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PREVALENCE OF DENTAL CARIES AND GINGIVITIS AMONG CHILDREN WITH TYPE 1 DIABETES MELLITUS ATTENDING AN OUTPATIENT CLINIC AT KENYATTA NATIONAL HOSPITAL IN KENYA.
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PREVALENCE OF DENTAL CARIES AND GINGIVITIS AMONG CHILDREN WITH TYPE 1 DIABETES MELLITUS ATTENDING AN OUTPATIENT CLINIC AT KENYATTA NATIONAL HOSPITAL IN KENYA

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ABSTRACT

Background: **Diabetes mellitus (DM) has previously been associated with affluence, but currently its prevalence has been rising at an alarming rate in all populations worldwide. The reduced salivary secretions associated with type 1 diabetes mellitus (T1DM) can predispose the children to dental caries and gingivitis.**

Objective of the study: **To determine the prevalence of dental caries and gingivitis among a cohort of 3-18 year-old children diagnosed with T1DM attending Kenyatta National Hospital (KNH) paediatric outpatient clinic.**

Design: **A descriptive cross-sectional study using a purposive sampling method.**

Setting: **KNH paediatric outpatient clinic.**

Subjects: **A total of 82 patients with T1DM and who attended the diabetic outpatient clinic at KNH during the months of January to May 2015 were studied. The diagnostic tests, duration since diagnosis of the disease and level of control of T1DM were obtained from the participants' hospital records. An oral examination was undertaken under field conditions. Dental caries was determined using the WHO criteria 2005 and gingivitis scored using the gingival index by Loe and Silness 1963. The collected data were analyzed using SPSS version 20 computer software. Fisher's exact test, Pearson's Chi Square and regression models were used to test significant relationships ($p<0.05$) between the variables.**

Results: **The mean age of the participants was 11.6 ±4.1 SD, with the duration of having T1DM ranging from one month to six years. Seventy-two percent of the children had poorly controlled T1DM. While the prevalence of dental caries among the children was 78% and for gingivitis was 100%, there were no statistically significant relationships between T1DM and dental caries ($p>0.05$) and gingivitis ($p>0.05$)**

Conclusion: **The prevalence of dental caries and gingivitis was high, perhaps as a result of the high level of uncontrolled T1DM (72%) and the lack of oral health education among the patients in the study.**

INTRODUCTION

DM has been demonstrated to be on the rise globally (1). Current trends show that the disease is more pronounced among children aged 5 years and below (2). In 2010, the incidence of T1DM in children aged 0–19 years in the United States was 1.7 per 1,000 children (3). In Sub-Saharan Africa, the incidence has been reported to range from 1.5 per 100,000 persons for Tanzania to as high as 12 per 100,000 persons per year in

Zambia (4, 5, 6). In Kenya, there is no available literature on the incidence of T1DM in children. Children with T1DM have been known to have significantly reduced salivary secretion rates (7), a phenomenon that puts them at risk to dental caries and gingivitis. However, through a good diabetic control method, these salivary changes can be mitigated (8). Adhering to a prescribed diabetic diet that has low simple carbohydrates and rich in fiber, the formation of dental plaque can be slowed down leading to a reduction of dental caries and gingivitis through reduced number of cariogenic bacteria found in plaque (9). Dental caries can lead to reduced child's quality of life by causing pain, premature tooth-loss, malnutrition and this can retard growth and development of the child (10). A study in Ghent University Hospital, Belgium, on children aged 3 to 16 years with T1DM attending the diabetic outpatient clinic, found that 80% of the children had untreated teeth decay (11). Another study in Sudan on prevalence of dental caries among type 1 diabetic children reported a 60.3% prevalence of caries with a DMFT index of 0.09 (12). Gingivitis or the inflammation of the gums can be induced purely by plaque and may be exacerbated by local or systemic factors. Gingivitis is associated with the loss of the stippling, an increase in the flow of gingival crevicular fluid and bleeding on gentle probing of the sulcus. Severity of gingival bleeding has been associated with the intensity of dental plaque deposits (13). Consequently, plaque should be eliminated in order to reduce the risk of gingival diseases in the diabetic patients (14, 15). There are no Kenyan studies on the relationship of dental caries and gingivitis with T1DM in children. Studies conducted elsewhere revealed inconsistent relationships of T1DM with dental caries and gingivitis.

