Dental caries among children with diabetes in Benghazi, Libya

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Abstract

Introduction: Diabetes mellitus affects over 537 million worldwide and is expected to rise significantly. Diabetic children are more prone to dental health problems.

Aim: To assess the prevalence and experience of dental caries among children diagnosed with Type 1 diabetes mellitus.

Methods and subjects: A cross-sectional study included diabetic children aged 4-15 years, was conducted in Benghazi-Libya at Benghazi Medical Center, Benghazi Children's Hospital, and the National Center for Diabetes Diagnosis and Treatment. Data were collected through patient records, and a validated questionnaire completed by the participants' caregivers. Dental caries experience was assessed according to the World Health Organization (WHO) oral health examination using the DMFT/dmft indices. All collected data were coded, entered, and analyzed using the Statistical Package for the Social Sciences (SPSS), version 25, ensuring data accuracy, confidentiality, and integrity throughout the research process.

Results: A total of 151 participants aged 4 to 15 years in Benghazi City were included in the analysis. With a slight female majority (53.6%) and diagnosed with type 1 diabetes (98%), of which 96% were uncontrolled diabetes. Clinical examination revealed a high prevalence of dental caries in both primary (56.5%) and permanent dentitions (54.5%), with mean dmft and DMFT scores of 2.31 and 1.63, respectively.

Conclusion: The study revealed a high prevalence of dental caries among diabetic children in Benghazi, affecting over half of the sample in both primary and permanent teeth. There were no notable differences in caries prevalence by gender. Additionally, 96% of the participants had uncontrolled diabetes, which likely exacerbated their oral health problems.

Keywords: Diabetes, Children, Dental caries, DMFT/dmft, Benghazi, Questionnaire

Introduction

Dental Caries is a chronic, ecological disease characterized by a dysbiosis of the dental biofilm, influenced by dietary substrates and modulated by various biological, behavioral, psychosocial, and environmental factors. This dysbiosis leads to a net demineralization of the dental hard tissues, ultimately manifesting as a cavitated carious lesion [1]. Dental caries is the most prevalent chronic infectious disease among children worldwide, affecting both primary and permanent dentitions [2,3]. It poses a significant public health challenge, especially in developing regions, with nearly half of the global adult population experiencing caries [2, 3]. In children, caries prevalence is linked to socioeconomic status, dietary habits, and limited access to preventive care [3]. Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease resulting in insulin deficiency and affects over half a million children globally [4]. Its incidence continues to rise in many countries, adding to the early-onset disease burden [4]. Diabetes is characterized by hyperglycemia. Long-term hyperglycemia may cause various complications and it is associated with long-term dysfunction, damage and failure of numerous organs, predominantly kidneys, eyes, blood vessels and nerves. Diabetic complications can be chronic (long term) or acute (short term). Chronic complications are characterized by damage to the vascular system and categorized into macro-vascular complications (damage to larger blood vessels) and micro-vascular complications (damage to small blood vessels). Diabetic people have a higher risk of developing macro-vascular diseases or heart disease**.** Heart disease is a disorder of the large arteries and an inflammatory process which leads to stroke, peripheral arterial disease and arteriosclerosis. Cardiovascular conditions are the leading cause of mortality and morbidity in T1D and T2D patients. Risk of heart disease can be decreased by lowering the increased blood pressure and blood glucose levels and by using medications that can lower cholesterol levels in diabetic patients [5]. A growing body of evidence suggests that children with T1DM are at increased risk for oral health complications, including dental caries [4, 6]. A meta-analysis found that approximately 67% of children and adolescents with T1DM experience dental caries, prevalence significantly higher than in the general pediatric population [4]. Geographical differences were observed: prevalence peaked at 84% in South America but dropped to 47% among those with good metabolic control [4]. Age-related differences were also reported, with younger children (≤10 years) showing higher caries prevalence than older youth [4]. Several mechanisms may explain this elevated risk. Poor glycemic control is associated with decreased salivary flow and buffering capacity, increasing

the likelihood of enamel demineralization [6, 7]. Elevated salivary levels of Streptococcus mutans and Lactobacillus are key cariogenic bacteria and have been reported in T1DM children, especially those with suboptimal metabolic control [6, 7]. Further, qualitative changes in the oral microbiota among diabetic children may predispose them to caries [6].

