The Severity of Periodontitis in Elderly Patients with Type 2 Diabetes Mellitus: A Community-Based Study

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Abstract

Objective Indonesia is one of the top five countries with the highest prevalence of diabetes mellitus (DM). There were 18 million DM patients in 2020, and this number has doubled in has doubled in 2022. The main complication of DM in the oral cavity is periodontitis. Periodontitis and DM have a bidirectional relationship. Controlling the severity of both diseases can improve the quality of life of DM patients. The aim of this study is to determine the severity of periodontitis in older people with type 2 DM.

Material and Methods This research is observational with a cross-sectional design. The research subjects were 263 patients aged $\geq$ 60 years, taken using a purposive sampling technique. The diagnosis and severity of periodontitis were based on the European Federation of Periodontology (EFP) and the American Academy of Periodontology (AAP) with the Centers for Disease Control and Prevention (CDC), using the clinical attachment loss (CAL) and probing depth (PD) clinical parameters. The diagnosis of DM was established by measuring HbA1c. Descriptive statistics was used to describe the distribution of severity of periodontitis.

Results In total, 42 people (16%) in this study did not experience periodontitis, and 221 people (84%) experienced periodontitis with 4.5% of the study population suffering from mild periodontitis, 21.3% moderate periodontitis, and 74.2% severe periodontitis. The results of this study indicated that severe periodontitis was the most common category in patients with type 2 DM. Severe periodontitis is the most common type of periodontitis at all levels of age, occupation, and education. It was found most commonly among those aged 60 to 65 years, housewives, and those with elementary education level with moderate or poor oral hygiene.

Conclusion Almost all respondents who suffered from type 2 DM experienced periodontitis, severe periodontitis being most common category at all age levels, occupations, education, and oral hygiene status. The severity of periodontitis in this study tended to be due to high HbA1c levels.

Keywords
- elderly
- type 2 diabetes mellitus
- severity of periodontitis

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Introduction

Type 2 diabetes mellitus (DM) has a significant financial impact on the society, the health care system, and the general public. It imposes a considerable economic burden, which most directly affects the patients in low- and lower-middle-income countries.[1] Age as a confounding factor or direct determinant of a disease is a key variable in determining the diagnosis, etiology, and intervention in research related to caries and periodontitis. Old age increases the risk of periodontitis caused by immune system dysregulation, decreased type 1 collagen, and decreased wound healing response.[2]

Indonesia is one of the top five countries with the highest prevalence of DM. There were 18 million DM patients in Indonesia in 2020, and this has doubled within 2 years. The main complication of DM in the oral cavity is periodontitis.[3] Periodontitis is an infectious disease caused by specific bacteria in the dental plaque biofilm. In susceptible individuals, it causes damage to the periodontal ligament and alveolar bone.[4] The prevalence of periodontitis in the world population is around 20 to 50%, which increases by 44% in older people. Patients with type 2 DM with severe periodontitis have a three times greater mortality risk.[5] DM and periodontitis have a bidirectional relationship. Hyperglycemia causes the formation of advanced glycation end products (AGEs), which are highly oxidant compounds. These bind to receptors for AGEs (RAGE) on the endothelium to cause oxidative stress and disruption of the blood vessels of the periodontal tissue. When this happens, inflammatory mediators such as tumor necrotizing factors-alpha (TNF-α), interleukin-6 (IL-6), and interleukin-1 (IL-1) are increased. These inflammatory mediators have important effects on lipid and glucose metabolism, namely, as insulin antagonists, which increase blood sugar levels, thereby exacerbating hyperglycemia in DM patients.[6]

Periodontitis is a chronic inflammatory disease with the highest prevalence among the elderly. The prevalence and severity of periodontitis increase with age.[7] The diagnosis of periodontitis is established based on the presence of a periodontal pocket, often measured using probing depth (PD) and clinical attachment loss (CAL), as well as the radiological examination of alveolar bone damage. Measurement of CAL is the gold standard for periodontitis. CAL measurements are more accurate in representing the history and progression of periodontitis than PD. It is commonly used in clinical trials and epidemiological studies.[8] Periodontitis case definitions were established based on the case definition proposed by the European Federation of Periodontology (EFP), American Association of Periodontology (AAP), and Centers for Disease Control and Prevention (CDC). This case definition has been widely accepted and used in both clinical and epidemiological studies. Respondents were declared to have periodontitis if there was interdental CAL 2 in the teeth that were not adjacent or if there was CAL $\geq$3 mm with PD greater than 3 mm in 2 or more teeth. The severity of periodontitis is defined based on interdental CAL. Interdental CAL 1 to 2 mm was considered mild, interdental CAL 2 to 4 mm was considered moderate, and interdental CAL $\geq$5 mm was considered severe.[9]

Materials and Methods

Research Subject Determination

Respondents were selected from primary health centers and clinics in Yogyakarta using a purposive sampling technique, namely, 263 type 2 DM patients aged ≥60 years s with at least 6 teeth and experiencing periodontitis. The ethical feasibility of the research was approved by the Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Gadjah Mada University.

