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REVIEW ARTICLE

The Effect of Oral Health Education Program on Awareness and Improving Glycemic Control of Patients with Type 2 Diabetes Mellitus in Erbil City

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Abstract:

Background and objectives: We can view the relationship between diabetes and periodontitis as bidirectional, as both diseases involve and exacerbate inflammatory mechanisms. The study aims to determine the level of oral health knowledge and awareness among a sample of type 2 diabetic patients and to assess the impact of a brief oral health education program on glycemic control.

Patients and Methods: A quasi-experimental study was conducted on seventy-four type 2 diabetes patients from the specialized Layla Qasem Diabetic Center in Erbil, Iraq, from the start of January 2023 to the end of August 2023. Results were assessed, including body mass index, hemoglobin A1C levels, and fasting blood sugar.

Result: The percentage of patients who were aware of the link between diabetes and periodontal disease was lower before the educational program (25.7%), but there were pronounced and substantial improvements following the program (93.2%). The study showed that the mean HbA1c was 8.56% before the educational program and significantly lowered to 7.81% after the program. Furthermore, the FBS significantly decreased from 214.78 mg/dl before the program to 189.04 mg/dl after it. Following oral health education, there was a significant improvement in all oral practice items, like going for dental checkups (37.8%) before and (75.7%) after the education program.

Conclusion: Most participants have poor knowledge about the association between diabetes and periodontal disease, and there was a significant impact in implementing oral health programs among patients with type 2 diabetes and a decrease in the level of glycated hemoglobin and fasting blood sugar.

Keywords: Glycemic control, oral health education program, periodontal disease, type 2 diabetes mellitus.

Introduction

Thehallmark of type 2 diabetes (T2DM) is a relative dearth of insulin due to pancreatic beta-cell failure and insulin resistance in the target organs. 1 Over 90% of persons with diabetes have T2DM, making it the most prevalent type of the condition. 2 Diabetes raises the chance of a wide range of serious, life-threatening health issues, which can raise medical costs, reduce quality of life, and even raise mortality. 3 The main factors contributing to DM-related morbidity and mortality are its complications, which put a significant burden on the healthcare system. According to the World Health Organization, it will be the seventh most prevalent cause of death by 2030. 4 Besides the more common complications associated with this disease, diabetic patients who do not carefully maintain their blood glucose levels are at a greater risk of systemic and oral consequences. Macrovascular and microvascular illnesses are the most frequent chronic forms, while the acute consequences include diabetic ketoacidosis, hyperosmolar hyperglycemia, and various acute infections. 5 Diabetes might express itself in various ways with adverse oral consequences. Diabetes mellitus, for example, harms the salivary glands and results in xerostomia (dry mouth) when left untreated for a protracted length of time; plaque and debris form much faster than normal. This could be a contributing cause to the higher risk of dental caries seen in diabetic patients. 6 Furthermore, research shows that diabetics are two to three times more prone to acquire periodontal disease and exhibit more severe periodontal diseases. 7 Periodontitis is a prevalent chronic disease of the tooth-supporting structures caused by the accumulation of bacterial deposits on the tooth surface. 8 A variety of oral diseases and disorders, including periodontal (gum) diseases, which are the most prevalent, can be caused by even slightly raised blood glucose levels, which have a detrimental effect on oral health. 9.10 Numerous mechanisms

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can be utilized to explain the connection between diabetes and periodontal health, including changes in the host's cellular, healing, and vascular processes. 11 The main etiologic factor directly contributing to the onset and progression of periodontal disease is microbial dental biofilms. 12 The complex interaction between inflammation, the immune system, neutrophil activity, and cytokine biology is the underlying cause of the link between diabetes and periodontitis. 13 Uncontrolled high blood sugar is linked to higher levels of inflammatory substances and cytokines in saliva and the fluid around the gums, increased oxidative stress in gum tissues, and the formation of advanced glycation end products (AGE). Additionally, the interaction between AGE and its receptor (RAGE) worsens the inflammation, causing cellular stress and damage to essential gum cells, which ultimately leads to the loss of gum tissue. 13. Also, moderate to severe periodontitis worsens glycemic control and increases the risk of T2DM. 14, 15 A recent meta-analysis of the results revealed a substantial correlation between periodontal disease and glucose dysregulation, including diabetes. 16

Even though there's a two-way link between diabetes and gum disease, studies from various countries show that many people with diabetes often lack knowledge, awareness, and adherence to good oral health practices. 5 Therefore, the study's objectives are to determine the level of oral health awareness and knowledge among a sample of type 2 diabetic patients and the impact of a brief program on glycemic management.

