

# A Comprehensive Review of the Various Risk Factors Associated with Periodontal Diseases

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## ABSTRACT

Periodontal diseases are prevalent inflammatory conditions affecting the supporting structures of the teeth, leading to tooth loss if left untreated. This review aims to provide a comprehensive overview of the multifactorial nature of periodontal diseases by examining various risk factors associated with their development and progression. The primary risk factors explored include microbial pathogens, host immune response, genetic predisposition, environmental factors, and lifestyle behaviors. Microbial pathogens, such as *Porphyromonas gingivalis* and *Tannerella forsythia*, play a crucial role in initiating and perpetuating periodontal inflammation. Host immune response, influenced by genetic factors, determines an individual's susceptibility to periodontal diseases.

Environmental factors such as smoking, poor oral hygiene, and systemic conditions like diabetes mellitus exacerbate periodontal inflammation and contribute to disease severity. Lifestyle behaviors including diet, stress, and socioeconomic status also impact periodontal health outcomes. Furthermore, systemic diseases such as diabetes, cardiovascular diseases, and respiratory diseases have bidirectional relationships with periodontal diseases, emphasizing the importance of considering systemic health in periodontal management. Understanding the complex interplay between these risk factors is essential for developing effective preventive and therapeutic strategies for periodontal diseases. Multidisciplinary approaches integrating periodontal care with systemic health management are crucial for improving overall patient outcomes and reducing the global burden of periodontal diseases. Further research is warranted to elucidate the mechanisms underlying these risk factors and their interactions, ultimately advancing our ability to prevent and treat periodontal diseases effectively.

**Keywords:** Periodontal diseases, Risk factors, Microbial pathogens, Lifestyle behaviors.

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## INTRODUCTION

Periodontal diseases represent a significant public health concern worldwide, encompassing a group of inflammatory conditions that affect the supporting structures of the teeth, including the gums and bone. These diseases range from gingivitis, characterized by inflammation of the gingival tissues, to more severe forms such as periodontitis, which can result in tooth loss if left untreated. The etiology of periodontal diseases is multifactorial, involving a complex interplay of microbial, host, genetic, environmental, and lifestyle factors.

Microbial pathogens play a central role in the initiation and progression of periodontal diseases. Certain bacteria, notably *Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola*, have been implicated as key pathogens responsible for triggering the host inflammatory response that leads to tissue destruction. However, the development of periodontal diseases is not solely determined by microbial factors; rather, it is influenced by the interplay between microbial virulence factors and host immune responses [1].

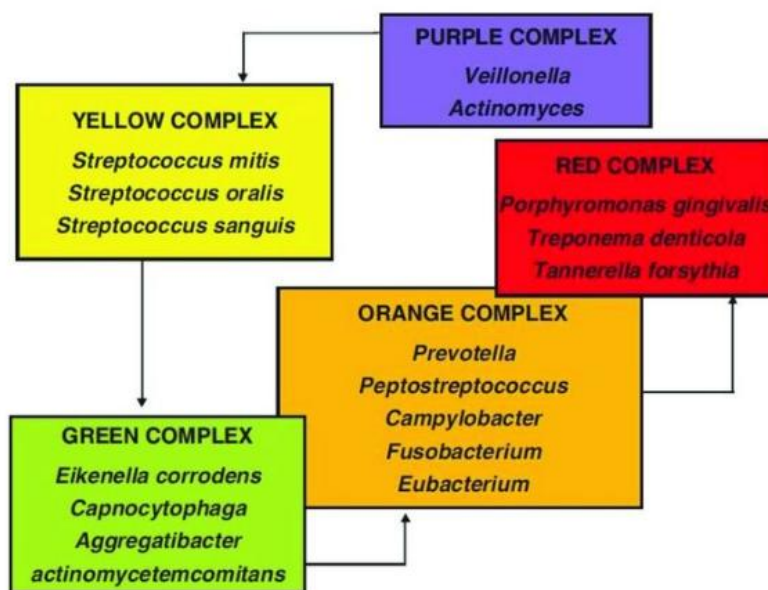
The host immune response plays a critical role in determining an individual's susceptibility to periodontal diseases. Genetic predisposition can modulate the host response to microbial challenge, influencing the severity and progression of periodontal inflammation. Additionally, systemic conditions such as diabetes mellitus and immunocompromised states can impair the host's ability to control periodontal pathogens, exacerbating disease progression.

