

Risk Indicators for Severe Periodontitis and Level of Oral Health Awareness in Type 2 Diabetic Patients Attending A Tertiary Bangkok Metropolitan Administration Hospital

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Abstract

This cross-sectional study investigated the periodontal status and potential risk indicators for severe periodontitis in type 2 diabetic patients. The oral health knowledge and behaviors of the patients were also evaluated. A systematic random sampling method was used to recruit 290 dentate patients with physician-diagnosed type 2 diabetes mellitus who visited a diabetic center at a Bangkok Metropolitan Administration (BMA) tertiary hospital. Data on socioeconomic, diabetic status, oral health knowledge, and behaviors were collected using a questionnaire. The Periodontal Screening and Recording (PSR) Index was used to assess the periodontal status of the patients. The findings showed that 61.03 % of the diabetic patients had periodontitis (PSR code 3 = 26.89 % and PSR code 4 = 34.14 %). A univariate analysis found that increased age, lower education level, smoking, self-perceived “poor” blood glucose control, diabetes duration of ≥ 5 years, and diabetes complication increased the risk of severe periodontitis (PSR code 4). A multiple regression analysis determined that having primary education (odds ratio: OR = 3.75), being a former smoker (OR = 2.99) or current smoker (OR = 4.06), and a diabetes duration of 5–10 years (OR = 2.17) were significantly associated with severe periodontitis ($p < 0.05$). Only 42.4 % of the patients had “adequate” oral health knowledge, 64.5% had never used interdental cleaning devices, and only 29.7 % went for a dental check-up every six months. Patients with type 2 diabetes at the BMA tertiary hospital had a high prevalence of periodontitis. Significant predictors of severe periodontitis were education level, smoking, and diabetes duration. Furthermore, most of the diabetic patients lacked oral health knowledge and had poor oral health behaviors.

Keywords: Awareness, Diabetes mellitus, Periodontal disease, Risk factors, Thailand

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Introduction

Diabetes mellitus is a noncommunicable disease that represents a major public health problem worldwide. In 2021, 537 million adults suffered from diabetes mellitus;

significantly, three out of four people with diabetes live in low- and middle-income countries.¹ In Thailand, the prevalence of diabetes mellitus increased continuously

from 7.8 % in 2009 to 9.9 % in 2014.² In 2021, 6.1 million people in Thailand were reported to suffer from diabetes mellitus, resulting in Thailand having the fourth-highest number of cases of diabetes mellitus in the Western Pacific Region.³ Type 2 diabetes mellitus is the most common form of the disease, accounting for 90 – 95 % of all cases.⁴

Long-term poor glycemic control may lead to many diabetes complications. Periodontitis has been recognized as the sixth diabetes complication,⁵ apart from retinopathy, neuropathy, nephropathy, and cardiovascular and peripheral vascular disease.⁶ Diabetes mellitus and periodontitis have a bidirectional association,⁷ with diabetics having a higher prevalence and severity of periodontitis than non-diabetics.⁸ Severe periodontitis is also associated with poor glycemic control⁹ and may increase the risk of other diabetic complications.¹⁰ In diabetic patients, periodontitis affects mastication and nutritional status, as well as overall health and quality of life.

A previous meta-analysis of epidemiologic studies showed that the prevalence of periodontitis in all types of diabetics was 68.7 %, ¹¹ while the rates of periodontitis in type 2 diabetic patients varied from 20–95 %, depending on the studies.¹²⁻¹⁴ Risk indicators for periodontitis in diabetic patients include age, gender, level of education, body mass index (BMI), hemoglobin A1C level (HbA1C), duration of diabetes, and diabetic complications.^{12,13,15-18} However, these factors differ among previous studies and remain controversial.

To date, no study has been conducted on periodontal status and associated risk indicators in Thai diabetic patients. Ample evidence exists for the association between periodontitis and diabetes, but data concerning oral health knowledge and awareness remains limited.¹⁹ This study aimed to 1) investigate periodontal status and potential risk indicators for severe periodontitis by analyzing the demographic, socioeconomic, and diabetes-related variables in type 2 diabetic patients, and 2) evaluate the oral health knowledge and behaviors in type 2 diabetic patients. The information obtained can be used as guidelines

for oral health education to promote the optimal management of diabetic patient care.