PATIENTS AND METHODS

We conducted a quasi-experimental study at the clinics of Layla Qasem Specialized Diabetic Centers in Erbil City, Iraq. A quasi-experimental design is an evidence-based interventional study that uses non-random assignment to estimate the effectiveness of treatment or intervention. The study period spanned from the first of January 2023 to the end of August 2023. A structured questionnaire with closed-ended questions was used. A convenient type of sampling technique was implemented to recruit participants. Ninety patients with type two diabetes who had been diagnosed by a specialist at least six months before the study were invited to participate. However, sixteen patients dropped out and refused to continue. The research ethics committee of the executive office of the Arab Board of Health Specializations approved the protocol, and a formal consent letter from the director of health in Erbil was obtained before the initiation of the study. The researcher verbally obtained consent from each enrolled patient after explaining the study's objectives to them. The researcher conversed with the patient in both Arabic and Kurdish throughout the interview.

The researcher used a designed questionnaire. The questionnaire was composed of three sections and contained closed-ended questions. The first section included the participants' sociodemographic characteristics, medication, the duration of DM, other comorbid conditions, and history of mouth disease. In the second section, participants' oral health knowledge was evaluated. Questions were asked regarding the relationship between DM and oral diseases, whether diabetic patients are more susceptible to periodontal disease or not, the impact of gum disease on blood glucose control, whether they need to see a dentist more frequently due to diabetes, the impact of treating periodontal diseases on blood glucose, and the symptoms of periodontal disease. The third section included a review of the participants' oral health behaviors, such as visiting the dentist regularly, changing their toothbrush frequently, brushing for the recommended amount of time, direction of use while brushing, and using toothpaste, dental floss, mouthwash, and other cleaning products. The researcher next counsels each patient in a face-to-face discussion about the relevance of oral health and the regular scientific practices that they should engage in during the following three months. The points that were expounded are

Brush your teeth at least twice a day.

Use dental floss at least once daily.

See your dentist if you notice any signs of gum disease, such as red, swollen, or bleeding gums while brushing or flossing.

Understand the importance of regular dental check-ups, at least every six months.

Quit smoking or drinking alcohol, as these habits increase your risk of gum disease.

Monitor your blood sugar regularly, following your doctor's recommendations.

Replace your toothbrush every three months.

Brush your teeth for two minutes each time.

- Use a consistent brushing technique.

All participants were required to give a fasting blood sample in the laboratory room under fully aseptic settings once the interview and questionnaire were finished. HbA1c % and fasting blood glucose (FPG) in mg/dl were assessed. The HbA1CFS (particle-enhanced immunoturbidimetric test), a particular immunoassay for human HbA1c, was used to assess HbA1c. Participants were evaluated again in the second visit after three months for their continued adherence to diabetes mellitus (DM) treatment, oral health knowledge and behaviors, and fasting blood sugar and HbA1c% levels. Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 26). The McNemar (or McNemar-Bowker) test was used to compare the proportions of the same sample but at two different times (before and after the educational program). A paired t-test was used to compare means of numerical variables before and after the educational program. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Out of seventy-four patients, four participated in the study. Their mean age (SD) was 56.27 (11.21) years, the median was 58 years, and the age range was 31-89 years. Table 1 shows that the largest proportion of the sample (58.1%) were aged 50-69 years, and more than half of the sample (55.4%) were females. More than half (60%) of the sample were living in urban areas, and the majority (91.9%) were married. A considerable proportion (41.9%) of the sample was illiterate, and 16.2% could only read and write or had primary education. The income was not sufficient for the majority (70.3%) of the sample; 56.8% were unemployed (including retired and housewives), and only 12.2% were working in high-level occupations (Table 1).

Table 1. Socio-demographic characteristics.

	No.	(%)
Age (years)		
30-49	23	(31.1)
50-69	43	(58.1)
70-89	8	(10.8)
Gender		
Male	33	(44.6)
female	41	(55.4)
Residency		
Rural	29	(39.2)

Urban	45	(60.8)
Marital status		
Married	68	(91.9)
Single	4	(5.4)
Widowed	2	(2.7)
Educational level		
Illiterate	31	(41.9)
Read and write and primary	12	(16.2)
Intermediate	5	(6.8)
Secondary	13	(17.6)
College and above	13	(17.6)
Income		
Not sufficient	52	(70.3)
Sufficient	13	(17.6)
Exceeds daily needs	9	(12.2)
Occupation		
Unemployed	42	(56.8)
Unskilled manual worker	11	(14.9)
Skilled manual worker	9	(12.2)
Non-manual worker	3	(4.1)
High level occupation	9	(12.2)
Total	74	(100.0)

The rate of smoking was 21.6%, and none of the patients was alcoholic. The duration of diabetes was 5-9 years in 35.1% of the sample and 10-14 years in another 35.1% of the sample. Around two-thirds (67.6%) of the patients were on oral anti-diabetic medications only, and 17.6% were on insulin. Two-thirds (66.2%) of the patients had comorbidities, and 56.8% had a history of mouth diseases, as shown in Table 2.

