

## Lifestyle as a Risk Factor of High Periodontitis Prevalence with and without Type 2 Diabetes Mellitus in Surabaya

Titiek Berniyanti<sup>1\*</sup>, Retno Palupi<sup>1</sup>, Dini Setiyowati<sup>1</sup>, Aulia Rahmadhani<sup>1</sup>, Dinda Novia<sup>1</sup>, Novitasari Mira Afanda<sup>1</sup>, Nadya Innasa Khairani<sup>1</sup>, Annisa Zahra Nurlaili<sup>1</sup>, Fidelia Kartikasari<sup>1</sup>

1. Faculty of Dental medicine Universitas Airlangga, Surabaya, Indonesia.

### Abstract

Periodontitis is a chronic inflammation infectious disease of the supporting teeth which is irreversible with destructive characteristics due to failure to eradicate pathogens that attack the sub-gingival epithelium in the biofilm. This disease has the potential to worsen the quality of life, especially life expectancy. Data confirm that diabetes is a major risk factor for periodontitis. Evidence supports a bidirectional relationship between Type 2 Diabetes Mellitus (T2DM) and periodontitis. T2DM increases the risk of periodontitis, and periodontal inflammation negatively impacts on blood sugar control and tooth loss.

This study identified lifestyle as a risk factor for high prevalence of periodontitis with and without T2DM. This study was an analytic observational study with a cross-sectional approach. Measurement of periodontal status was done according to the 2015 World Health Organization's (WHO) Oral Health Basic Methods Survey Standard. During the process, bleeding on probing and pocket depth was measured, and lifestyle was identified using a questionnaire. Data analysis was performed using the Chi-square difference test.

There were significant differences between lifestyles in the four health status groups except oral hygiene in the periodontitis group with periodontitis-type 2 diabetes, diet in the normal group with periodontitis, and exercise in the normal group with periodontitis being relatively similar. Poor oral hygiene, poor diet, and lack of activity are risk factors for T2DM, periodontitis-DM type 2, and without DM type 2.

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### Introduction

Data from the Tambakrejo Primary Healthcare Center of Surabaya in 2018 showed that chronic periodontitis was the fifth most common dental and oral disease, while diabetes mellitus (DM) was ranked as the fourth most common systemic disease. Retrieved from the data on dental and oral health services at health centers, the percentage of patients with chronic periodontitis was 16%, with 5.2% of them also having DM. Periodontitis is an infection-driven inflammatory disease in tooth-supporting tissues characterized by damage to the supporting

structures of the teeth (periodontal ligament and alveolar bone). Moreover, genetics and environmental and behavioral factors are involved in the development of the disease, the exposure of susceptible individuals to its initiation, and the speed of progression. This disease has a high prevalence, and even severe periodontitis occurs in 10-15% of adults. It has a negative impact on the quality of life.<sup>1</sup>

Epidemiological data in the Preshaw's study showed that DM is a major risk factor for periodontitis, and susceptibility to periodontitis increases three times in people with DM. DM is a metabolic disease that is characterized by hyperglycemia due to lack of insulin production, inadequate insulin action, or both.<sup>2</sup> It is the main cause of complications of microvascular disease (retinopathy, nephropathy, neuropathy), which comes unexpectedly. Many of the sufferers are not aware of this disease. By the time they know their condition, complications often occur. It is

#### \*Corresponding author:

Titiek Berniyanti

Dental medicine Universitas Airlangga

Jl Mayjend Prof. Dr. Moestopo No. 47, Surabaya, Indonesia.

