

# Assessment of oral health status and practice among diabetic and nondiabetic participants

Aljohara S. Almeneessier<sup>1</sup>, Rawa A. Alharbey<sup>2</sup>, Abdullah A. Alshehri<sup>3</sup>,  
Haila A. Alhuraishi<sup>4</sup>, Wafa A. AlGheriri<sup>5</sup>, Fouzia A. Alhreashy<sup>6,7</sup>

<sup>1</sup>Department of Family and Community Medicine, College of Medicine, King Saud University, Riyadh, Saudi Arabia,

<sup>2</sup>Department of Periodontology, Public Health in Health System Management, Riyadh Second Health Cluster, Ministry of

Health, Riyadh, Saudi Arabia, <sup>3</sup>Dental Care Services, Imam Mohammed Ibn Saud Islamic University (IMSIU), Riyadh,

Saudi Arabia, <sup>4</sup>Department of Orofacial Pain and Jaw Function, Riyadh Specialized Dental Center, Riyadh Second Health

Cluster, Ministry of Health, Riyadh, Saudi Arabia, <sup>5</sup>Dental Care Services, Johns Hopkins Aramco Healthcare, Dhahran, Saudi Arabia, <sup>6</sup>General Directorate of Nutrition, Deputyship of Therapeutic Services, Ministry of Health, Riyadh, Saudi Arabia,

<sup>7</sup>College of Medicine, Imam Mohammed Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia

## ABSTRACT

**Introduction:** Patients with diabetes are diagnosed and managed through family practice. They are more likely to have more severe periodontal disease. Good oral hygiene can prevent oral health problems. This study explored and identified the status, practice, and prevalence of oral hygiene among patients with diabetes compared with nondiabetic patients. **Methods:** A cross-sectional study of dental health care clinic patients was conducted using questionnaires and a validated oral examination tool, the Simplified Oral Hygiene Index (OHI-S). Data were analyzed using SPSS software. **Results:** A total of 238 participants enrolled in the study (46.6%) had diabetes mellitus. The mean age of the participants was  $40.01 \pm 13.03$  years. Diabetics' Oral Hygiene Index (OHI) mean was  $2.72 \pm 1.19$ , compared with  $2.02 \pm 1.08$  in nondiabetics ( $P < 0.001$ ). There was no statistically significant difference in OHI scores between males and females ( $P > 0.05$ ). Simplified OHI score  $> 3$  was higher among diabetics than nondiabetics, with an age-adjusted rate of 32.41 per 1000 compared to 13.63 per 1000 and an odd ratio of 3.66, 95% CI (3.5 to 3.8)  $P < 0.0001$ . Oral disease symptoms, gum bleeding, swelling, and tooth mobility were reported among patients with diabetes (37.8%, 36%, and 30.6%, respectively). Oral hygiene practices were suboptimal in patients with diabetes compared to nondiabetics. **Conclusion:** There is a high prevalence of poor oral hygiene among patients with diabetes compared to nondiabetics which calls for multidisciplinary diabetic care in family practice to ensure the optimal quality of care.

**Keywords:** Diabetes, family practice, oral health, oral hygiene, periodontitis, simplified oral hygiene index

## Introduction

Diabetes world prevalence is predicted to be 12.2% in 2045, with 19.3% in the Middle East and North Africa (MENA).<sup>[1]</sup> In Saudi Arabia, the overall prevalence is 16.4%.<sup>[2]</sup> Patients with diabetes

visit family physicians as their primary healthcare provider.<sup>[3]</sup> However, interprofessional team management is mandatory to improve the quality standards of diabetes care.<sup>[4]</sup> Despite the high prevalence, diabetic care quality indicators lack an essential element that affects disease treatment and complications, namely, periodontal health care.<sup>[3,5,6]</sup>

Periodontal diseases account for 19% of people older than 15 years of age, peaking at 55.<sup>[7]</sup> Poor oral hygiene is a risk factor

**Address for correspondence:** Dr. Aljohara S. Almeneessier, Department of Family and Community Medicine, College of Medicine, King Saud University, Riyadh, Saudi Arabia. E-mail: aljoharas@yahoo.com

