

**ASSESSMENT OF THE RISK FACTORS FOR  
PERIODONTITIS IN PATIENTS ATTENDING  
THE HOSPITAL UNIVERSITI SAINS MALAYSIA:  
A RETROSPECTIVE STUDY**

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A RETROSPECTIVE STUDY**

by

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## LIST OF ABBREVIATIONS

AAP	American Academy of Periodontology
AL	Attachment Loss
AOR	Adjusted Odds Ratio
AUC	Operating Characteristic Curve
BOP	Bleeding on Probing
CAD	Coronary Artery Disease
CAL	Clinical Attachment Loss
CDC	Centers for Disease Control and Prevention
COR	Crude Odds Ratio
CPI	Community Periodontal Index
DMFT	Decayed, Missing and Filled Teeth
KNHANES	Korea National Health and Nutrition Examination Survey
NHANES	National Health and Nutrition Examination Survey
OCT	Optical Coherence Tomography
PCR	Polymerase Chain Reaction
PD	Probing Depth
PRA	Periodontal Risk Assessment
PRC	Periodontal Risk Calculator
RN	registration numbers
SEP	Socioeconomic Position
SPSS	Statistical Product and Service Solution

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**PENILAIAN FAKTOR RISIKO PERIODONTITIS DALAM KALANGAN  
PESAKIT YANG HADIR DI HOSPITAL UNIVERSITI SAINS MALAYSIA:  
SATU KAJIAN RETROSPEKTIF**

**ABSTRAK**

Periodontitis adalah bentuk penyakit gusi yang teruk yang dicirikan oleh jangkitan dan keradangan tulang dan tisu penghubung yang menyokong gigi. Menurut kajian Beban Penyakit Global, penyakit periodontal adalah di tempat ke-11 sebagai penyakit paling lazim di seluruh dunia. Insiden dan prevalens penyakit periodontitis boleh dipengaruhi oleh pelbagai faktor, termasuk umur, jantina, genetik, merokok, gangguan kesihatan sistemik (seperti diabetes), status sosioekonomi yang rendah, dan amalan yang berkaitan dengan kebersihan mulut. Dua ratus tujuh puluh empat pesakit telah dikenalpasti sebagai subjek penyelidikan. Maklumat pesakit seperti nama, umur, jantina, etnik, taraf pendidikan, alamat, dan jumlah pendapatan telah diambil daripada rekod pesakit. Selain itu, aduan utama pesakit, carta pemeriksaan pergigian, sejarah penyakit sistemik, sejarah alahan, sejarah ubat-ubatan, prosedur pergigian terdahulu, keterukan penyakit periodontal dan diagnosis telah direkodkan. Selanjutnya, DMFT, indeks plak, skor gingivitis dan kedalaman poket periodontal telah direkodkan. Data seterusnya dipindahkan ke perisian Excel dan kemudian diproses dan dianalisis menggunakan SPSS. Seramai 274 subjek (lelaki: 51.8% dan perempuan: 48.2%) menyertai kajian ini. Umur median subjek ialah 51.0 tahun. Kebanyakan subjek adalah Melayu (92.3%) dan bekerja (70.8%). Tambahan pula, kebanyakan subjek tidak mempunyai tabiat (71.2%) atau tiada tindak balas alahan (84.7%). Bagi ciri-ciri perubatan, lebih daripada separuh (57.9%) daripada subjek tidak mempunyai masalah perubatan, dengan prevalens hipertensi dan diabetes masing-masing pada 31.8% dan

15.0%. Kajian mendapati skor gingivitis mempunyai korelasi negatif yang signifikan dengan peratusan kedalaman poket subjek < 4mm ( $r = -0.13$ ,  $p = 0.038$ ) dan korelasi positif yang signifikan dengan peratusan kedalaman poket 4-6mm ( $r = 0.15$ ,  $p = 0.032$ ). Keputusan analisis regresi logistik menunjukkan bahawa dua faktor (iaitu, kumpulan umur dan etnik) dikekalkan dalam model akhir dan oleh itu dianggap sebagai faktor peramal yang penting untuk penyakit periodontitis ( $\geq 4$ mm). Bagi kumpulan umur, mereka yang berumur 18-44 tahun adalah 2.7 kali lebih berkemungkinan menghidap periodontitis berbanding mereka yang berumur 65 tahun dan ke atas (AOR = 2.73,  $p = 0.066$ ), dan yang berumur 45-64 tahun adalah 3.0 kali lebih berkemungkinan mengalami periodontitis yang teruk berbanding mereka yang berumur 65 tahun dan ke atas (AOR = 3.04,  $p = 0.035$ ). Bagi kumpulan etnik, orang Melayu adalah 12.5 kali lebih berkemungkinan menghidap periodontitis berbanding kumpulan lain - lain (AOR = 12.50,  $p = 0.015$ ). Etnik adalah satu-satunya faktor sosiodemografi yang mempunyai perkaitan yang signifikan secara statistik dengan keterukan periodontitis. Skor gingivitis adalah satu-satunya parameter klinikal yang dikaitkan dengan keterukan periodontitis ( $p=0.01$ ). Peramal penting periodontitis adalah faktor sosiodemografi seperti kumpulan umur dan etnik, seperti yang ditentukan oleh analisis regresi logistik binari. Tiada perkaitan yang signifikan secara statistik dalam peranan keadaan sistemik seperti diabetes, hipertensi, asma, gastritis, dan keadaan sistemik lain sebagai faktor risiko untuk periodontitis. Faktor sosio-demografi seperti umur, jantina dan tabiat sosial tidak banyak dikaitkan dengan keterukan periodontitis dan lokasi poket periodontal.