The global economic burden is $710B due to oral conditions in 2019, of which $387B was due to direct costs and $323B was due to productivity losses. Low-income countries were found to spend an average of $0.52 per capita on dental care, whereas high-income countries spent an average of $260 per capita a 500-fold difference. These findings suggest that oral conditions continue to substantiate an enormous economic burden to individuals and society. The oral conditions in 2019 were greater than that for 2010 and 2015. For 2010, direct costs were estimated at $298B and indirect costs at $144B. For 2015, direct costs were estimated at $357B and indirect costs at $188B [8]. Considering general trends in worldwide health spending since 2010, direct costs (dental expenditures) remained stable at a level of 4.6% relative to overall health spending. Understanding the economic impacts of oral conditions is essential for evidence-informed oral health policy making, including for the prioritization of cost-efficient oral health programs and needs based planning of the oral health [9]. Studies comparing diabetic and healthy youth have shown higher DMFT scores among the former, with metabolically uncontrolled children displaying greater caries rates than well-controlled peers [7, 10]. Conversely, a few studies in certain regions have found lower or comparable caries rates in diabetic children, potentially due to stricter dietary restrictions [11, 12]. Early-onset diabetes may further increase caries risk, possibly by affecting enamel development in primary teeth and compromising salivary defense mechanisms [12, 13]. Diabetic children may also experience enamel defects and impaired pulpal defense, accelerating caries progression [13]. While many diabetic youths report adequate oral hygiene habits, their efforts may be undermined by poor diet or structural saliva changes [6, 7]. Given that dental caries can impair nutrition, academic performance, and quality of life, the high prevalence among diabetic children warrants attention [4]. Preventative strategies-such as routine screenings, fluoride therapies, and caregiver education are crucial to mitigate oral health disparities in this high-risk group [4, 7]. Additionally, achieving and maintaining glycemic control plays a dual role in metabolic and oral health [6, 7]. Children and adolescents suffering from TIDM exhibit a marked elevation in dental caries prevalence compared to the general population. Studies report a pooled prevalence exceeding 67%, with a mean DMFT (Decayed, Missing, Filled Teeth) score of 5.7, also a positive correlation has been observed between the duration of TIDM and the mean decayed-Missing-Filled Teeth (DMFT) score in some studies [14]. The maximum and minimum prevalence of dental caries in children with TIDM were observed in Chile (92%) and Iran (36%), respectively Prevalence in South America was at (84%), North America (64%) and Europe (57%) [14]. The prevalence of dental caries among children with type 1 diabetes mellitus in Riyadh, Saudi Arabia is 53% (32 out of 60 children). The mean decayed, missing, and filled primary teeth (dmft) score was 5.6, while the mean decayed, missing, and filled permanent teeth (DMFT) score was 3.6. No significant gender-based differences in caries prevalence were observed (males: 60.6%; females: 44.4%). The prevalence of dental caries among children with type 1 diabetes mellitus (DM) in Khartoum -Sudan is 60.3% (38 out of 63 diabetic children). The mean DMFT (Decayed, Missing, Filled Teeth) score for diabetic children (0.09). No significant differences in caries prevalence were noted based on gender in either group [15]. The prevalence of dental caries among children with type 1 diabetes in Beirut-Lebanon is 43.2% [16].

Despite growing awareness, current evidence remains limited by small sample sizes, cross-sectional designs, and heterogeneity across studies [4, 6]. More robust longitudinal and interventional research is needed to clarify the interaction between metabolic control, biological changes, and dentists' preventive care. This study aims to further characterize caries prevalence in diabetic children, and offer insights into integrated metabolic dental care models that could improve long-term outcomes.