Environmental factors also contribute significantly to the development of periodontal diseases. Smoking, poor oral hygiene practices, and dietary habits can create a favorable environment for periodontal pathogens to thrive,

exacerbating inflammation and tissue destruction. Furthermore, socioeconomic factors and access to dental care can impact oral health outcomes, highlighting the importance of addressing disparities in oral healthcare delivery [2].

Lifestyle behaviors, including diet, stress, and substance abuse, have been increasingly recognized as modifiable risk factors for periodontal diseases. Dietary factors such as high sugar consumption and low intake of antioxidants can compromise periodontal health, while chronic stress and substance abuse can weaken the immune system and exacerbate inflammation [3].

Understanding the complex interplay between these various risk factors is essential for the development of effective preventive and therapeutic strategies for periodontal diseases. By elucidating the mechanisms underlying disease pathogenesis and progression, clinicians and researchers can identify novel targets for intervention and improve patient outcomes. In this comprehensive review, we aim to examine the various risk factors associated with periodontal diseases, highlighting their individual and synergistic effects on disease development and progression [4].



**Figure 1: Microbial complexes involved in the progression and development of periodontal diseases**

### LITERATURE REVIEW

Numerous studies have investigated the diverse array of risk factors associated with periodontal diseases, shedding light on the intricate interplay between microbial, host, genetic, environmental, and lifestyle factors. Microbiological studies have identified specific bacterial species, such as *Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola*, as key pathogens implicated in the initiation and progression of periodontal diseases. These bacteria, along with others comprising the oral microbiome, form complex biofilm communities that evade host defenses and perpetuate chronic inflammation within the periodontal tissues [5].

Host immune response to microbial challenge plays a pivotal role in determining the outcome of periodontal diseases. Genetic predisposition has been shown to influence individual susceptibility to periodontal diseases, with certain polymorphisms in genes related to immune function and inflammatory pathways predisposing individuals to increased disease severity. Furthermore, systemic conditions such as diabetes mellitus, obesity, and autoimmune disorders can exacerbate periodontal inflammation by impairing host immune defenses and promoting dysbiosis within the oral microbiome [6,7].

Environmental factors, including smoking, poor oral hygiene, and dietary habits, significantly impact periodontal health outcomes. Smoking, in particular, has been strongly associated with an increased risk of periodontal diseases, as it alters immune function, impairs wound healing, and promotes microbial colonization within periodontal pockets. Poor oral hygiene practices, characterized by inadequate plaque control and irregular dental visits, create a conducive environment for periodontal pathogens to proliferate, leading to gingival inflammation and tissue destruction [8].

Lifestyle behaviors, such as diet, stress, and substance abuse, also influence periodontal health. High sugar consumption, low intake of antioxidants, and deficiencies in essential nutrients compromise host immune function and exacerbate periodontal inflammation. Chronic stress and substance abuse weaken the body's ability to mount an effective immune response, increasing susceptibility to periodontal diseases and impairing treatment outcomes [9].

Integrating findings from microbiological, genetic, epidemiological, and behavioral studies, researchers have developed comprehensive models to elucidate the multifactorial nature of periodontal diseases. These models underscore the importance of adopting a holistic approach to periodontal care, addressing not only microbial pathogens but also modifiable risk factors related to host immunity, genetics, environment, and lifestyle. By targeting these risk factors through tailored preventive and therapeutic interventions, clinicians can optimize treatment outcomes and improve the long-term oral health of patients [10].

### RISK FACTORS ASSOCIATED WITH PERIODONTAL DISEASES

The risk factors associated with periodontal diseases encompass various perspectives, including microbiological, immunological, genetic, environmental, and behavioral theories. These theories provide a comprehensive framework for elucidating the complex etiology and pathogenesis of periodontal diseases, guiding both research endeavors and clinical practice. Microbiological theory posits that periodontal diseases result from dysbiosis within the oral microbiome, where a shift in microbial composition and virulence factors leads to inflammation and tissue destruction. Specific pathogens, such as *Porphyromonas gingivalis* and *Tannerella forsythia*, are thought to play key roles in initiating and perpetuating periodontal inflammation, forming biofilm communities that evade host defenses and promote disease progression [11,12].