E-mail: [titiek-b@fkg.unair.ac.id](mailto:titiek-b@fkg.unair.ac.id)

often called as a silent killer or a secret killer. Symptoms such as easy thirst, frequent urination, sudden weight loss, extreme and repetitive fatigue, blurred vision, and injuries that are difficult to heal can be indicators of high sugar levels.<sup>3</sup>

High blood sugar levels is correlated with the severity of periodontitis. How the two conditions occur cannot be explained in detail, but it involves aspects of the immune system, neutrophil activity, and cytokines. According to Preshaw, evidence to support a two-way relationship between diabetes mellitus and periodontitis. Diabetes mellitus increases the risk of periodontitis, while periodontitis has a negative impact on live blood sugar control.<sup>2,4-6</sup>

There are two types of diabetes: type I insulin dependent (T1DM) and type II non-insulin dependent (T2DM). T1DM occurs due to damage to the Langerhans cells in the pancreas, and thus insulin production is absent. T2DM is more commonly found in patients and characterized by insulin resistance, decreased insulin production, and pancreatic beta cell failure. The main causes of T2DM are bad lifestyle and poor diet.<sup>7,11</sup>

DM is one of the seven diseases i.e., heart disease, stroke, hypertension, eye disorders, kidney disease, and diseases of the oral cavity leading to deaths as complications often arise afterwards.<sup>12</sup>

Lifestyle and economic status are associated with DM. However, there have been few reports on the relationship between these factors and the periodontal condition of diabetics. The association between disease status and lifestyle of DM patients has to do with the clinical features of advanced periodontitis, such as probing depths and severe alveolar bone loss. As many as 57 DM patients were examined in this study. Clinical assessment of probing pocket depth and radiographic alveolar bone loss was performed.<sup>13</sup> Increased physical activity improves insulin sensitivity and glucose metabolism and thus affects incidence of periodontitis.<sup>14</sup> Body mass index has a strong relationship with diabetes and insulin resistance. In obese individuals, the amount of non-esterified fatty acids, glycerol, hormones, cytokines, pro-inflammatory markers, and other substances involved in the development of insulin resistance increased.<sup>15</sup> It is estimated that 80-85% of people with T2DM are overweight. It indicates that people's lifestyles can cause an increased risk for

T2DM. Individuals who have irregular eating patterns have worse blood sugar levels than those who have an irregular diet.

Therefore, this study analyzed periodontitis in patients with and without T2DM in Surabaya. The research outputs can be used to identify effective steps in preventing and reducing the incidence of lifestyle-related periodontitis with or without T2DM among patients in Surabaya, thereby reducing mortality risk and improving their quality of life.

## Materials and methods

### Research Methods

This study was an analytic observational study with a cross-sectional approach. Measurement of periodontal status was done according to the 2015 WHO's Oral Health Basic Methods Survey Standard. It was done by measuring bleeding on probing and pocket depth, while quantifying lifestyle was studied using a questionnaire.

### Research samples

The research sample was respondents who were selected randomly to determine the prevalence of periodontitis with and without DM. Samples were taken using the multistage random sampling technique. The Surabaya area was divided into five parts, namely the Center, North, South, West, and East where the participants were randomly selected from each section according to the population proportions and the age of above 45 years. The control group used were healthy respondents. This study excluded (1) individuals who were taking corticosteroids, antibiotics, and/or non-steroidal anti-inflammatory drugs, or (2) individuals with systemic disorders such as HIV infection, heart disease, hepatitis B, and hepatitis C.

An intra-oral examination was performed using the WHO's periodontal probing and a mouth mirror to assess the participants' pocket, LOA (loss of attachment) and BOP (bleeding on probing). Probing pocket depth was recorded at six sites (mesiofacial, facial, distofacial, mesiolingual, lingual, and distolingual) for each tooth in every subject.

### Data related to lifestyle

The participants were interviewed about the following habits: lifestyle (oral hygiene, dietary habit, and physical activity), financial problems, and age. The data explained the questionnaire to

observe the participants' health history and habits. T2DM.

### Results

Figure 1 shows the highest prevalence of DM and periodontitis is experienced by participants aged less than 60 years. The highest prevalence of periodontitis-DM is among participants aged more than 60 years. The lowest prevalence of health status is experienced by participants with periodontitis-DM at the age of less than 60 years and DM at the age of more than 60 years.