**ASSESSMENT OF THE RISK FACTORS FOR PERIODONTITIS IN  
PATIENTS ATTENDING THE HOSPITAL UNIVERSITI SAINS MALAYSIA:  
A RETROSPECTIVE STUDY**

**ABSTRACT**

Periodontitis is a severe form of gingival disease characterized by infection and inflammation of the bone and connective tissue supporting the teeth. According to the Global Burden of Disease study, periodontal disease was the 11th most prevalent condition globally. The incidence and prevalence of periodontitis can be influenced by various factors, including age, gender, genetics, smoking, systemic health disorders (such as diabetes), low socioeconomic status, and practices related to oral hygiene. Two hundred seventy-four subjects were included. This was a retrospective study and subjects includes periodontitis patients who attended School of dental sciences at Universiti Sains Malaysia between the year 2011 to 2020. The patient's name, age, sex, ethnicity, education, address, and income were retrieved from the patients record. Additionally, main presenting complaints, dental examination record, history of systemic diseases, allergies, medication history, prior dental operations, severity and diagnosis of periodontal disease, and list of past dental procedures were all documented. Further, the DMFT, Plaque index, Gingivitis score and pocket depth were recorded. The data was transferred to the Excel sheet and then processed and analysed using SPSS. A total of 274 subjects (male: 51.8% and female: 48.2%) participated in this study. The median age was 51.0 years. Most subjects were Malay (92.3%) and employed (70.8%). Furthermore, most subjects had no habits (71.2%) or no allergic reactions (84.7%). For the medical characteristics, more than half (57.9%) of the subjects had no other medical condition, with the prevalence of hypertension

and diabetes at 31.8% and 15.0%, respectively. The study found that gingivitis score had a significant and negative correlation with subjects' percentage pocket depth < 4mm ( $r = -0.13$ ,  $p = 0.038$ ) and a significant and positive correlation with percentage pocket depth 4-6mm ( $r = 0.15$ ,  $p = 0.032$ ). The results of the logistic regression analysis show that two factors (i.e., age group and ethnicity) were retained in the final model and therefore considered significant predictors of periodontitis ( $\geq 4$ mm). For age group, the 18–44-year-olds were 2.7 times more likely to have periodontitis than the 65-year-olds and above (AOR = 2.73,  $p = 0.066$ ), and the 45–64-year-olds were 3.0 times more likely to have severe periodontitis than the 65-year-olds and above (AOR = 3.04,  $p = 0.035$ ). For ethnicity, the Malays were 12.5 times more likely to have periodontitis than the others (AOR = 12.50,  $p = 0.015$ ). Ethnicity was the only sociodemographic factor that had a statistically significant association with the severity of periodontitis. The gingivitis score was the only clinical parameter significantly associated with the periodontitis severity ( $p=0.01$ ). Significant predictors of periodontitis were the sociodemographic factors such as age group and ethnicity determined by binary logistic regression analysis.

# CHAPTER 1

## INTRODUCTION

### 1.1 Background of the study

Both gingivitis and periodontitis are included in the category of periodontal disease, and they are two of the most common types (Scannapieco & Gershovich, 2020). These diseases damage the tissues that support the teeth, such as the gingiva, alveolar bone, cementum, and periodontal ligaments. Plaque, the sticky film that accumulates on the teeth due to the presence of bacteria, is the primary cause of both disorders (Kinane *et al.*, 2017).

Gingivitis, commonly called gingival inflammation, is an early stage of periodontal disease (Rathee & Jain, 2022). Over 90% of people worldwide have gingivitis (Gasner & Schure, 2022; Verma, 2018). It is caused by plaque that forms along the gum line and irritates the gums (Miron *et al.*, 2022). Inadequate dental hygiene, insufficient brushing and flossing of teeth, hormonal shifts (such as during pregnancy), certain medications, and systemic disorders can all contribute to developing gingivitis (Rathee & Jain, 2022). Gingivitis can be recognized by its symptoms, including red, swollen, or sensitive; bleeding gums when brushing or flossing; poor breath; and gum recession (Broomhead *et al.*, 2022). Practising good oral hygiene consistently, such as brushing and flossing the teeth daily and seeing the dentist for expert cleanings, could reverse gingivitis. Gingivitis can develop into periodontitis if not treated (Nettemu *et al.*, 2017; Preshaw, 2015).

Periodontitis is a severe form of gum disease characterized by infection and inflammation of the bone and connective tissue supporting the teeth (Kwon *et al.*,



2021). When gingivitis is left untreated, pockets between the gums and teeth are created, which allows germs to go deeper into the gum tissues. These crevices collect tartar and plaque, causing more infection and damage (Mark, 2022; Verma, 2018). Periodontitis symptoms include persistent foul breath, receding or swollen gums, sensitive gums, deep pockets developing between the gingiva and the teeth, moving or loose teeth, and alterations to the bite or fit of dentures (AlKafaji *et al.*, 2022; Phillips, 2018). Gingivitis is the early and reversible stage of gingivitis which is characterized by inflammation of the gums. In contrast, periodontitis is an advanced and potentially irreversible stage involving infection and damage to the gum tissues and supporting structures (Rathee and Jain, 2022). Gingivitis and periodontitis can be prevented and treated by maintaining a healthy oral hygiene routine and going to the dentist for assessment on a regular basis (Al-Kafaji *et al.*, 2022; Verma, 2018).