Received: 16-08-2024

Revised: 23-10-2024

Accepted: 26-10-2024

Published: 25-04-2025

### Access this article online

#### Quick Response Code:



#### Website:

<http://journals.lww.com/JFMPC>

#### DOI:

10.4103/jfmprc.jfmprc\_1414\_24

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**How to cite this article:** Almeneessier AS, Alharbey RA, Alshehri AA, Alhuraishi HA, AlGheriri WA, Alhreashy FA. Assessment of oral health status and practice among diabetic and nondiabetic participants. J Family Med Prim Care 2025;14:1313-9.

for periodontal diseases. Hence, periodontitis can be prevented with good oral hygiene practices.<sup>[8]</sup> The overall prevalence of periodontitis among patients with diabetes is 67.8% compared to 35.5% in patients without diabetes (OR, 1.85; 95% CI 1.61 to 2.11).<sup>[9]</sup> It was reported that better oral hygiene habits, mainly tooth brushing  $\geq 3$  times daily, minimize the risk of new-onset diabetes.<sup>[10]</sup>

Multidisciplinary health care for diabetes and periodontal diseases is the future through Saudi 2030 vision of a new health transformation system and the adoption of family medicine and family practice dental programs as the entry to the health care system.<sup>[11]</sup>

We conducted this study to explore the status and prevalence of oral hygiene among patients with diabetes compared with nondiabetics and to identify oral hygiene behavior and dental symptoms in these groups.

## Material and Methods

A cross-sectional study was conducted at a governmental dental care facility over 6 months. The Ministry of Health Institution of the Research Board has granted ethical approval (Ref. No. 18-494E, October 2018). The authors conducted this survey and oral examination according to Helsinki's ethical guidelines and regulations. This study is reported according to STROBE-checklist-v4-cross-sectional ([www.strobe-statement.org](http://www.strobe-statement.org)).

Quantitative data were collected using a self-administered questionnaire and clinical dental examination. The authors explained the research context and objectives and obtained informed consent from all participants before enrolment in the study.

The study participants were recruited from a convenience sample of dental care clinic patients, selected according to the following criteria: all Saudis who attended the dental care clinic, both sexes, aged 18 years and older, and consented to participate in answering the questionnaire and oral examination. The selected participants for the clinical oral examination should meet the following inclusion criteria: Saudis,  $\geq 18$  years of age, both sexes, have most of the natural teeth, and provide consent for the oral examination. Exclusion criteria for oral examination applied to patients who have significant diseases such as cancer, epilepsy, or heart disease, receiving anticoagulant medication (heparin, warfarin, dabigatran, apixaban, and rivoraxaban), calcium channel blockers, nonsteroidal anti-inflammatory drugs or antiepileptic medication, and patients with prosthetic teeth or edentulous.

The required number of participants was 384, based on the Cochran formula  $n_0 = Z^2pq/e^2$  at a confidence level of 95% precision equal to 0.05 and a prevalence of 50%.

We adopted a previous study instrument for patients with diabetes.<sup>[12]</sup> The study instrument consists of two parts. The first

part was a self-administered questionnaire to collect quantitative personal data and practice oral hygiene; the second part was for oral examination by a trained dentist. A question was added; "Are you diabetic? (Y, N)" to count for diabetic and nondiabetic patients.

The authors used the Simplified Oral Hygiene Index (OHI-S) for oral examination.<sup>[13,14]</sup> The examination sites were the maxillary buccal surfaces of the right and left molars, labial surface of the upper central incisor, mandibular lingual surfaces of the right and left molars and labial surface of the lower central incisor.<sup>[13,15]</sup> The OHI-S score ranged from 0 to 6, and it was categorized as good (OHI-S = 0–1.2), fair (OHI-S = 1.3–3), and poor oral hygiene (OHI-S = 3.1–6).<sup>[13,16]</sup>

## Statistical analysis

We used the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 29.0) to analyze the data. Continuous variables were expressed as mean  $\pm$  standard deviation, and categorical variables were expressed as numbers and percentages. An independent *t*-test was performed to compare mean values between the two groups. One-way ANOVA was used to compare multiple groups. A Pearson's Chi-square test of independence was conducted to examine the association between the groups. Missing data were treated as missing. Statistical significance was set at  $P < 0.05$ . To adjust for age differences between the diabetic and nondiabetic groups, we used the reference population as per the mid-2019 census ([https://data.gov.sa/Data/ar/dataset/population\\_by\\_age\\_groups\\_and\\_gender\\_ar](https://data.gov.sa/Data/ar/dataset/population_by_age_groups_and_gender_ar)).

