Experience of dental caries among libyan children with type 1 diabetes mellitus: a cross-sectional study

Areej El-Sallak[1], Suliman O. Ergieg[2] and Rasmia Huew[2*]

[1] Lecturer, Department of Pediatric Dentistry, Faculty of Dentistry, University of Benghazi (UOB), Benghazi, Libya

[2] Professor, Department of Pediatric Dentistry, Faculty of Dentistry, University of Benghazi (UOB), Benghazi, Libya

Correspondence Author: Rasmia Huew

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Abstract

Background: Diabetes is often associated with a number of medical and oral complications as a result of the metabolic changes taking place systemically.

Aim: To assess the impact of type1 diabetes mellitus (T1DM) on oral health among a group of Libyan children and compare these findings to matched medically fit children.

Subjects and methods: A comparable cross-sectional study between diabetic and non-diabetic groups of children. A total of 80 children aged between 8 and 15 years with Insulin Dependent Diabetes Mellitus presenting to the pediatric endocrinology clinic of the BMC and Pediatric hospital, Benghazi were age, gender and socioeconomic matched to a control group of 80 children attending for a dental checkup at the dental clinics. Caries experience of all children was recorded using WHO examination criteria and personal data was collected using self-administered questionnaire. The SPSS Inc., Chicago, IL for Windows version 24.0 was used for statistical analysis.

Results: The two groups were matched in term of gender and each of them was composed of 37 (46.3%) males and 43 (53.7%) females. The prevalence of dental caries was higher among non-diabetic subjects (58.8%, 52.5% respectively) compared to diabetic group (38.7%, 41.3% respectively). Whereas children with diabetes mellitus had a higher DMFT score with mean 1.48±2.2 which indicate more carious intensity (p=0.33). More than one third of diabetic children (41.3%) had at least one decayed, missing or filled tooth. Decayed teeth comprised the biggest component of the DMFT and dft scores in the two groups.

Conclusion: The difference in caries experience between the diabetic and non-diabetic children were not statistically significant. A more detailed study may provide more information on the influence of T1DM on the oral health status in this group.

Keywords: Children, Type 1 diabetes mellitus, Prevalence of caries, DMFT, DFT

Introduction

Diabetes mellitus (DM) is a chronic disease affecting all age groups, adults as well as children, which could result either due to insulin deficiency, resistance to insulin, or both. DM encompasses a heterogeneous group of disorders with the common characteristic of altered glucose tolerance and impaired lipid, protein and carbohydrate metabolism [1]. Worldwide, diabetes mellitus is a growing public health problem because its complications exert heavy socio-economic and disease burdens that put a huge stress on the health care organizations in many countries including Africa and it is one of the main reasons of mortality and morbidity both in developing and developed countries [2].

Diabetes mellitus can be classified as Type 1 which is insulin dependent (IDDM), Type 2 which is non-insulin dependent (NIDDM), gestational diabetes and other specific types. Type 1 diabetes is the most common form of diabetes in children, so it is also known as juvenile diabetes and early onset diabetes which accounts for about 5–10% of all the cases of diabetes with most of the patients (approximately 50%–60%) diagnosed before the age of 20 [3]. According to the World Health Organization and American Diabetes Association, type1 diabetes is an idiopathic disease with immune mediated destruction of pancreatic β-cells in genetically susceptible individuals [4], hyperglycemia, accompanied by the classical symptoms of diabetes, occurs only when 80-90% of the beta cells have been destroyed. Type 2 is the most common form of diabetes; it refers to as non-insulin dependent diabetes mellitus and mainly affects adults. Type 2 diabetes accounts for 90%–95% of all cases of diabetes and about 15%–45% of the newly diagnosed cases in children and adolescents. It results from resistance to insulin in individuals having a relative but not complete insulin deficiency; insulin secretion may also reduce with age, thus leading to the onset of diabetes [5]. Also, the disease is very heterogeneous with respect to its genetic, metabolic, lifestyle factors as well as clinical characteristics.

