

Caries experience and selected caries-risk factors among a group of adult diabetics

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نخر الأسنان ونخبة من عوامل خطورة الإصابة به لدى مجموعة من مرضى السكري البالغين (النوعين ١ و ٢) الأهداف: التحقيق في نسبة انتشار وعوامل خطورة نخر الأسنان بين مجموعة من مرضى السكري البالغين وتحديد أثر العوامل الاجتماعية والتاريخ الطبي وعوامل الخطورة وسلوكيات صحة الفم على مدى انتشاره. الطريقة: أجريت الدراسة (مراقبة حالة) على ١٥٠ بالغ من مرضى السكر (النوع ١ = ٤٩، النوع ٢ = ١٠١) و ٥٠ ضابط سليم مطابق من حيث الجنس العمري. جمعت البيانات عن طريق استبيان وفحص سريري وتحاليل مختبرية. النتائج: خبرة نخر الأسنان لدى مرضى السكري مباشرة على المؤشر dmft لم يختلف إحصائياً عن فريق الضابط. ولكن من خلال استبعاد مساهمة فقدان الأسنان من المؤشر dmft أظهرت النتيجة انخفاض نخر الأسنان لدى المرضى وذلك يرجع إلى حد كبير إلى انخفاض عدد ملاء الأسنان (حشوها) ($p > .001$). معدل نخر الأسنان الجذري الحالي لدى مرضى السكري كان أعلى من غير مرضى السكري على الرغم من أن المؤشر dmft الجذري لم يظهر اختلاف بين المجموعات. مرضى السكري أظهروا زيادة في القدرة العازلة لدى اللعاب مع زيادة في عدد العصبيات اللبينية ولكن لا يوجد هناك اختلاف في معدل التدفق اللعابي أو عدد العقديات الطافرة مقارنة مع الضوابط. أشارت النتائج الإجمالية أنه ليس هناك اختلافات إحصائية كبيرة في انتشار نخر الأسنان وعوامل الخطورة بين نوعي السكري الأول والثاني. العوامل التي تساهم في ارتفاع نخر الأسنان بين المجموعات كانت متوافقة مع المعلومات الحالية عن مخاطر نخر الأسنان مثل زيادة العقديات الطافرة وانخفاض القدرة العازلة لللعاب وقلة التنظيف. خاتمة: وجود نخر الأسنان لدى مرضى السكري لم يكن إحصائياً مرتفعاً ولكن بعض من مرضى السكري في خطر وخاصة للإصابة بنخر جذور الأسنان.

OBJECTIVES: To investigate the prevalence of dental caries and selected caries-risk factors among a group of adult diabetics and to determine the impact of sociodemographic, medical history, caries risk factors and oral health behaviors on caries experience. **SUBJECTS and METHODS:** A case-control study was conducted on 150 adult diabetics (Type 1= 49, Type 2= 101) and 50 healthy, sex and age-group matched controls. The data were gathered by questionnaire, clinical examination and laboratory investigations. **RESULTS:** The diabetics' coronal caries experience based on the DMFT scores was not statistically different from that of non-diabetics. However, by excluding the contribution of missing teeth from the coronal DMF index, the result showed lower diabetics' caries experience due to a lower number of filled teeth ($P < .001$). The prevalence of diabetics' current root caries (DT scores) was statistically significantly higher than that of non-diabetics, although there were no statistical significant differences in the root DMFT values between the groups. The diabetics showed significantly higher buffer capacity and *lactobacilli* counts but similar salivary flow rates and *mutans streptococci* counts in comparison to controls. The overall results indicated no significant statistical differences in the prevalence of dental caries or caries-risk factors between Type 1 and Type 2 diabetics. Factors contributing to higher caries experiences among the groups were plausible with current information on caries risk, e.g., high *mutans streptococci* counts, lower buffer capacity and less brushing frequency. **CONCLUSION:** The presence of dental caries is not significantly elevated in most diabetics but a certain subpopulation may be at risk, especially for root caries.

