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Original Article

Dental health status of children with diabetes in Riyadh, Saudi Arabia

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ABSTRACT

Objective: The impact of diabetes on oral diseases remains debatable. We aimed to determine the prevalence of dental caries, gingival health status and knowledge, and oral hygiene level and practice in children with type 1 diabetes mellitus in Riyadh, Saudi Arabia.
Methods: The teeth of Sixty children with diabetes (33 males and 27 females; age 11.3 ± 2.2 [7–14] years) were examined for dental caries following the modified World Health Organization criteria. Data on age, sex, medical history, gingival health status and knowledge, and oral hygiene level and practice were collected from parents.
Results: In this study, 53 % of the children had dental caries with decayed, missing, and filled primary and permanent teeth scores of 5.6 ± 3.8 and 3.6 ± 3.2, respectively, with similar scores for male and female children. Children with and without caries had similar oral hygiene practices and oral health knowledge but differed in the rates of good or fair oral hygiene status (89.2 vs. 56.6 %; $P = 0.024$) and normal gingival health status or mild gingivitis (96.5 vs. 81.3 %; $P = 0.010$).
Conclusions: We found that the oral hygiene status and rate of gingivitis differed in children with type 1 diabetes mellitus with or without dental caries.

1. Introduction

Diabetes mellitus (DM) is an increasing health concern, with overall 463 million individuals having DM. Moreover, 1.1 million children and adolescents aged <20 years have type 1 DM. This number is expected to reach 578 million worldwide by 2030 (IDF, 2019). The Saudi Health Interview Survey reported a DM prevalence of 14.8 % in males and 11.7 % in females in 2013 (MOH, 2020). Studies in children and adolescents in Saudi Arabia showed that type 1 DM was more prevalent in females than males and had higher incidence rates in the older age groups of children and adolescents than in the younger age groups (Alotaibi et al., 2017). Type 1 DM is a chronic metabolic disease that damages the pancreatic beta cells, resulting in insulin deficiency that affects carbohydrate metabolism (Novotna et al., 2015). Elevated blood glucose concentrations might harm various organs in the body (Zaccardi et al., 2016). Children with diabetes are subjected to a significantly higher risk of intraoral diseases than healthy individuals (Lamster et al., 2008). However, the impact of diabetes on oral diseases and the underlying mechanisms remains debatable (Moore et al., 2001). Oral complications that might develop due to hyperglycemia, include salivary alterations, gingivitis, periodontitis, and candidiasis (Orbak et al., 2008; Malicka et al., 2014). The risk of dental caries in type 1 DM remains controversial. Some studies have shown that the incidence of dental caries was higher in children with type 1 DM than in the control groups (Wang et al., 2019). Poor oral hygiene has been reported as the main cause of dental decay among children with diabetes (Alavi et al., 2006), and decreased salivary pH and flow rate have been recorded as causative factors among these children (Rai et al., 2011). Additionally, a study attributed low caries rates observed in children with controlled diabetes to a diet comprising low refined carbohydrates, which is less cariogenic (Novotna et al., 2015; Kamran et al., 2019).

Periodontal disease and gingivitis occur more frequently in children with diabetes than in those without, and their severity is associated with the degree of glycemic control (Jindal and Parihar, 2015; Rafatjou et al., 2016).

Previous studies in Saudi Arabia have reported a very high caries prevalence among school children (AlDosari et al., 2010; Alhabdan et al., 2018; Al-Rafee et al., 2019). However, the true prevalence of dental caries and periodontal diseases in those with type 1 DM requires further investigation.

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In healthy children, oral hygiene status has been associated with caries and gingival status (Wyne et al., 2002). However, studies on oral hygiene, gingival health, and caries in Saudi children with DM are limited (Wyne et al., 2016; Al-Badr et al., 2020). Further information is needed to understand the extent of dental problems in children with type 1 DM and quantify possible links and causative factors so that oral disease preventive programs could target susceptible populations. This study aimed to determine the prevalence rate of dental caries, gingival health status and knowledge, and oral hygiene level and practice in children with type 1 DM in Riyadh, Saudi Arabia.