Diabetes mellitus is a group of pathological changes in every tissue of the body. The basic feature of which is hyperglycemia that result from defects in the insulin action and/or insulin secretion, a hormone that decreases the concentration of glucose in the blood [5], with concomitant complications in various regions of the body. Diabetes mellitus is described as one of the most common chronic endocrine diseases in medicine and despite the fact that not every diabetic case is reported, it has reached epidemic proportions that expected to rise as the ageing of the population [6]. It is characterized by very distinct features including; polydipsia, polyphagia, polyuria, unexplained weight loss, fatigue, neurosensory

disorders, recurrent infections and slow wound healing. In addition to a lot of oral manifestations; the most frequent include gingivitis, periodontitis, recurrent periodontal abscess, delayed healing after extraction, dry socket, oral infections, xerostomia, and neurosensory disorders [7]. Diabetes mellitus is considered a leading cause of death due to its microvascular and macrovascular complications [8].

Monitoring of blood glucose, dietary and lifestyle modifications as well as screening for diabetes-related complications have been found to play an important role in the management of the disease [9]. By the year 2025, the prevalence of diabetes is estimated to be more than 300 million [10], a clear indication that this public health problem is on the increase. Therefore, the health care workers should have a clear understanding of the disease in terms of its diagnosis, prevention and treatment so as to improve the quality of care offered to such patients [11]. The WHO has recently declared it to be a pandemic with huge social, health and economic implications [12]. Large international collaborative studies have reported an upward trend in the incidence of T1D among children under the age of 15 years in many countries with an overall annual increase estimated at 3% [13, 14]. This present situation has been described as the most challenging health problem of the 21st century, with an estimated 542,000 children (under the age of 15) worldwide living with type 1 diabetes and 86,000 developing type 1 diabetes annually [8]. Like the rest of the world, in sub-Saharan Africa diabetes has emerged as a major health challenge and 46,400 children (below the age of 14) are suffering from type 1 diabetes with 7,600 children newly diagnosed annually [8].

The prevalence has been found to be higher in Western countries compared to the African region partly due to higher surveillance and diagnostic rates in the developed world compared to Africa. Finland has the highest incidence of onset of type 1 diabetes in the world followed by Sardinia. Canada and Sweden is in fourth place [4]. There are few African studies in the literature that have reported the prevalence and incidence of T1D. However, in children less than 14 years in the African region, an incidence estimate of 6.4/100000 per year of new cases of T1D has been reported [15].

In 2015, the incidence of T1DM in Qatar (33.49/100000) was only lower than Finland (62.3/100000), Sweden (43.2/100000), and higher than Norway (32.5/100000), the United Kingdom (28.2/100000), Canada (25.1/100000) and USA (23.7/100000) and this incidence has been increased to 38.05/100000 in 2020. In Kuwait, the incidence of T1DM in children and adolescents reached to 40.9/100000 (in 2011-2013). These data confirm significantly high incidence and markedly increasing trend of T1DM in children and youths in the Arab Gulf states where the reported incidence of T1DM in children and adolescents changed from 18.05/100000 (1990-1998) to 33.5/100000 in 2017 in KSA [16].

According to the diabetes estimate of international diabetes federation 2021, the number of new cases of type1 diabetes among 0-14 years was 1.1/1000 for Egyptian and 0.2/1000 for Libyan children; the prevalence was 7.2/1000 for Egyptian and 0.8/1000 for Libyan children [17]. In the period 2014-2018, the incidence rate was 31.7/100000populations in the West, South and Tripoli regions according to Khashebi *et al.*,[18]. Whereas in Benghazi, the average annual incidence rate per year was 7.8/100000 population according to Kadiki and Roaeid [19]. Although, a lot of research has been done worldwide to determine the incidence of T2D, comparatively very little attention has been focused on type 1 diabetes in the developing countries. Therefore, more efforts are needed in the African region to collect data and generate enough evidence in order for the governments of this region to see the impact of type1 diabetes in this vulnerable group.

Oral health is an essential part of general health. Oral health may have profound impacts on the physical, social, and psychological well-being. The psychosocial impact of oral diseases can have a detrimental effect on the quality of life of individuals, as well as their families [20]. Diabetes related oral diseases such as caries, tooth loss, periodontal disease, dental infections, oral dryness, craniofacial disorders have got a negative impact on oral health [21].

Dental caries is the most common chronic infectious disease in young children that has posed an international public health challenge. It begins early in life and progress rapidly especially in individuals who are at high risk, and often goes untreated [22]. Additionally, its consequences can lead to poor food intake, poor school performance, and mental health problems, which can affect the quality of life of the child, family impact significant social and economic burdens as well [23].