INTRODUCTION

Diabetes mellitus (DM) is a common chronic metabolic disorder which affects millions of people. The prevalence of diabetes for all age groups worldwide was estimated to be 2.8% in 2000 and may reach 4.4% by 2030. Additionally, the diabetic population is expected to rise from 171 million in 2000 to 3666 million by 2030.¹ Recent World Health Organization calculations indicated that

worldwide, almost 3 million deaths per year are attributed to diabetes, equivalent to 5.2% of all deaths.²

As a systemic disorder, the disease affects the oral cavity. Investigators have reported several oral lesions and conditions associated with the disease. These include among others, xerostomia, burning mouth, altered taste sensation, gingivitis, periodontal disease, candidal infection and lichen planus.³⁻⁵ However, among researchers there is a lack

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of consensus about the relationship between DM and dental caries. They reported increased,⁶⁻⁹ decreased^{10,11} and similar^{5,12,13} caries experiences between those with and without diabetes. Taylor and others concluded in their literature review that there was insufficient evidence to determine whether a relationship exists between diabetes and coronal or root caries risk, and they recommended that further investigations should be carried out.¹⁴

Beside the contradictory findings on caries prevalence among diabetic populations, similarly conflicting results have been reported on the identity of the underlying risk factors of such relationships.¹²⁻¹⁶ It is not clear whether this variability is mainly related to different patho-physiologic changes of diabetes such as the type, duration or degree of control, or is in part a reflection of racial and environmental differences among diabetic populations worldwide.

In Saudi Arabia, diabetes mellitus is recognized as a major health problem. Earlier reports indicated that nearly one Saudi in five above the age of 30 years has DM,¹⁷ while the latest report showed that the overall prevalence of DM among adult Saudis of both sexes in rural as well as urban communities is 23.7%.¹⁸ Despite these recognized high rates of DM among the Saudi population, efforts that have been made to evaluate the oral health among diabetic groups were scanty.^{19, 20}

Motivated by all of the above information, this study was carried out with the following objectives:

1. To assess and compare the prevalence of dental caries and oral health status among a group of adult diabetics versus their age and gender-matched non-diabetic controls.
2. To evaluate the prevalence and impact of selected caries-risk factors, sociodemographic, medical history and oral health behaviors on caries experience in the sampled diabetics.

MATERIALS AND METHODS

Study Population

One hundred fifty diabetic patients and 50 healthy controls participated in this study. The diabetic groups were recruited from the diabetic clinics of King Abdul-Aziz University Hospital (KAAUH), Jeddah, Saudi Arabia. Consecutive eligible patients during sampling day were asked to participate and 100% of those who were invited to participate in the study agreed. The inclusion criteria were diagnosed having diabetes either Type 1 or 2, and age of up to or more than 18 years. The control group included age-grouped and sex-matched healthy volunteers with no history of diabetes. They were selected from KAAUH, including diabetic patients' companions as well as dental auxiliaries. Individuals who had received antibiotics or steroid therapy or had been using antiseptic mouthwashes during the previous 3 weeks were excluded from the study. All subjects in both groups gave informed signed consents to participate in the study. The study protocol was approved by the ethics committees of the KAAU medical faculty.

Data Collection

The data were gathered through questionnaire, clinical examination and laboratory investigations. The investigators controlled the completion of the questionnaire which included questions on personal sociodemographic data, medical history and oral health behaviours.

The patient's hospital records were used to provide information regarding diabetes type, duration, current medication and presence of diabetic-related systemic complications (retinopathy, nephropathy, neuropathy and peripheral vascular diseases). The presence of any of these

complications was considered a positive finding and rated on a scale of yes or no.

All the participants underwent the following clinical examinations and laboratory investigations between 9 am to 12 noon.