Diabetes Mellitus Diagnosis

The diagnosis of DM in this study was made by examining the HbA1c levels. The HbA1c value limit based on the American Diabetes Association (ADA) is ≥6.5%. The HbA1c examination utilized the National Glycohemoglobin Standardization Program (NSGP) technique, carried out by a health analyst from the Yogyakarta CITO Laboratory.

Definition of Periodontitis Case

Periodontitis case definition was established by consensus in 2018 by the EFP and the AAP in collaboration with the CDC, which is widely accepted and used. Probing depth and CAL measurements were performed on all teeth (full mouth) using a standardized periodontal probe (WHO's periodontal probe) on six surfaces of the examined dentition: mesio-vestibular, vestibular, disto-vestibular, mesio-oral, oral, and disto-oral.[10] PD is the distance from the gingival margin to the bottom of the gingival sulcus or periodontal pocket, while CAL is the distance from the cementoenamel junction (CEJ) to the bottom of the periodontal sulcus or pocket.

The severity of periodontitis is defined based on interdental CAL (European Federation of Periodontology, American Academy of Periodontology, Center of Disease Control and Prevention, 2018):

- Interdental CAL 1 to 2 mm (stage 1, *mild*).
- Interdental CAL 2 to 4 mm (stage 2, *moderate*).
- Interdental CAL $\geq$5 mm (stages 3 and 4, *severe*).

The examination was carried out by four dentists. Calibration and validation related to PD and CAL measurements by the four dentists were conducted using audiovisual media as well as 10 pictorial questions about probing the periodontal tissue and reading the results, followed by a simulation of CAL and PD examination on the tooth model. These observers measured the periodontal sulcus or pocket on the artificial tooth and gums using a WHO periodontal probe. The results were analyzed using the Spearman correlation test to determine the reliability of the measurements, with a correlation coefficient of 0.76 ($p = 0.01$).

Oral hygiene was measured using the Simplified Oral Hygiene Index (OHI-S) and was carried out by four dentists. Dental and oral hygiene status was divided into three categories: good (0–1.2), moderate (1.3–3.0), and poor (3.1–6).

Table 1 Characteristics of respondents based on periodontitis severity

Characteristics	Periodontitis severity				
	Normal	Mild	Moderate	Severe	Total
Age (y)					
60–65	25	8	14	82	129
66–69	8	1	11	38	58
70–75	6	1	13	30	50
76–79	2	0	6	9	17
80–85	1	0	3	5	9
Gender					
Female	25	9	29	97	160
Male	17	1	18	67	103
Occupation					
Retired	14	2	13	39	68
Farmer	3	0	4	11	18
Housewife	11	0	9	47	67
Entrepreneur	12	7	18	48	85
Laborer	2	1	3	19	25
Education level					
None	5	2	9	22	38
Elementary School	12	4	13	53	82
Junior High School	7	0	7	20	34
Senior High School	8	3	11	44	66
Higher Education	10	1	7	25	43
Smoking Habit					
Yes	39	9	43	149	240
No	3	1	4	15	23
OHI-S					
Good	4	0	4	18	26
Moderate	27	7	35	101	170
Poor	11	3	8	45	67

Abbreviation: OHI-S, Simplified Oral Hygiene Index.

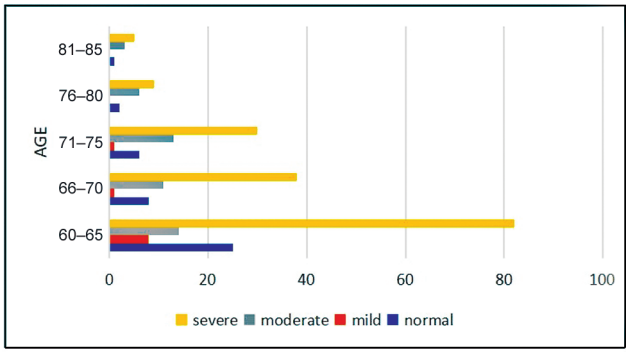

Fig. 1 The proportion of periodontitis severity levels by age.