Materials and methods

The research was approved by the Bangkok Metropolitan Administration Ethical Committee and conducted according to the Declaration of Helsinki and the Belmont Report, and the CIOM and ICH-GCP guidelines (S011h/64_EXP).

Inclusion/exclusion criteria

This cross-sectional study was conducted among dentate patients who visited the diabetic center at the Bangkok Metropolitan Administration (BMA) Taksin Hospital. The inclusion criteria were being 18 – 80 years of age with physician-diagnosed type 2 diabetes mellitus over one year and being literate in the Thai language. Patients who had an intellectual impairment, were not able to cooperate with oral examinations, or did not agree to participate were excluded from the study.

Sample size and sampling method

The sample size was estimated using the Cochran formula. According to a previous study,²⁰ 45 % of diabetic patients had adequate oral health knowledge. At an alpha level of 0.05, this study required 290 participants. Systematic random sampling was used to recruit participants between January and June 2022.

Questionnaire

The researcher developed the questionnaire, which was validated by three experts with PhDs in dental public health and periodontology. Their areas of expertise were research methodology, oral health, and diabetes. Thirty tests were conducted on the participants, with a Cronbach's alpha coefficient (α) of 0.790.²¹ The questionnaire included 49 closed-ended questions and a checklist with alternative statements related to demographic and socioeconomic data, diabetes status, oral health knowledge, oral health behavior, and accessibility to oral health knowledge. The oral health knowledge portion included questions regarding knowledge of periodontal disease,

oral complications, diabetes-periodontitis association, and oral hygiene care methods. For the 18 questions; the answer choices were “Yes,” “No,” and “Don’t know.” One point was scored for the correct answer, while the wrong and don’t know answers resulted in 0 points. The participants were divided into two groups based on their level of knowledge. Those who scored higher than the mean were placed in the “adequate knowledge” group, and those who scored lower than the mean were placed in the “inadequate knowledge” group.²² The latest HbA1C levels of the participants within the last six months and their history of complications were sourced from medical records.

Periodontal examination

The periodontal status of the participants was determined using the Periodontal Screening and Recording (PSR) Index developed by the American Academy of Periodontology (AAP) and the American Dental Association (ADA).²³ The examinations were performed by a periodontist (the researcher) at the dental department of the hospital using a periodontal probe (PCP11.5B, Hu-Friedy® Chicago, IL, USA). The patients were divided into groups based on their highest PSR. A PSR code of ≤ 2 indicated non-periodontitis, a PSR code of ≥ 3 indicated periodontitis, and a PSR code of 4 indicated severe periodontitis. An intra-examiner calibration using Cohen’s Kappa statistic

was conducted before the study with a value greater than 0.90, considered nearly perfect agreement.

Data analysis

The collected data were analyzed using the SPSS statistical package version 26.0. Chi-square test was used as categorical variables to compare the two groups. Univariate and multivariate logistic regression analyses were used to calculate the odds ratios. For continuous variables, an independent *t*-test or analysis of variance (ANOVA) was used to assess the differences between groups. A *p*-value of <0.05 was considered statistically significant.

Results

The mean age of the participants was 57.39 ± 12.17 years (range: 32 – 80 years). The majority (69.7 %) were female, and 98.6 % were of Thai nationality. The average BMI was 27.94 ± 6.14 , while an average HbA1C was 7.46 ± 1.57 %. Of the participants, 61.03 % were classified as PSR ≥ 3 (PSR code 3 = 26.89 % and PSR code 4 = 34.14 %). The demographic and socioeconomic characteristics of the participants and their diabetes status classified by the presence or absence of severe periodontitis are shown in Tables 1 and 2. Results showed significant differences between the two groups in terms of age, level of education, smoking history, diabetes duration, and diabetes complications.