Clinical Examination

The clinical examination included an evaluation of dental coronal and root caries, by any of the calibrated researchers using the decayed missing filled teeth (DMFT) index according to the criteria and recommendations of the World Health Organization in 1997.²¹

Laboratory Investigations

Salivary Samples

Mixed unstimulated saliva was collected from each participant over a 5-minute period. The subject was typically instructed not to eat, drink or smoke 2 hours before the test and to lean the upper body forward, and allow oral fluid to drip into a graduated collection vial, without swallowing.²² The sample was sent immediately to the microbiology laboratory at KAAUH and used subsequently to calculate the salivary flow rate as ml / min and to determine saliva buffering capacity as well as the microbiological assay counts of *mutans streptococcus* (*MS*) and *Lactobacillus* (*Lb*). Saliva buffering capacity was determined with the use of a test strip featuring a special indicator system from CRT buffer (Ivoclar Vivadent, 9494 Schaan, Principality of Liechtenstein, FL). The bacterial assay was performed to determine the proportion of *MS* and *Lb* counts of each sample, using bacterial kits of dentocult method (CRT bacteria, Ivoclar Vivadent, 9494 Schaan, Principality of Liechtenstein, FL). The assay procedures for the above

investigations were carried out according to the manufacturer's instructions of the mentioned kits. The colony densities were classified into three groups: $\leq 10^4$, $10^4 - 10^5$ and $\geq 10^5$ colony forming units / ml saliva indicating low, medium and high bacterial counts respectively.

Blood Samples

Five milliliter of blood were collected from each participant in the phlebotomy laboratory and analyzed at the hematology laboratory of KAAUH. For diabetic patients, the sample was used to measure the glycosylated haemoglobin concentrations (HbA_{1c}) which assess the glycaemic control of that patient. Measures of less than 10% were classified as indicating satisfactory control of diabetes, values from 10-13% were moderate and values greater than 13% were classified as poor control of diabetes. However, for control subjects, the samples were used to measure the fasting plasma glucose level. Those with values greater than or equal to 6.8 mmol / ml were excluded from the study.

Statistics

Data were collected and analyzed using SPSS program version 12. The data were analyzed descriptively and comparison between the groups was done using independent t-test, Chi-square, Fisher's Exact test as well as Mann Whitney tests whenever applicable. Variable relations were expressed about demographic data, medical history and oral health habits. Pearson's correlation test was used to calculate correlation coefficients between continuous variables, while the analysis of variance (ANOVA) was applied in the comparison of several means. The level of significance was set at 0.05 throughout the study.

RESULTS

The distribution of participating subjects in relation to age, sex, race and socio-economic status is shown in Table 1. There were no statistically significant differences between the socio-demographic data of the diabetic patients and the control groups, except for the educational levels and the nationalities, where more non-Saudi subjects with higher education were encountered among the control group ($P < .005$).

The diabetic cases comprised 49 Type 1 and 101 Type 2 diabetic subjects. There were no statistically significant differences between the two types either in their socio-demographic data or in their disease history except for the age and the degree

of glycaemic control. Type 2 diabetics were older than Type 1 and showed better glycaemic control in comparison to Type 1 ($HbA_{1c} \bar{X} \pm SD = 8.95 \pm 1.78$ versus 10.06 ± 2.06 , respectively, t-test $P = .001$) as shown in Tables 1 and 2.

The results of the oral health behaviour questionnaire are illustrated in Table 3. The results showed better oral health habits regarding brushing frequency, use of dental floss and dental visits among the control group in comparison to the diabetic patients ($P < .005$). However, no such significant differences were found between the two types of diabetic groups. Also, there were no statistically significant differences between the three groups relative to current tobacco use.

Table 1. Demographic data of diabetic and control subjects.

Variable	Diabetic patients		†P-value	Diabetic patients (n=150)	Healthy controls (n=50)	†P-value
	Type 1 (n=49)	Type 2 (n=101)				
Gender						
Male	34.7%	44.6%	.250	41.3%	38%	.678
Female	65.3%	55.4%		58.7%	62%	
Age – group (years)						
18 – 20	16.3%	1%		6%	2%	
20 – 30	16.3%	2%		6.7%	12%	
30 – 40	20.4%	6.9%	.000	11.3%	20%	.126
40 – 50	10.2%	33.7%		26%	32%	
> 50	36.7%	56.4%		50%	34%	
Nationality						
Saudi	31.3%	33%	.831	32.4%	10%	.002
Non Saudi	68.8%	67%		67.6%	90%	
Education						
< High School	65.3%	73.3%		70.7%	36%	
High School >	20.4%	12.9%	.467	15.3%	14%	.000
High School	14.3%	13.9%		14%	50%	
Income						
* SR / month						
< 1500	46.2%	34.2%		37.4%	30%	
1600 – 3000	23.1%	39.7%		35.4%	50%	
3000 – 5000	11.5%	15.1%	.334	14.1%	14%	.277
> 5000	19.2%	11.0%		13.1%	6%	