Table 2. Medical history.

	No.	(%)
Smoking		
Smoker	16	(21.6)
Non-smoker	55	(74.3)
Ex-smoker	3	(4.1)
Alcohol		
Yes	0	(0.0)
No	74	(100.0)
Diabetes duration (years)		
< 5	8	(10.8)
5-9	26	(35.1)
10-14	26	(35.1)
≥ 15	14	(18.9)
Diabetes treatment		
Insulin	13	(17.6)
Oral	50	(67.6)
Both	11	(14.9)
Other drugs		
Yes	39	(52.7)
No	35	(47.3)
Comorbidities		
Yes	49	(66.2)
No	25	(33.8)
History of mouth disease		
Yes	42	(56.8)
No	32	(43.2)
Total	74	(100.0)

It is evident in Table 3 that there was some improvement in drug compliance after the educational program, but all the differences were not significant as follows: forgetfulness to take the medicine (p = 0.092), carelessness at times of taking medicine (p = 0.146), sometimes stopping the medicine when feeling better (p = 0.180), and sometimes stopping the medicine when feeling worse (p = 0.180) (Table 3).

Table 3. Compliance with taking the medicine, before and after the educational program.

	Before	After	P*
	No. (%) (n = 74)	No. (%) (n = 74)	
Forgetfulness to take the medicine.	22 (29.7)	15 (20.3)	0.092
Carelessness at times of taking medicine.	17 (23.0)	11 (14.9)	0.146
Sometimes, stopping the medicine when feeling better.	15 (20.3)	10 (13.5)	0.180
Sometimes, stopping the medicine when feeling worse.	15 (20.3)	10 (13.5)	0.180

*By McNemar test.

It is evident in Table 4 that 37.8% of the patients went to dental clinics for checkups; this proportion increased significantly (p < 0.001) to 75.7% after the educational program. The table shows that there was a significant (p < 0.001) improvement in the frequency of tooth brushing after the educational program. A considerable proportion (39.7%) of the patients used to change their toothbrush every year, and only 14.3% change it every month. The table shows that 25.4% of patients spent two minutes cleaning teeth before the educational program; this proportion increased significantly (p < 0.001) to 76.2% after the program. There was also significant improvement in the movements used in tooth brushing (p = 0.004). The toothpaste use increased significantly from 81.1% before the program to 91.9% after the program (p = 0.008). The use of dental floss also increased significantly from 23% before the program to 43.2% after the program (p < 0.001). No significant differences were detected regarding the use of other cleaning aids (p = 0.664) and the use of mouthwash (p = 1.000) (Table 4).

Table 4. Oral health practices before and after the educational program.

	Before	After	P
	No. (%) (n = 74)	No. (%) (n = 74)	
Going for dental checkup.	28 (37.8)	56 (75.7)	< 0.001*
Frequency of tooth brushing / day			
Once	27 (36.5)	29 (39.2)	
Twice	13 (17.6)	25 (33.8)	
Thrice	2 (2.7)	2 (2.7)	< 0.001**
Occasionally	21 (28.4)	12 (16.2)	
Never	11 (14.9)	6 (8.1)	
Frequency of changing toothbrush (n = 63)			
Once a year	25 (39.7)		
Every 4 months	17 (27.0)		
Every three months	9 (14.3)		
Every two months	3 (4.8)		
Every month	9 (14.3)		
Duration of tooth cleaning (minutes) (n = 63)			
One	40 (63.5)	9 (14.3)	
Two	16 (25.4)	48 (76.2)	< 0.001**
Three	5 (7.9)	5 (7.9)	
Five	2 (3.2)	1 (1.6)	
Movements used in tooth brushing (n = 63)			
Up - down	18 (28.6)	24 (38.1)	
Left - right	17 (27.0)	10 (15.9)	0.004**
Circular movements	12 (19.0)	2 (3.2)	
Combined	16 (25.4)	27 (42.9)	
Using toothpaste	60 (81.1)	68 (91.9)	0.008*
Using dental floss	17 (23.0)	32 (43.2)	< 0.001*
Use of other cleaning aids	17 (23.0)	20 (27.0)	0.664*
Use of mouth wash	19 (25.7)	20 (27.0)	1.000*

*By McNemar test. **By McNemar-Bowker test.