Table 1 Demographic and socioeconomic characteristics classified by the presence or absence of severe periodontitis

Characteristics	Total (n= 290)	PSR ≤ 3 (n=191)	PSR = 4 (n=99)	χ^2	p-value
	n (%)	n (%)	n (%)		
Gender					
Female	202 (69.7)	140 (73.3)	62 (62.6)	3.513	0.061
Male	88 (30.3)	51 (26.7)	37 (37.4)		
Age (years)					
<60	149 (51.4)	109 (57.1)	40 (40.4)	7.248	0.007*
≥ 60	141 (48.6)	82 (42.9)	59 (59.6)		
Income (baht)					
No income	83 (28.6)	47 (24.6)	36 (36.4)	5.837	0.212
<5,000	63 (21.7)	41 (21.5)	22 (22.2)		
5,001–15,000	72 (24.8)	52 (27.2)	20 (20.2)		
15,001–30,000	50 (17.2)	34 (17.8)	16 (16.2)		
>30,000	22 (7.6)	17 (8.9)	5 (5.1)		

Table 1 Demographic and socioeconomic characteristics classified by the presence or absence of severe periodontitis (cont.)

Characteristics	Total	PSR ≤ 3	PSR = 4	χ ²	p-value
	(n= 290)	(n=191)	(n=99)		
	n (%)	n (%)	n (%)		
Level of education					
Primary	125 (43.1)	71 (37.2)	54 (54.5)	14.018	0.007*
Lower secondary	44 (15.2)	31 (16.2)	13 (13.1)		
Upper secondary	49 (16.9)	34 (17.8)	15 (15.2)		
Associate degree	24 (8.3)	14 (7.3)	10 (10.1)		
Bachelor's degree or higher	48 (16.6)	41 (21.5)	7 (7.1)		
Smoking history					
Never smoked	234 (80.7)	166 (86.9)	68 (68.7)	13.980	0.001*
Former smoker	37 (12.8)	17 (8.9)	20 (20.2)		
Current smoker	19 (6.6)	8 (4.2)	11 (11.1)		
Alcohol intake					
Lifetime abstainer	212 (73.1)	144 (75.4)	68 (68.7)	1.848	0.397
Former drinker (No drinking within the last 12 months)	55 (19.0)	32 (16.8)	23 (23.2)		
Current drinker (Drinking ≥ 1 time within the last 12 months)	23 (7.9)	15 (7.9)	8 (8.1)		

Abbreviations: PSR = Periodontal Screening and Recording

Chi-square was used to compare the results of the two groups. A p-value of <0.05 was considered statistically significant.

Table 2 Diabetes-related characteristics of type 2 diabetic patients classified by the presence or absence of severe periodontitis

Characteristics	Total	PSR ≤ 3	PSR = 4	χ ²	p-value
	(n= 290)	(n=191)	(n=99)		
	n (%)	n (%)	n (%)		
BMI					
Normal weight	53 (18.3)	39 (20.4)	14 (14.1)	3.305	0.192
Overweight	38 (13.1)	21 (11.0)	17 (17.2)		
Obese	199 (68.6)	131 (68.6)	68 (68.7)		
Self-perceived blood sugar control					
Good	58 (20.0)	44 (23.0)	14 (14.1)	6.420	0.093
Moderate	177 (61.0)	117 (61.3)	60 (60.6)		
Poor	46 (15.9)	24 (12.6)	22 (22.2)		
Unknown	9 (3.1)	6 (3.1)	3 (3.0)		
Diabetes duration (years)					
< 5	98 (33.8)	76 (39.8)	22 (22.2)	9.151	0.010*
5–10	104 (35.9)	61 (31.9)	43 (43.4)		
>10	88 (30.3)	54 (28.3)	34 (34.3)		
Diabetes treatment					
Oral	221 (76.2)	147 (77.0)	74 (74.7)	2.551	0.279
Insulin	20 (6.9)	10 (5.2)	10 (10.1)		
Oral + insulin	49 (16.9)	34 (17.8)	15 (15.2)		
HbA1C (%)					
<7.0	133 (45.9)	94 (49.2)	39 (39.4)	2.564	0.277
7.0–8.5	106 (36.6)	65 (34.0)	41 (41.4)		
>8.5	51 (17.6)	32 (16.8)	19 (19.2)		

Table 2 Diabetes-related characteristics of type 2 diabetic patients classified by the presence or absence of severe periodontitis (cont.)

