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ORIGINAL ARTICLE

Oral health status and impact on the oral health-related quality of life of Egyptian children and early adolescents with type-1 diabetes: a case-control study

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Abstract

Objectives The purpose of the present study is to (1) evaluate the oral health-related quality of life (OHRQoL) among a group of Egyptian children and early adolescents with type-1 diabetes mellitus (T_1DM) aged from 8 to 14 years and the impact of individual, environmental, oral health care and biological independent predictors (2) assess oral health status (OHS) in terms of oral hygiene, caries experience, untreated carious cavities and gingival condition.

Materials and methods A case-control investigation conducted on eligible 444 participants who have been assigned into four groups (two case groups included 125 children and 97 early adolescents with T_1DM and two matched control groups). The OHRQoL was measured using a validated structured $CPQ_{8–10}$ for children and $CPQ_{11–14}$ short-form questionnaires for early adolescents. The questionnaire comprised of four parts that represented the study independent variables. Descriptive data were analysed using Mann-Whitney *U* test for the non-parametric data. Pearson's correlations have been calculated to inspect the interrelation between metabolic disease control and study of different OHS representatives. Log-linear Poisson model regression analyses performed to determine associations between the OHRQoL and independent predictors.

Results The prevalence of dental caries ($DT \geq 1$) in children with diabetes was 49.6% (75.3%). The worse GI mean and median scores were recorded among early adolescents with T_1DM [mean (SD) = 2.24 ± 0.61; median (IQR) = 2.3(1)]. The social well-being of CPQ domains was a prominent concern that negatively affected children and early adolescents' life aspects. A strong correlation between OHRQoL and the level of HbA_{1c} in the two diabetic groups ($r = 0.69$ for children's group and 0.74 for the early adolescent group) was observed. The final model of log-linear Poisson regression analysis demonstrated that the odds ratio (OR) of poor OHRQoL among children and early adolescents with poor metabolic control was 1.30 [95% CI 1.18–1.47] and 1.22 [95% CI 1.11–1.38] times more than those with good metabolic control do.

Conclusions The overall self-reported OHRQL appears to be adversely affected by T_1DM especially among children and early adolescents with poor metabolic control. Socioeconomic status and oral health care demonstrate a significant impact on the OHRQoL; however, the effect was obvious in the diabetic and non-diabetic groups.

Clinical relevance 1. In Egypt, the number of new cases rises progressively in a retrospective survey to figure out the prevalence of T1DM among children and adolescents. The available data is limited regarding the incidence and prevalence of dental caries

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and gingival condition among Egyptian children and early adolescents. 2. The present study is a premier study that assesses the OHRQoL and studies the impact of the individual, environmental, biological and oral health care variables. 3. This study highlights the urgent need for improving the oral health status of diabetic children and adolescents and the necessity for qualified oral health education programs for children and parents. There is an intense need to reinforce the role of preventive oral hygiene measures.

Keywords Quality of life · Diabetes mellitus · Oral health · Dental caries

Introduction

Type-1 diabetes mellitus (T_1DM) is an endocrine-metabolic disturbance that occurs as a result of the devastation of the pancreatic beta cells under autoimmune infirmity and genetic influence [1]. T_1DM is mainly a disease of childhood and adolescence characterized by insufficient insulin production and subsequent increase of the blood glucose level (i.e., hyperglycaemia) [2, 3] . Despite the global nature of the disease, its incidence shows geographical heterogeneity. For instance, a very low annual incidence has been reported in China and Venezuela (0.1 per 100,000 individuals) while in Finland, the incidence is high (40.9 per 100,000) [4]. In Egypt, the number of new cases rises progressively; in a retrospective survey to figure out the prevalence of T_1DM among children and adolescents, it was found unremitting increases in the disease prevalence over the period from 1994 to 2011 to reach 26.8 per 100,000 [5]. The oral health status of diabetic children is the pivot of several investigations. Oral complications are common among adolescents with T1DM, especially those of poor metabolic disease. Periodontal diseases and opportunistic candidal infection are well-established sequelae of diabetes. A controversial data correlate dental caries with diabetes; high caries may be related to reduce salivary flow [6–9]. In contrast, other studies have not confirmed this relationship [2, 10].

