activity of neutrophils and promoting macrophage polarization toward a proinflammatory phenotype. The resulting immune imbalance causes chronic inflammation and accelerated destruction of periodontal tissues [17].

4. Hyperglycemia and advanced glycation end products (AGEs)

Chronic hyperglycemia in diabetes promotes the accumulation of advanced glycation end products (AGEs) in periodontal tissues. AGEs bind to their receptors, triggering the activation of inflammatory pathways, which leads to increased production of proinflammatory cytokines (IL-1β, TNF-α). AGEs affect gingival fibroblasts as well as osteoblasts, reducing the capacity for bone and periodontal tissue regeneration [17].

5. Oxidative stress

Hyperglycemia leads to increased production of reactive oxygen species, which affect cellular structures and the extracellular matrix. These species induce inflammation and apoptosis and interfere with tissue regeneration. Thus, oxidative stress is a central mechanism in periodontal deterioration in patients with diabetes mellitus [16].

Material and methods

This paper is a review study based on an analysis of current scientific articles in the specialized literature. Its purpose is to examine the relationship between periodontal disease and diabetes mellitus with a focus on the influence of glycemic control on periodontal status, the effects of periodontal therapy on metabolic balance and common pathophysiological mechanisms. The null hypothesis of the present research was that there are no statistically significant differences between patients with type 1 and type 2 in terms of severity and progression of periodontal disease.

The information selected for this study was searched in databases such as: PubMed, Google Scholar, Wiley Online Library, Science Direct, and Springer Link. Official guidelines and consensus reports issued by international organizations such as the American Diabetes Association (ADA), World Health Organization (WHO), European Federation of Periodontology (EFP) and American Academy of Periodontology (AAP) were also analyzed. The keywords used to find relevant studies are: "diabetes mellitus", "inflammation", "periodontitis", "glycemic control", "periodontal therapy in diabetic patients", "HbA1c and periodontitis" and "bidirectional relationship".

For the purpose of this analysis, relevant scientific papers on the relationship between diabetes mellitus and periodontal disease were

selected without applying any restrictions related to patient age. Non-randomized and randomized studies, comparative analyses and well-documented clinical cases were included, regardless of the year of the publication.

Opinions, seminar presentations, incomplete works, and studies without direct relevance with this subject were excluded, with the final selection being limited by the small number of available publications. The search yielded a total of 278 articles. After removing the non-compliant articles (based on title and abstract), the duplicates, 103 original articles remained. After applying the selection criteria, 19 scientific articles were included in the analysis representing a variety of sources: clinical studies, systematic reviews, meta-analyses, and prospective or retrospective cohort studies (Figure 1).