Immunological theory emphasizes the host response to microbial challenge as a critical determinant of periodontal disease susceptibility and severity. Genetic factors influence individual variations in immune function and inflammatory pathways, predisposing some individuals to heightened inflammatory responses and increased risk of periodontal diseases. Furthermore, systemic conditions such as diabetes mellitus and autoimmune disorders can dysregulate immune function, exacerbating periodontal inflammation and tissue destruction. Genetic theory suggests that variations in genes related to immune function, inflammation, and tissue remodeling contribute to individual susceptibility to periodontal diseases. Polymorphisms in genes encoding cytokines, receptors, and enzymes involved in the host immune response have been implicated in altering periodontal disease risk and severity, highlighting the importance of genetic factors in disease pathogenesis [13].

Environmental theory underscores the impact of external factors such as smoking, oral hygiene practices, and dietary habits on periodontal health outcomes. Smoking, in particular, has been strongly associated with increased risk of periodontal diseases, as it impairs immune function, delays wound healing, and alters microbial composition within the oral cavity. Poor oral hygiene practices, characterized by inadequate plaque control and irregular dental visits, create an environment conducive to microbial colonization and periodontal inflammation [14].

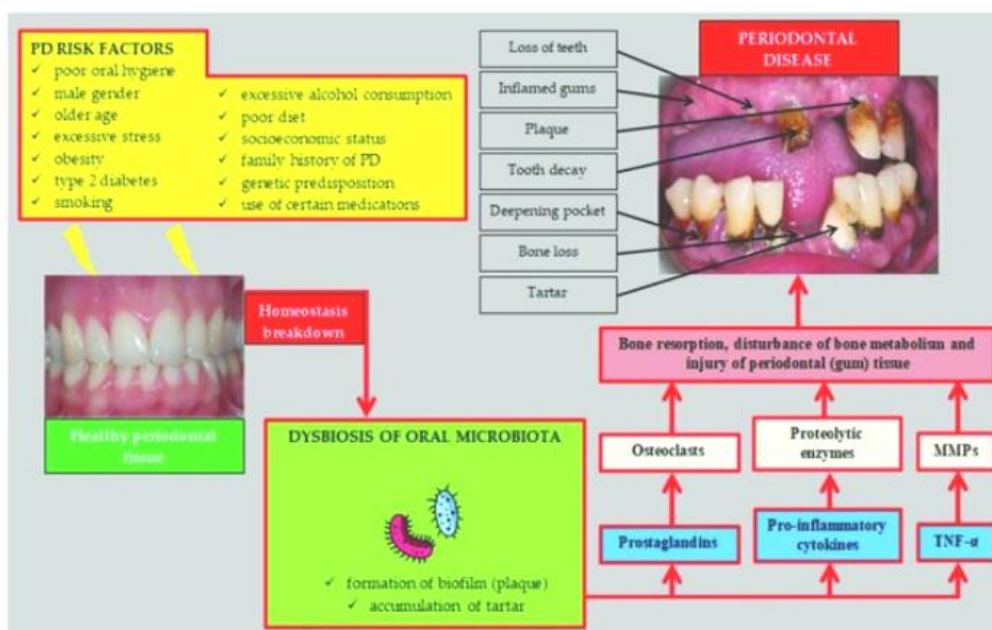


Figure 2: Personal, social, systemic, and local risk factors associated with oral dysbiosis lead to periodontal disease development and progression through activating pathogenic pathways [19]

Behavioral theory acknowledges the influence of lifestyle behaviors, including diet, stress, and substance abuse, on periodontal health. High sugar consumption, low intake of antioxidants, and chronic stress compromise immune

function and promote periodontal inflammation, while substance abuse, such as tobacco and alcohol use, exacerbates disease severity and impairs treatment outcomes [15].

Integrating these theoretical perspectives provides a holistic framework for understanding the multifactorial nature of periodontal diseases, guiding efforts to develop tailored preventive and therapeutic strategies. By addressing microbial, immunological, genetic, environmental, and behavioral factors, clinicians can optimize treatment outcomes and improve the long-term oral health of patients [16-18].