## Results

A total of 238 patients (62% response rate) were enrolled in this study. The Cronbach's alpha of the study instrument was 0.78. The instrument for oral examination was piloted on five patients; the interexaminer reliability test was  $k = 0.70$ , 95% CI (0.53 to 0.87), and  $P < 0.001$ .

There were 59.7% (142) of female participants. The mean age of the studied sample was  $40.01 \pm 13.03$ . One hundred eleven participants were diabetic (46.6%), and the nondiabetics were younger, with a mean age of  $32.7 \pm 10.4$  years. An independent *t*-test was performed to determine the mean age difference. There was a statistically significant difference in age between patients with diabetes ( $48.37 \pm 10.47$ ) and nondiabetic ( $32.7 \pm 10.4$ ) with  $t_{(236)} = 11.55$ ,  $P < 0.0001$ , and a mean difference of 15.7 (95% CI: 12.99 to 18.33). Twenty-five (10.5%) participants reported being current smokers, and 152 (64%) were married. Forty percent of patients with diabetes were diagnosed for more than 10 years; comparative details of the participants with diabetes and nondiabetics demographic data are shown in Table 1.

Analysis of oral hygiene behavior and dental symptoms showed that 27 (21%) nondiabetic participants, compared with nine (8%)

diabetic participants, reported tooth brushing 3-4 times daily. Table 2 and Figure 1 detail the participants' differences in their oral hygiene practices. Forty-two participants with diabetes (37.8%) reported gum bleeding compared with 39 (29.9%) nondiabetic participants. Table 3 details the participants' differences in dental symptoms.

Participants were screened for eligibility for the oral examination; thirty-one patients were excluded from the examination for the following reasons: the use of a calcium channel blocker (n = 17), regular daily use of NSAIDs for joint pain (n = 11), use of an anticoagulant (n = 2), and one epileptic patient on Depakene.

**Table 1: Comparative demographic characteristics of diabetic and nondiabetic participants (n=238)**

	Diabetic (No, %)		Nondiabetic (No, %)	
	(No 111)	(46.6%)	(No 127)	(53.4%)
Age (mean±SD)	48.4±10.5		32.7±10.4	
Gender				
Male	30	27%	66	52%
Female	81	73%	61	48%
Smoking (no)	100	90.1%	110	86.6%
Marital (yes)	92	82.9%	60	47.2%
Work				
Unemployed	61	55.0%	55	43.3%
Government employee	27	24.3%	38	29.9%
Private sector employee	8	7.2%	27	21.3%
Retired	14	12.6%	2	1.6%
Education				
<6 years (illiterate and primary level)	31	28.4%	3	2.4%
6-12 (Intermediate and high school)	41	37.6%	44	35.2%
>12 (University, Master and PhD)	37	34%	78	61.4%

Two hundred and seven participants were eligible and included in the dental examination, of which 103 had diabetes and 104 were nondiabetics.

The OHI categories showed that 37.9% of patients with diabetes had poor oral hygiene (OHI>3) compared to 15.4% of nondiabetics. Table 4 shows the detailed distribution of the OHI categories.

One-way ANOVA was performed to determine if there was any statistical difference in the mean age between the participants in the oral health hygiene (OHI) groups. There was a statistical difference in the mean age between the oral hygiene groups  $F(2,204) = 3.83, P = 0.023, \eta^2 = 0.036$  (95% CI: 0–0.093). The age-adjusted rate of poor oral hygiene was 32.41 per 1000 among patients with diabetes compared with 13.63 per 1000 among nondiabetics, and the age-adjusted odd ratio for poor OHI was 3.66 (95% CI: 3.5, 3.8)  $P < 0.0001$ .

A Chi-square test of independence was performed to examine the association between the oral health index (oral hygiene) and diabetes. There was a statistical association between oral hygiene and diabetes  $X^2(2, N = 207) = 16.58, P < .001$ ; the adjusted residual between poor oral hygiene and diabetes was 3.7, indicating an association between poor oral hygiene and diabetes.