The proportions of patients having knowledge about the association between periodontal disease and diabetes were not so high before the educational program, as presented in Table 5 which shows marked and significant ($p < 0.001$) improvements in all the knowledge items after the educational program (Table 5).

Table 5. Knowledge about the association between periodontal disease and diabetes, before and after the educational program.

	Before	After	P*
	No. (%) (n = 74)	No. (%) (n = 74)	
Thinking that there is an association between diabetes and oral disease.	19 (25.7)	69 (93.2)	< 0.001
Awareness that diabetic patients are more prone to periodontal / oral diseases than others (non-diabetics).	19 (25.7)	55 (74.3)	< 0.001
Thinking that gum diseases affect blood glucose.	11 (14.9)	42 (56.8)	< 0.001
Being informed that you should be ultracareful of oral health and visit dentist more often because you have diabetes.	10 (13.5)	66 (89.2)	< 0.001
Awareness that treatment of periodontal disease among diabetics may improve blood glucose.	7 (9.5)	41 (55.4)	< 0.001
Symptoms of periodontal diseases:			
Gum bleeding with brushing or flossing	48 (64.9)	67 (90.5)	< 0.001
Soreness of gum	28 (37.8)	52 (70.3)	< 0.001
Redness and swelling of gum	20 (27.0)	39 (52.7)	< 0.001
Bad breath	9 (12.2)	38 (51.4)	< 0.001
Gum that pulls away from the teeth	0 (0.0)	23 (31.1)	NA

*By McNemar test*By McNemar test

It is evident in Table 6 that the mean of HbA1c was 8.56% before the educational program, it decreased significantly to 7.81% after the program ($p < 0.001$). The FBS also decreased significantly from 214.78 mg/dl before the program, to 189.04 mg/dl after the program ($p = 0.003$). No significant difference was detected in the mean of BMI ($p = 0.192$) as presented in Table 6.

Table 6. HbA1c, FBS, and BMI, before and after the educational program.

	Before		After		
	Mean	(SD)	Mean	(SD)	P*
HbA1c%	8.56	(0.73)	7.81	(0.96)	< 0.001
FBS (mg/dl)	214.78	(77.56)	189.04	(67.35)	0.003
BMI (Kg/m^2)	30.12	(5.47)	29.96	(5.32)	0.192

*By paired t-test.

DISCUSSION

Diabetes increases the likelihood of oral health issues, and there appears to be a close link between glucose levels and periodontal disease. Periodontal inflammation can trigger inflammatory reactions that worsen diabetes and increase mortality. 17 All health practitioners should prioritize educating diabetic patients about the reciprocal association between oral illnesses and diabetes mellitus, encouraging healthy oral habits, and referring them to the dentist regularly when necessary.

Knowledge

In the current study, 25.7% of patients knew that diabetes mellitus and oral disease were related, 14.9% believed that gum disease impacted their blood sugar, and only 9.5% knew that treating periodontal disease in diabetics may lower blood sugar. In contrast, the findings of the studies in Jordan by Habashneh R et al.,18 and in Iran by Atarbashi MF et al.,19 revealed that 48% and 50%, respectively, of the participants were aware that individuals with diabetes are more prone to periodontal diseases. Similarly, the Bahammam MA study revealed that 46.7% of patients were aware of the link between diabetes and periodontal disease. 7 Furthermore, compared to Shanmukappa's study, which was done in India and found that 31% of patients were aware that diabetics are more prone to gum problems than non-diabetics, the present study found that 25.7% of patients were aware that diabetic patients are more prone to oral diseases than non-diabetics. 21 Also, the fact that only 13.5% of patients were informed that they should exercise extreme caution in maintaining their oral health and should visit the dentist more frequently due to their illness suggests that clinicians may be underestimating the importance of dental health for diabetes patients. In contrast, Bahammam research found that 74.9% of patients received dental advice to take care of their oral health and monitor their blood sugar levels. 7 Such a discrepancy could be explained by cultural differences. Knowing the symptoms of periodontal disease is essential for people with diabetes because they are more likely to develop oral disorders. In the current study, participants' knowledge of the symptoms of periodontal diseases was assessed, and it was found that only a small percentage of participants correctly answered various questions. For example, only 64.7% of patients knew that gum bleeding when flossing or brushing, 37.8% knew that gum soreness and swelling were symptoms of periodontal diseases, 27% knew that gum redness and swelling were symptoms of periodontal diseases, and none of the participants were aware that gum pulling away from the teeth is one of the symptoms of periodontal disease. As regards the knowledge of symptoms of periodontal disease, another study done in Abha City, Saudi Arabia, found that 25% of participants recognized bleeding during brushing as a symptom of gum disease. Additionally, just 21.2% were aware that swollen, red gums indicate gum disease, and 21.7% identified gum soreness as a sign of gingival issues. 20 However, the present study showed marked and significant ($p < 0.001$) improvements in all the knowledge items after the educational program. There has been a lot of research done to see if people with diabetes understand oral health; however, there isn't much material available in Iraq.