Statistical Analysis

Descriptive statistical analysis was used to quantify the severity of periodontitis based on the following variables: age, education, occupation, smoking, oral hygiene, and HbA1c levels. The obtained data are presented in statistical analysis section ►**Table 1** and ►**Figs. 1–234567**.

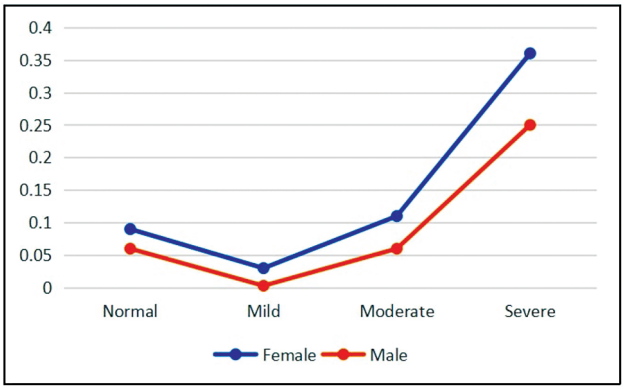

Fig. 2 The proportion of periodontitis severity by gender.

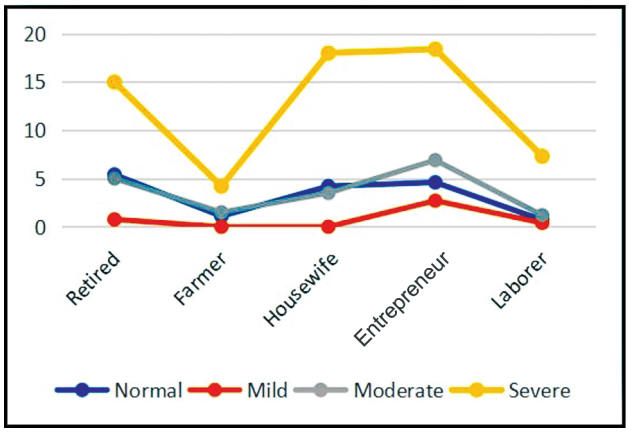

Fig. 3 The proportion of periodontitis severity level by occupation.

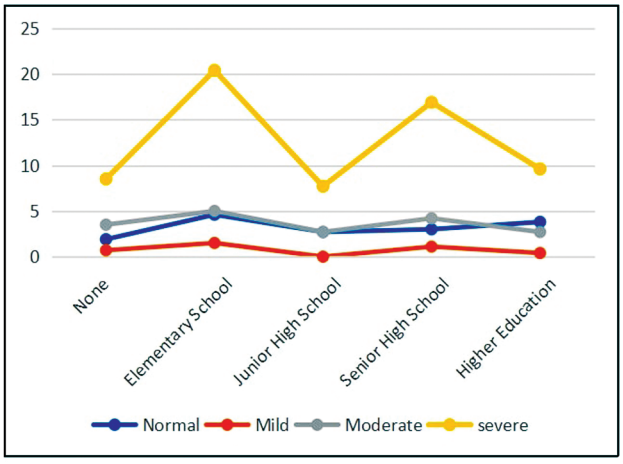

Fig. 4 The proportion of periodontitis severity level by education level.

Result

Almost all of the study participants (221 people) with DM had periodontitis, 4.5% having mild periodontitis, 21.3% having moderate periodontitis, and 74.2% having severe periodontitis.

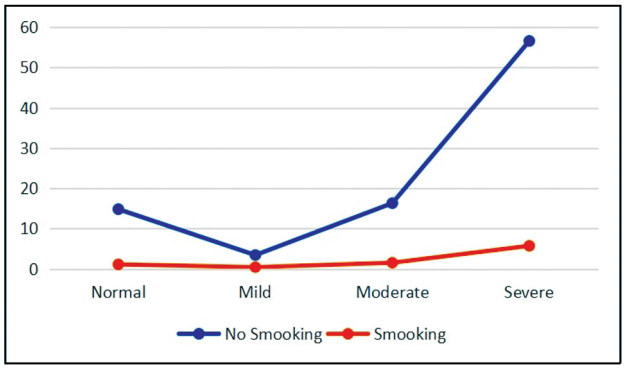

Fig. 5 The proportion of periodontitis severity by smoking habits.