Methods and subjects

The ethical approval of the study was obtained from the Ethics Research Committee at the University of Benghazi (Approval No: 0213), and informed consent was secured from parents or guardians of all participants. Letters of approval were sent from the Dental Collage to the participating healthcare facilities. The permission to the clinics was granted by Ministry of Health. A written informed consent that explained the purpose of the study was distributed to parent/guardian of each participant before the commencement of the study. Also, the researcher had to explain the purpose of the study to the participants before data collection. All subjects' information was dealt with as confidential. A hospital based cross-sectional study design was conducted. The study used a paper-based questionnaire and clinical dental examination for investigating the dental caries. The study participants were diabetic children who are living in Benghazi city and selected using convenience sampling technique. It was carried out from December 2024 to march 2025. The study sample were children suffering from type 1 diabetes mellitus who were registered and attending the diabetes clinics for children and adolescents at Benghazi Medical Center, Benghazi Children's Hospital and the National Center for Diabetes Diagnosis and Treatment in the eastern region. Descriptive statistics were used to provide summaries for different variables (count / percentage). Comparisons of different outcomes were performed using chi square test and fisher exact test at p value less than 0.05 for significance. A minimum sample size of 151 participants has been indicated to be enough to estimate the proportion of diabetic children with dental caries at 95% confidence level and 0.08 margin of error. The data used in this study was collected from the clinical examination and patient's files. The consent form was distributed by a researcher to the participants during their visits

to the diabetic and dental clinics, then filled out and collected within the same day just before clinical dental examination. The questionnaire contained demographic data as age, gender. The oral health evaluation was performed by a single examiner (pediatric dentist) at the diabetic and dental clinics. The examiner was trained and calibrated to a gold-standard examiner according to the WHO Basic Surveys Calibration Protocol, which consists of a theoretical training session followed by oral examination of ten children (not part of the study sample) at the College of Dentistry. The oral examination was carried out using a pre-packed sterilized disposable oral examination kits which contained a plastic plain mouth mirror, disposable probe and sterilized gauze were used. Disposable gloves and masks were also used during the examination. And an electric artificial light in the upright position and the teeth were dried with a cotton roll to remove any plaque or debris when necessary. The caries experience was measured using the Decayed, Missing and Filled Teeth (DMFT) index for permanent teeth and the decayed, missing and filled Teeth (dft) index for primary teeth according to the WHO diagnostic criteria [17]. Once the information was collected and the returned questionnaire reviewed for completeness, the data was entered and summarized using the Statistical Package for the Social Sciences (version 25).

Results

A total of 151 participants were included in the analysis. More than half of participants were females (53.6%) and most of them were diagnosed with type 1 diabetes (98%) and uncontrolled (96%). This study examined the prevalence of dental caries among diabetic children aged 4 to 15 years **in** Benghazi City. The age distribution of participants revealed a varied representation across different age groups, with the highest proportion being 15-year-olds (18.5%)**,** followed by 12-year-olds (13.9%) and 11-year-olds (13.2%)**.** Other age groups included 14- and 13-year-olds (9.9% each)**,** 10-year-olds (6%)**,** 9- and 8-year-olds (6.6% each)**,** 7- and 6-year-olds (4% each)**,** 5-year-olds (4.6%), and the smallest group being 4-year-olds (2.6%)**.**

Table 1: Total primary and permanent teeth (dmft/DMFT)

Index	Total Number (N)	Count	(%)	Mean	SD	P
d	108	59	54.6	1.97	2.489	0.24
m	108	15	13.9	0.19	0.520	0.05
f	108	6	5.6	0.14	0.648	0.062
dmft	108	61	56.5	2.31	2.790	0.268
D	134	71	53.0	1.54	2.021	0.175
M	134	3	2.2	0.03	0.21	0.018
F	134	6	4.5	0.10	0.604	0.052
DMFT	134	73	54.5	1.63	2.061	0.178

The prevalance of dental caries in priamry teeth is in above half of participants (61, 56.5%) found to have dental caries during clincal examination. Table 1 describes the distribution of oral health indicators. The mean of decayed primary teeth was 1.97 ±2.489. The mean of missing teeth and filled teeth were 0.19 ± 0.520 and 0.14 ±0.648, respectively. The prevalance of dental caries in permanent is in above half of participants (73, 54.5%) found to have dental caries during clincal examination. Table 1 describes the distribution of oral health indicators. The average mean of decayed permanent teeth was 1.54 ±2.021 whereas ranging between zero and nine. The mean of missing teeth and filled teeth were 0.03 and 0.10, respectively.

