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Review

# Interwoven strands: the complex connection between diabetes, depression, and periodontal disease

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## Abstract

Maintaining good oral health throughout life is essential for overall wellbeing, as it is frequently seen as a mirror of general health. Beyond comfort and appearance, dental health is important because it is inextricably related to overall health and quality of life. Even with improvements in dental care, oral health issues are still common worldwide, with dental caries and periodontal diseases being the most common. Growing research indicates that oral infections, especially periodontal disease, might worsen systemic inflammation, which in turn supports the etiopathogenesis of a number of chronic diseases. A complex relationship between mental health issues, especially depression, and dental health conditions is suggested by emerging studies. The chronic inflammation associated with periodontal disease is one potential mechanism linking these conditions. This underscores the importance of considering oral health within a holistic framework of overall health management. A commitment to good oral hygiene, which includes brushing, flossing, and routine dental check-ups, is crucial for preventing oral disorders as well as lowering the chance of related systemic conditions as per their interconnection. Including dental health in primary care is essential for holistic health management, especially for those with chronic conditions like diabetes, cardiovascular disease and other systemic illness.

**Keywords:** periodontal disease, diabetes mellitus, depression, oro systemic link, oral health

## Introduction

Oral health, often considered a reflection of overall health, is crucial for maintaining well-being throughout the lifespan. It encompasses not only the health of the teeth and gingiva but also the entire oral-facial complex, which facilitates essential functions such as speech, mastication, and emotional expression. The significance of oral health extends beyond aesthetics and comfort; it is intrinsically linked to systemic health and quality of life. Compromised oral health can significantly impact an individual's ability to eat, speak, and interact socially, potentially leading to psychological distress and impaired social interactions.

Despite advancements in dental care, oral health problems remain globally prevalent, with periodontal diseases and dental caries being the most common. These conditions have far-reaching implications, impacting systemic health. Dental caries result from the demineralization of tooth enamel caused by acid produced by oral bacteria. Without intervention, dental caries can progress to tooth decay, infection, and

ultimately tooth loss. These consequences can significantly impair an individual's overall well-being and quality of life [1].

Similarly, periodontal disease, an inflammatory disorder affecting the tissues surrounding teeth, can have serious systemic implications. The early stage of periodontal disease, known as gingivitis, is characterized by bleeding, swelling and redness in the gums. If not properly managed, periodontitis may develop, where inflammation extends to the bone supporting the teeth, increasing the likelihood of tooth repositioning and potential tooth loss. In addition, numerous chronic illnesses, such as cardiovascular disease, diabetes, respiratory infections, and unfavorable pregnancy outcomes, have been connected to periodontal disease [2].

The relationship between systemic health and oral health is supported by increasing evidence suggesting that oral infections, particularly periodontal disease, can exacerbate systemic inflammation, supporting the etiopathogenesis of various chronic diseases. For example, periodontal pathogens and the inflammatory mediators they produce can enter the bloodstream, potentially influencing distant organs and systems [3]. This bidirectional relationship is particularly evident in the case of diabetes, where poor glycemic control can worsen periodontal health, and severe periodontal disease can, in turn, impair blood glucose regulation [4].

Furthermore, the impact of oral health on mental health is increasingly recognized. Emerging research suggests a complex interplay between oral health conditions and mental health disorders, particularly depression (Figure 1) [5]. The chronic inflammation associated with periodontal disease is one potential mechanism linking these conditions. This underscores the importance of considering oral health within a holistic framework of overall health management.

Given these interconnections, adherence to proper oral hygiene practices, including regular dental check-ups, brushing, and flossing, is essential not only for the prevention of oral diseases but also for mitigating the risk of associated systemic conditions. Integrating oral health into primary care, particularly for individuals with chronic diseases such as diabetes and cardiovascular disease, is crucial for comprehensive health