Oral health is an integral part of the multidimensional aspects of an individual's general quality of life perception. Oral health has an influence on physical, psychological, social and emotional life aspects [11]. One of the tools designed by Jokovic et al. to measure oral health-related quality of life (OHRQoL) in children is child perception questionnaire (CPQ) for age groups 8 to 10 years ($CPQ_{8–10}$) and 11 to 14 years ($CPQ_{11–14}$) [12].

Several epidemiological studies have evaluated the association between diabetes and quality of life. However, most of these investigations have focused on adults with type-2 diabetes. The main concern of these studies was the general health-related quality of life (HRQoL). In addition, most of these investigations have been conducted in developed countries and a little was known about OHRQoL in children and early adolescents with T_1DM in developing countries.

In Egypt, the number of new cases suffering from T_1DM rises progressively and the available data concerning children and early adolescent's OHRQoL and OHS among Egyptian children and early adolescents with T_1DM are still obscured. Therefore, the current study was conducted on a group of Egyptian children and early adolescents with T_1DM aged from 8 to 14 years to (1) evaluate their OHRQoL and the impact of individual, environmental, oral health care and biological independent predictors and (2) assess their oral health status (OHS) in terms of oral hygiene, caries experience, untreated carious cavities and gingival condition.

Materials and methods

Setting, design and sample size determination

The study was conducted on diabetic children, who attended the Endocrinology Outpatient Clinic, Paediatric Department, Faculty of Medicine and Paediatric Dentistry Department, Faculty of Dentistry, Minia University during the period from February 2018 to January 2019.

Based on the estimated standard deviation (15.5) of the OHRQoL scales obtained from a pilot study included 70 diabetic participants (35 children and 35 teenagers), 0.05 degree of precision, a power of 0.8 and 5% significant level; 201 diabetic participants were enrolled in this cross-sectional investigation. An additional 21 children (10%) were included to compensate the non-response cases. The total number of diabetic participants was 222 and, for comparison, another 222 healthy children were recruited. The two groups to be matched, the children in the control group were selected randomly from the same schools, age and gender of the diabetic children.

Eligibility criteria

Inclusion criteria

The children included in the current study must have the following criteria:

1. Aged from 8 to 14 years
2. Medical reports revealed T_1DM exclusively with a minimum of 2 years of diagnosis [13]
3. Only caries experience and gingival status were selected to represent the clinical variables that may mediate the children's OHRQoL
4. No emergency dental recall in the last 3 months [14]

Exclusion criteria

Children with the following condition have been excluded:

1. Orthodontic treatment or malocclusion

Systemic, psychological or intellectual disabilities

Allocation

Eligible participants in both groups were selected using a computer-generated simple randomisation. Then, they were assigned into four groups: (i) case group (8- to 10-year-old children with T_1DM), (ii) control group (8 to 10-year-old children without T_1DM) ($n = 125$ children per each group), (iii) case group (11 to 14-year-old early adolescents with T_1DM) and finally, (iv) control group (11 to 14-year-old early adolescents without T_1DM) ($n = 97$ early adolescents per each group).

Study measuring tools and variables

The variables adopted in this study were classified into five levels based on previously suggested variables by Sischo and Broder [15]. The first level considered the following individual characteristics: (i) demographic data (e.g., gender) and (ii) the metabolic disease status evaluated using the glycated haemoglobin level (HbA_{1c}) adjusted as less than or equalled 8% and over 8% [16]. The second level included the environmental predictors in terms of socioeconomic status (SES) that incorporated

1. Mother and father's levels of education, which were categorized into four classes: "greater than secondary, secondary, less than secondary and illiterate" [17]
2. Household expenditures per person recorded in the local currency (Egyptian LE) per month then divided by 30 days. The cut-off point of poverty per day in Egypt was US$1.99 [17, 18].
3. Dental service utility, represented with a question about the regular annual dental visit "yes" or "no" response.