2. Materials and methods

This cross-sectional cohort study randomly sampled children with type 1 DM from the Endocrinology and Metabolism Clinic at King Abdulaziz University Hospital in Riyadh, Saudi Arabia. Based on sample size determination at alpha level of 0.05 and effect size (ES) of 0.49 (between median and large) with power of 0.90, the total sample size should be at least 60 children. The participants were examined during routine visits at the clinic. Children with other medical conditions (unrelated to DM) were excluded. Patients were selected with a diabetes duration of over two years (range, 2–12 years) who received daily insulin injections. The ethics committees of the College of Dentistry Research Center at King Saud University (NF 2215) and King Abdulaziz University Hospital (P NO, E-10-238) approved this study. A consent form, which contained an explanation of the study objectives, was used to obtain permission from the parents of the children to participate in the study.

The information used in this study was pre-tested on parents who did not participate in the study, and modified to make it more comprehensible to parents. This data included general required information on the child's age and sex and specific queries on gingival health status and knowledge and oral hygiene level and practice. All participants were examined by the same senior pediatric dentist, following the 1997 World Health Organization criteria for diagnosing dental caries (Oral Health Survey, 1997) (Status: Sound code A for primary teeth and O for permanent teeth, Decayed code B for primary teeth and 1 for permanent teeth, Filled, with decay code C for primary teeth and 2 for permanent teeth Filled, No decay code D for primary teeth and 3 for permanent teeth, Missing [caries] code E for primary teeth and 4 for permanent teeth, Fissure Sealant code F for primary teeth and 6 for permanent teeth).

Assessing decayed, missing, and filled primary teeth (dmft) and decayed, missing, and filled permanent teeth (DMFT) separately. This study followed the previously reported oral hygiene examination, (James et al., 1960) with three dental cleanliness categories: good, the teeth were clean with no sign of food debris or *materia alba*; poor, the teeth were very dirty with considerable long-standing food debris and *materia alba*; fair, between good and poor, showing some evidence of debris, but to lesser extent than that in poor. The gingival index described by Nanda (Nanda, 1990) was used to assess gingival health status, with the following severity classification: normal: pale pink color, firm, no bleeding on firm digital pressure, pointed to slightly rounded contour; mild gingivitis: a slight color change and a minor loss of contour; moderate gingivitis: swelling, glazing, redness, tendency to bleed on slight pressure, blunted or rounded papillae or margins unlike normal tissue; profound gingivitis: severe inflammation with swelling, redness, spontaneous bleeding, and slight degeneration; very severe gingivitis: more severe than profound gingivitis and includes ulceration and sloughing. Intra- and inter-examiner reproducibility were assessed. The intra-examiner reproducibility was assessed in a group of 10 children aged 7–14 years, resulting in a weighted kappa of 0.95. The inter-examiner reproducibility (the examiner with a senior pediatric dentist) involved a different group of 10 children with similar age, which yielded a weighted kappa of 0.93.

The clinical examination was performed at the King Abdulaziz University Hospital (after obtaining the signed consent from the parents) using disposable examination kits (Yancheng Diling Medical Instrument Co., Ltd, Yancheng, Jiangsu, China) and portable lights while the child sat on a portable chair. Data were recorded in a form specially designed for this study.

Data analysis was performed using SPSS for Windows, Version 16 (SPSS Inc., Chicago, IL, USA) and included descriptive statistics and chi-squared and Z tests. Statistical significance was set at $P < 0.05$.

Table 1
The prevalence of dental caries by sex in children with diabetes.

Gender	Total	Children with Caries		Children without Caries		*P*-value
		Number	%	Number	%	
Male	33	20	60.6	13	39.4	0.211
Female	27	12	44.4	15	55.6	
Total	60	32	53.3	28	46.7	–

Table 2
Dental caries relation to oral hygiene practices in children with diabetes.

Oral hygiene practices	Total (*n*)	Children with caries		Children without caries		*P*-value
		Number	%	Number	%	
Teeth cleaning time						
-Morning	6	4	67	2	33	0.816
-Night	14	7	50	7	50	
-Both morning and night	9	5	56	4	44	
-After every meal	4	3	75	1	25	
-No specific time	27	13	48	14	52	
Teeth brushing duration						
-1 min	16	10	63	6	37	0.806
-2 min	14	7	50	7	50	
-3–4 min	5	3	60	2	40	
-Do not know	25	12	48	13	52	
Toothbrush change frequency						
-Every 1–3 months	25	15	60	10	40	0.979
-Every 6 months	11	3	27	8	73	
-When the bristles get frayed	5	2	40	3	60	
-When the indicator color fades	8	7	88	1	12	
-Whenever (I/my parents) buy a new tooth brush	11	5	45	6	55	
Other aids used to clean the teeth						
-None	20	12	60	8	40	0.921
-Inter-dental brush	3	2	67	1	33	
-Mouth wash	3	2	67	1	33	
-Tooth pick	9	4	44	5	56	
-Miswak	33	18	54	15	46	
If you clean your tongue, what do you use						
-Tooth brush	23	13	56	10	44	0.696
-Tongue cleaner	0	0	0	0	0	
-I do not clean	37	19	51	18	49	
The function of toothpaste is to						
-Freshen the breath	28	15	54	13	46	0.94
-Deliver fluoride	28	15	54	13	46	
-Facilitate brushing	42	21	50	21	50	
Does your toothpaste contain fluoride?						
-Yes	16	7	44	9	56	
-No	3	2	67	1	33	0.627
-Do not know	41	23	56	18	44	