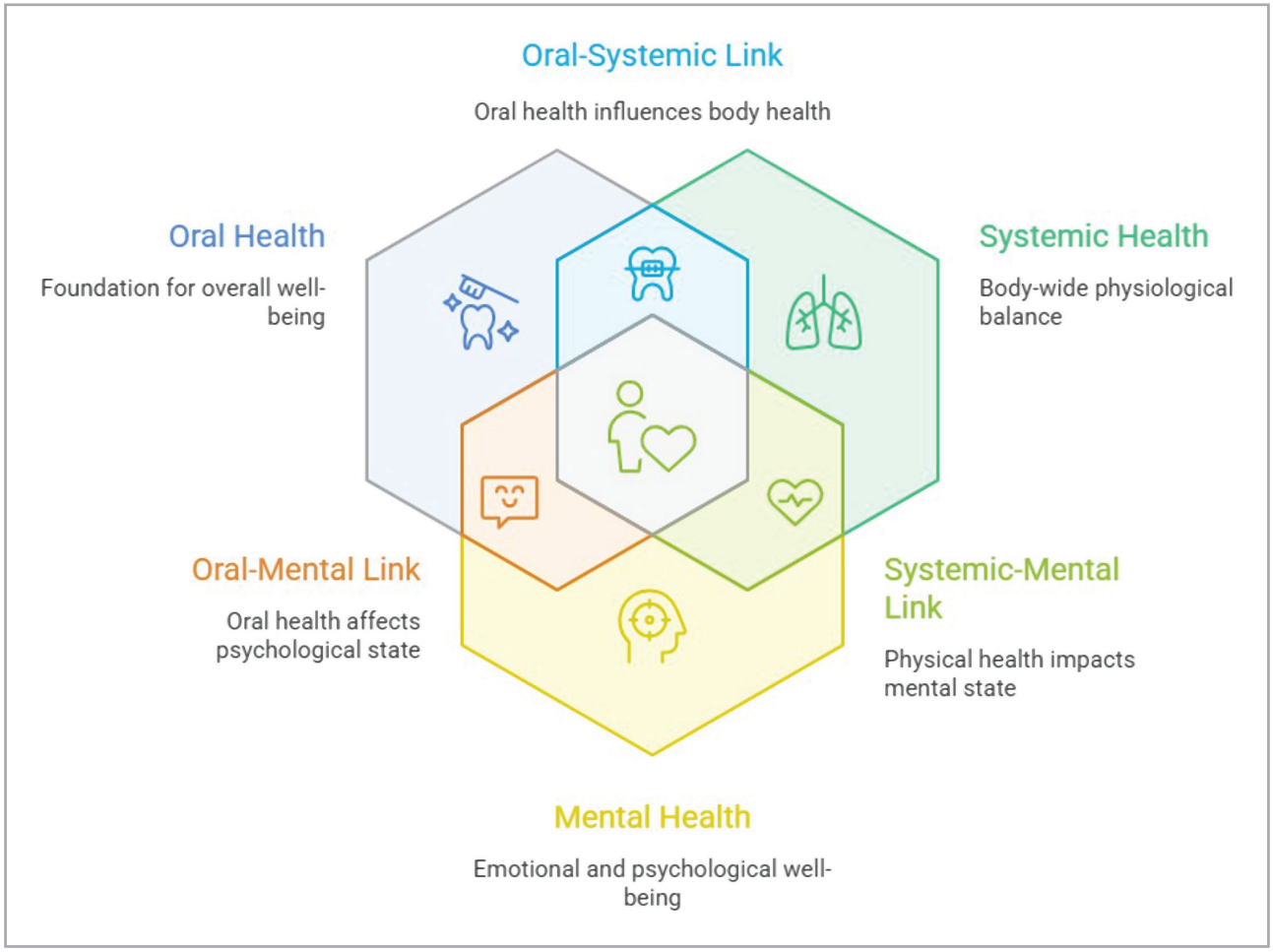


Figure 1: Interconnection of oral, systemic and mental health.


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management. This narrative review explores the intricate relationships among oral health, systemic health, and mental well-being, emphasizing the need for integrated care strategies to improve overall health outcomes and quality of life.

## Periodontal disease and systemic health

Periodontal disease is a significant health concern, particularly for individuals with diabetes. Numerous risk factors contribute to its development, including smoking, stress, hormonal fluctuations, and importantly, diabetes itself (Figure 2).