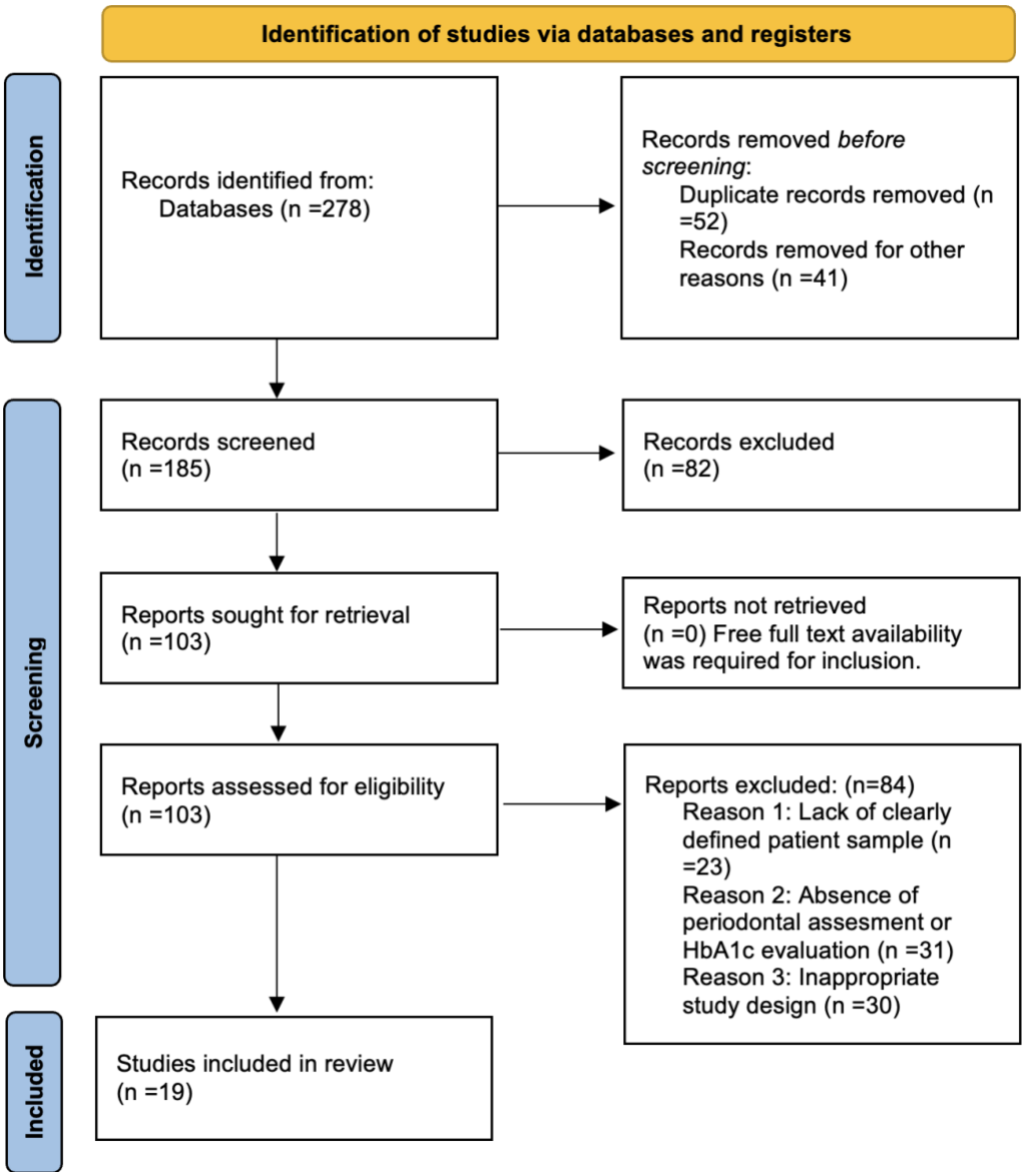

Figure 1. PRISMA Flow Diagram Data.

Results

The results of the present research are presented in Table 1.

Table 1. Main outcomes of the included studies.

STUDY AUTHORS (REF. NO.)	YEAR	STUDY TYPE	NO. OF PATIENTS	STUDY TIME	PURPOSE OF THE STUDY	CONCLUSIONS
PRESHAW PM ET AL.[17]	2012	Prospective longitudinal study	2626	Not specified	Assessment of the influence of diabetes type and glycemic control on periodontal disease progression and tooth loss	The results confirm a bidirectional relationship between diabetes and periodontitis: poor glycemic control promotes periodontal destruction, and periodontal inflammation aggravates metabolic imbalance
HASAN SMM ET AL. [18]	2021	Prospective cohort study	379	August-September 2018	Assessing the impact of diabetes on periodontal disease	The prevalence of any form of periodontal disease is higher in patients with diabetes mellitus
TRULLENQUE-ERIKSSON A ET AL. [19]	2024	Retrospective cohort study	878.000 (280.446 diagnosed with diabetes)	2010-2020	Compare the prevalence of periodontitis in patients with diabetes vs. the general population	There is a strong association between type 2 diabetes mellitus and periodontitis, influenced by glycemic control
COSTA R. ET AL. [20]	2025	Cross-sectional study	139	October 2022 - July 2023	Assessment of periodontal status in patients with T1DM	Higher prevalence of periodontal disease in patients with DM, as well as more severe forms and faster progression of the disease
SHARMA E. ET AL. [21]	2025	Cross-sectional study	150	Not specified	Assessment of the correlation between glycemic control and the severity of chronic periodontitis	There is a significant association between poor glycemic control and the severity of chronic periodontitis
SARKER R. ET AL. [22]	2023	Cross-sectional study	81	April-December 2023	Assessment of the frequency and severity of periodontal disease in diabetic individuals	This study highlights the increased prevalence of periodontal disease among patients with diabetes in Bangladesh and emphasizes the negative impact of inadequate glycemic control on periodontal health
MENDES-FRIAS A. ET AL. [23]	2025	Observational Study	190	Not specified	Assessment of the influence of type 1 diabetes on the severity of periodontal and on the local inflammatory response through the analysis of cytokines present in saliva and gingival crevicular fluid	The result of the study highlights the importance of early periodontal monitoring in patients diagnosed with this condition. Type 1 diabetes correlates with more severe and extensive forms of periodontal disease
SHIN H.S. [24]	2025	Retrospective	3178	During 2015	Analysis of the synergistic effect of the association	Diabetes mellitus and periodontal disease influence each other through a common inflammatory mechanism,