The third level scrutinized the personal oral health care, including the frequency of tooth brushing and mouthwash that assessed through three responses: "none, three times or less/week, once/day and twice/day". For dichotomization, none or three times or less/week responses were considered as "irregular" frequency use and once/day and twice/day were considered as "regular" frequency use. The fourth level considered the biological factors that the oral health status (OHS) in terms of (i) caries experience measured with decayed, missing and filled teeth index (DMFT) of permanent teeth for caries experience and decayed teeth index (DT) for untreated carious cavities. Both indices were addressed as "0" or "≥ 1". (ii) Oral hygiene and gingival condition were appraised using the Plaque index (PI) and Gingival index (GI), respectively. PI scores classified excellent/good oral hygiene (0–0.9), fair oral hygiene (1–1.9) and poor oral hygiene (2–3). GI scores categorised as no/mild gingivitis (0–1), moderate gingivitis (1.1–2) and severe gingivitis (2.1–3) [19]. To assess the OHRQoL, a face-to-face interview was using a validated Arabic version of $CPQ_{8–10}$ and $CPQ_{11–14}$ short-form questionnaires. Responses categorized on a 5-point Likert scale: 0 never, "1" once or twice, "2" sometimes, "3" often and "4" every day or almost every day [20–22] (Appendix 1).

Data collection and calibration

Before launching the study, two dentists with at least 2 years of residency at the Paediatric and Dental Public Health Department, Faculty of Dentistry, Minia University, were trained for 1 week. After the training period, all the investigators involved in the study and their recorded DMFT, PI examined 47 children and GI scores examined for reliability. Dental caries examination performed by a visual-tactile method using a dental mirror and WHO probe plus previous tooth brushing and air-drying for 5 s per each dental surface under artificial light [23, 24]. The gingival condition was evaluated using the gingival index (GI), and the criteria of Loe and Silness were adopted to calculate the GI scores [25].

Statistical methods

Statistical Package for the Social Sciences (SPSS) version 20 was used for data entry and analysis. Descriptive statistics included frequency tables, mean and standard deviation (SD), median and interquartile range (IQR) of $CPQ_{11–14}$ different domains. Both Mann-Whitney *U* binary non-normally distributed data. To inspect the relationship between metabolic disease control and study different OHS representatives, Pearson's correlations have been used.

Log-linear Poisson model regression analysis was performed to determine associations between the OHRQoL and independent predictors. Statistical models in the current study were released according to a hierarchical strategy of

determinant factors. Predictors were categorized into four models; "Model 1" included the individual characteristics, "Model 2" incorporated model 1 plus environmental factors, "Model 3" contained Model 2 plus the oral health care predictors and Model 4 implicated model 4 plus the OHS variables. At each level and after bivariate analysis, predictors with a level of significantly lower than 0.2 ($p < 0.2$) were included in the subsequent model until constructing the final model. For bivariate and multivariate statistical analysis, independent variables were dichotomized. The cut-off point of the level of significance was specified at less than 5% ($p > 0.05$) and 95% confidence interval (95% CI).

Results

Out of the examined 579 children and early adolescents, 444 participants were selected. The response rate was high 100% and 98% in the case and control groups The inter-examiner reliability of DMFT and DT scores Kappa coefficients (κ) was 0.93, and for PI and GI, the degree of agreement was 0.87 and 0.89 respectively. Cronbach's alpha of the CPQ of different domains in the children group with T_1DM ranged from 0.76 to 0.88 and from 0.78 to 0.91 for the early adolescent group.

Based on the cut-off point of HbA_{1c}, the frequency of poorly controlled children with T_1DM was 117 (93.6%). In the early adolescent group, the frequency of both uncontrolled and controlled diabetic status was 74 (76.3) and 23 (23.7) respectively. The prevalence of sever gingivitis was predominant among early adolescents The prevalence of dental caries (DT ≥ 1) in the children and early adolescents with T_1DM was 49.6% and 79.4% group with diabetes (75.3%). On the other hand, poor oral hygiene was prevalent in the children group with T_1DM. The other baseline characteristics and objective measures are illustrated in Table 1.