* SR= Saudi Riyals, † Chi-square test

Caries Prevalence

The median scores of the decayed, missing and filled teeth indices according to the coronal and root examinations is summarized in Tables 4 and 5,

Table 2. Medical characteristics of the studied diabetic groups.

Variable	Type 1 (n=49)	Type 2 (n=101)	P-value
Disease duration (years)			
≤ 5	31.1%	32.3%	
5 – 10	17.8%	20.8%	
10 – 15	20%	24.0%	.759*
≥ 15	31.1%	22.9%	
Physician follow up			
≤ 3 month	50%	36.4%	
3 month– 1 year	40%	53.4%	.322*
≥ 1 year	10%	10.2%	
Systemic complications			
Yes	94.1%	97.7%	.310†
No	5.9%	2.3%	
HbA1c			
$\bar{X} \pm SD$	10.06 ± 2.06	8.95 ± 1.78	.001‡

* Chi-square test, † Fisher's Exact test, ‡ T-test.

Table 3. Oral health behavior of diabetic and control subjects.

Variable	Diabetic patients		* P-value	Healthy control (n= 50)	Patient diabetics (n= 150)	* P-value
	Type 1	Type 2				
Tooth brushing frequency						
None	10.6%	15.5%		4.1%	13.9%	
< Once a day	2.15	2.1%		0.0%	2.1%	
Once a day	36.2%	38.1%	.832	18.4%	37.5%	.002
> Once a day	51.1%	44.3%		77.6%	46.5%	
Oral cleaning methods						
Brush	83.3%	78.3%		52%	79.9%	
Miswak (tooth stick)	4.8%	8.7%	.698	4%	7.5%	.000
Brush + floss	11.9	13%		44%	12.7%	
Regular dental visit						
Yes	8.5%	6.1%		38%	6.8%	
No	55.3%	53.5%	.801	50%	54.1%	.000
Some times	36.2%	40.4%		12%	39.0%	
Last dental visit						
< 1 month	13.2%	17.2%		35.4%	16.0%	
1-6 month	15.8%	12.6%	806.	35.4%	13.6%	000.
6 mos-1 yr	105%	14.9%		10.4%	13.6%	
> 1 year	60.5%	55.2%		18.8%	56.8%	
Tobacco use						
Yes	12.8%	8.9%	47.	10%	10.1%	98.
No	87.2%	91.1%		90%	89.9%	

* Chi-square test

respectively. Comparison of coronal caries experiences between the diabetic patients and the control groups showed that there were no statistically significant differences in coronal DMF teeth scores as well as the median scores of the current active caries (DT) shown in Table 4. However, by excluding the contribution due to

Table 4. The median (IQR) values of coronal decayed, missing and filled teeth indices.

Variable	Diabetic patient			Diabetic patients MD (IQR)	Healthy control MD (IQR)	* P-value
	Type 1 MD (IQR)	Type 2 MD (IQR)	* P-value			
DMFT	8 (11)	11 (12)	.164	9.5 (12)	11 (10)	.670
DFT	3 (4)	3 (5)	.861	3 (5)	6 (6)	.001
DT	2 (4)	1 (3)	.153	1 (4)	0 (3)	.286
MT	3 (9)	5 (11)	.121	4 (10)	3 (5)	.290
FT	0 (1)	0 (3)	.081	0 (2)	3 (6)	.000

* Mann-Whitney test

Table 5. The median (IQR) values of root decayed, missing, filled teeth indices.