Smoking negatively impacts oral health by suppressing the immune response and reducing blood flow to the gingiva, increasing susceptibility to infection [6]. Diabetes further elevates the risk of periodontal disease due to impaired immune function, compromising the body's ability to combat infections (Figure 3) [4]. Psychological stress, through its influence on inflammation and immunity, can exacerbate periodontal issues [7]. Additionally, hormonal fluctuations in women, especially during pregnancy or menopause, contribute to increased vulnerability to gingival and periodontal diseases. The risk is further increased by an inadequate diet, certain medications that decrease salivary flow, and illnesses such as HIV/AIDS that compromise immune function [8].

The interconnectedness of oral health and systemic health is well established. Poor oral hygiene not only increases the risk of infections, tooth loss, and halitosis but also contributes to systemic conditions such as diabetes and heart disease. This is attributed to the ability of oral bacteria to enter the bloodstream and contribute to the formation of arterial plaques [2].

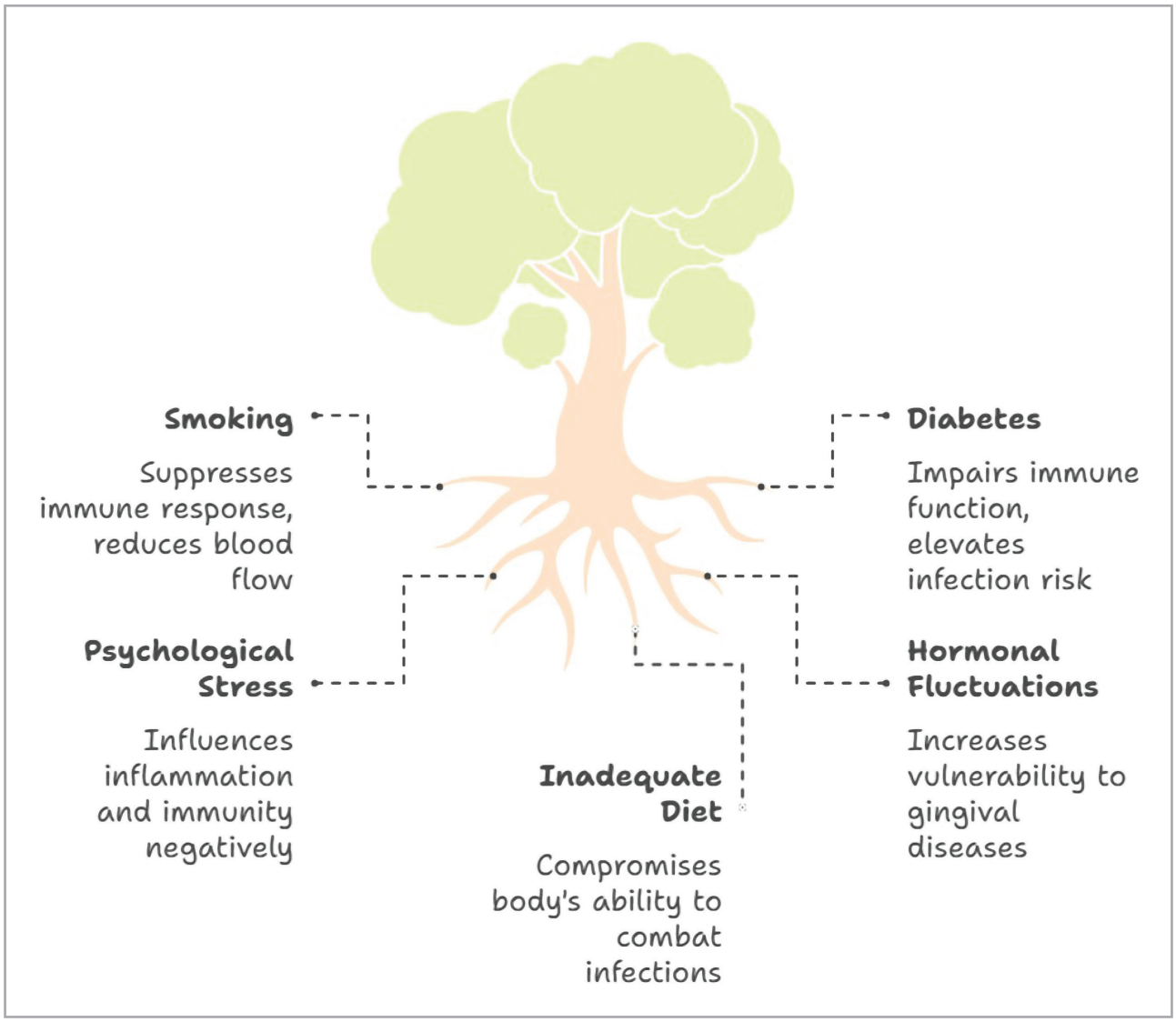


Figure 2: Risk factors for periodontal disease.