Periodontal diseases, which include gingivitis and periodontitis, are conditions that are widespread throughout the world (Nazir *et al.*, 2020b). According to the Global Burden of Disease study, periodontal disease was the 11th most prevalent condition globally (Nazir *et al.*, 2020b). Gingivitis is a frequent oral health problem, and its prevalence varies by population. According to the Centers for Disease Control and Prevention (CDC), over 47% of persons in the United States aged 30 and up have periodontal disease, which includes gingivitis (CDC, 2023). The National Oral Health Survey conducted in 2010 indicated that approximately 90% of Malaysian adults had some form of periodontal disease with varying degrees of severity (NOHS, 2010). Another study conducted in 2019 found that 96% of the population exhibited signs of periodontal disease (Yaacob *et al.*, 2019). The incidence of gingivitis might differ based on oral hygiene habits, socioeconomic status, access to care, eating habits, and overall health status (Al Anouti *et al.*, 2021). Gingivitis is quite common, but it is often

not as severe compared to periodontitis and is more amenable to treatment (Rathee and Jain, 2022).

Although periodontitis has a lesser incidence than gingivitis, it still has the potential to affect a significant portion of the general population. Over half of the adult population in developed countries suffers from periodontal disease, making it one of the most widespread dental diseases (Fashing, 2008). The prevalence of periodontal disease was reported to range from 20% to 50% worldwide (Nazir *et al.*, 2020b). According to estimates from the Global Burden of Disease Study conducted in 2017, 11.2% of the world's population suffered from severe periodontitis (Wu *et al.*, 2022). In the United States alone, cross-sectional studies indicate that nearly 50 per cent of adults still have some form of gingivitis, and up to 80% have undergone some periodontal disease throughout their lifetime. Some individuals have been shown to have a greater prevalence of periodontal disease (Nazir, 2017).

The incidence and prevalence of periodontitis can be influenced by various factors, including age, gender, genetics, smoking, systemic health disorders (such as diabetes), low socioeconomic status, and practices related to oral hygiene (Păunică *et al.*, 2023). People with lower incomes had a 1.8 times greater chance of developing severe periodontitis than those with higher incomes (Nazir *et al.*, 2020b; Zhou *et al.*, 2015). Certain age groups are associated with the start of chronic periodontitis, and the severity of the condition worsens with advancing years (Păunică *et al.*, 2023). An epidemiological study indicated that the senior population had the highest prevalence of the disease (82%), followed by adults (73%), and then adolescents (18.8%) (Nazir *et al.*, 2020b). The epidemiology and incidence of gingivitis and periodontitis can change across different populations and regions due to the influence of cultural, genetic, and environmental factors. (Karojari *et al.*, 2022).

Plaque, a bacterial film that constantly forms on the teeth and gums, is the primary cause of the development of gingivitis and periodontitis (Kumar *et al.*, 2019). Plaque is a persistently developing, sticky layer of bacteria, food debris, and saliva that coats the teeth. (Kumar *et al.*, 2017). Plaque can irritate and inflame the gums if it is not adequately removed using proper oral hygiene techniques like brushing and flossing (Sarkar *et al.*, 2023). The bacteria in the plaque produce toxins that cause an immunological reaction in the body, resulting in the typical gingivitis symptoms of redness, swelling, and bleeding gums (Bhatnagar & Bhatnagar, 2023). Gingivitis is typically caused by bacteria such as *Streptococcus mutans*, *Actinomyces* species, and *Porphyromonas gingivalis* (Contaldo *et al.*, 2021).

Gingivitis can develop into periodontitis, where the bacterial infection spreads below the gum line and damages the tooth-supporting tissues if not treated (Mark, 2022; Nettemu *et al.*, 2017; Preshaw, 2015). As the infection continues, the bacteria in the plaque penetrate deeper into the gum tissues, forming pockets between the gums and teeth (Birtia & Mahapatra, 2020). These pockets produce an environment conducive to the growth of anaerobic bacteria, which are more harmful and aggressive (Carmello *et al.*, 2020). In addition to harming the gum tissues, the bacteria in these pockets also target the bone and ligaments that support the teeth in place. When these bacteria are present, the immune response that results in persistent inflammation also contributes to tissue destruction (Loos & Van Dyke, 2020).

*Porphyromonas gingivalis*, *Tannerella forsythia*, *Aggregatibacter actinomycetemcomitans*, *Prevotella intermedia*, and *Treponema denticola* are a few of the most important bacteria which are linked to periodontitis (Chigasaki *et al.*, 2021).

Several risk factors can influence periodontal diseases, which could be divided into two categories: local factors within the mouth and systemic factors affecting the entire body (Gunepin *et al.*, 2018).

### **1.1.1 Local factors**

**Poor oral hygiene:** Bacterial plaque can build up on teeth and gingiva due to inadequate brushing and flossing. The plaque includes harmful bacteria that can irritate and inflame the gingiva, causing gingivitis and eventually leading to periodontitis (Mark, 2022; Nettemu *et al.*, 2017).

**Tartar or Dental Calculus:** Plaque can solidify into dental calculus or tartar if not regularly removed, creating a rough surface that encourages the attachment and growth of more bacteria.

**Regular brushing and flossing** will not be able to remove calculus; instead, professional dental cleaning is required (Fagernäs & Warinner, 2023). **Dental prosthetics or Faulty restorations:** Plaque can be built in regions where dental restorations, such as fillings or crowns, have rough surfaces or are poorly fitted. Similarly, improperly fitting dental prostheses like dentures or bridges can irritate and inflame the gum tissues (Srimaneepong *et al.*, 2022). **Crowding or Malalignment of teeth:** Crowded or misaligned teeth might generate overlaps or small areas that are challenging to clean. Periodontal diseases may develop due to the accumulation of plaque and food particles in these areas (Javali *et al.*, 2020). **Occlusal disorders,** such as an irregular bite or malocclusion, can put too much pressure on some teeth, harming the supporting tissues and gum tissues. Gingival recession and bone loss can result from this (Zhou *et al.*, 2017).