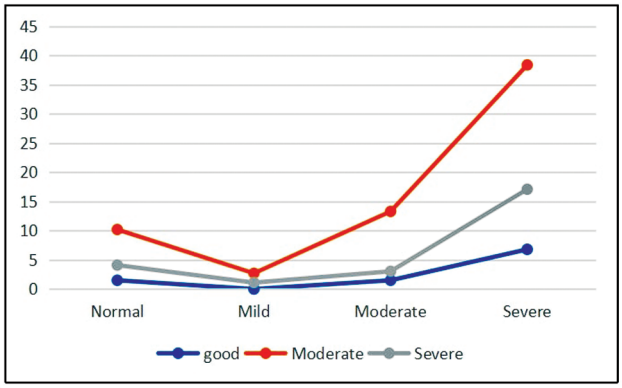

Fig. 6 The proportion of periodontitis severity by oral hygiene status.

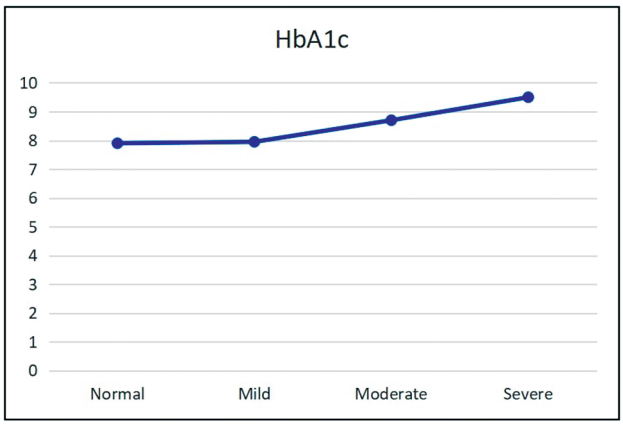

Fig. 7 Periodontitis severity level based on average HbA1c value.

Discussion

Almost all respondents who suffered from DM in this study experienced periodontitis; 42 people (16%) did not experience periodontitis, and 221 people (84%) experienced periodontitis with 4.5% of the study population suffering from mild periodontitis, 21.3% moderate periodontitis, and 74.2% severe periodontitis. The results of this study indicated that most patients with type 2 DM suffered from severe periodontitis. most common type of periodontitis at all levels of age, occupation, and education (►**Figs. 2**–**4**). It was found most commonly among those aged 60 to 65 years, housewives, and those with elementary education level with moderate or poor oral hygiene. DM and periodontitis are chronic diseases that occur most commonly the elderly, especially those over the age of 65 years.[11] DM risk factors are interactions between genetic and metabolic factors. Ethnicity, family history of DM, and gestational history of DM, combined with older age, obesity, unhealthy diet, physical activity and smoking, can increase the risk of DM.[12] Aging is associated with the incidence of periodontal disease. The severity of periodontal disease in the elderly is caused by cumulative destruction rather than a result of increased rate of destruction. Socioeconomic status, alcohol consumption, nutrition, and stress levels are associated with periodontal status, although this relationship has not been clearly established.[13] The prevalence of DM increases with age. Old age, obesity, and low activity are risk factors for DM. The highest prevalence is in older men with high levels of education and obesity.[14] One of the effects of aging and the use of drugs is xerostomia. Xerostomia has been associated with increasing age, in line with the aging process, with a global prevalence of 30% in those aged 65 years and above. Xerostomia causes a decrease in oral self-cleansing and oral hygiene status, thereby increasing the risk factors of gingivitis and periodontitis.[15] Severe periodontitis is more common among respondents who do not smoke (►**Fig. 5**). Most of the respondents in this study had quit smoking more than 5 years ago. Smoking was not a significant risk factor for the incidence of periodontal attachment loss over 5 years among South Australians aged ≥60 years.[11] Previous studies found smoking had a negative impact on periodontal health. Cross-sectional and longitudinal studies revealed that increased smoking habits also increases the risk of CAL and alveolar bone damage. Smokers who have stopped smoking for more than 2 years have a lower risk of CAL than current smokers. The odds ratio for developing periodontitis disease in former smokers is 1.68, while in current smokers, it is 3.97. The development of periodontal disease also depends on the smoking dose. In vitro studies revealed changes in cytokine and proteolytic profiles in gingival sulcus fluid and in Cyclooxygenase-2 (COX-2) messenger RNA (mRNA) expression in gingival fibroblast tissue in smokers. However, until now, it has not been explained how the mechanism of smoking can affect periodontal disease.[13] Age, gender, smoking, and level of oral hygiene are risk factors for periodontitis. A previous study indicated a significant correlation between smoking habit and healing time of apical periodontitis. Smoking may be a modulating factor that inhibits periapical healing.[16] There is a statistically significant relationship between the sociodemographic factors and behavioral habits in periodontal status, increasing the severity of periodontal disease with decreasing socioeconomic levels, old age, tobacco use, and gender.[17]