Characteristics	Total	PSR ≤ 3	PSR = 4	χ ²	p-value
	(n= 290)	(n=191)	(n=99)		
	n (%)	n (%)	n (%)		
Diabetes complications					
Yes	83 (28.6)	45 (23.6)	38 (38.4)	7.013	0.008*
No	207 (71.4)	146 (76.4)	61 (61.6)		

Abbreviations: PSR = Periodontal Screening and Recording, BMI = body mass index, HbA1C = hemoglobin A1C

Chi-square was used to compare the results of the two groups. A p-value of <0.05 was considered statistically significant.

Table 3 Univariate and multivariate predictors of severe periodontitis (PSR = 4) in type 2 diabetic patients (n=290)

Factors	Univariate analysis			Multivariate analysis		
	OR ¹	95%CI	p-value	OR _{adj} ²	95%CI	p-value
Age (years)						
<60	1.00	1		1.00	1	
≥60	1.96	(1.20–3.21)	0.007*	1.80	(0.96–3.37)	0.068
Level of education						
Primary education	4.46	(1.86–10.7)	<0.001*	3.75	(1.40–10.07)	0.009*
Lower secondary	2.46	(0.88–6.88)	0.087	2.12	(0.68–6.56)	0.194
Upper secondary	2.58	(0.95–7.07)	0.064	2.78	(0.92–8.37)	0.069
Associate degree	4.18	(1.34–13.09)	0.014*	4.15	(1.17–14.67)	0.027*
Bachelor’s degree or higher	1.00	1		1.00	1	
Smoking history						
Never smoked	1.00	1		1.00	1	
Former smoker	2.87	(1.42–5.82)	0.003*	2.99	(1.34–6.66)	0.007*
Current smoker	3.36	(1.29–8.71)	0.013*	4.06	(1.36–12.13)	0.012*
Self-perceived blood sugar control						
Good	1.00	1		1.00	1	
Moderate	1.61	(0.82–3.17)	0.167	1.33	(0.62–2.86)	0.461
Poor	2.88	(1.25–6.64)	0.013*	2.16	(0.82–5.71)	0.121
Unknown	1.57	(0.35–7.12)	0.558	1.45	(0.27–7.80)	0.665
Diabetes duration (years)						
<5	1.00	1		1.00	1	
5–10	2.44	(1.32–4.50)	0.005*	2.17	(1.08–4.36)	0.030*
>10	2.18	(1.15–4.12)	0.017*	1.46	(0.67–3.17)	0.341
Diabetes complications						
Yes	2.02	(1.20–3.42)	0.009*	1.65	(0.89–3.05)	0.114
No	1.00	1		1.00	1	

Abbreviations: OR = odds ratio; ORadj = adjusted odds ratio; CI = confidence interval

Variables with a p-value <0.050 in univariate analysis were included in the multivariate model.

1OR estimated by binary logistic regression. 2 ORadj estimated by multiple logistic regression

Table 3 shows the predictors of severe periodontitis using univariate and multivariate analyses. In univariate analysis, older age, lower education level, former/current

smoker, self-perceived “poor” blood glucose control, diabetes duration of ≥5 years, and diabetes complication increased the possibility of having severe periodontitis.

Furthermore, multiple regression analysis found that education level, history of smoking, and diabetes duration were significantly associated with severe periodontitis. Participants whose highest level of education were primary education and those with an associate degree had a greater risk of severe periodontitis than those with a bachelor's degree or higher by 3.75-fold and 4.15-fold, respectively. Participants who were former smokers and current smokers had a 2.99-fold and a 4.06-fold higher risk of severe periodontitis than those who had never smoked respectively. Participants who experienced a diabetes duration of 5–10 years had a 2.17-fold higher risk of severe periodontitis than patients with a diabetes duration of <5 years.

Oral health knowledge

The mean knowledge score was 9.22 ± 0.42 (range: 0–18), and 42.4% of the patients had “adequate” oral health knowledge. Significant factors associated with higher mean scores are shown in Table 4.