Although the relationship between diabetes and dental caries is still unclear, diabetic patients are more born to the development of new and recurrent dental caries. Salivary dysfunction that reduces the cleansing and buffering capacity of the saliva, increase of carbohydrate in the saliva, increased levels of streptococcus mutans and lactobacilli could increase the likelihood of dental caries. Chronic hyperglycemia may cause irreversible pulpitis leading to pulp necrosis [24]. Some studies have shown that periapical lesions and apical periodontitis are more common in diabetic compared to non-diabetic individuals [25]. Previous study reported that a higher prevalence was observed only in diabetic children with poor metabolic control [26]. Moreover, arecent systematic review conducted by Liu *et al.*,[27] revealed that DMFT and DMFT were significantly higher in T1DM group than the non-T1DM group and stimulated flow rate was significantly lower in T1DM group [27]. Although several studies have evaluated the relationship between diabetes mellitus type 1 and the oral health, they reported conflicting results and the exact prevalence of oral diseases remains controversial in children and adolescents with type 1 diabetes especially in those with poor metabolic control [28, 29]. Because of the controversy on the impact of diabetes on oral diseases, the mechanisms through which this occurs and lack of public awareness and parent conscious in this regard [30], further studies in this area are reasonable.

However, to the best of our knowledge, there is no data on the impact of type 1 diabetes mellitus on experience of dental caries among patients in Libya. Accordingly, the present study was carried out to evaluate the oral health status including

dental caries in type1 diabetes mellitus children and compare these finding to match medically fit children.

Subjects and methods

This study was approved by the Dental Collage Research Ethics Committee, University of Benghazi and by the Ministry of Health Committee. 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 observational cross-sectional comparative study design was conducted. The study used a paper based questionnaire and clinical dental examination for investigating the oral health.

The study was involving both diabetic and non-diabetic children who are living in Benghazi city and selected using convenience sampling technique. It carried out from May to August 2022. The study group consisted of children with type 1 diabetes mellitus who were registered and attending the diabetes clinics for children and adolescents at Benghazi Medical Center (BMC) and Pediatric Hospital. These clinics are specifically designed for the monitoring and appropriate treatment of these children. In addition, these clinics aimed to educate the patients and their families on how to achieve the best possible glucose control. The control group consisted of 80 children with age and sex matched non-diabetic controls. In order to assess the age consistency between the two groups, independent sample t-test was used. The number of males and females were equal in both groups and education level was used as indicator to determine the consistency in socioeconomic status using Chi-square test [31]. The control group was free of any systemic diseases and not taking any medications attending the dental clinic at the Specialized Center for Oral and Dental Education-Benghazi (Al-Salmani clinic).

The sample size was calculated based on variance reported by previous related studies [32, 33]. A minimum sample size of 63 subjects in each group is sufficient to estimate moderate difference between two groups at 80% power and 0.05 margins of error. Moreover, the sample size in the present study was comparable or even higher than many previous studies conducted on T1DM patients [32, 33].

The data used in this study was collected using a prepared questionnaire specially designed for this study. The questionnaire and consent forms were 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, family size, and parents' educational levels. Family size divided into low, medium and high according to number of family members. The parents' educational level categorized into those who completed low-level education (less than university degree), and high-level education (university degree/postgraduate). The questions have been answered by the parents/guardians of the participants or children under the supervision of parents.

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, Pediatric Clinic at Libyan International Medical University.

The oral examination was carried out using a dental mirror, twizer, the ball ended WHO CPI periodontal probe 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 [34]. The intra-examiner reliability was performed and kappa value was measured and found to be 0.783 which considered acceptable.

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 24.0; SPSS Inc., Chicago, IL, USA). Descriptive statistics such as frequencies, percentages, mean and standard deviations were determined. For inferential statistics, independent t-test was used to analyze the differences in means of DMFT/dft indices between the two groups. P-values equal to or less than 0.05 was considered statistically significant.