The data in Table 2 showed a distinct statistically significant difference between the study and control groups concerning the OHS. Children and early adolescents with T_1DM showed a higher average of untreated carious cavity scores compared to their peers without T_1DM. Despite that poor oral hygiene was obvious in all groups, the average PI scores in the two case groups were statistically significantly higher than those recorded in the control groups ($p < 0.01$). The worse gingival index (GI) mean and median scores were recorded among early adolescents with T_1DM [mean (SD) = 2.24 ± 0.61; median (IQR) = 2.3(1)] indicating severe gingivitis. Other groups revealed moderate gingival inflammation. The average and median scores of HbA_{1c} in the early adolescents with T_1DM were 11.85 ± 0.65 and 10.8(2) respectively which are higher than the records of children with diabetes [mean (SD) = 8.68 ± 1.37, median (IQR) = 8.8(1)] (not shown in the table). A statistically significant difference in the overall CPQ mean and median scores between the participants with and without T_1DM in the two groups have been disclosed ($p < 0.01$). The social well-being of CPQ domains was a prominent concern that negatively affected children and early adolescents' life aspects.

There is strong correlation between OHRQoL and the level of HbA_{1c} in the two diabetic groups ($r = 0.69$ for children group and 0.74 for the early adolescent group). (Figure 1). Moderate correlations between HbA_{1c} of children group and DMFT, DT, GI and PI scores have been recorded as follows: [$r = 0.18$ ($p < 0.05$), 0.59 ($p < 0.01$), 0.31 ($p < 0.01$) and 0.44 ($p < 0.01$)] respectively. For the early adolescent group, there is strong highly significant correlation between HbA_{1c} PI and GI scores ($r = 0.66$ and 0.61) respectively and a moderate correlation with DT ($r = 0.48$) and DMFT scores ($r = 0.42$) with a high level of significance ($p < 0.01$).

The association between different study variables and the OHRQoL is declared in Tables 3 and 4. There was no statistically significant difference in the overall CPQ scores between males and females in all groups. In addition, the father's level of education was not statistically significantly associated with OHRQoL and this was in contrast with the maternal level of education, which was statistically associated with the OHRQoL average and median scores. The gingival condition had no statistically significant impact on the children with T_1DM ($p > 0.05$) while its impact was evident among early adolescents with T_1DM ($p < 0.01$). High dental plaque accumulation was statistically significantly associated with high scores of OHRQoL in all groups except for children without T_1DM.

The final model of log-linear Poisson regression analysis demonstrated that the odds ratio (OR) of poor OHRQoL among children and early adolescents with poor metabolic control was 1.30 [95% CI 1.18–1.47] and 1.22 [95% CI 1.11–1.38] times more than those with good metabolic control do. The mother's education had a statistically significant influence on the OHRQoL of both groups with diabetes, while the father's education level does not seem to catch such effect. In the children group with diabetes, the OR of caries experience showed no statistically significant effect on the OHRQoL and this was contrary to the untreated cavities and gingival condition that revealed a statistically significant influence on the CPQ overall score. Concerning the early adolescents with T_1DM, the OR of OHRQoL was 1.18 [95% CI 1.11–1.29] times among the participants with poor gingival and oral hygiene in comparison with those with good gingival and plaque status. In addition, the OR of OHRQoL among early adolescents with untreated cavities was 1.17 [95% CI 1.10–1.26] when compared to those without carious lesions (Table 4).

Table 1 Baseline characteristics of the diabetic group and the non-diabetic group

