Dental caries and dental care level (restorative index) in children with diabetes mellitus type 1

Article *in* International Journal of Paediatric Dentistry · January 2011

DOI: 10.1111/j.1365-263X.2010.01094.x · Source: PubMed

Azza Tagelsir
Indiana University-Purdue University Indiana…

Rita G E C Cauwels
Ghent University

Luc Constant Martens
Ghent University

DOI: 10.1111/j.1365-263X.2010.01094.x

INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY

Dental caries and dental care level (restorative index) in children with diabetes mellitus type 1

AZZA TAGELSIR[1], RITA CAUWELS[1], SARA VAN AKEN[2], JACKIE VANOBBERGEN[3] & LUC C. MARTENS[1]

[1]Department of Paediatric Dentistry and Special Care – PaeCaMeD-Research, Ghent University, Gent, Belgium, [2]Department of Paediatrics, Ghent University, Gent, Belgium, and [3]Department of Community Dentistry and Oral Public Health, Ghent University, Gent, Belgium

International Journal of Paediatric Dentistry 2010

Summary

Introduction The aim of the study was to investigate caries experience and dental care index in diabetic children and to determine if correlation exists between caries experience and metabolic control, insulin treatment, and the duration of diabetes.

Materials and methods The study group consisted of 52 children and adolescents, 3–16 years of age with type 1 diabetes attending the outpatient diabetic clinic at Ghent University Hospital, Belgium. Fifty healthy subjects recruited from the paediatric dental clinic served as the control group. Caries lesions were assessed using DMF-index both at cavity and non-cavity levels. Participants and/or their guardians provided information about oral hygiene habits and dietary habits. Diabetes-related data (type, duration, insulin regimen) were collected from medical records and completed with the lab data on HbAlc.

Conclusion It became clear that, although children with type 1 diabetes mellitus could be expected to run a potential high caries risk taking into account the diabetes-associated biological and behavioural alterations, no significant differences were observed regarding caries experience and dental care between diabetic children and healthy controls. The level of untreated dental decay among the diabetic children is, however, considerably high, which was reflected by a significant lower dental attendance.

Introduction

The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action, or both[1]. Oral health in patients with type 1 diabetes mellitus has received substantial attention in the literature throughout the years. Although it is generally accepted that diabetic patients are susceptible to gingival inflammation[2] and periodontal destruction – even very early in life –[3], there is lack of consensus about the association between diabetes mellitus and dental caries[4]. In contrast to children and adults with type 2 diabetes that is often associated with obesity and intake of high-calorie and carbohydrate rich food, children with type 1 diabetes were often given diets that restrict their intake of carbohydrate-rich, cariogenic foods[5]. Previous research has mainly explained the lower caries prevalence among diabetics by the sucrose-restricted diet that is a part of the life-long treatment[6]. Lately, the recent management of diabetes based on the flexibility of insulin administration and regular monitoring of blood glucose allows a less restricted diet and reduces the significance of the influence of dietary factors on caries development in diabetics[4].

Other diabetes-related factors that have been associated with the cariogenic changes in the oral environment of diabetic children and adolescents included less resting and stimulated whole saliva[7–10], lower saliva buffering capacity and acidic pH [6,7,11], higher salivary glucose [6,7,12,13], higher salivary albumin

Correspondence to:
Prof Dr Luc C. Martens, Department of Paediatric Dentistry & Special Care, Dental School (P8), De Pintelaan 185, B-9000 Gent, Belgium.
E-mail: luc.martens@ugent.be

concentrations[10], high proportion of salivary *Streptococcus mutans*[14], and positive salivary yeast growth[9]. Poor metabolic control of diabetes has also been proposed as a risk factor being linked to both dangerous salivary changes[6] and certain behavioural factors including poor adherence to both the diabetes regimen and the oral health recommendations[15].

Despite all the aforementioned proposed risk factors for dental caries among diabetics, the relationship between dental caries and diabetes remains controversial. Although several studies have reported higher incidence of dental caries and higher DMF values among diabetic children[6,16], other cross-sectional studies have reported similar caries experience[14,17–19] or even lower caries prevalence in children and adolescents with type 1 diabetes mellitus and their non-diabetic controls[9,20].

The aims of this study were:

1. to investigate the caries experience, dental care level, and oral hygiene in a group of diabetic children compared with healthy age and sex-matched controls.
2. to determine if correlation exists between the caries experience of diabetic patients and the metabolic control of diabetes, insulin treatment, and the duration of diabetes.

Materials and methods

Ethical approval

The study protocol was approved by the ethical committee of the Ghent University Hospital (project 2004/226). Parents/legal guardians of participants signed a consent form.