A total of 56.9 % of participants were aware of periodontitis being one of the complications of diabetes mellitus, 32.4 % were aware that untreated periodontitis made controlling blood glucose levels more difficult, and 36.2 % were aware that periodontal treatment helped control blood glucose levels. Approximately half of the participants (48.6 %) had received oral health education from dentists (60.3 %), doctors/nurses (21.3 %), and other sources like media/internet (18.4 %).

Table 4 Comparison of mean oral health knowledge scores among type 2 diabetes mellitus patients (n=290)

Factors	n	Mean (SD)	t/F	p-value
Gender				
Female	202	9.77 (3.91)	3.472	<0.001*
Male	88	7.94 (4.58)		
Age (years)				
<60	149	9.44 (4.30)	0.912	0.362
≥60	141	8.99 (4.10)		
Level of education				
Primary	125	8.89 (4.04)	3.555	0.008*
Lower secondary	44	7.64 (4.47)		
Upper secondary	49	9.82 (4.19)		
Associate degree	24	9.83 (4.07)		
Bachelor's degree or higher	48	10.60 (4.00)		
Diabetes duration (years)				
<5	98	9.51 (4.36)	0.509	0.601
5–10	104	9.22 (4.31)		
>10	88	8.89 (3.91)		
Dental check-ups every six months				
Yes	86	10.90 (3.94)	4.564	<0.001*
No	204	8.51 (4.12)		
Received oral complications screening				
Yes	129	10.22 (4.35)	3.736	<0.001*
No	161	8.41 (3.91)		
Received knowledge of oral health				
Yes, and understood	51	10.78 (4.01)	14.389	<0.001*
Yes, but inadequate	90	10.36 (4.07)		
No	149	7.99 (3.99)		

Abbreviation: SD = standard deviation, t/F = t value from independent t-test /F value from analysis of variance (ANOVA) test

An independent t-test or analysis of variance (ANOVA) was used to assess the differences between the groups.

A p-value of <0.05 was considered statistically significant.

Oral health behaviors

The data showed that 83.4 % of the participants brushed their teeth ≥ 2 times per day; only 13.4 % used the modified Bass brushing method; 64.5 % never used any interdental cleaning devices; 77 % used fluoride toothpaste; and only 29.7 % had a dental check-up every six months. The reason for the last dental visit comprised 35.4 % for tooth extraction/emergency, 32.5 % for dental cleaning, and 12.8 % for periodontal treatment. Of the participants, 44.5 % had been examined for oral complications after being diagnosed with diabetes, of whom 76.7 % had been referred by doctors and 23.3 % by their own self-awareness.

Discussion

The prevalence of periodontitis in type 2 diabetic patients at the BMA hospital was high at 61.03 % (PSR ≥ 3). Compared to studies that used the Community Periodontal Index (CPI) or PSR Index to evaluate periodontal status, the results of this study showed a higher disease prevalence than in the northeast of Thailand (40.6 %) ²⁴ and Malaysia (55.3 %) ¹⁸ but a lower prevalence than in Germany, or Iran where the prevalence of periodontitis in type 2 diabetic patients was above 85 %. ^{13,15} The rate of severe periodontitis in this study was 3.0 times higher than in the general elderly Thai population, as reported by the 8th National Oral Health Survey 2017 ²⁵ (34.1 % and 12.2 %, respectively). This difference supports previous evidence that diabetes mellitus increases prevalence and the severity of periodontitis. ^{8,26}

More females than males participated in this study, with a ratio of 70:30 (Table 1), which reflected the higher prevalence of diabetes mellitus in females in Thailand. ² Female participants were more likely to cooperate with treatment at the diabetic clinic. No statistically significant difference was found between gender and periodontal status, in contrast to previous studies that found a three-fold higher risk of severe periodontitis in males than in females. ^{18,27}

Most diabetic patients in the study were obese (68.6 %). Obesity (BMI ≥ 30 kg/m²) increases the risk of

several debilitating diseases, especially for those diagnosed with type 2 diabetes (relative risk [RR] = 2.5–5.1). ²⁸ Most cross-sectional studies have found that obesity increases the risk of periodontal disease. ²⁹ However, this study concurs with those few others that did not find an association between periodontal status and BMI. ¹⁸

Several previous studies have reported that glycemic control (measured by HbA1C level) was associated with periodontal status. ^{12,15,26} However, similar to other cross-sectional studies (see Table 2), the current study did not find this association ^{17,18,30} Differences in research methodologies, classification of HbA1C levels, and periodontal diagnosis criteria made it difficult to compare among studies.