Baseline characteristics	Diabetic children ($N = 222$)		Normal children ($N = 222$)		p value*
	$CPQ_{8–10}$ $N = 125$ $N(\%)$	$CPQ_{11–14}$ $N = 97$ $N(\%)$	$CPQ_{8–10}$ $N = 125$ $N(\%)$	$CPQ_{11–14}$ $N = 97$ $N(\%)$	
Gender					
Boys	56 (44.8)	50 (51.5)	65 (52)	53 (54.6)	0.256
Girls	69 (55.2)	47 (48.5)	60 (48)	44 (45.4)	
Mother's education					
More than secondary education	44 (35.2)	45 (46.4)	43 (34.4)	36 (37.1)	0.001***
Secondary education	44 (35.2)	36 (37.1)	45 (36)	41 (42.3)	
Less than education	26 (20.8)	11 (11.3)	11 (8.8)	14 (14.4)	
Illiterate	11 (8.8)	5 (5.2)	26 (20.8)	6 (6.2)	
Father's education					
More than secondary education	58 (46.4)	59 (60.8)	52 (41.6)	60 (61.9)	0.007**
Secondary education	38 (30.4)	25 (25.8)	41 (32.8)	26 (26.8)	
Less than secondary education	24 (19.2)	10 (10.3)	19 (15.2)	5 (5.2)	
Illiterate	5 (4)	3 (3.1)	13 (10.4)	6 (6.2)	
Household expenditures per day					
More than 1.99$	43 (34.4)	45 (46.4)	41 (32.8)	33 (34)	0.168
Less than 1.99$	82 (65.6)	52 (58.6)	84 (67.2	64 (66)	
Frequency of tooth brushing per day					
None	54 (43.2)	33 (34)	73 (58.4)	66 (68)	0.0001****
Once	34 (27.2)	26 (26.8)	38 (30.4)	21 (21.6)	
Twice	30 (24)	30 (30.9)	14 (11.2)	10 (10.3)	
More than twice	7 (5.6)	8 (8.2)	0 (0)	0 (0)	
Frequency of dental recalls in the last year					
None	72 (57.6)	68 (70.1)	79 (63.2)	59 (60.8)	0.776
Once	45 (36)	21 (21.6)	39 (31.2)	32 (33)	
Twice	8 (6.4)	8 (8.2)	7 (5.6)	6 (6.2)	
DMFT (decayed, missed and filled)					
0	8 (6.4)	5 (5.2)	14 (11.2)	6 (6.2)	0.0001****
≤ 3	53 (42.4)	23 (23.7)	67 (53.6)	43 (44.3)	
> 3	64 (51.2)	69 (71.1)	44 (35.2)	48 (49.5)	
Gingival index (GI)					
0 to 1	4 (3.2)	4 (4.1)	9 (7.2)	16 (16.5)	0.0001****
1.1 to 2	37 (29.6)	20 (20.6)	100 (80)	65 (67)	
2.1 to 3	84 (67.2)	73 (75.3)	16 (12.8)	16 (16.5)	
Plaque Index (PI)					
0 to 0.9	1 (0.8)	4 (4.1)	36 (28.8)	13 (13.4)	0.0001****
1 to 1.9	40 (32)	34 (35.1)	60 (48)	56 (67)	
2 to 3	84 (67.2)	59 (60.8)	29 (23.2)	19 (19.6)	

p value: chi-square test: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$; ****$p \leq 0.0001$

Discussion

The current study was designed as a case-control study that aimed mainly to assess the OHS among a group of children and early adolescents with T_1DM and its impact on their OHRQoL. A face-to-face interview has been chosen to perform this study because of the guarantee of obtaining a high quality and more accurate data [26].

Although there were several researches concerned with DM and its influence on the quality of life, it was difficult to implement a direct comparison between the findings of the current study and previously published findings. This might be attributed to a number of reasons. For instance, (i) the methodology and design variability (i.e. the use of different tool for measuring OHRQoL, number of recruiting participants and their age groups) and (ii) the difference in

Table 2 Median and interquartile range of child perception questionnaire (CPQ) domains of the diabetic and the non-diabetic groups

CPQ Domains	Diabetic groups		Non-diabetic groups		*p* value
	$CPQ_{8–10}$ Median (IQR)	$CPQ_{11–14}$ Median (IQR)	$CPQ_{8–10}$ Median (IQR)	$CPQ_{11–14}$ Median (IQR)	
Oral symptoms	10 (15)	11 (8)	5 (12)	5 (11)	0.18
Functional limitations	10 (40)	9 (7)	4 (12)	4 (9)	0.024*
Emotional well-being	11 (14)	9 (6)	4 (14)	4 (12)	0.0001****
Social well-being	20 (28)	12 (8)	4 (14)	5 (14)	0.0001****
Overall score	52 (70)	40 (22)	17 (44)	18 (42)	0.0001****

Mann-Whitney *U* test: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$; ****$p \leq 0.0001$

participants' baseline characteristics as well as the divergent socioeconomic backgrounds. However, it was useful to highlight some of these findings.