Results

In the present study, 160 children (80 cases suffering from T1DM and 80 healthy subjects) were completed the questionnaire and undertaken clinical dental examination. As two groups were matched in terms of gender, each of them was composed of 37 (46.3%) males and 43 (53.7%) females. The children were aged 8-15 years with average age of the study group was 12.18$\pm$2.4 years while the average age of the control group was 12.48$\pm$2.7 years. In order to check the consistency of age between two groups, independent sample *t*-test was employed and there was no significant difference between the two groups (P=0.55). Moreover, there was no statistically significant difference in the education level which has been used as indicator for socioeconomic status SES (p=0.34, p=0.07 respectively). Lower educational level has been found among parents of diabetic children where nearly half (48.7%) of mothers and about two thirds (67.5%) of fathers of diabetic children had educational level less than university. Almost half of the study participants had medium family size (48.7% of diabetics and 46.2% of non-diabetics) (Table 1).

Table 1: Demographic characteristics of the two study groups (n=160)

Variables	Categories	Diabetic	Non diabetic
		Number (%)	Number (%)
Gender	Male	37 (46.3)	37 (46.3)
	Female	43 (53.7)	43 (53.7)
Mother education	University degree/ Postgraduate	41 (51.3)	47 (58.7)
	Less than university degree	39 (48.7)	33 (41.3)
Father education	University degree/ Postgraduate	26 (32.5)	37 (46.3)
	Less than university degree	54 (67.5)	43 (53.7)
Family size	Low (≤5)	16 (20.0)	17 (21.3)
	Medium (6-7)	39 (48.7)	37 (46.2)
	High (≥8)	25 (31.3)	26 (32.5)

Dental caries characteristics of the study sample are summarized in Table 2. When the decayed, missing and filled teeth indices were compared between the two groups, it was observed that; although there were no statistically significant differences in caries experience among the two groups, the prevalence of caries in both primary and permanent teeth was higher among non-diabetic subjects (58.8%, 52.5% respectively), compared to diabetic group (38.7%, 41.3% respectively). Whereas children with diabetes mellitus had a higher DMFT score with a mean value of 1.48± 2.2 which indicate more carious intensity (*P*=0.33). More than one third of diabetic children (41.3%) had at least one decayed, missing or filled tooth. Decayed tooth comprised the biggest component of the DMFT and dft scores in the two groups and the prevalence of dental caries in both primary and permanent teeth was higher in all components among non-diabetic children (Figures 1 and 2).

Table 2: Comparison of experience of dental caries of the two study groups (n=160)

Variables	Diabetic		Non-diabetic		*p* value
	Number (%)	Mean (SD)	Number (%)	Mean (SD)	
Decay (D)	32 (40)	1.31±2.10	36 (45)	1.01±1.40	0.29
Missing (M)	3 (3.8)	0.04±0.19	4 (5)	0.05±0.21	0.70
Filled (F)	6 (7.6)	0.14±0.56	7 (8.8)	0.13±0.43	0.88
DMFT	33(41.3)	1.48±2.2	42 (52.5)	1.18±1.5	0.33
decay (d)	31(38.7)	1.58±2.54	46 (57.5)	2.18±2.69	0.15
filled (f)	3 (3.8)	0.06±0.36	7 (8.8)	0.09±0.28	0.63
dft	31(38.7)	1.6±2.6	47 (58.8)	2.2±2.7	0.14