Univariate analysis showed that type 2 diabetic patients with at least one complication had a significantly higher risk of severe periodontitis, that is, a 2.02 times greater risk than diabetic patients without complications, although this factor was not significant in multivariate analysis (see Table 3), concurring with previous studies have found retinopathy, cardiovascular disease, and renal diabetes complication significantly associated with periodontitis. ^{16,31} Thus, diabetics patients with other complications should be informed to closely monitor periodontitis.

Multi-regression analysis showed that significant predictors for severe periodontitis in diabetic patients were education level, smoking, and duration of diabetes, in agreement with other cross-sectional studies (see Table 3). ^{12,15,17,30} Diabetic patients with primary education and those with an associate's degree had a greater risk of severe periodontitis than those with a bachelor's degree or higher by 3.75-fold and 4.15-fold, respectively. Lower educational attainment was associated with a low level of dental service use and poor oral hygiene habits, which leads to high plaque accumulation and, eventually, severe periodontitis. ³² Diabetic patients who were former smokers and current smokers were 2.99–4.06 times more likely to develop severe periodontal disease than non-smokers. These results confirmed the association of smoking as a risk factor for periodontitis. ^{33,34} The effect of past smoking on the periodontium is irreversible, but the destruction

decreased when smoking ceased.²⁷ Smoking and diabetes mellitus also have a synergistic effect on more severe periodontal destruction,^{35,36} indicating that diabetics who smoke should be encouraged to quit smoking and be referred to a smoking cessation program.

Multivariate analysis results showed that long diabetes duration was the only diabetes-related factor that increased the likelihood of severe periodontitis, similar to Kim *et al.*¹⁷ Participants with diabetes duration of 5 - 10 years were twice as likely to develop severe periodontitis as those suffering from diabetes for <5 years (Table 3). For participants with a diabetes duration of >10 years, the strength of association decreased and was not statistically significant. This could be explained by the fact that teeth with more severe periodontal disease may have been lost or extracted as, according to previous studies, long-term diabetic patients showed a significantly greater number of missing teeth.³⁷

Most diabetic patients in this study had poor oral health knowledge, did not follow optimal oral health behavior and were unaware of the bidirectional link between periodontitis and diabetes; this is similar to the results of other studies conducted worldwide.³⁸ Receiving oral health education, screening for oral complications, and having regular dental check-ups significantly increased the mean oral health knowledge (Table 4). An increase in the level of oral health awareness may promote proper oral health practices in diabetic patients.³⁹

The clinical implications of the findings in this study include the need for close collaboration between diabetes healthcare and oral healthcare providers to set up an effective referral system for periodontitis screening for all diabetic patients. According to this result, a long duration of diabetes increases the risk of severe periodontitis, so periodontal examination should be performed when diabetes mellitus is first diagnosed to reduce the severity and allow for early treatment. Diabetes patients who do not show indications of periodontitis should receive regular monitoring to track periodontal changes. Oral health education should be integrated into the overall

diabetic education program. Dental care providers should emphasize the bidirectional association between diabetes mellitus and periodontitis and inform patients about the factors which increase the risk for severe periodontitis, as mentioned above. The goal of these proposed preventive programs is to increase oral health awareness, which will lead to better oral dental care habits, reduce the incidence of periodontitis, improve the quality of life of diabetics, and reduce the economic burden on both patients and the dental public health system.

The findings of this study should be interpreted under limitations. The research was conducted in only one tertiary hospital and may not be directly applicable to all diabetic patient populations. This is a cross-sectional study. In the future, longitudinal studies should be conducted to identify the true risk factors for this study group.

Conclusion

Type 2 diabetic patients in the BMA tertiary hospital showed a high prevalence of periodontitis. Significant predictors for severe periodontitis were education level, smoking, and diabetes duration. The majority of diabetic patients slightly lacked oral health knowledge and had poor oral health behaviors.

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