Variable	Diabetic patient			Diabetic patients MD (IQR)	Healthy control MD (IQR)	* P-value
	Type 1 MD (IQR)	Type 2 MD (IQR)	* P-value			
DMFT	4 (11)	7 (14)	.281	6 (14)	3 (9)	.146
DFT	1 (3)	0 (3)	.966	.5 (3)	0 (2)	.107
DT	1 (3)	0 (2)	.844	.5 (3)	0 (2)	.035
MT	3 (8)	5 (11)	.181	4 (9)	3 (5)	.343
FT	0 (0)	0 (0)	.500	0 (0)	0 (0)	.093

*Mann-Whitney test

missing teeth, the prevalence of coronal decayed and filled teeth was significantly lower among the diabetics than their matched controls. The median DFT in diabetics was 3 (IQR=5) versus 6 (IQR= 6) in the controls and the differences were attributed mainly to more restored teeth in the control group.

Regarding root caries prevalence, the diabetic group showed statistically significantly higher current root decays than the control group ($P = .035$) although there were no statistically significant differences in the root DMFT or DFT

median scores between the groups ($P > .05$, Table 5).

Comparison of the prevalence of both coronal and root caries in the diabetic groups according to the types of the disease showed almost consistently higher scores among Type 2 diabetics than Type 1, but the results were not statistically significant ($P > .05$).

Caries-Risk Factors

The studied caries-risk factors among the diabetics and their matched controls are described in Table 6. The diabetics had statistically significant higher buffer capacity as well as *lactobacillus* counts compared to the controls. However, there were no statistically significant differences in the levels of the salivary flow rates or in the *mutans streptococci* counts among the groups ($P > .05$).

A comparison between the types in the diabetic groups showed that there were no

Table 6. Distribution of caries-risk factors between the groups.

Variable	Diabetic patient		† P-value	Diabetic patients MD (IQR)	Healthy controls MD (IQR)	† P-value
	Type 1 MD (IQR)	Type 2 MD (IQR)				
Salivary flow rate (ml / min)	1.0 (1.3)	1.5 (1)	.195	1.5 (1)	1.5 (1.5)	.479
Buffer capacity	Median (1)	High (1)	.23	High (1)	Median (1)	.029
<i>Mutans streptococcus</i> counts (CFU/ml) *	<10 ⁴ (2)	<10 ⁴ (2)	.50	<10 ⁴ (2)	<10 ⁴ (2)	.314
<i>Lactobacillus</i> counts (CFU/ml) *	>10 ⁵ (1)	>10 ⁵ (2)	.73	>10 ⁵ (2)	<10 ⁴ (20)	.000

*CFU/ml= colony forming units/ ml saliva, †Mann-Whitney test

statistically significant differences in any of the studied salivary parameters among the groups.

Association Between High Caries Experience and Caries-Risk Indicators.

Table 7 summarizes the significant results of the univariate analyses of demographic data, medical history, caries-risk factors and oral health behaviour on high caries experience (coronal-DF and root-DMF indices) among the diabetics groups.

Table 7. P-values of the significant caries-risk indicators.

Variables	Coronal-DFT		Root-DMFT	
	Type 1	Type 2	Type 1	Type 2
Age	.003 older	NS	.006 older	.001 older
Gender	NS	NS	NS	.04 male
Nationality	NS	.049 Saudi	.02 Non-Saudi	NS
Education	NS	NS	NS	.047 higher
Disease duration	.012 <10ys	NS	.012 >10ys	.008 >10ys
Medical follow up	NS	NS	NS	.013 >1y
Tooth brushing frequency	NS	NS	.014 < once a day	.002 < once a day
MS counts	NS	.026 high	NS	NS
Buffer capacity	NS	.025 low	NS	NS

NS = non-significant

DISCUSSION

Studies that address the association between diabetes mellitus (DM) and dental caries are many, but their results have not revealed any strong pattern of association.⁸⁻¹³ Diabetes mellitus is a chronic disease that may impact on personal behaviour and socioeconomic status. Therefore, caution should be taken when assessing the impact of

the pathophysiology of diabetes on oral health status when these factors are not considered.¹³ This also may be one of the reasons that a difference in socioeconomic level was found between the diabetic patients and the control groups. The strength of this study is that the dental caries assessment included an array of potential risk factors for coronal and root caries including salivary factors and dental health behaviour.