		observational study			between periodontitis and diabetes mellitus	and their association causes a significant increase in systemic inflammation
ALWITHANANI N. [25]	2023	Systematic review with meta-analysis	49.262	Not specified	Determining whether poorly controlled diabetes is associated with the onset and/or progression of periodontal disease	Diabetes mellitus, especially when poorly controlled, significantly increases the risk of developing and progressing periodontal disease, confirming the existence of a close relationship between the two conditions
DEMMER R.T. ET AL. [26]	2012	Population cohort study	2626	2006-2011	Analysis of the impact of diabetes type and glycemic control on the progression of periodontal disease and tooth loss	Uncontrolled diabetes, regardless of type, accelerates the progression of periodontal disease and increases the risk of tooth loss
KOLTE A.P. ET AL. [27]	2025	Cross-sectional study	80	January-May 2025	Comparison of periodontal status, xerostomia, and oral quality of life in patients with diabetes	Poor glycemic control in type 2 diabetes is associated with periodontal disease, more severe xerostomia, and decreased oral quality of life
ALMAS K. ET AL. [28]	2001	Cross-sectional study	40	2 months	Determining the relationship between the severity of periodontal disease and blood glucose levels	The study shows that the severity of periodontal disease increases with blood sugar levels, indicating hyperglycemia as an aggravating factor
MERCHANT AT ET AL. [29]	2016	Prospective cohort study	126.800	2005-2012	Assessment of the long-term impact of periodontal treatment on glycemic control	Long-term periodontal care is associated with clinically relevant improvement in glycemic control in patients with type 2 diabetes mellitus
KIM SH ET AL. [30]	2021	Retrospective cohort study	4787	January 2010-December 2011	Assessment of the effect of non-surgical periodontal treatment on glycated hemoglobin levels	The results confirm the bidirectional relationship between diabetes and periodontal disease; non-surgical periodontal treatment helps maintain glycemic control in type 2 diabetes
ROMANO F. ET AL. [31]	2021	Cross-sectional study	104	March 2018 - July 2019	Analysis of the bidirectional relationship between metabolic control and periodontal disease severity, using clinical parameters and the PISA index	The study highlights the existence of a significant bidirectional relationship between type 2 diabetes mellitus and periodontal disease
MAYTA-MAYORGA M. ET AL. [32]	2024	Cross-sectional study	1606	December 2016-November 2017	Determining the association between type 2 diabetes mellitus and periodontitis	This study highlights the association between type 2 diabetes and the presence of severe forms of periodontitis
ALEXA I. ET AL. [33]	2025	Cross-sectional study	345	May-December 2024	Comparative assessment of periodontal status between patients with diabetes mellitus and non-diabetic patients	The cross-sectional study demonstrates that diabetes mellitus is associated with significantly more severe periodontal status