In addition, the Chi-square test of independence was used to investigate the association between oral health, demographic variables, oral symptoms, and oral hygiene practices. It revealed a statistical association between oral health and level of education  $X^2(4, N = 205) = 20.15, P < .001$ , the adjusted residual between poor oral hygiene and <6 years of

**Table 2: Oral hygiene behavior and practice among diabetic and nondiabetic participants (n=238)**

Oral hygiene practice	Total studied sample=n=238				Eligible for oral exam n=207	
	Diabetic n=111		Nondiabetic n=127			
	No.	(%)	No.	(%)	No.	(%)
Brushing						
3–4 times per day after each meal and before bedtime	9	8.1%	27	21.3%	33	15.9%
1–2 times per day	79	71.2%	84	66.1%	140	67.6%
Once every two days	9	8.1%	6	4.7%	16	7.7%
Once every week	7	6.3%	6	4.7%	11	5.3%
Never brush	5	4.5%	3	2.4%	8	3.9%
Flossing						
3–4 times per day after each meal and before bedtime	2	1.8%	3	2.4%	4	1.9%
1–2 times per day	9	8.1%	21	16.5%	20	9.7%
Once every two days	7	6.3%	9	7.1%	14	6.8%
Once every week	9	8.1%	26	20.5%	33	15.9%
Never use dental floss	73	65.8%	62	48.8%	121	58.5%
Miswak (yes)	25	22.5%	20	15.7%	51	24.6%
Dental visit						
Once every 6 months	13	11.7%	15	11.8%	22	10.6%
Once a year	16	14.4%	10	7.9%	23	11.1%
When there is a dental problem	67	60.4%	84	66.1%	143	69.1%
This is the first visit	5	4.5%	15	11.8%	19	9.2%

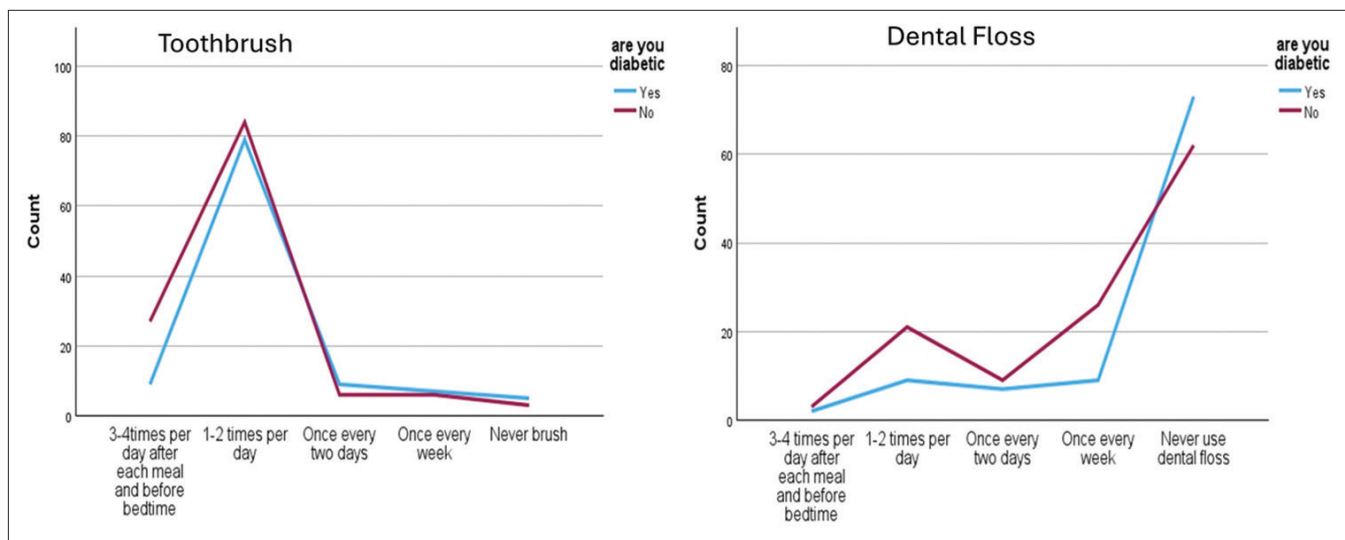
education was 3.7, indicating an association between poor oral hygiene and lower level of education. At the same time, the adjusted residual between good oral hygiene and >12 years of education was 2.8, indicating an association between good oral hygiene and a higher level of education, as shown in Figure 2. Moreover, there was a statistical association between smoking and oral health  $X^2 (2, N = 204) = 7.66, P < .022$ ; the adjusted residual between poor oral hygiene and smoking was 2.7, indicating an association between poor oral hygiene and smoking. There were no statistical associations between oral health and sex ( $P = .089$ ), marital status ( $P = .211$ ), or occupation ( $P = .205$ ).