The results showed that coronal caries experience among the diabetic group were almost similar to that of the non-diabetic group. There were no differences in their DMFT and current caries teeth (DT) scores. Because of the difficulty of obtaining accurate history on tooth loss due to caries, the DFT index was used excluding the M component to reflect the true caries experience. The results demonstrated that the diabetics showed lower DFT scores due to the smaller number of filled teeth among the group ($P = .001$). This result is in agreement with many authors who reported similar^{5,12,13} or lower^{10,11} coronal caries experience among adult diabetics. Whereas the present results are in disagreement, with local studies conducted earlier at the major cities of Saudi Arabia of Jeddah and Riyadh. The former indicated that caries experience of diabetics was higher than that of non-diabetics (DMF scores 12.76 versus 10.75),¹⁹ while the latter concluded that diabetic patients had higher levels of tooth mortality and greater needs for dental care.²⁰ The differences in the results can not be explained as long as none of these studies indicated the sample type or explained the criteria for assessing dental caries or specified the cause of tooth mortality that may have been due to reasons other than caries. To explain a lower caries experience in people with diabetes, authors usually attribute it to the fact that diabetics have traditionally been counseled to consume a diet low in

refined carbohydrates, especially sucrose, and have been advised to have an increased protein intake which enhances the buffering capacity of saliva.^{14,23} Other researchers reported a delayed eruption of permanent teeth in children with Type 1 diabetes, thus exposing teeth for less time to the caries process.¹⁰

However, root caries prevalence among the recruited diabetic group based on current root decays (DT score) was significantly higher than that in the non-diabetic group. The result is also supported by some researchers who reported a greater percentage of root caries in diabetics.^{6,7,9} However, controversy still exists on that point given that other authors indicated a lower prevalence of root caries in adult diabetics.²⁴

The caries-risk assessments give the dentist an excellent opportunity for prevention in order to avoid further decays. The current salivary tests were selected because they can be performed with ease and relatively quickly, and have been demonstrated to be valid indicators of caries prediction.²⁵ The results showed that diabetics had statistically significantly higher buffering capacity and *Lb* counts, but similar salivary flow rates and *MS* counts in comparison to the control group. As a part of the oral manifestations of diabetes, some authors reported changes in the salivary gland, such as increase in size, with alteration of its histology and changes in salivary flow rate and in the composition.^{11,12,26} But other authors have not observed changes in the flow rate, pH and salivary composition.^{6,27} Salivary buffering capacity is an important parameter for the maintenance of normal pH levels in saliva and plaque. The current results indicated a higher buffering capacity among the diabetic group than non-diabetics which may further explain the lower caries experience among the former group. The reason might be due to the higher-protein intake diet advised

for diabetics which increases the salivary buffer, and thus diminishing the impact of acid produced by bacterial plaque.^{14, 23}

Regarding the bacterial plaque, both *MS* and *Lb* have high acid tolerance and acidogenicity but *Lb* is not as cariogenic as *MS*.²⁸ The *Lb* levels are highly influenced by the intake of dietary carbohydrates and the frequency of food digestion, thus indicating an acid environment in the oral cavity.²⁵ The high *Lb* counts encountered among the studied diabetics could be explained by the enhanced acidic environments attributed to glucose secretion in both salivary and gingival fluids^{15, 29} as well as the repeated reduction in the pH of the oral cavity from frequent intervals of food ingestion.³⁰ However, many investigators reported no differences in *MS* and *Lb* counts between diabetics and non-diabetics subjects.^{11, 12} As far as the relation of salivary factors to dental caries among diabetics is concerned, some authors reported high caries prevalence or fillings to be related to oral yeast but not salivary flow rate, *MS*, *Lb* or buffering capacity,^{15, 16} while others reported a higher prevalence of dental caries among those with a lower salivary flow rate.^{13, 26}