Table 3
Dental caries condition in relation to oral health knowledge in children with diabetes.

Oral health knowledge	Total (*n*)	Children with caries		Children without caries	
		Number	%	Number	%
-Do you think tea with sugar can cause dental caries? [yes]	47	2 1	45	26	55
-Do you think tea without sugar can cause dental caries? [no]	57	30	53	27	47
-Do you think coffee with sugar can cause dental caries? [yes]	46	21	46	25	54
-Do you think coffee without sugar can cause dental caries? [no]	55	29	53	26	47
-Do you think fresh juices can cause dental caries? [no]	53	30	55	23	45
-Do you think canned juices can cause dental caries? [yes]	50	25	50	25	50
-Do you think flavored milk can cause dental caries? [yes]	37	17	46	20	54
-Do you think carbonated drinks can cause dental caries? [yes]	55	31	56	24	44
-Do you think energy drinks can cause dental caries? [yes]	44	25	57	19	43
-Do you think it is important to keep your mouth and teeth clean? [yes]	60	32	53	28	47
Source of dental information					
-Parents and family members	38	20	53	18	47
-Teachers	23	13	56	10	44
-Peers and friends	2	2	100	0	0
-Health professionals	29	15	52	14	48
-Newspapers	11	3	27	8	73
-Radio	9	3	33	6	67
-Television	15	5	33	10	67
-Internet	7	3	43	4	57

Table 4
Dental caries condition in relation to oral health knowledge in children with diabetes.

Oral hygiene practices	Total (n)	Children with caries		Children without caries		*P*-value
		Number	%	Number	%	
Why does dental caries happen?						
-Lack of oral hygiene	44	21	48	23	52	
-Hereditary	0	0	0	0	0	0.547
-Poor nutrition	25	15	60	10	40	
-Infection	3	2	67	1	33	
How can we prevent dental caries?						
-Brushing regularly with toothpaste	56	30	54	26	46	
-Eating healthy & balanced diet	48	26	54	22	46	0.99
-Visiting the dentist regularly	51	28	55	23	45	
If you receive brushing instructions, who mainly gave them to you?						
-Parents	35	18	51	17	49	
-School teacher	6	4	67	2	33	
-Dentist	16	9	56	7	44	0.797
-No one	3	1	33	2	67	
Reasons for brushing your teeth						
-To have clean teeth	51	28	55	23	45	
-To prevent dental caries	51	26	51	25	49	
-To prevent gum disease	36	17	47	19	53	0.996
-To have pleasant breath	42	21	50	21	50	
-To set a good example for others	23	12	52	11	48	
Reasons for not brushing your teeth						
-Bothers me	5	3	60	2	40	
-No time	19	12	63	7	37	0.916
-Useless	6	3	50	3	50	
-Gums bleed on brushing	8	4	50	4	50	
-Forget to brush	45	23	51	22	49	

3. Results

The study involved 60 children with type 1 DM (33 males and 27 females, mean age: 11.3 ± 2.2 [7–14] years). Of them, 32 (53 %) had dental caries, with mean dmft and DMFT scores of 5.6 ± 3.8 and 3.6 ± 3.2 points, respectively. No statistically significant difference (P = 0.211) was noted between male and female children in caries prevalence (Table 1).

Table 2 presents the dental caries conditions associated with oral hygiene practice factors. Diabetic children with and without caries had similar oral hygiene practices. Almost half of the children had no specific teeth brushing time and did not know when to brush their teeth. In total, 25 (42 %) of the children changed their toothbrush once every 1–3 months. Miswak was used by 33 (55 %) children to clean their teeth, and 37 (62 %) children did not clean their tongues. Seventy percent of children thought toothpaste facilitates brushing, and about the same number did not know if their toothpaste contained fluoride.