MATERIALS AND METHODS

This was a descriptive hospital based cross-sectional study to determine the relationship of dental caries and gingivitis with T1DM. Prior to the study, caregiver's consent and the child's assent were obtained. A semi-structured modified WHO oral health questionnaire was used to collect the socio-demographic data and the oral health practices of these children. The diagnosis of T1DM was obtained from the patient's medical records and level of uncontrolled T1DM pegged at glycated haemoglobin (HbA1c) >7% and Random Blood Sugar > 11.1mmol/L.

The oral examination was conducted by the Principal Investigator (PI) in the paediatric outpatient clinic with the children seated on a normal chair facing a natural source of light. Sterile mouth mirrors and WHO probes were used to score for gingivitis and dental caries. Gingivitis (Loe and Silness 1963) was scored using the modified WHO Oral Health Assessment Form 2005.

During the examination, the teeth were wiped with dry sterile gauze and dental caries determined using WHO criteria (2005). Caries was recorded for each tooth as present when a lesion in a pit, fissure or on the smooth tooth surface had unmistakable decay or was detected by probe catching. Initial caries seen as a white spot lesion was not considered as a tooth decay. A missing primary or permanent tooth was scored by the PI if a history of loss due to caries was established. Each child had a record made of decayed, missing or filled, and dmft for primary teeth or DMFT for permanent teeth appropriately calculated for each child. For purposes of validity and reliability of the data, the PI was initially calibrated on 10 children by the supervisors on detection of dental caries and gingivitis, and Cohen's Kappa scores of 0.90 for dental caries and 1.00 for gingivitis were obtained.

A duplicate clinical examination was conducted by the PI on every 5th child to ascertain intra-examiner consistency and Cohen's Kappa scores of 0.95 for dental caries and as 1.00 for gingivitis was obtained. Data Analysis and Presentations: Data were analyzed using SPSS version 20.0 computer software.

Pearson's Chi-Square and Fisher's exact test were used to compare categorical variables within the study population while bivariate analysis and regression models were used to test the relationship of dental caries and gingivitis with T1DM. F-ratio and Student's T-test were used to test mean differences in subgroups of the participants.

RESULTS

A total of 82 children, 39(47.6%) males and 43 (52.4%) females, participated in the study. Their mean age was 11.6 ±4.1 SD, with 54.9% aged between 12 and 18 years, 31(37.8%) aged 6 to 11 years and only 6(7.3%) aged 3 to 5 years.

In terms of the level of education of the children, 53(64.6%) were in primary school, 23(28%) were in secondary school while 6(7.3%) were in pre-school. When their residence was looked at, 62(75.6%) came from within Nairobi city county while the remaining came from outside Nairobi city county. From the patients' hospital records, 45(54.9% of the children had a valid HbA1c diagnostic test for T1DM while 37(45.1%) were confirmed to have T1DM using Random Blood Sugar (RBS). Majority of the participants with T1DM had poorly controlled T1DM 59(72%) compared to controlled T1DM, 23(28%).

The duration since the diagnosis of T1DM ranged from as low as 1 month to 6 years with a mean duration of 3.3 years. On the participants' oral health practices, 51(62.2%) reported cleaning their teeth once a day, compared to 28(34.1%) children who cleaned their teeth 2 or more times a day. Only one child cleaned the teeth just several times a month. Except one child, the rest of the children reported using toothbrush and fluoridated toothpaste to clean their teeth.

Generally, the children had poor oral hygiene. In terms of their dietary practices, a proportionately high number of the children 70(85.4%) reported never consuming sugary snacks. Similarly, the majority of the children reported never consuming fizzy drinks, jam/honey or anything containing sugar. There were reportedly low regular dental visits among the diabetic children as shown in table 1.

Table 1
Oral hygiene practices of the children who participated in the study

	No./percent	No./percent
Aids used to clean the child's teeth	Yes	No
Toothbrush	82(100%)	0(0%)
Wooden toothpicks	5(6.1%)	77(93.9%)
Plastic toothpicks	0(0.0%)	82(100%)
Thread (dental floss)	0(0.0%)	82(100%)
Charcoal	0(0.0%)	82(100%)
Chewing stick/miswaki	2(2.4%)	80(97.6%)
Visits to the dentist	Number	percent
Once	8	9.8
Twice	1	1.2
Four times	1	1.2
Not visited dentist in the last 12 months	62	75.6
Never visited a dentist	10	12.2
Total	82	100
Reason for the dental visits (only those who visited the dentist in the last 12 months)		
Pain or trouble with teeth, gums or mouth	4	40
Treatment/follow-up treatment	4	40
Routine check-up of teeth/treatment	1	10
I don't know/don't remember	1	10
Total	10	100