The majority of studies which assessed dental caries among diabetics were carried out on Type 1 diabetics in all age groups. However, only a few studies included subjects from both types but did not distinguish between the types in their analyses.¹⁴ The current study indicated no statistically significant differences in caries experience (both coronal and root) between Type 1 and Type 2 diabetics. The possible explanation is that the diabetic groups were homogenous based on their socio-demographic factors, disease history and oral health behaviour, except for age and glycaemic control, which would be expected, as these are part of the disease characteristics.³¹ Some authors indicated that Type 1 had a higher number of

caries and fillings than Type 2,^{5, 9} while others, such as Moore *et al.*,¹³ reported no significant differences in DFS rates between the two types.

The distribution of caries-risk factors among the diabetic group based on their types also showed no statistically significant differences in any of the studied salivary parameters between Type 1 and Type 2 diabetics, which may further explain the similarity in caries experiences between the types.

Further examination of caries-risk indicators among the diabetic groups by analyzing the impact of demographic data, medical history and oral health behaviour showed that factors contributing to a higher caries experience were plausible with current information on caries-risk, e.g., high *MS* counts, lower buffer capacity and less brushing frequency.

Regarding the demographic data, older age was consistently associated with higher coronal-DF and root-DMF scores. These results disagreed with Arrieta-Blanco and others who found no significant differences in the number of caries, missing teeth and fillings in the different age groups of the diabetic population,⁵ but still in accordance with many authors who reported high caries prevalence among older diabetics.^{11, 13}

Regarding the disease history, longer duration of the disease was associated with higher root-DMF scores in both types of diabetes, while the disease duration of less than 10 years was associated only in Type 1 diabetes with high coronal-DF score. But overall, there were no associations between the metabolic control of disease as well as the existence of late complications and dental caries in the groups. Within the diabetic population, the type of diabetes, degree of control, disease duration and the existence of late complications were assessed by several

studies, but no consistent findings have been found.^{5,8,12,13} An explanation of variations in the results could possibly be due to large variations of study design and methodology, settings, subjects included and analytic strategies. Some studies which considered disease duration in their analysis found no relationship between the diabetes duration and caries experience,^{5,7} others reported a greater experience in subjects with a longer duration,^{8,32} and other reported the reverse.³³ The current study supports many studies that found no differences in the caries experience and the metabolic control^{12,13} or the existence of diabetes late complications.^{5, 12}

Regarding oral health behaviour, Moore *et al.* found that tobacco use in diabetic subjects and oral health behaviour were similar to those of non-diabetic subjects, but diabetics were somewhat less likely to visit their dentists for routine examination.³⁴ The reasons reported previously were financial and a time burden.³⁵ However, in this study, we found that diabetics had general poor oral health behaviour in comparison to the non-diabetic controls. A possible explanation, apart from their medical status, was a lack of dental health education among the diabetic group.

Prevention of dental disease in diabetics depend on education and health promotions strategies such as early diagnosis, proper oral health, diet counseling, rigorous glycaemic control and smoking cessation counseling. Increasing the proportion of people with diabetes who have at least annual dental examinations is an objective of the American National Institutes of Health.³⁶ Further researches are needed to assess diabetic oral health behaviour, diabetics' need for oral health education and to determine the obstacles in acquiring proper oral health behaviours in various regions of Saudi Arabia.

CONCLUSION

The present study confirmed data from previously published reports that the presence of dental caries was not significantly elevated in most diabetic patients, but suggested that certain subpopulations may be at risk, especially for root caries. Therefore, prevention strategies should be individualized to patient needs and close collaboration between the patient, primary health care and oral health professionals could be an approach for improving the general and oral health of diabetic patients.

ACKNOWLEDGEMENT

The research group acknowledges with thanks, the Scientific Research Council of King AbdulAziz University (KAAU) which granted us the financial support during this research project (No. 424/061). Our sincere thanks also goes to the staff in KAAU hospital for their help and assistance, in particular the doctors at the Diabetic Clinics and technicians in the laboratories. Finally, our special gratitude goes to Prof. Hala Amer and Mrs. Susan Akyurt for their valuable assistance.

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