Severe periodontitis was more common in respondents with moderate and poor oral hygiene status (►**Fig. 6**). Dentogingival plaque accumulation increases with age. Gingival recession and exposed root surfaces are sites of plaque accumulation. The composition of the supragingival bacterial plaque is almost the same as that of the normal flora in the oral cavity, while the subgingival plaque is more dominated by *Pseudomonas*. The prevalence of *Porphyromonas gingivalis*,

Tannerella forsythia, *Treponema denticola*, *Aggregatibacter actinomycetemcomitans*, and *Prevotella intermedia* increased at the age of 60 to 75 years. Laboratory research demonstrated that with increasing age there would be changes in the expression of proinflammatory mediators and *MHC II gene expression*. These changes are related to the pathology of periodontal disease or antimicrobial function.[7]

Severe periodontitis tends to occur in respondents with high HbA1c values (≥6.5; ►**Fig. 7**). The HbA1c test is accurate and easy to administer. It is an effective tool for diagnosing DM, especially in low- to moderate-income countries with hard-to-reach populations. The results are readily available. The HbA1c test has been approved for the diagnosis of DM in most countries worldwide, although the cut-off value is still debatable.[18] The criteria for diagnosing DM, according to the American Diabetes Association, are HbA1c levels ≥6.5% or fasting plasma glucose levels ≥126 mg/dL or random plasma glucose levels ≥200 mg/dL or patients with classic symptoms of hyperglycemia or hyperglycemia crisis with random plasma glucose levels ≥200 mg/dL. The results of a systematic review suggested that HbA1c and fasting blood glucose levels are equally effective screening tools for detecting type 2 DM. Several studies revealed that HbA1c has less intraindividual variation and can better predict micro- and macrovascular complications.[19] In relation to it, there is a relationship between the HbA1c value and the severity of periodontitis; the higher the HbA1c value is, the higher the periodontitis severity will be. It proves a relationship between poor glycemic control and the parameters of periodontal disease. Odds ratios include 2.8 to 3.4 between type 2 DM patients and non-diabetics. Furthermore, longitudinal studies revealed that the increased risk of periodontal tissue damage in patients with type 2 DM compared to nondiabetics is 4.2.[13] Periodontitis affects the onset and development of DM disease.[20]

All prospective studies included in the systematic reviews reported a positive association between high glucose levels and the onset and development of periodontitis. There was an adequate 86% increase in the incidence or risk of developing periodontitis in uncontrolled diabetes compared with non-DM or people with well-controlled DM. The incidence of periodontitis in uncontrolled DM patients is 86%.[21] Previous research demonstrated that the prevalence of hyperglycemia was very high in the elderly, which was around 12.4%, and the risk factors were a family history of DM, obesity, and age.[22,23] Hyperglycemia can affect the migration and phagocytic activity of mononuclear and polymorphonuclear neutrophil (PMN) cells. Thus, although it is affected by the same bacteria, periodontitis is more progressive in DM patients than in non-DM patients.[24] Alveolar bone loss or periodontal disease is one of the oral complications of DM. The average overall alveolar bone loss prevalence is greater in diabetic patients than in nondiabetic patients. Distribution of moderate and severe alveolar bone loss is higher in diabetic patients than in nondiabetic patients.[25]

Good control of glycated glucose and serum glucose can reduce the level of periodontal tissue damage. Moreover, the treatment of periodontitis impacts metabolic control and reduction of systemic inflammation in patients with type 2 DM.[26,27]

Conclusion

Almost all respondents with type 2 DM had severe periodontitis. Severe periodontitis being the most common category at all age levels, occupation, education and oral hygiene status. The duration of smoking cessation of more than 2 years was an important aspect of periodontitis in type 2 DM patients. The severity of periodontitis in this study was likely caused by high HbA1c level.

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Conflict Interest
None declared.

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