KAUR PK. ET AL. [34]	2015	Randomized controlled clinical trial	100	February 2010-January 2012	The effect of non-surgical periodontal therapy on periodontal status and glycemic control, depending on initial blood glucose levels	Confirms the bidirectional relationship between periodontal disease and diabetes, with each condition contributing to the worsening of the other
BELIZÁRIO LCG ET AL. [35]	2024	Non-randomized clinical trial	40	September 2020 - January 2022	Assessment of the impact of hyperglycemia on the periodontal healing process and the progression of periodontal diseases	Uncontrolled type 2 diabetes is associated with reduced periodontal tissue healing capacity and persistent periodontal disease progression, highlighting the close link between the two conditions

Discussions

An integrated analysis of studies published in the literature consistently highlights the existence of a close, bidirectional relationship between diabetes mellitus and periodontal disease. A major common element, consistently found in the literature reviewed is the association between diabetes mellitus and more severe periodontal disease [18,26,28]. Regardless of the type of diabetes analyzed in the published studies, patients with diabetes have a higher prevalence of periodontal disease and more severe forms compared to the non-diabetic population. Most research shows that chronic hyperglycemia and systemic inflammation associated with diabetes promote periodontal destruction and attachment loss [31-33]. Some studies have specifically analyzed patients with type 1 diabetes and have shown a more rapid progression of periodontal disease, even at a young age. The results suggest that the duration of the disease and inadequate metabolic control may play an important role in the worsening and spread of periodontal lesions [20,23]. Most of the analyzed studies, regardless of their methodological design, including cross-sectional studies, clinical trials, population-based analyses, and cohort studies consistently indicate the presence of a bidirectional relationship between diabetes mellitus and periodontal disease. Diabetes, particularly when glycemic control is inadequate, is frequently associated with more severe forms of periodontitis. At the same time persistent periodontal inflammation may contribute to the deterioration of metabolic control by increasing systemic inflammatory burden [19,21,24,26,30,34].

Preshaw PM et al. [17] and Mendes-Frias A et al. [23] have identified systemic inflammation as a key mechanism connecting these two conditions. Their studies show that periodontal inflammation can lead to elevated levels of systemic inflammatory markers, which may contribute to the development of insulin resistance, while chronic hyperglycemia further intensifies the local inflammatory response. Shin HS [24] and Romano F et al. [31] emphasizes that the coexistence of diabetes mellitus and periodontitis may generate a synergistic effect on systemic inflammation, which appears to be more pronounced than when each condition occurs independently. This interpretation is supported biologically and clinically and explains the bidirectional nature of the diabetes–periodontitis relationship, which is currently accepted by most authors.

The most important difference between the studies analyzed concerns the impact of periodontal treatment on glycemic control. These studies generally include patients with initially elevated HbA1c and longer follow-up periods [25,29,34]. Studies that do not show significant changes in HbA1c: some randomized clinical trials with short follow-up, studies that include patients who are already well metabolically controlled. The differences are not necessarily contradictory, but reflect methodological variations such as study duration, initial disease severity and continuity of periodontal therapy [30,31].

From a general medical point of view, the literature reviewed supports the idea that

periodontal disease is not only a complication of diabetes, but can actively contribute to metabolic imbalance. This justifies the inclusion of oral health assessment in the management of diabetic patients and interdisciplinary collaboration between the diabetologist and the dentist.

Conclusions

An analysis of the literature highlights the fact that diabetes mellitus and periodontal disease are closely interlinked, influencing each other through inflammatory and metabolic mechanisms. For dental practice, these data are particularly important because:

-uncontrolled diabetes negatively affects the response to periodontal treatment;

-identifying patients with severe periodontitis may signal a possible undiagnosed metabolic imbalance;

-periodontal treatment and regular monitoring can help reduce systemic inflammation and stabilize glycemic control. Thus, the dentist plays an active role not only in maintaining oral health but also in the overall management of diabetic patients.

Author Contributions (CRediT Taxonomy)

Conceptualization: T.F.; V.A.; Data curation: T.F.; Methodology: V. A.; Project administration: L.L; Software: T.F.; V.A.; Writing original draft: T.F.; V.A.; Supervision: L.L.; Writing review and editing: L.L.

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Conflict of interest

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None to declare.

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