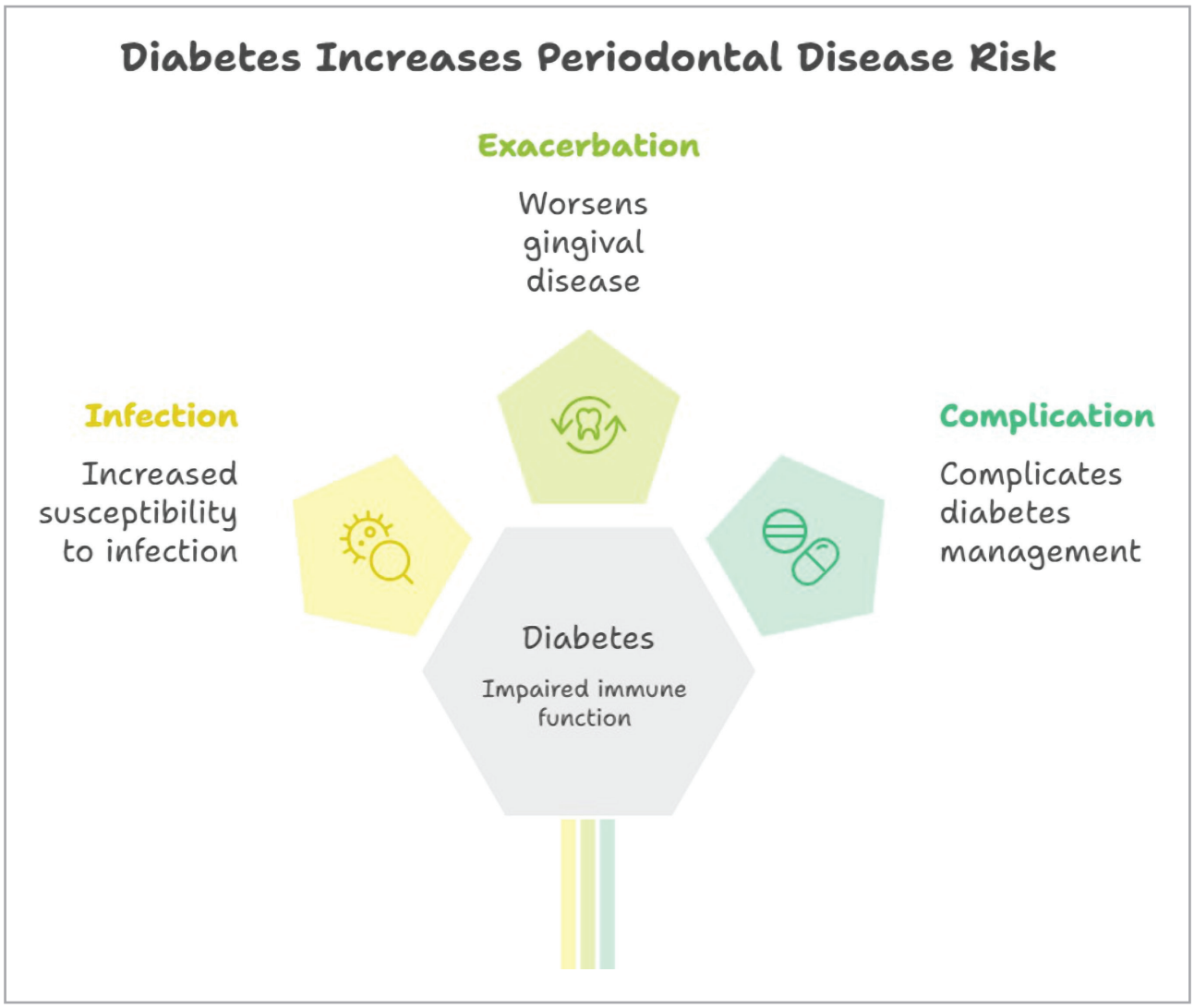


Figure 3: Effect of diabetes on periodontium.