### 1.1.2 Systemic Factors

An increased risk of acquiring periodontal diseases and having more severe symptoms are linked to poorly controlled diabetes. Diabetes-related high blood sugar levels impair the immune system's ability to respond, making it more challenging to prevent bacterial infection and inflammation (Genco & Borgnakke, 2020). Periodontal problems have been related to an elevated risk of several systemic diseases, including cardiovascular disease, rheumatoid arthritis, and some respiratory diseases. The development and progression of periodontal conditions may be influenced by underlying systemic inflammation and immune system dysfunction (Bui *et al.*, 2019a). Periodontal problems are significantly increased by smoking. It weakens the body's immunological system, making it harder to fight off infections. Smoking also reduces blood flow to the gums, delaying healing and encouraging bacterial colonization in the periodontal pockets (Silva, 2021b). Immune deficiency: immunological systems are weakened in people with immunological shortcomings, such as those who have HIV/AIDS or are receiving immunosuppressive medication. They are less able to fight off bacterial infections, which increases their susceptibility to periodontal diseases (Knight *et al.*, 2016).

Changing hormone levels throughout adolescence, pregnancy, and menopause can increase the risk of gum inflammation. An elevated risk of gingivitis might result from the blood vessels in the gingiva becoming more reactive and susceptible to plaque bacteria when certain hormone levels are high (Mahendra *et al.*, 2022). Anticonvulsants, immunosuppressants, and certain calcium channel blockers are a few drugs that can impact oral health. They may result in xerostomia or other adverse effects that raise the chance of developing periodontal diseases, such as gingival hyperplasia (Heasman and Hughes, 2014). Periodontal diseases may be a genetic

predisposition in some people. The immune system's response to bacteria is influenced by specific genetic variants, which raises the risk of bone loss and gum inflammation (Genco and Borgnakke, 2013).

## **1.2 Problem Statement and Justification of the Study**

Periodontal disease, a chronic inflammatory condition affecting the supporting structures of the teeth, poses a significant public health concern worldwide (Chan *et al.*, 2021; Nazir *et al.*, 2020b). While the accumulation of dental plaque and calculus is widely recognized as the primary cause of periodontal disease, there is increasing evidence suggesting that systemic conditions may play a crucial role in its development and progression (Nazir, 2017). Understanding the relationship between systemic conditions and periodontal disease is vital for effectively preventing, diagnosing, and managing this oral health condition. There is currently a lack of comprehensive tools to assess periodontal risk factors precisely. Although instruments like the Periodontal Risk Assessment (PRA) and Periodontal Risk Calculator (PRC) have been created and used, they have limitations that hinder how well they can provide a thorough evaluation. These currently available methods frequently concentrate on a few risk factors and do not consider the complete range of systemic factors contributing to periodontal diseases. To give a more accurate assessment of periodontal disease risk, there is a need for a more comprehensive and inclusive risk assessment tool that considers a broader range of risk factors. Despite the well-established connection between systemic conditions and periodontal diseases, systemic diseases have not yet been thoroughly investigated as potential risk factors. Despite the growing body of research exploring the association between systemic

conditions and periodontal disease, a comprehensive and retrospective assessment of their role as risk factors is necessary.

The problem lies in the need to systematically analyze the existing evidence and evaluate the impact of various systemic conditions on periodontal health. By conducting such an assessment, healthcare professionals, researchers, and policymakers can gain valuable insights into the complex interplay between systemic health and periodontal disease, leading to improved preventive strategies, earlier diagnosis, and more effective treatment approaches. In Malaysia, where periodontal disease is prevalent, oral health is a significant issue. Around 94% of Malaysian dentate adults have some form of periodontal disease (NOHS, 2010). Malaysia is a multi-ethnic and multicultural country with diverse genetic backgrounds, lifestyles, and healthcare practices (Amanat *et al.*, 2020). Malaysia faces a significant burden of systemic conditions such as diabetes, cardiovascular diseases, and respiratory infections (Akl *et al.*, 2021). These conditions have been associated with an increased risk of periodontal disease.

Understanding the specific impact of these systemic conditions on the Malaysian population can assist healthcare professionals in developing effective screening, prevention, and management strategies. Socioeconomic factors, cultural practices, and oral health behaviours vary across different regions and ethnic groups within Malaysia (Kuppusamy *et al.*, 2021). Investigating the role of systemic conditions as risk factors specific to the Malaysian socioeconomic and cultural context can provide insights into the local burden of periodontal disease and help tailor preventive strategies and interventions accordingly. Conducting a retrospective assessment of the role of systemic conditions as periodontal risk factors in Malaysia can provide evidence to inform policy decisions related to oral health and systemic

disease prevention and management. It can contribute to developing guidelines, educational programs, and integrated healthcare approaches addressing the Malaysian population's oral and systemic health needs. Focusing on the Malaysian population in studying the relationship between systemic conditions, periodontal disease and associated risk factors can generate locally relevant research findings and contribute to the body of knowledge on periodontal health. This can promote academic and scientific advancements in oral health research in Malaysia and provide a foundation for future studies on preventive strategies and treatment interventions.

### **1.3 Objectives**

#### **1.3.1 General objectives**

To access the risk factors for periodontitis in patients attending the hospital Universiti Sains Malaysia.

#### **1.3.2 Specific objectives**

1. To determine the association between socio-demographic factors (i.e., age, gender, ethnicity, work history), habits, and periodontitis severity.
2. To determine the association between systematic diseases (conditions), clinical parameters, and periodontitis severity.
3. To develop a binary logistic regression for assessing risk factors of periodontitis.



#### **1.4 Research questions**

1. Is there any significant difference in the association between socio-demographic factors (i.e., age, gender, ethnicity, work history), habits, and periodontitis severity?
2. Is there any significant difference in the association between systematic diseases (conditions), clinical parameters, and periodontitis severity?
3. Is there any significant difference in the binary logistic regression for assessing risk factors of periodontitis?