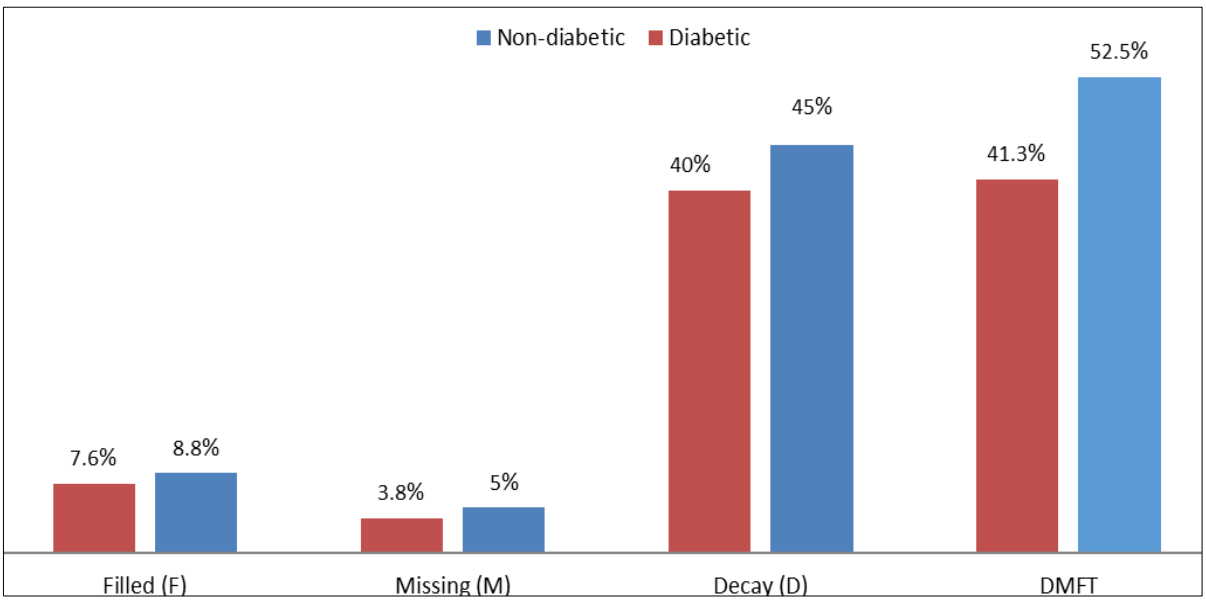

Fig 1: Comparison of DMFT scores between the two study groups

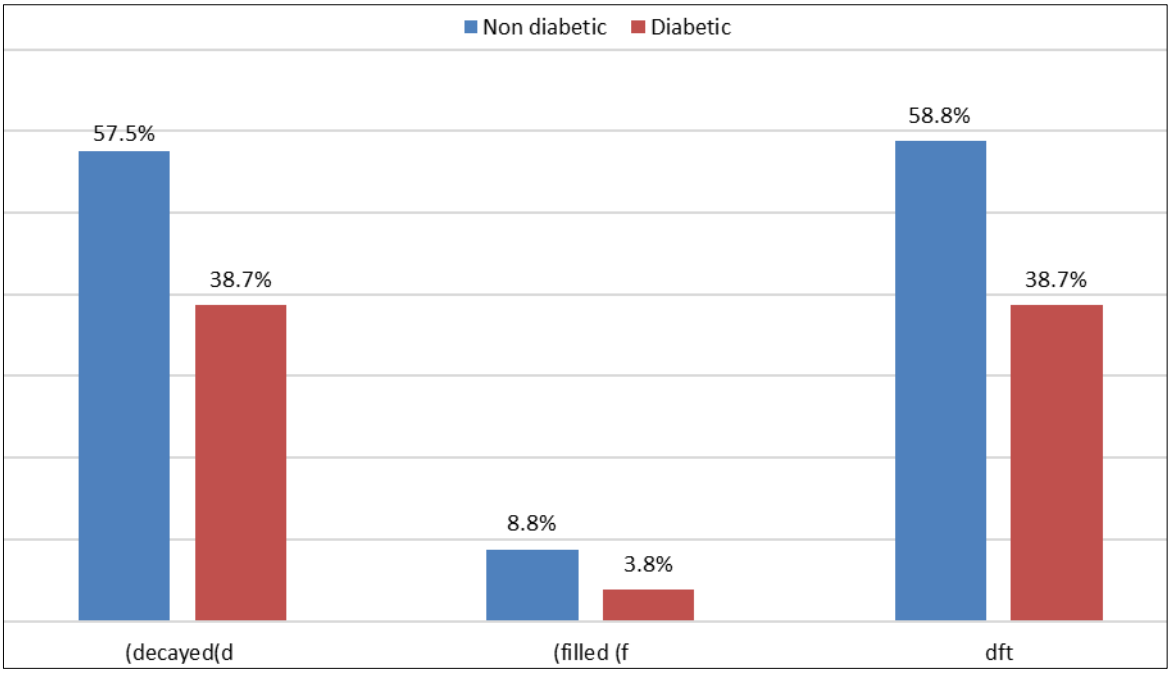

Fig 2: Comparison of dft scores between the two study groups

Discussion

There has been an increase in the incidence of diabetes mellitus among children and adolescents across the globe. This increase has included both type 1 (IDDM) and early onset type 2 diabetes mellitus [35]. Children with T1DM face numerous health challenges in their life, including dental and oral diseases. A cross-sectional study design using a paper based questionnaire and clinical dental examination were used to meet the study aims. The current study aimed to examine the impact of type 1 diabetes mellitus on the oral health among children aged 8–15 years in Libya and to compare these findings to non-diabetic healthy subjects. To our knowledge, this is the first time to conduct such study among Libyan children.