Furthermore, a bidirectional relationship exists between diabetes and oral health. Poorly controlled blood sugar levels can exacerbate gingival disease, severe periodontal disease can complicate diabetes management [3]. In addition to diabetes, oral bacteria have also been implicated in respiratory illnesses and adverse pregnancy outcomes. Maintaining good oral hygiene is crucial for overall well-being, promoting self-esteem, and enhancing quality of life [9].

## Diabetes and periodontal disease

Diabetes mellitus and periodontal disease share a complex and bidirectional relationship, each significantly influencing the other. The hyperglycemic environment associated with diabetes contributes to an impaired immune response and compromised wound healing, creating a favorable environment for the development and progression of periodontal disease. Conversely, the presence of periodontal disease can exacerbate glycemic control in individuals with diabetes. The chronic inflammation characteristic of periodontal disease is believed to increase insulin resistance, further complicating diabetes management [3].

Importantly, research suggests that effective periodontal treatment can lead to improvements in glycemic control [4].

A reduction in HbA1c levels, can be key indicator of long-term blood glucose control, following periodontal therapy, which underscores the importance of integrating oral health care, particularly regular periodontal assessments and treatments, into comprehensive diabetes management plans [10].

Timely intervention and management of periodontal disease in individuals with diabetes can not only prevent the further progression of oral disease but also contribute to improved overall health outcomes and


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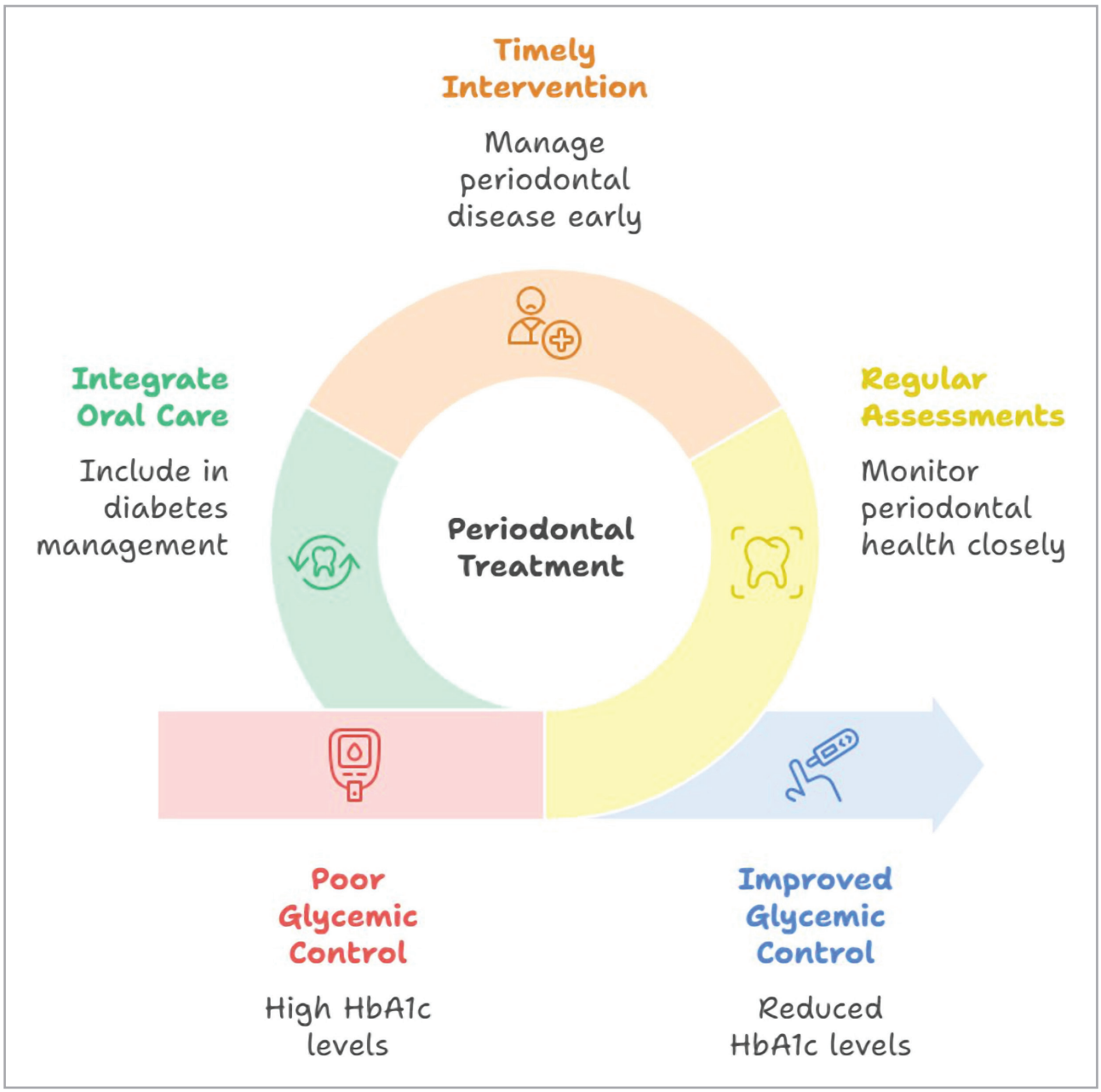