The association between oral health and oral disease symptom variables revealed a statistical association between oral health and tooth mobility  $X^2 (2, N = 192) = 9.87, P = 0.043$ , the adjusted

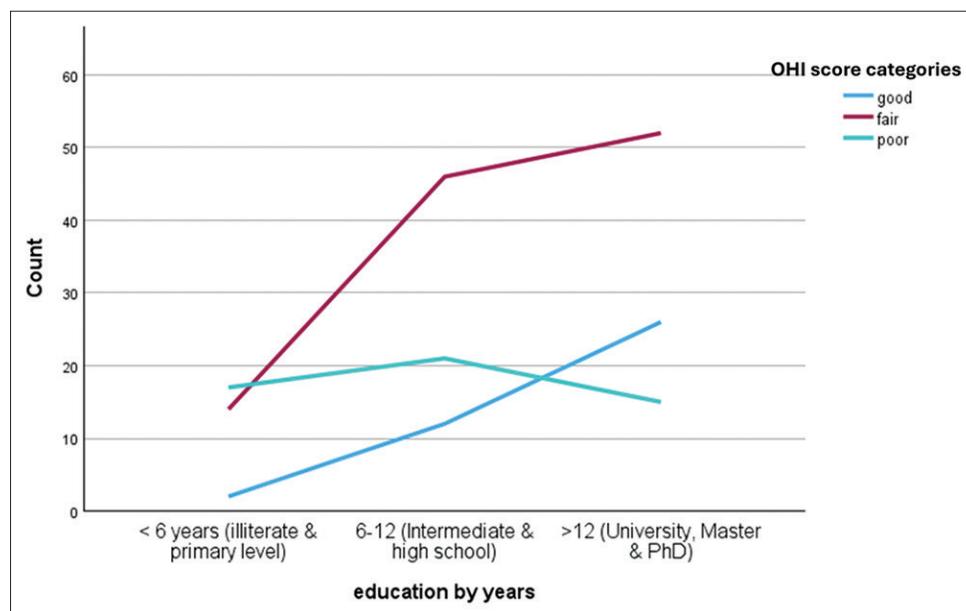
residual equals 2.6 between poor oral health and tooth mobility, indicating an association between these two variables. In addition, there was a statistical association between oral health and gum

**Table 3: Oral disease symptoms among diabetic and nondiabetic participants (n=238)**

Oral disease symptoms	Total studied sample=238				Eligible for oral exam n=207	
	Diabetic n=111		Nondiabetic n=127			
	No.	(%)	No.	(%)	No.	(%)
Gum bleeding (yes)	42	37.8%	38	29.9%	73	35.3%
Tooth mobility (yes)	34	30.6%	25	19.7%	51	24.6%
Gum swelling (yes)	40	36%	33	26.0%	67	32.4%
History of gum disease (yes)	33	29.7%	32	25.2%	57	27.5%
History of gum treatment (yes)	33	29.7%	29	22.8%	59	28.5%



**Figure 1: Oral hygiene practices (toothbrushing and flossing) among patients with diabetes and nondiabetics**



**Figure 2: Distribution of the oral health categories according to years of education**



**Table 4: Oral hygiene index (OHI-S) among diabetic and nondiabetic participants**

	Diabetic		Nondiabetic	
	No.	(%)	No.	(%)
OHI score categorization				
Good (OHI=0-1.2)	12	11.7%	28	26.9%
Fair (OHI=1.3-3)	52	50.5%	60	57.7%
Poor (OHI=3.1-6)	39	37.9%	16	15.4%
Total	103	100%	104	100%
The age-adjusted rate of poor oral health OHI-S >3	32.41 per thousand		13.63 per thousand	
Age Adjusted Odd Ratio 3.66 (95% CI: 3.5, 3.8)				