**Figure 1.** Prevalence of participants' health status by age

Figure 2 shows the highest blood sugar levels is mostly experienced by respondents with periodontitis-T2DM (>200)/48.6%. The lowest blood sugar levels are mostly experienced by healthy respondents and respondents with periodontitis (140-200)/18.1%.

**Figure 2.** Distribution of participants' blood sugar levels.

Figure 3 shows the highest prevalence of periodontitis with and without DM is periodontitis-

**Figure 3.** Prevalence of periodontitis with and without DM.

Variable	Diseases Status	Normal	Periodontitis	Type 2 DM	Periodontitis-Type 2 DM
Age	Normal		0.634	0.898	0.004*
	Periodontitis			0.750	0.019*
	Type 2 DM				0.012*
	Type 2 DM-Periodontitis				
Blood Sugar Level	Normal		0.267	0.000*	0.000*
	Periodontitis			0.000*	0.000*
	Type 2 DM				0.405
	Type 2 DM-Periodontitis				
Oral Hygiene	Normal		0.000*	0.008*	0.000*
	Periodontitis			0.015*	0.993
	Type 2 DM				0.013*
	Type 2 DM-Periodontitis				
Diet	Normal		0.523	0.000*	0.001*
	Periodontitis			0.000*	0.000*
	Type 2 DM				0.024*
	Type 2 DM-Periodontitis				
Physical Activity	Normal		0.119	0.000*	0.000*
	Periodontitis			0.000*	0.000*
	Type 2 DM				0.405
	Type 2 DM-Periodontitis				

**Table 1.** Significant differences between age, blood sugar level, lifestyle using the Mann-Whitney test.

Table 1 shows a significant difference in the age variable of the T2DM-periodontitis group, as well as normal, periodontitis, and T2DM groups. There was a significant difference in the blood sugar levels of the T2DM and T2DM-periodontitis groups against the normal and periodontitis groups. There were significant differences in oral hygiene between the normal and periodontitis groups, the T2DM and T2DM-periodontitis groups, and the periodontitis and T2DM groups. There were significant dietary differences in the normal and periodontitis groups against the T2DM and T2DM-periodontitis group, as well as the T2DM group against the T2DM-

periodontitis group. There was a significant difference in physical activity in the normal and periodontitis groups against the T2DM and T2DM-periodontitis groups.

## Discussion

The study was conducted on patients aged over 35 years in accordance with a study at a periodontitis clinic where 262 patients aged over 35 years were treated at Jordan University of Science and Technology had the highest percentage of chronic periodontitis. This study shows that the prevalence of DM and periodontitis was mostly experienced by participants aged less than 60 years, while the prevalence of periodontitis-T2DM was mostly experienced by participants aged more than 60 years. The theory of aging and physiological body function mentions that the body function will experience a decrease with age. Periodontal tissue also tends to experience attachment loss and will result in an increase in the incidence of tooth loss in the elderly.

The older the age, the higher the risk of developing periodontitis with or without T2DM. T2DM is described as a combination of low amounts of insulin production from pancreatic-cells and peripheral insulin resistance.<sup>16,17</sup> With age, associated with a decline in the body's physiological functions, pancreatic beta cells begin to shrink continuously and reduces insulin secretion and receptor sensitivity. Dysfunction of cells is a main factor across the progression from pre-DM to DM. Insulin resistance leads to elevated fatty acids in the plasma, causing decreased glucose transport into the muscle cells, as well as increased fat breakdown, subsequently causing elevated hepatic glucose production.<sup>15</sup>

Insulin resistance and pancreatic-cell dysfunction must occur simultaneously for T2DM to develop. Anyone who is overweight and/or obese has some kinds of insulin resistance as the large number of fat cells causes the secretion of TNF- $\alpha$  and leptin in the local circulation to increase. TNF- $\alpha$  is a pro-inflammatory cytokine released by macrophages, and it is known for its substantial role in periodontitis-mediated bone loss.<sup>18,19</sup> TNF- $\alpha$  is considered to be a major cytokine involved in the pathogenesis of periodontal disease. Tissue destruction and the erosive reaction in periodontitis T2DM only

develops in individuals who lack sufficient insulin secretion to match the degree of insulin resistance. Insulin in those people may be high, yet not enough to normalize the level of glycemia.<sup>11</sup> Dysfunction of cells is a main factor across the progression from pre-diabetes to diabetes. After the progression from normal glucose tolerance to abnormal glucose tolerance, postprandial blood glucose levels increase.