Figure 4: Effect of periodontal treatment on diabetes.

potentially reduce the risk of diabetes-related complications (Figure 4) [3].

## Periodontal disease and depression

Recent research has revealed an intriguing link between periodontal disease and depression, two seemingly distinct conditions that impact a significant portion of the global population. Emerging evidence suggests a bidirectional relationship. Individuals with periodontal disease appear to be more susceptible to experiencing symptoms of depression, whereas those struggling with depression may exhibit poorer oral health, increasing their likelihood of developing periodontal disease [5].

Several factors contribute to this complex interplay (Figure 5):

1. *Shared inflammatory pathways*: Both periodontal disease and depression are characterized by chronic, systemic inflammation. Inflammatory molecules released in response to periodontal infection are capable of crossing the blood–brain barrier, potentially impacting brain function and exacerbating depressive symptoms [5]. Conversely, the inflammatory state associated with depression, potentially linked to hypothalamic–pituitary–adrenal axis

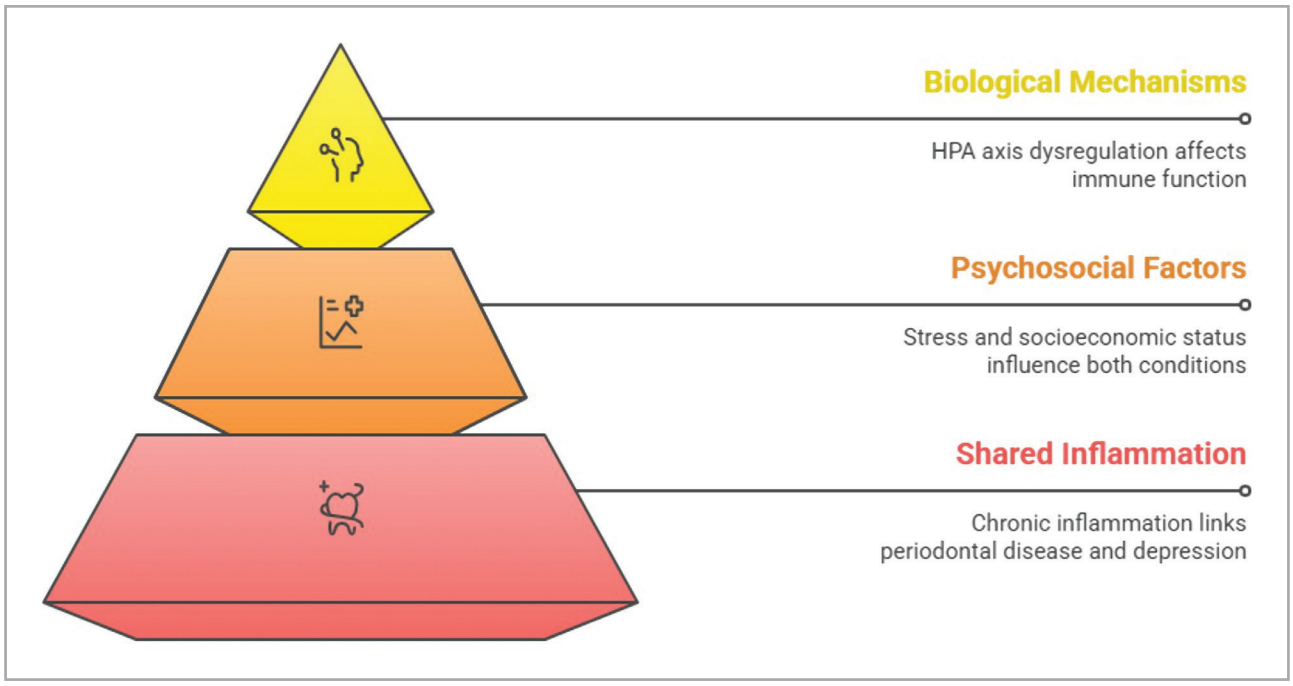


Figure 5: Health pyramid displaying complex interplay.

dysregulation, could suppress immune function and worsen periodontal health [5];

2. *Psychosocial factors*: Stress, socioeconomic status, and health behaviors are crucial factors influencing both periodontal disease and depression. Elevated stress levels and inadequate coping mechanisms can contribute to the onset and progression of both conditions, highlighting the need for holistic healthcare approaches that address both physical and mental well-being [7];