Table 3 shows some oral health knowledge factors related to dental caries, including dietary intake and dental information sources. Most participants (62–95 %) correctly answered information about the effect of sugar in common drinks and whether it could cause dental caries; however, answers differed between children with and without caries. Parents and family members were the source of dental information for 38 (63 %) participants.

Other information about dental caries-related oral health knowledge is presented in Table 4. Children with and without caries had similar oral health knowledge. Forty-four participants (62 %) answered that poor oral hygiene could cause dental caries. Most participants (80–93 %) answered the question "How can we prevent dental caries?" correctly, stating the need to brush regularly with toothpaste, eat a healthy and balanced diet, and visit the dentist regularly. Thirty-five participants (58 %) answered that parents were the main source of toothbrushing instructions. Moreover, 85 % of the participants answered that toothbrushing aimed to have clean teeth and prevent dental caries. Forty-five participants (75 %) answered that forgetting to brush their teeth was the reason for not brushing their teeth.

Oral hygiene status significantly differed (P = *0.0240*) between children with and without caries [Fig. 1]. Good or fair oral hygiene was more prevalent in children without caries (89.2 %) than in those with caries (56.6 %). Gingival health status also significantly differed (P = *0.0100*) between children with and without caries [Fig. 2]. Normal to mild gingivitis was more prevalent in children without caries (96.5 %) than in those with caries (81.3 %).

4. Discussion

This study described the association between oral health variables and type 1 DM in children in Riyadh, Saudi Arabia. Majority of our study participants had dental caries with rates lower than those reported in previous studies (Wang et al., 2019). The dmft and DMFT scores in this study were comparable to those previously reported by Wyne et al (2016) for children with type 1 DM in Riyadh, Saudi Arabia. In this study, the mean dmft score was higher than the mean DMFT score. This could be explained by several reasons; first, this could be due to the decrease in cariogenic bacteria during the transition from mixed to permanent dentition (Schlagenhauf and Rosendahl, 1990). Accelerated eruption of dentition at younger age could explain the higher amount of caries in primary dentition, in comparison to permanent teeth where it has been reported that a delay in eruption of these teeth is observed in

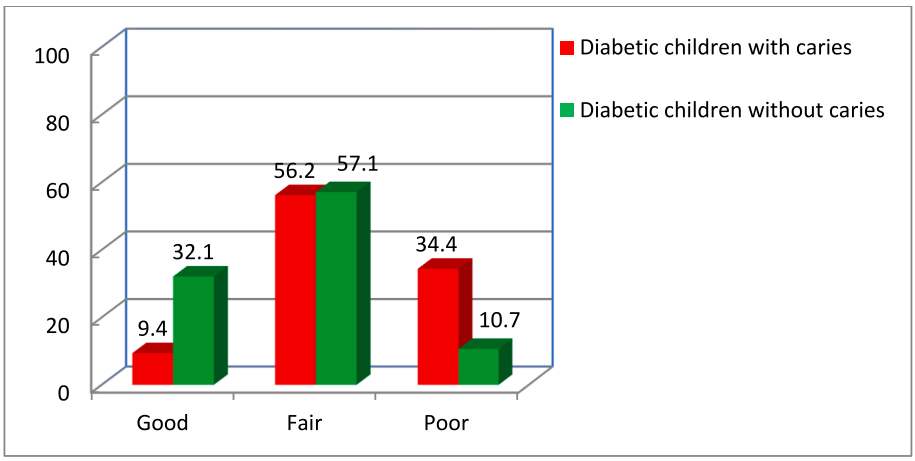

Fig. 1. Oral hygiene status in diabetic children with and without caries.

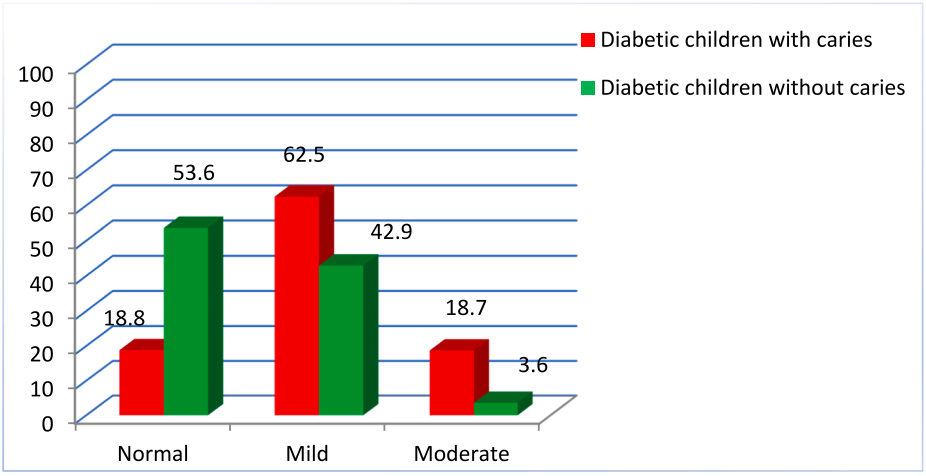

Fig. 2. Gingival health status in diabetic children with and without caries.