The findings of the present study highlighted that emotional difficulties were the apparent concern among children and early adolescents with T_1DM. This was in agreement with outcomes of Roa et al. who declared a negative impact of DM on the emotional and psychosocial aspects [27]. This might be explained through linking the social well-being to social-environmental determinants such as socioeconomic status and the level of education of early adolescents' parents/caregivers that diminish the participant's self-management of the disease [28]. Low family income and parental education level also constrained dental services utility and oral hygiene measures [29]. This was in line with the results of the current study, which elucidated the correlation between socioeconomic status and untreated carious lesions and its subsequent inferior influence on OHRQoL. Psychological difficulties might be aroused from the lack of awareness about the importance of family support. This explanation is supported by Frank's claim that psychological issues are related to the care of adolescents with T_1DM, as well as Noueiri and Nassif, who declared that the negative impact of psychological changes reaches the peak in the adolescence stage [30, 31]. The study findings emphasized the negative impact of poor metabolic control of T_1DM on the OHRQoL. Psychological make-up plays a key role in metabolic disease control in terms of lack of adherence to insulin therapy and diminished efficient self-management behaviour [32].

The current study declared the negative impact of poor metabolic glycated control on the OHRQoL.

This influence might be correlated with the poor OHS recorded by the children and early adolescents with T_1DM.

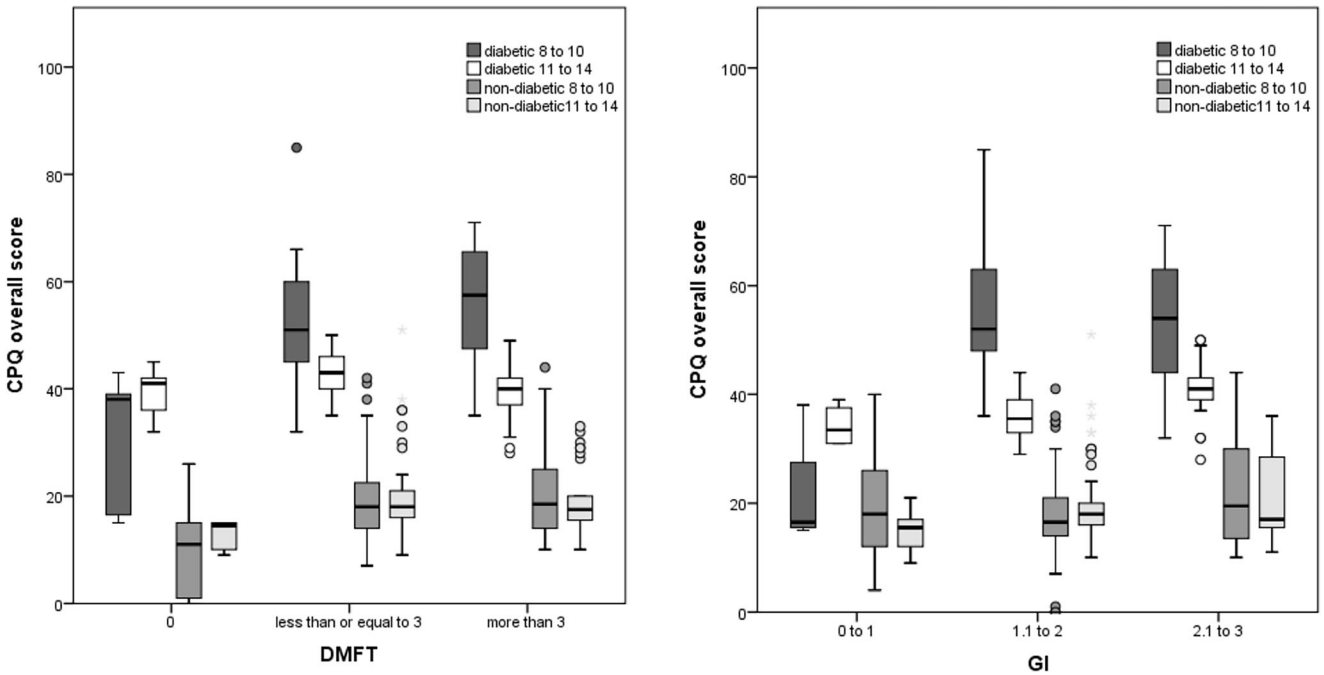

Fig. 1 Pearson's correlation (r) between OHQoL and glycated haemoglobin of children group **a** r = 0.69 and early adolescent group **b** r = 0.74