Dental caries experience

The overall prevalence of dental caries was 78.0% with a mean DMFT/dmft of 3.23+2.86. While the total DMFT/dmft scores ranged from 0 to 11, the mean DMFT/dmft increased with age of the children. The mean DMFT/dmft was higher among 12-18 year-olds who were in permanent dentition (3.49±2.93) compared to the children who were either in primary or in mixed dentition stages. None of the children had a filled tooth and, therefore, the mean scores were mainly brought by the decayed component of the DMFT/dmft. The analysis of variance F-test and the t-tests did not show significant relationship of dental caries with age and gender of the children as shown in table 2.

Table 2

Relationship between DMFT/dmft and the socio-demographic characteristics of the children who participated in the study

	DMFT/dmft Mean±SD	Dt Mean±SD	mt Mean±SD	ft Mean±SD
Age of the child				
3 - 5 years	1.67±2.42	1.67±2.42	0.00±0.00	0.00±0.00
6 - 11 years	3.16±2.82	2.94±2.61	0.29±0.78	0.00±0.00
12 – 18 years	3.49±2.93	3.20±2.75	0.27±0.72	0.00±0.00
	F(1,80)=.443, p=0.51	*F(1,80)=.496, p=0.48*	*F(1,80)=0.24p=0.63*	
Gender				
Male	3.31±2.94	3.05±2.72	0.28±0.79	0.00±0.00
Female	3.16±2.82	2.93±2.66	0.23±0.65	0.00±0.00
	t(80)=0.228, p=0.82	*t(80)=0.22, p=0.84*	*t(80)=0.31, p=0.76*	

DMFT/dmft in relation to duration and level of control of T1DM: The DMFT/dmft scores were analysed using a negative binomial regression mode where change of the total scores were related to level of control and increase in duration since diagnosis of T1DM. Children with poorly controlled T1DM were 1.28 times more likely to have a higher DMFT/dmft scores than those with well-controlled diabetes (O.R 1.28{0.711-2.29}). The percentage change in DMFT/dmft scores was a 0.2% decrease for every unit increase of duration in months. The expected log counts of DMFT/dmft decreased by 0.002 for each one-month increase in duration (O.R. 0.998{0.992-1.005}. The regression model is shown in table 3

Table 3

Relationship between DMFT/dmft score, duration and level of control of T1DM using a negative binomial regression model

Parameter		Hypothesis Test			Exp(B) (CI)
	B	Wald X^2	Df	p≤0.05	
(Intercept)	1.054	17.519	1	0.00	2.870(1.752-4.703)
Duration	-0.002	0.225	1	0.64	0.998(.992-1.005)
[Poor Control]	0.243	0.666	1	0.41	1.275(.711-2.287)
[Well Control]	0[a]				1
(Scale)	1[b]				
(Negative binomial)	1[b]				

Gingivitis

The children had a mean of gingival index score of 1.3 ± 0.28 (moderate gingivitis), with gingival scores being lower in the 3-5 year-olds (1.2±0.19) who were in primary dentition (1.2±0.29). There were no statistically significant relationships of gingivitis with age (p=0.13) and gender (p=0.56).

Gingivitis in relation to duration and level of control of T1DM

The prevalence of gingivitis in the study population was 100% where 63.4% had mild gingivitis while 36.6% had moderate gingivitis as shown in table 4

Table 4

Bivariate analysis between T1DM (control and duration) and severity of gingivitis

	Gingivitis			
	Mild	Moderate	Total	Test
Level of control				
Controlled	16 (19.5%)	7 (8.5%)	23 (28.0%)	χ^2 (1) = .521, p =
Uncontrolled	36 (43.9%)	23 (28.0%)	59 (72.0%)	.470
Total	52 (63.4%)	30 (36.6%)	82 (100%)	
Duration since diagnosis of T1DM				
Less than 1 year	8 (9.8%)	3 (3.7%)	11 (13.4%)	Fisher's Exact =
1 - 5 years	36 (43.9%)	18 (22.0%)	54 (65.9%)	3.228,
6 - 10 years	6 (7.3%)	8 (9.8%)	14 (17.1%)	p = .342
Above 10 years	2 (2.4%)	1 (1.2%)	3 (3.7%)	
Total	52 (63.4%)	30 (36.6%)	82 (100.0%)	