Reference population as per mid-2019 census at [https://data.gov.sa/Data/ar/dataset/population\\_by\\_age\\_groups\\_and\\_gender\\_ar](https://data.gov.sa/Data/ar/dataset/population_by_age_groups_and_gender_ar)

swelling  $X^2 (4, N = 194) = 10.07, P = 0.039$ , the adjusted residual between poor oral health and the presence of gum swelling equals 2.5, indicating an association between these two variables; at the same time, the adjusted residual between the absence of gum swelling and good oral health equals 2.3, suggesting an association between them. There was no association between oral health and gum bleeding ( $P = 0.221$ ), no association between oral health and previous history of gum treatment ( $P = 0.081$ ), the association between oral health and prior history of gum disease was borderline with  $X^2 (4, N = 190) = 9.42, P = 0.051$  and the adjusted residual between good oral health and no history of gum disease was 2.6 suggesting an association of good oral health and absence of a history of gum disease.

The investigated association between oral health and oral hygiene practice variables showed no association with any of the following variables: daily miswak use ( $P = 0.901$ ), tooth brushing ( $P = 0.699$ ), tooth flossing ( $P = 0.057$ ), or dental clinic visits ( $P = 0.052$ ).

## Discussion

Good oral health is desirable for maintaining general health and can be achieved with proper oral hygiene. We conducted this study to explore the oral hygiene status among a sample of patients attending a dental care clinic. Almost half of our study sample (47%) was diabetics; this result could be considered as a reflection of the high prevalence of diabetes in Saudi society.<sup>[2]</sup> In this study, we compared patients with type 2 diabetes and nondiabetics, and our assessment instrument was based on the use of plaque index and calculus index to calculate the oral hygiene index (OHI = PI/CI) and categorized our results as per OHI-S scores.<sup>[13,14]</sup> We found that poor oral hygiene is prevalent among patients with diabetes compared with nondiabetics. Many confounding risk factors, in addition to diabetes mellitus itself, may explain our results. The first factor was the age-related influence. The diabetic participants' mean age was higher than that of nondiabetic participants. The age range of participants with diabetes was between 21 and 69 years, whereas of nondiabetics ranged from 18 to 64 years. The age difference between the two groups could be explained by the increasing

diabetes prevalence with advancing age.<sup>[2]</sup> Moreover, periodontitis occurred more frequently in people older than 65 years and more frequently in males than females.<sup>[17]</sup>

In addition to the age and sex of the participants as nonmodifiable risk factors contributing to our results, smoking was associated with poor oral hygiene. Smoking is a modifiable risk factor that leads to changes in oral microbiota, resulting in periodontitis.<sup>[18]</sup>

Education has been reported as one of the risk factors and has a mutual relationship with periodontitis.<sup>[19]</sup> In our study, many nondiabetics attained education higher than the primary level compared with less than three-quarters of diabetic participants (96.6% vs. 71.6%), and those with a university and higher degrees were two-thirds of the nondiabetic participants compared with one-third of diabetic participants. An analysis of the education subgroups revealed that poor oral hygiene was associated with a lower level of education. According to this result, we can conclude that better oral hygiene and oral health are more common among individuals who have received higher education. Our results agree with those of a study that explored the relationship between individuals' educational levels and knowledge of oral health.<sup>[19]</sup>