Practice

Before the teaching program, only 37.8% of patients had frequent dental checkups, which was different from that done in Iraq, as reported by the Aziz HK research, where 8.3% of patients had regular dental appointments. 6 Furthermore, a minority of participants (23%) used dental floss to clean in between their teeth, 23% of participants used other cleaning tools, 25% of participants used mouthwash, and 39.7% of the patients changed their toothbrush once per year, and the duration of teeth cleaning in 63.5% of patients who brushed their teeth took one minute. These findings demonstrated that oral health practices are uncommon in this cohort. Only 36.5% of participants brushed their teeth once a day, 28.4% occasionally, and 14.9% never did. This result disagrees with the result of research by Shanmukappa SM et al. that found 70% of patients brushed their teeth once each day, 25% twice a day, and 2.2% occasionally. 21 People with diabetes may believe that when their gums bleed while brushing, they should stop brushing or flossing. Similarly, people with diabetes who experience dry mouth might not know that using alcohol-based mouthwash can worsen their condition. These misconceptions and lack of

accurate oral health knowledge can significantly hinder the effective management and prevention of oral diseases in groups of high susceptibility. 21 In another study done in Hamedan city, Iran, conducted by Taheri JB et al. among 371 diabetic patients, knowledge of diabetic patients was evaluated at baseline, then an oral education program was provided. One month later, knowledge of patients was evaluated, yet no significant increase in the knowledge regarding oral manifestation and complication was observed (p=0.518). 22 The improvement in oral health practices following oral health education for patients is the most remarkable finding in this study. Therefore, supporting excellent oral hygiene practices and promoting information about their application should be done to enhance periodontal health and prevent gingival illnesses in this population, who are at high risk. Similar findings of poor oral hygiene in individuals with diabetes have been reported by other researchers. 18

Glycemic control

Other significant findings in this study are the mean of HbA1c before and after the educational program (8.56 and 7.81, respectively) with high significance ($p < 0.001$) and the mean of FBS before and after OHC measures (214.7 and 189, respectively) with $p = 0.003$. These findings are similar to those of Hadratie et al., a study done in Iraq that found a significant difference in HbA1c after three months of oral hygiene control measures. 8 To counteract any adverse impacts that diabetes may have on an individual's quality of life, it is evident that raising diabetic patients' awareness of DM complications is crucial. At the same time, raising healthcare professionals' understanding will likely result in an improvement in their attitudes and actions toward the treatment of diabetes patients. 8 More than half of the patients (56.8%) in this study had a history of mouth diseases. That is inconsistent with the result of a study conducted by Zhang et al., 23, which showed that 58% of the participants had oral disease in the previous year. Similarly, another study done by Weinspach et al., 24, demonstrated that 63.1% of T2DM sufferers had severe periodontal disease, whereas only 26.7% had moderate periodontal disease. Regular preventative dental care identifies oral health problems early and provides opportunities for oral self-care instruction. The result of this study did not show any significant changes in compliance with taking the antidiabetic medications before and after the educational health program. Forgetfulness in taking the medicine, carelessness at times in taking the medicine, and stopping the medicine when feeling better or worse (p=0.092, p=0.146, p=0.180, and p=0.180, respectively), the cost, and the availability were reasons that may have contributed to non-adherence. Therefore, adherence instruction, the use of alarms, and the way to mitigate non-affordability, including anti-diabetic medications into a drug program, should all be considered. Due to its straightforward, practical, and noninvasive manner, BMI is still the most widely used indication for diagnosing obesity at this time, and it is frequently employed in research. This study showed the mean BMI before and after oral health education (30.12 and 29.96, respectively), with no significant decrease in BMI after education ($p = 0.192$). Like current findings, another study done in Iraq (8) also showed no change in BMI before and after three months of the instructions (the mean was 24.128 and 23.866, respectively). A longer period of ongoing follow-up could potentially support education and yield more beneficial outcomes.

Lastly, it's critical to recognize a few drawbacks of the current study. First of all, because this was a quasi-experimental study, recruiting subjects to come back for additional testing and follow-up proved difficult. Even though the sample size was chosen using a convenient sample, it's still a small one. Finally, let's discuss the brief study session.

Conflict of interest: The authors declare no conflict of interest.

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