## PERIODONTAL FACTORS

### Modifiable risk factors

#### Smoking

Cross-sectional and longitudinal data provide strong support for the statement that the risk of developing periodontal disease as measured by clinical attachment loss and alveolar bone loss increases with increased smoking. Studies have shown that smoking does not reduce the amount of plaque present and in fact, smokers may experience less gingival bleeding than nonsmokers with lower plaque indexes. It has been suggested that this reflects an alteration of the caliber of the blood vessels perfusing the gingival tissues. It has also been suggested that reduced bleeding reflects an underlying disruption of the immune response and that this may account for the increased loss of clinical attachment and alveolar bone. It has been demonstrated that there are differences in the oxygen saturation of hemoglobin in the gingiva of smokers Risk factors for periodontal disease Mehta and non-smokers, suggesting that smokers have functional impairments in the gingival microcirculation.<sup>6</sup> Furthermore, it has been shown that smoking has significant adverse effects on the immune system, which include the modification of the humoral and cellular immune systems, and cytokine and adhesion molecule network [20].

#### Diabetes mellitus

It is proven beyond doubt that diabetes (poorly controlled) can lead to aggravation of periodontal infection and exaggerated bone loss and vice a versa is also true i.e. poorly controlled diabetes can be due to chronic periodontitis.<sup>8</sup> The increase in blood glucose level is associated with periodontitis in diabetic patients. Studies have shown there is reduction in glycated hemoglobin after periodontal treatment. All these evidences suggest that control of periodontal infection is not only important for oral health, but also for general health in diabetic patient. Microorganisms and periodontal disease Of all of the various microorganisms that colonize the mouth, there are three, Porphyromonas gingivalis, Tannerella forsythia (formerly Bacteroides forsythus), and Actinobacillus actinomycetemcomitans which have been implicated as etiologic agents in periodontitis [21].

#### Socio-economic status

Results from the National Health and Nutrition Examination Survey III in US population suggest that socioeconomic disparities are contributing to the oral health inequities. It was found that the prevalence of gingival bleeding and loss of attachment of = 4 mm increased with the decrease in the socioeconomic level. Low income and a rural residence were significant risk indicators for attachment loss. This and other studies suggest that measures of socioeconomic status, including income, education levels, and urban status are fairly good risk indicators for periodontal diseases. Groups with low socioeconomic status (low income and/or education) are at a higher risk of having periodontal diseases than groups with high socioeconomic status, and the increased risk level in this group seems to be attributed to behavioral and environmental factors [22].

#### Psychological factors

A hypothesis of an increased risk for destructive periodontal diseases due to psychological disorders has long been promoted. There is an increased focus on study of the cellular and molecular basis for an increased risk for periodontal tissue loss due to stress and other psychosocial factors, and the interaction between the immune system and the central nervous system, which mediates the effects of these factors in maintaining the host response to infection. It is well established that psychological stress can down regulate the cellular immune response, and disrupt the homeostasis of the network of signals linking the nervous, endocrine, and immune systems thereby interfering with the communication between the central nervous system and the host immune system [23].

#### Stress

The term stress serves as a convenient description for complex and incompletely understood psychological and physiological phenomena. Anxiety, as well as other emotional or psychosocial stresses, produces well-characterized neuroendocrine and biochemical changes in experimental animals. The physiological consequences of these stress-mediated changes have been shown to have significant adverse effects on the proper functioning of the immune [24].

#### Nutrition

Nutrition can influence the growth, development and metabolic activities of the periodontium; the high rate of cell turnover in the periodontal tissues requires that essential nutrients are readily available. Iron deficiency has a deleterious effect on macrophages, cells that are intimately involved in the immune and inflammatory systems. Cells of the immune

system have a high turnover rate, a high demand for the building blocks of DNA, and are vulnerable to folic acid deficiency. Zinc plays a significant role in the regulation of the inflammatory process and a deficiency could negatively influence host resistance to gingivitis [25].