#### **1.5 Research hypothesis**

1. There is a significant difference in the association between socio-demographic factors (i.e., age, gender, ethnicity, work history), habits, and periodontitis severity.
2. There is a significant difference in the association between systematic diseases (conditions), clinical parameters, and periodontitis severity.
3. There is a significant difference in the binary logistic regression for assessing risk factors of periodontitis.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Periodontal disease

Periodontal diseases are characterized by inflammatory responses and the ongoing destruction of the tissues surrounding and supporting the teeth. These tissues include the gingiva, periodontal ligament, cementum, and alveolar bone. The periodontal disease consists of inflammation in the gingiva (gingivitis) and the periodontium (Periodontitis). The plaque is the initial reason for both conditions, which further depends on the individual's immune and inflammatory responses. Furthermore, several risk factors like medications, alcohol, smoking, age and gender of the individual, and the underlying systemic diseases modify the Periodontal disease. (Madiba & Bhayat, 2018).

Gingivitis is the initial stage of periodontal disease and is characterized by red, swollen, bleeding gums, pain, and discomfort. If left untreated, gingivitis can proceed to periodontitis, which results in the loss of periodontal attachment and supporting bone (WHO, 2022). Periodontitis can be defined as gingival inflammation at sites with a pathological loss of attachment. This loss of attachment contributes to pocket formation. The rate of progression of periodontitis is neither predictable nor steady (WHO, 2022).

Chronic periodontitis is classified into two conditions: generalized and localized. Generalized chronic periodontitis is the name given to the ailment when it affects more than ten teeth in a person's dentition, whereas localized chronic periodontitis only affects fewer than ten. Dental plaque, influenced by environmental variables, microbial biofilm, and hereditary factors, gingivitis and chronic

periodontitis proceed. Periodontal diseases are widespread in developing countries like India. Periodontal disease is expected because of poor oral health knowledge, low socioeconomic level, inappropriate or no dental appointments, and low literacy (Karobari *et al.*, 2022).

Over the past 50 years, there has been a significant change in the global epidemiology of periodontal disease, driven by new measurement techniques and our growing understanding of the disease's natural history and distribution (Dye, 2012). A recent study on the global burden of periodontal diseases in 204 countries revealed that in 2019 there were 1,087,367,744.0 instances of periodontal diseases worldwide—nearly twice as many as in 1990. About 91,518,820.6 new cases were registered. Additionally, from 1990 to 2019, the growth rate in age-standardized incidence, age-standardized prevalence, and age-standardized rates has accelerated (Zhang *et al.*, 2022).

Studies show that periodontitis is more common in developing nations than in wealthy countries. In a rural Brazilian community, the prevalence of periodontitis ranged from 24.4% to 83%. (Corraini *et al.*, 2008; Scordamaglio *et al.*, 2009), And it varied from 92% to 100% in the Thai population (Dowsett *et al.*, 2001). In the Vietnamese study population, at least one site had attachment loss in about 100% of cases (Do *et al.*, 2003). the prevalence of periodontitis among adults in Malaysia that was gathered through the National Oral Health survey showed that the distribution of moderate periodontitis was 30.3% and severe periodontitis was 18.2%, respectively. It also signifies that the economic burden in managing periodontal diseases was estimated on national levels was about 29.1 billion which accounts for 3.83% of gross domestic product (Mohd Dom *et al.*, 2016).

Periodontal disease affects more people than any other form of oral illness. Periodontal disease is common in both industrialized and developing countries. 20-50% of the world's population is potentially at risk from this disease, primarily affecting people living in developing countries (Karobari *et al.*, 2022). Periodontal disease is a severe public health issue because of its widespread occurrence among people of all ages (Kandhan & Rajasekar, 2020). The prevalence of periodontal disease globally is predicted to rise in the following years, owing to an ageing population and increasing natural tooth retention due to a significant decrease in tooth loss among the elderly (Tonetti *et al.*, 2017a). According to the Global Burden of Disease Study conducted in 2016, severe periodontal disease ranked as the eleventh most widespread condition in the world. It is one of the most common reasons for tooth loss, which can negatively affect chewing, appearance, sense of self-worth, and overall quality of life (Nazir *et al.*, 2020b).

## **2.2 Etiology and pathogenesis of periodontal disease**

According to the current concept, bacterial infection is believed to be the primary cause of periodontitis. The presence of disease-causing microorganisms in dental plaque biofilm is thought to be the root cause of periodontitis (Ray, 2022). The pathogenesis of periodontitis is brought on by the host's reaction to the bacterial insult, which leads to the development of adhesion molecules, an increase in capillary permeability, and the movement of PMNs from the junctional epithelium to the gingival sulcus (Ford *et al.*, 2010). Improper oral hygiene habits are crucial in the onset and progression of periodontal diseases. Poor oral hygiene procedures can cause germs and plaque to build up on the teeth, causing gingivitis and possibly leading to periodontitis. The literature shows this link, with higher dental plaque accumulation

directly linked to increased periodontal disease prevalence and severity (Gasner & Schure, 2020).