Apart from total dmft of primary teeth in 7-13 age group, higher numbers of decayed teeth, filled teeth overall average DMFT/dmft among females are higher than males. However, these differences were not statistically significant (p value = 0.293, 0.612, 0.161, 0.612, 0.235). It also shows that 25.7% of the male children are caries free while 22.2% of the female children where are caries free. 38.3% and 39.5% of the female children are low caries experience and high caries experience respectively (Table 2).

Table 2: Experience of dental caries by gender and age

Age Index		Gender	N	Mean	Std. Deviation	Std. Error Mean
4-6	dmft	Male	7	0.57	0.535	0.202
		Female	10	0.70	0.483	0.153
		p value	0.293			
7-13	dmft	Male	38	0.58	0.500	0.081
		Female	53	0.53	0.504	0.069
		p value	0.612			
	DMFT	Male	38	0.39	0.495	0.080
		Female	53	0.51	0.505	0.069
		p value	0.235			
14-15	DMFT	Male	25	0.64	0.490	0.098
		Female	18	0.83	0.383	0.090
		p value	0.161			
Total	dmft	Male	45	0.58	0.504	0.091
		Female	63	0.65	0.501	0.087
		p value	0.612			
	DMFT	Male	63	0.54	0.499	0.092
		Female	73	0.71	0.401	0.078
		p value	0.235			

Gender		No caries	1-3	≥4	Total No.
Male	Count	18	25	27	70
	% Within Gender	25.7%	35.7%	38.6%	100.0%
Female	Count	18	31	32	81
	% Within Gender	22.2%	38.3%	39.5%	100.0%
Total	Count	36	56	59	151
	% Within Gender	23.8%	37.1%	39.1%	100.0%

Discussion

The present study highlights the prevalence of dental caries among children with Type 1 diabetes in Benghazi, with DMFT/dmft rates (54.5% and 56.5%) slightly lower than the global average (67%) [18], yet indicating a rising trend compared to past local data [19]. The fact that DMFT/dmft prevalence are 54.5% and 56.5% respectively reveals that caries prevalence in diabetic children is lower than the global estimated ratio which is 67%, which confirms that the disease's prevalence is not the same everywhere [18].

The study findings indicate caries level is on increase locally [19]. These findings are important as they suggest that dental caries in diabetic children is affected by broader contextual factors beyond individuals' control (Sisson and epidemiology 2007) and support the notion that the living and political environment created by war can cause changes in health and disease [20].

The DMFT score of 1.63 observed in the current study indicates an increase in the prevalence of dental caries compared to findings reported in previous research, where DMFT values of 1.46 and 1.19 were documented, respectively. This upward trend may reflect deterioration in oral health status among diabetic children having dental caries, potentially may be influenced by complications of hyperglycemia [19, 21, 22]. The comparison suggests that despite global and regional efforts to reduce dental caries through community-based interventions and school oral health programs, there remain significant gaps in implementation or effectiveness [19, 21, 22].