3. *Biological mechanisms*: Dysregulation of the HPA axis and alterations in neurotransmitter levels may further contribute to the link between periodontal disease and depression. Stress hormones such as cortisol, which are often dysregulated in depression, can modulate immune function and inflammatory responses within the oral cavity, potentially increasing susceptibility to periodontal disease [8].

## Diabetes and depression

Diabetes and depression represent two highly prevalent and interconnected health challenges with significant public health implications. The presence of diabetes significantly increases the risk of developing depression, and this comorbidity can pose substantial challenges in managing both conditions effectively [4].

Depression affects a substantial proportion of individuals with diabetes, with prevalence rates estimated to be as high as 30% (Figure 6) [3]. The intricate relationship between diabetes and depression involves multiple interconnected systems:

1. *Insulin resistance*: Insulin resistance, a hallmark of type 2 diabetes, is independently associated with an increased risk of depression. This association may be mediated by the effects of stress hormones and inflammatory cytokines, both of which are often dysregulated in the context of insulin resistance [5];
2. *HPA axis dysregulation*: Chronic hyperglycemia, a characteristic of diabetes, can disrupt the delicate balance of the hypothalamic–pituitary–adrenal axis. This dysregulation can contribute to the development or exacerbation of depression, potentially by overactivating the stress response system and disrupting neurotransmitter balance [8];
3. *Neurological impact*: Diabetes-related microvascular damage and neuroinflammation can have detrimental effects on brain function, increasing the risk of mood disorders, including depression. Conversely, depression itself can alter brain structure and function, particularly in regions involved in mood regulation, potentially creating a vicious cycle [10];
4. *Oxidative stress*: Chronic hyperglycemia in diabetes leads to increased production of reactive