children with type 1 DM (Orbak et al., 2008); therefore, the newly erupted permanent teeth's exposure to cariogenic substances, such as sugars have not affected them yet. Moreover, children with diabetes and their families are often overwhelmed by managing and treating this chronic disease, especially during onset or at early stages of the disease, hence, general health conditions and oral health might be overlooked (Jindal and Parihar, 2015). Lower dmft and DMFT values in children with DM compared to healthy children were reported, and a correlation between caries rate and oral hygiene compliance was found (Kamran et al., 2019). Surprisingly, similar oral hygiene practices were noted in children with and without caries in our study, possibly due to one of our study's limitations—small sample size. However, similar studies with a similar sample size have been previously published (Ismail et al., 2017; Babu et al., 2018). Moreover, children with DM are recommended to have a more active lifestyle and follow a strict diet, less cariogenic diet that is low in refined carbohydrates to control the glycemic index, which may play a positive role in having lower caries rate in these children (Lai et al., 2017).

In this study, most of the children received dental information from their parents or family members; however, previous studies have shown that parents of children with diabetes lacked knowledge of oral health, especially regarding the association between diabetes and oral health (Sohn et al., 2015). Furthermore, less than half of the children in our study received dental information from a healthcare professional, possibly explaining the lack of knowledge regarding oral hygiene practices among the participants. Knowledge of oral health was related to dental caries in this study, as most participants had an acceptable level of oral health knowledge, although majority of these children had dental caries. These findings suggest the need for oral health education by health care professionals to provide this special group of patients with appropriate knowledge in oral complications of the disease.

Nevertheless, most children with fair or good oral hygiene status in our study were caries-free. Dental caries has been associated with the level of glycemic control among children with type 1 DM; children with poor glycemic control tended to have more dental caries (Carneiro et al., 2015). In our study, children with DM and poor oral hygiene were more likely to develop dental caries, which in consistent with a previous study on healthy children that found an association between dental caries and oral hygiene (Quadri et al., 2018). However, research on the association between dental caries and oral hygiene in children with type 1 DM is scarce.

This study found a higher prevalence of gingivitis in children with dental caries than in those without caries. This could be because of differences in oral hygiene compliance between the groups. Previous studies have also shown that this population gives less priority to oral health care as their time is consumed by making lifestyle changes, such as diet, glucose monitoring, drug administration, and regular visits to the physician (Carneiro et al., 2015). Therefore, pediatricians treating patients with diabetes should be aware of the importance of oral health in these children and encourage regular visits to the dental clinic as part of the disease management. However, during such dental visits, health assessment and (Zampetti and Scribante, 2020) or other recently

introduced remineralizing agents (Khanduri et al., 2020). Oral hygiene instructions should be regularly provided to these patients and their parents as part of oral health promotion as well as frequent recall visits to the dentist.

This study has few limitations. It has small sample size, and a larger sample size could be more representative of the population. Moreover, questions regarding the type of diet, glycemic control of diabetic children, and number of dental visits were not included. This information should be considered in future research.

5. Conclusion

In conclusion, the study found an association between oral hygiene status and gingivitis and dental caries in children with type 1 DM. These children and their parents should be made aware of the importance of oral health. Moreover, oral hygiene instructions and preventive and restorative treatment, as needed, should be provided to children with type 1 DM and their parents through regular dental visits.

CRediT authorship contribution statement

Yousef H. Al-Dlaigan: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Funding acquisition. **Rasha A. Al-Dabaan:** Conceptualization, Software, Validation, Writing – review & editing, Visualization, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethical approval

The ethics committees of the College of Dentistry Research Center at King Saud University (NF 2215) and King Abdulaziz University Hospital (P NO, E-10-238) approved this study.

Place of research

This study was conducted at College of Dentistry and King Abdulaziz University Hospital at King Saud University Riyadh, Saudi Arabia.

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Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approval for this study was by King Abdulaziz University Hospital (P NO, E-10-238) in 2010.

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

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