Poor oral hygiene can cause two to five times risk of developing periodontitis. In this study, oral hygiene was measured from debris and the presence of tartar, and visits to the dentist. It revealed 75% of patients with periodontitis-T2DM had poor oral hygiene status. A similar result of another study stated that proper brushing time and visits to the dentist could reduce 34% and 32% experience periodontitis. Oral hygiene is a bigger risk factor for periodontitis than diabetes mellitus and smoking.<sup>12</sup>

T2DM causes a decrease in the number or quality of insulin receptors or resistance in peripheral tissues, thereby resulting in ineffective insulin action or impaired insulin affinity. The reduced quality of insulin receptors prevents glucose from entering cells, disrupting the function of mitochondria in producing ATP as a cell energy source. Disrupted mitochondrial function affects neutrophil apoptosis in the autophagic process, disrupts macrophage migration, and increases pro-inflammatory cytokines, namely TNF- $\alpha$  and IL-6 produced by pro-inflammatory macrophages or M1.<sup>13,14</sup> Increased blood glucose levels (hyperglycemia) in people with T2DM cause complications which are characterized by the occurrence of increased advanced glycation end-product (AGE) levels in plasma and tissues. Cytokine secretion and synthesis, mediated by the presence of periodontal infection, amplify the magnitude of the AGEs-mediated cytokine response and vice versa. The formed AGEs-products can occur in proteins, lipids, and nucleic acids. The hyperglycemic state will create AGEs, which then interact with RAGE on the endothelium, causing oxidative stress, and thus blood vessel disorders in periodontal tissues will occur. Blood vessel disorders will disrupt the distribution of nutrients and oxygen in the periodontal tissues, which leads to anaerobic gram-negative bacteria as commensal bacteria in periodontal pockets, becoming more pathogenic. Disorders of blood

vessels will also affect the disposal of metabolic waste in the periodontal tissue, leading to toxicity of the periodontal and gingival tissues; therefore, people with T2DM are more susceptible to periodontitis. In this study, there were more T2DM patients with periodontitis than without periodontitis.

Physical activity is known to have an effect on the incidence of periodontitis with or without T2DM.<sup>15,20-22</sup> Regular exercise can reduce the risk of periodontitis by 16%. In this study, it was found that physical activity had a significant relationship with the incidence of disease with a p-value of less than 0.05. This is consistent with a previous study stating that a lifestyle included 150 minutes of physical activity a week reduced the risk of developing impaired glucose tolerance (IGT) for T2DM by 58%.<sup>17</sup> This is also supported by other studies discovering that diet alone, exercise alone, and a combination of diet and exercise are equally effective in reducing the progression from IGT to diabetes. Therefore, all of these findings are firmly consistent with the evidence that increased physical activity have an influence on the incidence of T2DM.

## Conclusions

Periodontitis and T2DM are influenced and exacerbated by various factors such as age, diet, oral hygiene, and physical activity. Periodontitis and T2DM are interrelated diseases, and the prevention of the two diseases can be done by improving lifestyles. For example, patients should have better diet, prevent obesity, maintain oral hygiene, and do regular physical activity. All of these efforts will improve the quality of life.

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## Declaration of Interest

The authors declare that there are no conflicts of interest.

## Ethical policy and institutional review board statement

This research was approved by the Ethical Committee of Faculty of Dental Medicine, Universitas Airlangga (No. 187/HRECC.FODM/IV/2021).

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