### NON-MODIFIABLE RISK FACTORS

#### Genetic factors

Although bacterial infection is the etiologic agent in periodontal disease, studies of identical twins suggest 50% of the susceptibility to periodontal disease is due to host factors. Interleukin-1 (IL-1) gene polymorphisms have been linked to periodontal disease. Thus, specific IL-1 genotypes have been linked to the presence of pathogenic microorganisms, and to an increased risk of Mehta Risk factors for periodontal disease periodontal diseases in non-smokers and smokers. Furthermore, the evidence suggesting possible interactions between IL-1 and smoking and diabetes suggest that there is interplay between genetic and environmental factors that results in periodontal disease. Evidence also suggests possible relationships between periodontal disease and formyl-methionyl-leucyl-phenylalanine and Fc receptor polymorphisms [11].

#### Osteoporosis

Osteoporosis is a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration with a consequent increase in bone fragility and susceptibility to fracture. Several cross-sectional studies have shown that alveolar bone density is altered in osteoporotic individuals. In longitudinal studies, a relationship has been shown between osteoporosis and alveolar bone loss, but not between osteoporosis and clinical attachment levels [12].

#### Other systemic diseases

Several deficiencies of neutrophil function have been related to periodontal disease. These include Chediak-Higashi syndrome, cyclic neutropenias, lazy leukocyte syndrome, agranulocytosis and leukocyte adhesion deficiency and Down syndrome and Papillon-Lefevre syndrome. Except for Down's syndrome, these diseases are exceedingly rare, so probable though not definitive relationships to periodontal disease have not been established [13].

#### Ageing

Ageing is associated with an increased incidence of periodontal disease. Periodontal disease is a chronic infection therefore symptoms of periodontitis such as attachment loss, bone loss, gingival recession can be the result of the cumulative effect rather than older age of a person. To conclude, it is important to understand the etiological factors and the pathogenesis of periodontal disease to recognize and appreciate the associated risk factors. As periodontal disease is multi-factorial, effective disease management requires a clear understanding of all the associated risk factors [14].

### RESEARCH METHODOLOGIES

Research methodologies employed in studying periodontal diseases encompass a wide range of approaches, including observational studies, experimental studies, genetic studies, epidemiological studies, and clinical trials. Each methodology offers unique insights into the etiology, pathogenesis, and management of periodontal diseases, contributing to the advancement of knowledge and the development of evidence-based interventions [15].

Observational studies, such as cross-sectional studies, cohort studies, and case-control studies, are commonly used to identify associations between risk factors and periodontal diseases. These studies provide valuable information on the prevalence, incidence, and distribution of periodontal diseases within populations, as well as the potential risk factors contributing to disease development and progression [16].

Experimental studies, including laboratory-based investigations and animal models, allow researchers to explore the underlying mechanisms of periodontal diseases and test hypotheses regarding disease pathogenesis and treatment modalities. In vitro studies using cell cultures and animal models provide controlled environments for studying specific aspects of periodontal inflammation, tissue destruction, and host-microbial interactions, facilitating the identification of novel therapeutic targets and interventions [17].

Genetic studies utilize various techniques, including genome-wide association studies (GWAS), candidate gene approaches, and family-based studies, to investigate the role of genetic factors in periodontal diseases. These studies aim to identify genetic variants associated with increased susceptibility to periodontal diseases, elucidate underlying biological pathways, and inform personalized approaches to treatment and prevention.

Epidemiological studies assess the prevalence, incidence, and distribution of periodontal diseases within populations, as well as the impact of various risk factors on disease outcomes. These studies often involve large-scale surveys, data collection from electronic health records, and population-based surveillance systems to monitor trends in periodontal health and identify disparities in disease burden across demographic groups.

Clinical trials, including randomized controlled trials (RCTs) and intervention studies, evaluate the efficacy and safety of therapeutic interventions for preventing or treating periodontal diseases. These trials typically involve the recruitment of patients with periodontal diseases and the random assignment of participants to different treatment groups to assess the comparative effectiveness of interventions such as scaling and root planing, periodontal surgery, antimicrobial therapy, and adjunctive treatments [18].

Overall, the integration of diverse research methodologies provides a comprehensive understanding of the complex etiology, pathogenesis, and management of periodontal diseases. By combining observational studies, experimental investigations, genetic analyses, epidemiological surveys, and clinical trials, researchers can advance knowledge in the field, inform evidence-based practice, and improve the oral health outcomes of individuals worldwide [19].