It is estimated that about 90% of human body cells are microbes living on the skin and other exposed parts of the body. Microbes colonize the human body in various patterns on any surface exposed to the outside world. Because of their unique biological and physical characteristics, the skin, oral, digestive, and reproductive systems' microflora have individual communities. Dental plaque biofilm and the host immune response have evolved to thrive in the mouth's unique environment and ecology (Aas *et al.*, 2005; Khadka *et al.*, 2021; Wilson, 2005). Up to 500 bacterial species can be found in a single biofilm, making up the diverse and complex microbial ecosystems that cause periodontitis. Supragingival plaque and subgingival plaque are two types of dental plaque. Tooth surface plaque, pocket gap plaque, and soft pocket wall plaque are the three prominent locations for dental plaque (Botero Zuluaga *et al.*, 2012; Marsh & Zaura, 2017). Periodontitis has been linked to several bacterial species that live in a biofilm on tooth surfaces. These include *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis*, *Prevotella intermedia*, *Fusobacterium nucleatum*, *Bacteroides forsythus*, *non-classified spirochetes*, *Peptostreptococcus micros*, *Campylobacter rectus*, *Eubacterium nodatum*, *Treponema denticola*, *Streptococcus intermedia*, *Prevotella nigrescens*, and *Eikenella corrodens* (Darveau *et al.*, 1997; Haffajee, 1994; Madiba & Bhayat, 2018). Periodontitis is typically thought to be the result of a suboptimal host-parasite relationship. For over a century, scientists have debated the relative role of bacteria, local factors that aid their proliferation, and systemic effects in the etiology of periodontal disorders. Longitudinal research confirms an environmental, behavioral, or biological element as a periodontal disease risk factor. It enhances the likelihood of a disease arising if it is

present. If it does not exist, the probability of this happening decreases (Cho *et al.*, 2020; Timmerman & Van der Weijden, 2006). Etiopathology is explained in Figure 2.1, modified from Clarke & Hirsch (1995).



Figure 2.1 Etiopathology of periodontal disease

## **2.3 Risk factors of periodontal disease**

There are many periodontitis risk factors, including modifiable and non-modifiable risk factors.

### **2.3.1 Non-modifiable risk factors**

Age, gender, and ethnicity are non-modifiable periodontitis risk factors. In oral tissues, human ageing causes histological and clinical changes. These changes must be understood to distinguish pathological conditions from varied physiology of oral tissue (Hebling, 2012). Many factors influence whether a person develops a chronic disease. Most diseases are caused by exposure to bacteria and viruses, while inflammation plays a crucial role in many age-related diseases and can affect various organs (Persson, 2006). Systemic diseases become more common as people get older. Literature has found a link between periodontal infection and overall health (Genco & Williams, 2010; Williams *et al.*, 2008). Stroke, cardiovascular disease, depression, and aspiration pneumonia are among the dangers. Biological evidence is accumulating to describe how periodontitis can affect overall health. As a result, good oral health may be necessary for successful ageing in general (Persson, 2006).

According to a survey conducted by Nguyen *et al.* (2021) aimed to see if periodontal disease influences biological ageing over the course of a person's life span. The survey was performed by assessing the prevalence of periodontitis in the adult US population, which was a part of the National Health and Nutrition Examination Survey (NHANES), which has been collecting data on people across the country every two years since 1971. The NHANES 2001-2002 was used to test the hypothesis. The findings showed that periodontitis has a significant impact on life span. The authors concluded that the results pave the way for future research into the effects of

periodontitis on biological ageing parameters and possible intervention strategies for periodontitis in driving unhealthy ageing processes.

A cross-sectional study was carried out in Indonesia by Tadjoeidin *et al.* (2017) To determine the prevalence of periodontal disease and the relationship between age and periodontal disease among various groups. The medical records were checked for ten years, from 2004-2014. A positive correlation was reported between age and periodontal disease. Chronic periodontitis is the most common type of periodontal disease. Despite a positive weak correlation, periodontal disease tends to correlate with age. This research could reveal the age at which disease onset occurs and the disease's progression pattern.

Destructive periodontitis is more common in men than women, a trend that may be attributable to the fact that men, on average, consume more alcohol and tobacco than women do (Watt & Petersen, 2012). A Brazilian study found that the probability of periodontal damage among groups of black people was three times higher than among whites of the same age compared to the general population. The prevalence and severity of PD also vary within countries, and not just between them, depending on the racial or ethnic group (Gilbert, 2005; Petersen & Ogawa, 2005).

Inequality has a moral and ethical component. It refers to differences that are not only undesirable and preventable but also regarded as unfair and unjust. In a well-balanced community, differences produced by biological phenomena (such as ageing) are natural and unavoidable. However, some inequalities can be avoided and are unacceptable in modern society, and socioeconomic differences mainly generate them. Differences in the prevalence or incidence of oral health among people of higher and lower socioeconomic classes are called socioeconomic disparities in oral health



(Gautam *et al.*, 2012). Socioeconomic variables include income, occupation, education, unemployment, social class, living circumstances, and race. Lower socioeconomic position (SEP) is a well-identified risk indicator for periodontitis. The role of education, employment income, wealth, and site of living as indices of SEP has been most often investigated in studies on the relationships between SEP and periodontitis. It has also been observed that the higher the relative SEP, the better the health (Schuch *et al.*, 2017). In previous research, individuals from lower socioeconomic classes in the Korean population were found to be significantly more likely to qualify for periodontal therapy (Kim *et al.*, 2014). Another study conducted in Kota Bahru, Malaysia, discovered an association between periodontal disease and age, but no association was found between the prevalence of periodontal disease and other socio-demographic parameters (Alsanabani *et al.*, 2012). The risk factors of periodontal disease are shown in Figure 2.2