Tooth brushing 1–2 times per day is less than the recommended for oral hygiene.<sup>[8]</sup> We could not identify any association between poor oral hygiene and oral hygiene practice; this could be due to self-reporting bias or the nature of the participants included in the study. Furthermore, our findings were lower than the average of 2.66 reported by a cohort study.<sup>[20]</sup> Interdental cleaning involves using tools such as dental floss, interdental brushes, or water flossers to remove plaque, food particles, and debris from interdental spaces. It is essential for maintaining oral health as it helps prevent gum disease, cavities, and bad breath by reducing plaque and bacterial buildup in hard-to-reach areas. Regular interdental cleaning and brushing can improve dental hygiene and promote oral health.<sup>[21]</sup> Self-assessment is essential for recognizing signs of oral diseases and seeking timely dental care. It was reported that only 50% of patients could identify and report symptoms of oral diseases; females, young people, and nonsmokers were more likely to recognize the signs and symptoms objectively.<sup>[22]</sup> Self-assessment tools empowered patients to monitor their health and identify early signs of periodontal conditions.<sup>[23]</sup> Two-thirds of our study sample visited the dental care provider when they had dental problems, and only ten percent had regular dental visits. This result agrees with a national household survey among the Saudi population to explore barriers to visiting dental care clinics.<sup>[24]</sup> The authors reported that despite 88% of the respondents being eligible for free dental care services, only 20% had visited the dental care clinic over the past year. The need for dental care was reported as a significant predictor for dental health visits.<sup>[24]</sup> A population-based study reported that women had more dental preventive visits than men.<sup>[25]</sup> We found no difference between patients with diabetes and nondiabetics in regular 6-month dental visits. A 5-year national study reported that receiving a diagnosis

of type 2 diabetes does not influence individuals' utilization of dental care facilities.<sup>[26]</sup> Moreover, it was reported that only 43% of endocrinologists and 41% of general practitioners "sometimes" would refer their patients with diabetes to receive oral care from dentists.<sup>[27]</sup> Another study reported that 76% of health care provider "never" refer their patients with diabetes to dental care services.<sup>[28]</sup> Family medicine practitioners are expected to know about the relationship between oral health and diabetes; also, they are expected to be attentive to periodontal health and different system diseases. In one study, 74% of the general practitioners reported never asking about periodontal symptoms, and 87% admitted that they had insufficient knowledge and were ready to enroll in periodontal educational training programs.<sup>[29]</sup> General practitioners could adopt a short, noninvasive tool to aid in diagnosing and referring patients with periodontal problems.<sup>[30]</sup> Periodontal self-assessment tools, accessible referral systems, and targeted training courses are crucial in improving the care of diabetes and periodontal diseases.

Multidisciplinary diabetic care is a cornerstone for improving care quality by providing simultaneous care from different medical and dental healthcare team members. Incorporating diabetes and oral health into undergraduate medical and dental curricula and adopting an interprofessional strategy in health profession education will be the foundation for diabetes and oral health promotion and management.

## Conclusions

The clinical implication of this study is that the oral hygiene index serves as a reliable indicator of overall oral health. As oral hygiene behavior is a modifiable risk factor, it is crucial to prevent and manage periodontal diseases. This study showed suboptimal oral hygiene practice and a high prevalence of poor oral hygiene among diabetic participants compared to nondiabetic participants. Patients can reduce their risk of developing periodontal issues by improving oral hygiene practices such as regular brushing, flossing, and interdental cleaning. This highlights the importance of educating patients on effective oral care routines as a part of a comprehensive strategy to promote long-term oral health. The relationship between periodontal diseases and diabetes is bidirectional, and optimal management of one leads to improvement of the other.

Accessible referral systems ensure seamless coordination between healthcare providers, facilitating timely interventions and specialized care. Training courses for healthcare professionals enhance their skills and knowledge, equipping them to manage the complexities of diabetes and periodontal disease more effectively. These components improve patient outcomes and promote a more cohesive approach to managing these chronic conditions.

Diabetes care teams often include diabetologists, nutritionists, diabetic educators, and clinical pharmacologists. We recommend the recruitment of periodontologists or oral

hygienists as part of the diabetes care team to enhance the quality of diabetes care, in addition to adopting educational strategies targeting the main beneficiaries, namely, patients and health care providers.

## Limitation

As with cross-sectional studies, this study has the limitation of reporting bias, which could affect the results of oral hygiene practice. We recruited a convenience sample, which reduced the comparative ability of patients with diabetes and nondiabetics. A harmonized case-control or randomized controlled clinical study may reflect a great association between oral health and oral hygiene practice in relation to the state of diabetes.

## Ethics declaration

Ethical approval was granted by the Ministry of Health's Institution of the Research Board (Ref. No. 18-494E. October 2018). Informed consent was obtained from all subjects, and all methods were performed in accordance with the relevant guidelines and regulations.

## List of abbreviations

Abbreviation	Definition
OHI-S	Simplified Oral Hygiene Index
PI	Plaque index
CI	Calculus index

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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