Table 3 Mean rank of the HbA1c in relation to the oral condition and DMFT, PI, GI scores and the CPQ domains scores of the study groups

Predictor variables	HbA1c of 8–10 years			HbA1c of 11–14 years		
	Mean rank		*p* value*	Mean rank		*p* value*
	≤ 8%	> 8%		≤ 8%	> 8%	
DMFT	15.94	66.22	0.0001****	37.24	51.5	0.017*
PI	37	64.78	0.01**	38.41	52.29	0.01**
GI	30.44	65.23	0.001***	33.15	53.93	0.0001****
Oral symptoms score	26.13	65.52	0.003**	22.07	57.37	0.0001****
Functional limitations score	22.25	65.79	0.001***	42	51.18	0.158
Emotional well-being score	26.38	65.50	0.002**	47.41	49.49	0.743
Social well-being score	39.13	64.63	0.05*	50.07	48.67	0.831
Overall score	28.69	65.35	0.006**	35.48	53.20	0.008[b]

Mann-Whitney *U* test: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$; ****$p \leq 0.0001$

Concerning dental caries, the results revealed a significant difference between the diabetic and non-diabetic participants of both age groups. Several former studies supported our point of view [33, 34], while other published articles denied the association between diabetes and dental caries in children and early adolescents [35, 36]. This heterogeneity might be related to the variation of caries prevalence among the studied population, different sample sizes or the selected HbA1c cut-off points may play a role in such differences. In the present study, the high caries experience could be attributed to the following: (i) poor oral hygiene in commitment with an obvious shortage in oral health care especially among children with T_1DM and (ii) poor glycemic control might contribute in diminishing the salivary flow and buffer capacity and subsequent increase of the cariogenic bacteria such as *streptococci* and *lactobacilli* [37]. Moreover, high levels of Hba_{1c} might be associated with poor dietary habits and higher intake of saturated fat [38].

The outcomes of the present study showed a significant association between dental plaque, gingival inflammation and the level of HbA_{1c}. This was in agreement with the data published by Al-Khabbaz et al. who demonstrated a statistically significant difference in the GI and PI scores between the diabetic children aged 4 to 14 years and the non-diabetics [39]. Furthermore, the number of gingival bleeding sites as an indicator of gingival status was found to be statistically significant in children with diabetes in previous investigations [40, 41]. These observations could be due to the poor metabolic control that prompted the accumulation of dental biofilm. This augmented the host defence mechanism especially when accompanied with improper oral hygiene [42].

The pervasiveness of poor OHRQoL was obvious among not only the T_1DM participants, but also non-diabetic children and teenagers that suffered from the predatory impact of low SES, potentially conjugated with limited access to care. Furthermore, low SES might not force the parents/caregivers to deem oral health care a major concern among their vantages. Parent's education had a positive effect on the OHRQoL. Increasing the level of education might boost the awareness, attitude and practice toward enhancing their children's oral health care. This was in line with the findings of former published findings [43, 44]. The frequency of dental visit and gender showed no significant impact on the OHRQoL which was compatible with a previous article finding [45].

Study strengths and limitations

Some limitations of the current study warrant consideration. Firstly, the whole participants were recruited from a public health centre, which is mainly the destination of low SES families and might influence the generalization of the findings. Secondly, depending on visual-tactile method only to calculate the DMFT scores without the aid of bitewing radiographs might underestimate the findings of caries background. Finally, recall bias might be encountered in the children and early adolescents' responses.

However, the present study has several strong points, which could be concluded in the following aspects: (i) the high reliability, which is important for the internal validity of the study. (ii) To improve the data accuracy, a face-to-face interview was considered which aided in expressing and recording the true feelings of the participants rather than depending on the self-reported questionnaire. This method guaranteed that the extracted data were accurate, and this might explain the high reliability of variable scales. (iii) Up to the data, it is a premier studies that assessed the quality of life of children with T1DM in Egypt at these age groups.