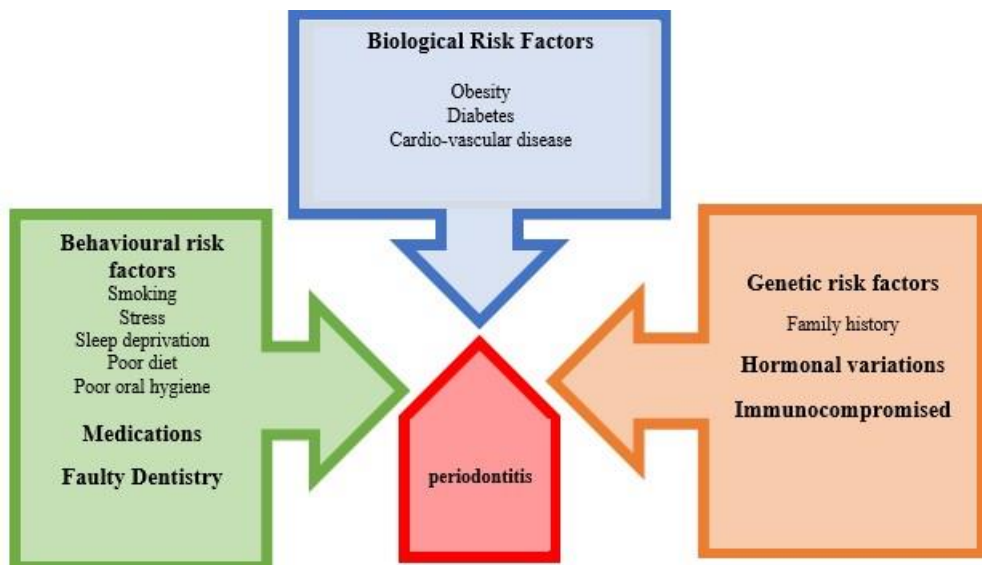


Figure 2.2 Risk factors of periodontal disease adapted from the American Academy of Periodontal Diseases.

### **2.3.2 Modifiable risk factors**

#### **2.3.2(a) Smoking**

Smoking is a behaviour that is related to a considerably higher risk of developing cardiovascular illnesses, lung diseases, and oral disorders such as periodontitis, tooth decay, and oral malignancies. People who smoke have a significantly increased risk of developing periodontitis and alveolar bone loss (Bergström, 2004). Smoke is a diverse chemical combination that contains around 7000 chemical components. Tobacco use has been linked to the development of periodontitis (Newman *et al.*, 2011). There is growing evidence that smokers have a greater rate of periodontal disease. Tobacco smoking causes significant damage to periodontal tissues and accelerates the course of periodontal disease (Zini *et al.*, 2011). Cigarette smoking is a significant cause of chronic periodontitis; compared to non-smokers, smoking is linked to increased tooth loss, worsened bone and attachment loss, and broader periodontal pockets in chronic periodontitis (Eke *et al.*, 2016b). Similarly, smokers with periodontal disease appear to have fewer symptoms of clinical inflammation and gingival bleeding. This might be due to nicotine's local vasoconstriction, which reduces blood flow, edema, and inflammation-related clinical symptoms (BERGSTRÖM, 1990).

According to Tomar and Asma (2000), approximately 50% of individuals with periodontitis are smokers. Tobacco use is an established risk factor for noncommunicable chronic diseases. Smoking-related disorders have become one of the world's top causes of death (Organization, 2014). There has been a change in smoking behaviour during the last decade. Because smoking is more common among young people, an increasing number of people may develop significant health

problems and periodontal disease at a very young age. This would be a significant public health concern. Smoking was prevalent among older people (those aged 60 and up) at 39.2%. In Malaysia, smoking is quite common (39.2%) among older guys, which is greater than in the United States (12.0%) and China (26.0 %) (Hum *et al.*, 2016). 15% of hospitalizations and 35% of deaths are related to smoking. In Malaysia, on an annual basis, there are many inpatient hospital fatalities. Twenty thousand people die yearly from tobacco use (Chan *et al.*, 2015).

Cigarette smoke is a complicated chemical mixture that contains around 7000 chemical components. According to several studies, it is reported that smokers are 2.6 to 6 times more likely than non-smokers to develop periodontal disease, and the effects of smoking on periodontal disease have a dose-response connection. Through a variety of mechanisms, smoking has a negative impact on periodontal tissues and the advancement of periodontal disease. In cigarette smokers, increased perio-pathogenic bacteria (e.g., *T. forsythia*, *P. gingivalis*, *A. actinomycetemcomitans*, and *T. denticola*) in subgingival plaque, irregular neutrophil chemotaxis, and phagocytosis, raised pro-inflammatory cytokines, proteolytic enzymes had been reported among the cigarette smokers. (Smoking *et al.*, 2010; Research and Periodontology, 1999; Zambon *et al.*, 1996).

A study was done by Bergström *et al.* (2000) among the Sweden population to investigate the impact of smoking on periodontitis in a specific group before and after a 10year follow-up interval. The frequency of periodontally diseased sites (probing depth  $\geq 4$  mm), gingival bleeding, and periodontal bone height were the clinical and radiographic characteristics used to assess the individual's periodontal health condition. A standard plaque index was used to determine the oral hygiene standard. Smoking was related to a substantial increase in bone height after correcting for age

and baseline bone height, with statistically significant differences between current and non-smokers and current and former smokers. Further, adjusted for age, the 10-year bone height loss increased significantly with increasing smoking exposure. The authors concluded that continuous smoking compromises periodontal health, as evidenced by a rise in periodontally diseased sites together with a loss of periodontal bone height when compared to non-smokers whose periodontal health remained unaffected over the 10-year study period (Bergström *et al.*, 2000).

Susin *et al.* (2004) conducted a cross-sectional study of the Brazilian population to identify the risk factors for periodontal disease. A multistage probability sampling procedure was used to obtain a representative sample of 853 persons (ages 30 to 103 years). The participants were clinically examined, including six sites per tooth, and an interview utilizing a structured written questionnaire. The persons who were smoking had a significantly higher risk for periodontitis. The authors concluded that there was an increased occurrence of periodontitis among smokers in the Brazilian population, and for managing the high event of attachment loss in this community, a population-based strategy that incorporates the implementation of prevention and health promotion programs targeted at high-risk populations is very desirable (Susin *et al.*, 2004).