Uncontrolled T1DM and an increase in duration of having the disease led to an increase in gingival scores. The odds of having moderate gingivitis in uncontrolled T1DM was 19.547{10.10-37.47} times that of controlled T1DM, a statistically significant relationship ($\chi 2$ (1) = 80.20, $p< 0.05$). The percentage change in gingival scores resulted in 0.1% increase for every unit increase in duration in months; a non-significant relationship (O.R 1.001{.998-1.004}. This ordinal probit regression model was illustrated in table 5.

Table 5

Gingival score in relation to duration and level of control of T1DM using an ordinal probit regression model

Parameter		B	Hypothesis Test			Exp(B) (CI)
			Wald X^2	df	p≤0.05	
Threshold	[GI=0]	-2.048	150.10	1	0.00	.129(.093-.179)
	[GI=1]	0.52	21.095	1	0.00	1.686(1.349-2.107)
	[GI=2]	2.973	80.201	1	0.00	19.547(10.198-37.467)
Duration		0.001	0.600	1	0.44	1.001(.998-1.004)
[Uncontrolled]		0.068	0.288	1	0.59	1.071(.835-1.373)
[Controlled]		0[a]				1
(Scale)		1[b]				

DISCUSSION

The present study on the relationship of dental caries and gingivitis with T1DM was hospital based cross-sectional study involving 3-18-year-old children.

The choice of the lower age limit meant that only children with full primary dentition as a minimum could be included in the study. KNH was chosen as a study site because it is a national and teaching referral hospital with good medical records to be relied upon to obtain the T1DM data which included diagnosis, level of control and the duration since diagnosis. Even though RBS was used in the diagnosis and evaluation of the level of control of T1DM in 45.1% of the participants, the children had the constitutional symptoms of diabetes and were being managed by paediatric endocrinologists.

The mean age of 11.6 years (±4.1 SD) for the participants in the current study was similar to that undertaken in Brazil (16) with a mean age of 11.3 years (± 3.4 SD) but lower than a Sudanese study (12) with a mean age of 13 years (± 3.19 SD) and much higher than a Turkish study (14) with a mean of 9 years (± 0.14 SD). The age distribution in the present study was skewed towards the 12-18 years age group probably due to later onset of T1DM. The male participants were also more than the females and this was similar to the Brazilian study (16).

The diagnosis of dental caries in the present study was solely based on visual clinical examination without any radiographic investigations. This could have led to an underestimation of especially proximal caries. Dental caries experience was measured using the DMFT/dmft index. The prevalence of dental caries in the study of 78%, was similar to the 80% reported in a Belgium study (11), but slightly higher than that of 60.3% for the Sudanese study (12).

The Belgium study attributed the untreated dental caries to low levels of dental visit among those diabetic children. That was also the case in the current study where 62(75.6%) of the children never visited the dentist for a year prior to the data collection time. The overall mean DMFT/dmft in this study was similar to that reported in the Sudan and it increased with age (14). There was observed higher DMFT/dmft in the permanent dentition as was also reported in Turkey and in Kuwait (14, 17). The increase in the mean DMFT/dmft with age could arise because of the diminished parental supervision. Furthermore, the increasing cumulative effects of uncontrolled T1DM could have

induced salivary changes with a resultant increase in caries experience with age.

In terms of gender variation, the male diabetic children had a higher mean DMFT/dmft scores, higher decayed and missing teeth compared to the females. The differences were, however, not statistically significant (p=0.82). A Hungarian study on children with T1DM reported significant gender differences in the DMFT/dmft scores with a higher dental caries burden in the male than in the female diabetic patients. Probably, the oral hygiene practices of the male children were poor compared to that of the female children.

In addition, the permanent dentition studied and the age bracket of 14 to 19 years by the Hungary study could further explain different findings in the two studies (20). Similarly, an Iranian study among 5-18 year-old diabetic children reported a higher DMFT/dmft scores and higher frequency of decayed teeth in boys than in girls (18).Dental caries experience and T1DM control did not show a significant relationship (P=0.41).