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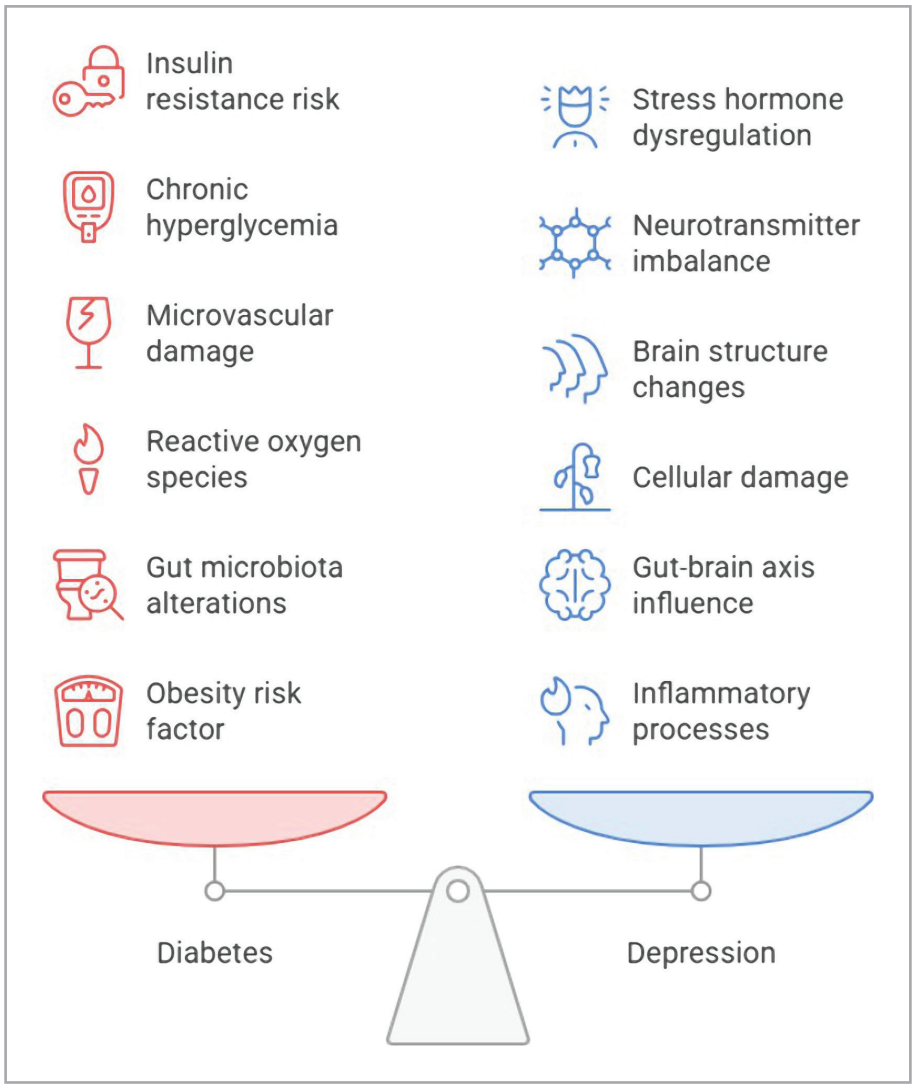


Figure 6: Interconnected health challenges for diabetes and depression.

oxygen species, resulting in oxidative stress [5]. This cellular damage is implicated in both insulin resistance and the pathophysiology of depression;

5. *Gut microbiota*: Emerging research suggests a potential role of the gut microbiota in the diabetes–depression link. Alterations in the composition and function of the gut microbiota can influence metabolism, inflammation, and the gut–brain axis, potentially contributing to both insulin resistance and depression [10];
6. *Obesity and adipokines*: Obesity, a major risk factor for type 2 diabetes, is associated with altered secretion of adipokines, which are signaling molecules produced by adipose tissue [3].

These alterations can contribute to insulin resistance and inflammatory processes linked to depression.

Managing comorbid diabetes and depression necessitates a comprehensive approach that addresses both conditions simultaneously. Medical management, including pharmacological interventions for both diabetes and depression, in addition to lifestyle modifications such as regular physical activity, a balanced diet, and stress reduction techniques, is essential to improve outcomes for individuals facing this dual health challenge [4]. Regular monitoring of both conditions is crucial to ensure treatment efficacy and adjust management strategies as needed.

## Conclusion

This narrative review has illuminated the complex interplay between oral health, diabetes, and mental health, emphasizing the need for a paradigm shift toward integrated health care approaches. Effective management of these interconnected conditions necessitates a holistic strategy that moves beyond traditional

silos and embraces collaboration among medical, dental, and mental health professionals. By adhering to evidence-based clinical practice guidelines and fostering interdisciplinary communication, we can optimize patient outcomes and empower individuals living with these cooccurring conditions to achieve improved overall health and well-being.

## Conflict of interest

The authors declare no conflict of interest.

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