Table 4 Beta coefficient of the OHRQoL, caries experience and gingival status of diabetic and non-diabetic children in relation to the socio-demographic variable, economic factor, dental care, DMFT, GI and PI scores

Predictor variables	OHRQoL		Caries experience		Gingival status	
	β	SE	β	SE	β	SE
Gender						
Diabetic younger age	0.086	1.729	0.062	0.097	0.073	0.073
Non-diabetic younger age	0.054	1.469	0.066	0.095	0.043	0.076
Diabetic teenagers	0.144	0.136	0.095	0.129	0.076	0.129
Non-diabetic teenagers	0.052	1.506	0.027	0.137	0.102	0.109
Father's education						
Diabetic younger age	− 0.312	1.656	− 0.015	0.066	− 0.319**	0.068
Non-diabetic younger age	− 0.113	1.187	− 0.029	0.077	− 0.076	0.061
Diabetic teenagers	− 0.064	0.691	− 0.021	0.107	− 0.153	0.107
Non-diabetic teenagers	− 0.079	0.331	− 0.060	0.030	0.007	0.024
Mother's education						
Diabetic younger age	− 0.038	1.636	− 0.036	0.093	− 0.361**	0.067
Non-diabetic younger age	− 0.071	1.090	− 0.174	0.070	− 0.050	0.056
Diabetic teenagers	− 0.107	0.677	− 0.091	0.104	− 0.048	0.104
Non-diabetic teenagers	− 0.035	0.881	− 0.073	0.080	− 0.095	0.064
Household expenditure						
Diabetic younger age	− 0.048	0.126	− 0.022	0.139	− 0.071	0.108
Non-diabetic younger age	− 0.020	1.710	− 0.143	0.109	− 0.018	0.087
Diabetic teenagers	− 0.104	0.121	− 0.070	0.133	− 0.098	0.133
Non-diabetic teenagers	− 0.167	1.509	− 0.152	0.139	0.011	0.110
Frequency of tooth brushing						
Diabetic younger age	− 0.090	1.173	− 0.288**	0.092	− 0.236**	0.048
Non-diabetic youger age	− 0.037	1.053	− 0.160*	0.068	− 0.064	0.055
Diabetic teenagers	− 0.197	0.749	− 0.051	0.072	− 0.174	0.072
Non-diabetic teenagers	− 0.127	1.174	− 0.069	0.108	− 0.094	0.085
Frequency of dental recall						
Diabetic younger age	− 0.130	1.931	− 0.147	0.120	− 0.529****	0.068
Non-diabetic younger age	− 0.005	1.266	− 0.07	0.081	− 0.112	0.065
Diabetic teenagers	− 0.081	0.696	− 0.121	0.107	− 0.313**	0.083
Non-diabetic teenagers	− 0.005	1.287	− 0.086	0.116	− 0.148	0.092
Plaque index (PI)						
Diabetic younger age	0.221*	1.176	0.497****	0.069	0.466****	0.055
Non-diabetic younger age	0.156	1.425	0.256*	0.107	0.223**	0.089
Diabetic teenagers	0.298**	0.787	0.281*	2.550	0.534****	0.10
Non-diabetic teenagers	0.214	1.555	0.217*	0.871	0.227*	0.121
Overall CPQ score						
Diabetic younger age			0.416****	0.004	0.235**	0.004
Non-diabetic	–	–	0.112	0.772	0.027	0.005
Diabetic teenagers			0.516****	0.006	0.516****	0.01
Non-diabetic teenagers			0.480****	0.010	0.089	0.008

β beta correlation coefficients, *SE* standard error

*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$; ****$p \leq .0001$

Conclusions

In sum, the overall self-reported OHRQL appears to be adversely affected by the presence of diabetes especially among children and early adolescents with poor metabolic control. Children and early adolescents with T_1DM showed a higher prevalence of caries experience, untreated carious cavities and gingival inflammation in comparison to their counterparts

without diabetes. SES and oral health care demonstrates a significant impact on the OHRQoL; however, the effect was obvious in the diabetic and non-diabetic groups. This study highlighted the urgent need for improving the oral health status of early adolescents with T_1DM and enforcing the role of preventive oral hygiene measures.

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Compliance with ethical standards

Conflict of interest The author declares that he has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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