However, an increase in DMFT/dmft scores in the present study was seen among the children with poorly controlled diabetes as was also reported in Finland (8)A longitudinal study conducted in Sweden reported that the participants with uncontrolled T1DM had slightly more dental caries already present at baseline and that the differences were not statistically significant (13). Nonetheless, a study in Lithuania conducted among 10-15 year-old diabetic children reported that there was a statistically significant association between the level of control of diabetes and high caries experience in the diabetics (19) which was contrary the results of the present study (p=0.64). The Hungarian study emphasised on maintaining a satisfactory metabolic control and appropriate oral hygiene practices to lower the dental caries experience among diabetic children (20).

This study found a higher dental caries prevalence of 78% compared to 46% reported among 3-18 year-old non-diabetic children in rural Kenya. It is possible that the higher prevalence could be the effects of uncontrolled T1DM (21). Nonetheless, a previous study conducted at the university of Nairobi dental hospital reported a high prevalence of dental caries of 73.8% in non-diabetic patients, but this was probably because the study population at the school had been on children who were seeking dental treatment, and were likely to have been doing so due to dental caries. It was also noted that only 3-9% of the children in the study had ever attended the clinic for a dental check-up (22).Use of gingival index by Loe and Silness (1963) could have resulted in possible inclusion of early presentation of aggressive forms of periodontitis commonly found in the African adolescent population. The children in the current study had a mean gingival index score of 1.3 ± 0.28 which increased with an increase in age as was also reported in Turkey (14). Whereas in the present study all the children had gingivitis, 63.4% had mild gingivitis while 36.6% had moderate gingivitis and there was no significant relationship between gingivitis and the type of dentition. The high prevalence of gingivitis had also previously been reported among 2-15 years old children with T1DM in Libya, a study in which statistically significant differences were found in gingival scores between the groups in the primary, mixed and permanent dentition (23). A lower prevalence of gingivitis compared to the current study was reported in a Turkish study where gingival inflammation was 69.7% for the 5 - 9 year-olds and 83.7% for the 10 - 14 year-old children (14). Probably the high percentage of uncontrolled T1DM (72%) and low regular dental consultations in the present study could have led to microvascular changes in the gingiva and hence the high prevalence of gingivitis in this study. Likewise, the high plaque deposits (mild 30.5% and moderate 69.5%) could have led to exaggerated gingival indices and hence the high prevalence of gingivitis in the current study.

There was a statistically significant relationship between level of control of diabetes and gingivitis in the present study ($p<0.05$) with higher gingival index score among the children with uncontrolled T1DM.

This finding contradicted with previous reports that there was a relationship between glycemic control and gingival inflammation but a clinically significant improvement in gingivitis had not been demonstrated (8, 24). On the other hand, an increasing duration of having T1DM seemed not to statistically increase gingivitis among diabetic children in the current study ($p=0.44$).

This was in agreement with the findings of a study conducted in Brazil with a mean duration of 4.5 years (16) compared to 3.3 years in the current study but still found much lower (27%) level of gingivitis than that of the present study (100%). The difference in the level of gingivitis could have been brought about by the lack of regular dental visits among the children in this study. There was also lack of proper interdental cleaning among the children in the current study compared to a third of the children in the Brazilian study who used a dental floss at least once daily.

The prevalence of gingivitis in a past Kenyan study in non-diabetic children of 75.1% (21) was much lower than the prevalence of gingivitis of 100% in the present study. Even the results of a study on children seeking dental treatments had also a much lower prevalence of gingivitis of 37% (22). Other than dental plaque, uncontrolled T1DM could have contributed to the higher prevalence of gingivitis in this study, through altered defense mechanism and increased susceptibility to bacterial infection and reduced healing capacity. In conclusion, The present study showed a high prevalence of dental caries (78%) and gingivitis (100%) among 3 to 18 years-old children diagnosed with T1DM. It is possible that this was probably a result of the high level of uncontrolled T1DM (72%) that was common and possibly coupled with the poor oral hygiene that was noticeable in the study population. Uncontrolled T1DM and an increase in duration of having T1DM were associated with significant increase in gingival scores among the children and that the disease duration did not show any significant change in the severity of gingivitis. Level of control and the duration of T1DM did have a slight effect on the prevalence of dental caries. Nonetheless, the study appears to show a need to achieve controlled T1DM that seem to lead to low gingivitis among diabetic children, and possibly will further lower the prevalence of dental caries.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this article.

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