Dental caries in children and adolescents remains a serious problem as suggested by literature that the incidence and severity of dental caries approaches the level of an epidemic [36]. Several studies have reported the prevalence of caries among children and adolescents with type 1 diabetes; however, studies have shown a high degree of variability in dental caries prevalence among such populations.

The current study highlighted that the experience of dental caries, a true oral-health end point, was lower among children and adolescents with type 1 diabetes than that in the non-diabetic group where approximately 52.5% of healthy children and adolescents had experienced dental caries in permanent teeth with the mean DMFT value was 1.18 and that 58.8% of them had experienced dental caries in primary teeth with mean value of 2.2. Even though, still high number of diabetic participants in this study experienced dental caries and its consequences (41.3% DMFT, 38.7% dft). Our data showed that the mean of DMFT/dft for the diabetic group were DMFT 1.48±2.2 and dft1.6±2.6 respectively. No statistical significance difference has been found between the two study groups. This finding was in agreement with previous results; a study conducted by Kamran *et al*. on a group of 100 children (aged 9-14 years) with type 1 diabetes showed no differences in the level of caries between the study and control groups [37]. Also, Kuźmiuk *et al.*,[38] in 2018 revealed that children with type 1 diabetes had a lower intensity of caries in their permanent dentition in comparison with non-diabetic children [38]. Furthermore, Rafatjou *et al.*,[39] in their study in 2016, reported that the differences in the occurrence of caries between a group of 80 diabetic individuals aged 5–18 years and a group of healthy individuals was not significant [39].

Although many literatures reported no significant difference in caries experience, a study by Svensson *et al.*,[40] in 2009 found a difference in caries risk between diabetic and healthy individuals [40]. Furthermore, in contrast to our findings, a systematic search investigating the prevalence of dental caries among diabetic children and adolescents showed that the prevalence of dental caries was higher among diabetic group and approximately 67% of children and adolescents with type 1diabetes had dental caries, and the mean DMFT value was 5.7 [41]. Moreover, a national survey in Greece showed that the mean dmft/DMFT values were 1.77, 2.05, and 3.19 in 5, 12 and 15-year-old children, respectively [42]. They attributed their findings to the related Xerostomia or the decreased salivary flow rate associated with hyperglycemia and the lack of preventive and regular dental care. In this research, there were no statistical differences in the values of individual components of the DMFT index between the study and control groups. However, the study by Arheiam *et al.*,[43] that conducted on a group of 70 children with type 1 diabetes reported significantly higher average values of the decayed and missing components of the DMFT index in the diabetic group compared with healthy children[43]. Dental caries is a multifactorial disease, the interaction of genetic factors; the levels of glucose in saliva and gingival fluid, oral cariogenic bacteria, diet, oral hygiene,

duration of diabetes, utilization or access to dental care may explain the contradictions found in the literatures [44].

Finally, the current study should be viewed keeping in mind certain limitations. First, the non-probability sampling technique which has been used due to lack of access to the accurate number of study population. This could make the findings of the current study difficult to generalize. Second, the cross-sectional nature of this study cannot show elements of causality and a stronger evidence of associations could be achieved in future longitudinal cohort study.

Despite these limitations, the cross-sectional surveys can estimate the prevalence of the outcome of interest for a given population at one point of time. This design allows the collection of information relevant to the outcome and its associated characteristics among the participants [45]. As well as this study provides information about the dental status of patients with type1 diabetes among children in Libya, which might be used in preparing preventive and therapeutic programs and as a base for further researches.

Conclusions

No statistically significant differences were found in caries experience between diabetic and non-diabetic children in this study, for both the primary and permanent dentitions. However children with diabetes mellitus had a higher DMFT/dft scores which indicate more carious intensity.

More researches and longitudinal cohort studies in children with type1 diabetes mellitus are necessary to further explore the long term impact of diabetes on oral health for such vulnerable patients.

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