### **2.3.2(b) Type II Diabetes**

It is estimated that 451 million people worldwide have type 2 diabetes, and it is anticipated that more than 693 million people will have type 2 diabetes within the next 20 years (Cho *et al.*, 2018). In Malaysia, studies were conducted on a national scale between the years 1996 and 2015. In 2015, the prevalence of diabetes mellitus stood at 17.5%, more than doubling since 1996. Diabetes mellitus was most prevalent

among women, people in their older age, Indians, and urban residents (Tee & Yap, 2017). The presence of dental plaque was found to be the most significant risk factor associated with type 2 diabetes. The reciprocal relationship between periodontitis and type 2 diabetes has been recognized for a very long time. People who have diabetes have a risk of periodontitis that is three times higher than the risk that is faced by people who do not have diabetes (Takeda *et al.*, 2021). The entry of periodontal bacteria and the virulence factors they produce into the microcirculation leads to systemic inflammation. Because of this, the levels of serum C-reactive protein and those of other acute phase reactants and indicators of oxidative stress increase. Biologically reasonable evidence suggests that non-resolving chronic inflammation caused by periodontal disease impacts the management of diabetes [elevated glycosylated hemoglobin levels- HbA1C] by affecting HbA1c levels, beta-cell activity, and insulin resistance. In the opposite direction, a growing body of research suggests that periodontitis deleteriously affects glycemic management in persons with type 2 diabetes (Long *et al.*, 2017; Preshaw *et al.*, 2012).

### **2.3.2(c) Cardiovascular disease**

Both periodontal disease and cardiovascular disease have a high prevalence rate worldwide and contribute significantly to the cost of healthcare everywhere. Numerous epidemiologic and observational studies have shown, in a consistent manner, that periodontal disease is independently related to subclinical and clinical cardiovascular disease across a variety of demographic types (Berlin-Broner *et al.*, 2017). Both disorders have similar risk factors and a common pathophysiology that involves inflammation. Recent evidence from extensive cohort studies has linked periodontitis to an elevated risk of coronary artery disease (CAD) and all-cause

mortality; this link also extended to preclinical cardiovascular disease and stable CAD (Stewart & West, 2016).

### **2.3.2(d) Dental caries**

The majority of the world's population suffers from periodontal disease and caries. Among the numerous etiological factors linked with these two frequent oral disorders, the dental biofilm's bacteria play a crucial role (Durand *et al.*, 2019; Sanz *et al.*, 2017). The pathogen-specific involvement might be able to explain why no link between these two frequent oral disorders has been documented. Despite this, the relationship between dental caries and periodontitis has been the subject of much discussion in scientific literature. Some research has shown that dental caries and periodontal disease have an inverse relationship (Iwano *et al.*, 2010; Sewón *et al.*, 1988; Sioson *et al.*, 2000), and other studies showing a positive relation (Albandar *et al.*, 1995; Ekstrand *et al.*, 1998; Saotome *et al.*, 2006). The presence of common risk factors, such as poor dental hygiene and social and behavioral background, may explain the strong correlation between these two diseases (Sanz *et al.*, 2017).

## **2.4 Epidemiology of periodontal disease**

Epidemiology is a subject that studies the distribution of diseases and health patterns in any given population and, by far, how these states are affected by ethnicity, biology, environment, genetics, and personal behavior. The epidemiology model of periodontal diseases has three fundamental prospects that are, and all individuals are equally at risk of developing severe periodontitis, gingivitis might progress to transform into periodontitis accompanying bone and subsequent tooth loss, and the risk of developing periodontitis increases as age advances (Costa *et al.*, 2012).

Periodontal disease, or periodontitis, is a globally widespread pathology of the human oral cavity (Bostanci & Belibasakis, 2018). It is the most common and mild form of oral/dental disease. Untreated gingival diseases in childhood may lead to severe conditions of periodontal diseases in adulthood (Shivakumar *et al.*, 2009). Gingivitis is the first stage of periodontal disease and is defined as an inflammation of the gingival tissues, with no apical migration of the junctional epithelium beyond the cemento-enamel junction (Fine *et al.*, 2018; Wooton *et al.*, 2018). Gingivitis, a reversible dental plaque-induced inflammation of the gingiva, is a common occurrence in children as young as five years of age, while periodontitis is a bacterial inflammatory disease of the supporting tissues and structures of the teeth, including gingiva, periodontal ligament, cementum, and alveolar bone (Mariotti & Hefti, 2015). Periodontal disease affects up to 90% of the world's population, making it the most prevalent oral illness. According to cross-sectional research, nearly half of all adults in the United States have gingivitis, and up to 80% have had some periodontal disease at some point. Periodontal disease has been linked to an increased incidence in specific demographics (Nazir *et al.*, 2017). Older people, men, and African Americans are among these categories. Severe periodontitis was also linked to lower income and education levels (Borrell *et al.*, 2006; Nazir, 2017; Pihlstrom *et al.*, 2005; Ridgeway, 2000). The disease prevalence is 13–57% worldwide (Kamra *et al.*, 2018). According to the most current Global Burden of disease Study, severe periodontitis, which affects 743 million people globally, is the sixth most common disease. (Tonetti *et al.*, 2017b).

A study published by Tuti Ningseh *et al.* in 2016. This study conducted in Malaysia aims to evaluate the distribution of periodontitis and the economic burden in managing periodontal diseases. It concluded that the prevalence of periodontitis among adults in Malaysia gathered through the National Oral Health survey showed