### SIGNIFICANCE OF THE STUDY

The significance of studying periodontal diseases lies in its profound impact on individual health, quality of life, and healthcare systems globally. Understanding the significance of this topic involves recognizing its implications across several key areas [20]:

**Public Health Burden:** Periodontal diseases, including gingivitis and periodontitis, affect a significant portion of the global population, with varying degrees of severity. These conditions not only result in discomfort and functional impairment but also contribute to systemic health complications. Addressing periodontal diseases is thus crucial for reducing the overall burden of oral diseases and improving public health outcomes [21].

**Systemic Health Connections:** Research has shown strong associations between periodontal diseases and various systemic conditions, including diabetes, cardiovascular diseases, respiratory diseases, adverse pregnancy outcomes, and rheumatoid arthritis, among others. Understanding and managing periodontal diseases can thus have far-reaching implications for systemic health and may contribute to the prevention or management of these co-existing conditions.

**Quality of Life:** Periodontal diseases can significantly impact an individual's quality of life by causing pain, discomfort, difficulty chewing, and aesthetic concerns related to tooth loss and gum recession. Furthermore, the social and psychological impacts of periodontal diseases, including embarrassment, social isolation, and reduced self-esteem, underscore the importance of effective prevention and treatment strategies [22].

**Economic Costs:** The economic burden of periodontal diseases is substantial, encompassing direct costs related to dental treatment and indirect costs associated with productivity loss, absenteeism from work or school, and the management of systemic health complications. By addressing periodontal diseases through preventive measures and early intervention, healthcare systems can potentially alleviate the financial strain on individuals and society as a whole.

**Preventive Potential:** Periodontal diseases are largely preventable through effective oral hygiene practices, regular dental check-ups, and lifestyle modifications. Investing in preventive efforts, such as oral health education, community-based interventions, and early screening programs, can help reduce the incidence and severity of periodontal diseases, thereby promoting long-term oral health and well-being.

**Research and Innovation:** Continued research into the etiology, pathogenesis, and treatment of periodontal diseases drives innovation in dental and medical fields. Advances in microbiology, immunology, genetics, and therapeutics offer opportunities for developing novel preventive and therapeutic interventions, personalized treatment approaches, and targeted strategies for managing periodontal diseases more effectively.

In summary, the significance of studying periodontal diseases extends beyond oral health to encompass broader implications for systemic health, quality of life, healthcare costs, preventive strategies, and research advancements. By addressing this multifaceted topic comprehensively, researchers, clinicians, policymakers, and public health professionals can work collaboratively to improve oral health outcomes and enhance overall well-being for individuals and communities worldwide [23-25].

### LIMITATIONS & DRAWBACKS

While studying periodontal diseases is essential for improving oral health outcomes and overall well-being, it's important to acknowledge the limitations and drawbacks associated with research in this field [26]:

**Complex Etiology:** Periodontal diseases have a multifactorial etiology involving interactions between microbial, host, genetic, environmental, and behavioral factors. The complexity of these interactions makes it challenging to isolate specific causal relationships and elucidate underlying mechanisms, leading to gaps in our understanding of disease pathogenesis.

**Heterogeneity of Disease:** Periodontal diseases manifest in various forms, ranging from mild gingivitis to severe periodontitis, each with distinct clinical presentations and outcomes. This heterogeneity complicates research efforts, as study populations may exhibit diverse disease phenotypes, making it difficult to generalize findings across different patient groups.

**Biological Variability:** Individual variations in genetic predisposition, immune response, and microbiome composition contribute to biological variability in periodontal diseases. This variability can confound study results and affect the reproducibility of findings, requiring large sample sizes and robust statistical methods to account for potential confounders.

**Difficulty in Establishing Causality:** While observational studies can identify associations between risk factors and periodontal diseases, establishing causality remains challenging. Reverse causation and confounding variables may obscure the true relationship between exposures and outcomes, necessitating longitudinal studies and experimental designs to elucidate causal pathways.

**Ethical Considerations:** Conducting research involving human participants with periodontal diseases raises ethical considerations related to patient consent, privacy, and potential harms associated with interventions. Ethical guidelines must be followed to ensure the rights and well-being of participants are protected while advancing scientific knowledge in the field.