It is clear that the filled and missing components of DMFT were the smallest, indicating an unmet treatment need for young children. This pattern of DMF components has been observed in many previous studies among Libyan children [23, 24], and it seems to be an outcome of poor dental services and low attention paid to oral health. This finding, however, sheds light on the provision of restorative and preventive of dental services in Libya and highlights the need of further research to understand why filled and missing teeth components of DMF were very low. Further research is required to identify the reasons for the gap in access to treatment of caries by different age group children despite the availability of free oral healthcare for all. Particularly investigating the preparedness of emerging dental workforce for caries diagnosis, prevention, and management will have huge implications for improving access to caries management, as a public health response to high caries prevalence. In addition, lower restorative rates could be attributed to contextual barriers. These are the political and economic stability of the country continues to be undermined by the impaired security and the severely diminished oil exports, shortage of medical supplies and skilled healthcare personnel has transformed the country into a fragile state with negative impact on the healthcare [25]. The fragile state of the economy has had an impact on the quality of oral healthcare and disease prevention with the potential to worsen the current caries unmet treatment needs in the country. The results of the study are consistent with previous literature that reported no statistically significant differences in dental caries experience between male and female children with type 1 diabetes mellitus. In particular, our findings align with the study conducted by Arheiam and Omar [19], which examined dental caries experience among 70 Libyan children with type 1 diabetes and found no gender-based variation in DMFT scores. Similarly, in our research, analysis of the diabetic group revealed comparable mean DMFT among boys and girls, with no statistically significant difference observed across any of the caries index components, including decayed, missing, or filled teeth. These results suggest that gender does not play a determinative role in caries prevalence among diabetic pediatric populations. The lack of disparity may reflect similar dietary patterns, oral hygiene behaviors, and access to dental care between male and female children in the studied population. Furthermore, it underscores the notion that systemic factors associated with diabetes such as altered salivary composition, poor metabolic control, and Xerostomia may equally affect both sexes. Therefore, prevention strategies and oral health interventions for diabetic children should be gender-neutral and instead focus on broader health education, metabolic control, and behavioral modifications. This agreement with prior research enhances the credibility of our findings and emphasizes the consistency of caries patterns in diabetic cohorts regardless of gender. Future longitudinal studies are warranted to confirm these trends over time and across diverse populations [19]. DMF indices do not display how severe caries are or what their effects are [26]. This indicates that relying on caries indices is insufficient to provide health policy makers with information regarding the seriousness of dental caries. The present study revealed a high prevalence of dental caries among children with type 1 diabetes mellitus, reinforcing concerns raised in recent literature regarding the increased susceptibility of this population to oral health complications. Our study has several limitations that should be acknowledged. Firstly, due to the cross-sectional design, it was not possible to assess temporal factors related to the progression of dental caries; as such designs provide only a snapshot in time and cannot determine causality [27]. The study also did not investigate the microbiological composition of dental plaque or saliva, which may differ significantly in diabetic individuals due to altered immune responses and salivary composition, influencing caries susceptibility [28].

Moreover, variations in access to dental care were not assessed, despite evidence suggesting that unequal access is a major determinant of oral health outcomes, particularly in populations with chronic conditions like diabetes [29]. The present study uses DMFT index which is although most commonly employed by the WHO surveys, is less sensitive. The WHO used the following case definition for caries: 'Caries is recorded as present when a lesion in a pit or fissure, or on a smooth tooth surface, has an unmistakable cavity, undermined enamel, or a detectably softened floor or wall' [17]. According to the WHO criteria, measuring caries at earlier stages that can be treated with preventive medication is not practical for epidemiologic surveys, and it further assumes that clinical decision making is irrelevant to the measurement of caries. So far, the data produced by the WHO standards have only been utilized to illustrate the total burden of what the WHO considers to be a chronic, irreversible condition at the cavitation level. Therefore, rather than being able to prevent, stop, or reverse the caries process in its early phases, health planners and care providers are limited to treating patients at the conclusion of the tooth decay process. However, effortless integration of epidemiologic data with clinical decisions should support practitioners and policy makers in designing programs to control and treat caries and preserve oral health. Future research should use more recent detection systems for caries are the Nyvad criteria, the International Caries Detection and Assessment system [30]. Also, the Caries Assessment Spectrum and Treatment (CAST) have higher sensitivity than DMFT.

Conclusion

The study confirmed a high prevalence of dental caries among diabetic children in Benghazi, affecting over half of the sample in both primary (56.5%) and permanent dentition (54.5%).The youngest age group (4-6 years) showed a notable rate of caries, highlighting early childhood as a critical period for preventive dental care among diabetic children.

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