**Resource Constraints:** Research in periodontal diseases requires access to specialized equipment, facilities, and expertise, which may be limited in certain settings. Resource constraints can impede research progress, particularly in low- and middle-income countries where oral health disparities are more pronounced.

**Longitudinal Challenges:** Longitudinal studies tracking disease progression over time are essential for understanding the natural history of periodontal diseases and evaluating the effectiveness of interventions. However, longitudinal research poses logistical challenges, including participant retention, attrition, and follow-up, which may affect the validity and generalizability of findings.

**Bias and Confounding:** Selection bias, information bias, and confounding variables can distort study results and undermine the validity of conclusions drawn from research in periodontal diseases. Adequate study design, rigorous methodology, and careful consideration of potential sources of bias are necessary to minimize these limitations.

Despite these limitations, ongoing research efforts aimed at addressing periodontal diseases are essential for advancing our understanding of disease pathogenesis, improving diagnostic and treatment strategies, and ultimately enhancing oral health outcomes for individuals worldwide. By acknowledging and addressing these challenges, researchers can strive to overcome barriers to progress and continue making meaningful contributions to the field of periodontology [27-28].

A comparative analysis of the limitations and drawbacks associated with studying periodontal diseases presented in tabular form [29-31]:

<b>Limitations &amp; Drawbacks</b>	<b>Description</b>
Complex Etiology	Periodontal diseases result from multifactorial interactions between microbial, host, genetic, environmental, and behavioral factors, making it challenging to isolate specific causal relationships and mechanisms.
Heterogeneity of Disease	Periodontal diseases exhibit diverse clinical presentations and outcomes, ranging from mild gingivitis to severe periodontitis, leading to difficulties in generalizing research findings across different disease phenotypes.
Biological Variability	Individual variations in genetic predisposition, immune response, and microbiome composition contribute to biological variability in periodontal diseases, confounding study results and requiring robust statistical methods to account for confounders.
Difficulty in Establishing Causality	Observational studies may identify associations between risk factors and periodontal diseases, but establishing causality remains challenging due to factors like reverse causation and confounding variables, necessitating longitudinal and experimental designs.
Ethical Considerations	Research involving human participants with periodontal diseases raises ethical concerns related to informed consent, privacy, and potential harms associated with interventions, necessitating adherence to ethical guidelines and principles.
Resource Constraints	Research in periodontal diseases requires access to specialized equipment, facilities, and expertise, which may be limited in certain settings, particularly in low- and middle-income

Limitations & Drawbacks	Description
	countries, posing challenges to research progress.
Longitudinal Challenges	Longitudinal studies tracking disease progression over time are essential but pose logistical challenges such as participant retention, attrition, and follow-up, affecting the validity and generalizability of findings.
Bias and Confounding	Selection bias, information bias, and confounding variables can distort study results and undermine the validity of conclusions drawn from research in periodontal diseases, emphasizing the need for rigorous methodology and consideration of potential sources of bias.

This tabular format provides a clear and concise comparison of the various limitations and drawbacks associated with studying periodontal diseases, facilitating an understanding of the challenges researchers face in this field.

### CONCLUSION

In conclusion, studying periodontal diseases is essential for improving oral health outcomes and overall well-being, but it comes with various limitations and challenges. Periodontal diseases have a complex etiology, involving interactions between microbial, host, genetic, environmental, and behavioral factors. This complexity, coupled with the heterogeneity of disease manifestations, makes it challenging to isolate specific causal relationships and mechanisms. Biological variability among individuals further complicates research efforts, necessitating large sample sizes and robust statistical methods to account for confounding variables. Additionally, establishing causality remains challenging due to the inherent limitations of observational studies and the ethical considerations involved in research with human participants.

Resource constraints, especially in low- and middle-income countries, pose challenges to research progress, limiting access to specialized equipment, facilities, and expertise. Longitudinal studies face logistical challenges such as participant retention and follow-up, which can affect the validity and generalizability of findings. Despite these limitations, ongoing research efforts are crucial for advancing our understanding of periodontal diseases, improving diagnostic and treatment strategies, and ultimately enhancing oral health outcomes for individuals worldwide. By acknowledging and addressing these challenges, researchers can strive to overcome barriers to progress and continue making meaningful contributions to the field of periodontology.

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