Subject's selection

Subjects enrolled in this study were children and adolescents with type 1 diabetes mellitus consecutively attending the outpatient diabetic clinic at Ghent University Hospital, Ghent, Belgium over a 9-month period (April–December 2008) for routine check-ups.

A total of 212 patients were selected and scheduled for invitation during their regular follow-up visits in the period between April and December 2008. During this 9-month recruitment period, families were sent written information regarding the study prior to their scheduled clinic appointment. Information and invitation was made with standard invitation letters sent by mail. The families of the patients were then contacted by telephone for an appointment at the same day of their endocrinology follow-up visit. A sample size was calculated based on the following parameters: alpha error level of 5%, power of 80% for detecting a DMFS difference of 2, study (diabetes children) and control group ratio of 1:1, standard deviation of 4.5. These parameters determined the need to examine 152 children, distributed evenly in 76 diabetes and 76 control children. To select the children, the initial sample size was increased by about 30%, including 202 children. To detect a DMFS difference of one, a sample size of 500 patients is needed. Many patients, initially selected, refused to be enrolled in the study. The final study group consisted of 52 patients in the diabetic group patients (i.e., 25% response rate) and 50 healthy controls, resulting in a power reduction to about 73% for detecting a DMFS difference of 2. Reasons of non-participation included unwillingness to participate, or difficulty of combining the dental appointment with the endocrinology follow-up appointment due to lack of time of the patient.

The study group consisted of a sample of 52 children and adolescents, 3–16 years of age (29 males and 23 females), without any other systemic disease or complications exclusive those related to type 1 diabetes mellitus. All patients were treated with multiple daily insulin injections or insulin pump therapy (continuous subcutaneous insulin infusion).

The control group consisted of 50 healthy children and adolescents (28 males and 22 females), aged 2–16 years, recruited from the paediatric dental clinic at Ghent University Hospital. The matching criteria were age (maximum 6 months difference) and gender. The control subjects were mainly attending for routine dental checkups. Children in the control group were excluded if they were undergoing active orthodontic therapy or had systemic disease. Children attending for routine checkups after total oral rehabilitation under general anaesthesia were also excluded from the control group. The groups were considered to be similar. According to the questionnaire analysis of the study participants, there were no significant differences ($P > 0.05$) between the groups with regard to the reported social background (based on parental occupation) and oral hygiene habits.

Data collection

Data were collected by means of a questionnaire, clinical oral examination, and patient records. Clinical and radiographic assessment of dental caries and assessment of oral hygiene were carried out for all the study participants.

Questionnaire

Data were collected by means of a self-administered questionnaire. Participants and/or their guardians responded to questions concerning the participants' oral hygiene and dietary habits and the frequency of dental visits. The questions about oral hygiene habits included frequency of tooth brushing (once per week, once per day, two times per day, more than two times per day), parental help with brushing (always, sometimes, rarely, never), frequency of approximal cleaning, and the use of fluoride containing toothpaste and other fluoride containing oral products (always, sometimes, rarely, never). The questions about dietary habits included questions about the consumption of main meals (breakfast, lunch, dinner), frequency of consumption of sweet snacks (none, maximum two per day, two per day, more than two per day) and sweet drinks (none, maximum two per day, two per day, more than two per day), and the consumption and frequency of sugar free drinks (none, maximum two per day, two per day, more than two per day). The socioeconomic status (SES) of all patients was assessed by combining the occupational status of the father and the mother. The classification of SES was based on the standard occupational classification published by the Office of Population Censuses and Surveys 1990 and the classification proposed by Vanobbergen *et al.*[21].

Clinical oral health assessment methodology

Dental caries examination. . Clinical oral examination was carried out by the same examiner under standardized condition at the paediatric dental clinic of Ghent University Hospital. All Examinations were performed using plane dental mirror and blunt dental explorer with the aid of compressed air and proper lighting.

The number of decayed, missing, and filled surfaces (dmfs/DMFS) in the coronal part of each tooth was determined. Decay was recorded at the level of cavitation (D3) and non-cavitation (D1, D2) based on WHO diagnostic threshold (DMFT index) following the WHO codes and criteria (WHO; 1997) and the criteria of the Dundee Selectable Threshold Method for caries diagnosis codes from Fyffe *et al.* [22, 23]**.** The percentages of caries-free subjects and subjects with caries in the primary and/or permanent dentition were also calculated. Diagnostic criteria included sound surface with no visual signs of treated or untreated dental caries, white spot lesion and brown spot lesion (D1), enamel cavity (D1,D2), uncavitated dentine lesion and dentine cavity (D1,D2,D3), pulp involved (D1,D2,D3), and arrested dentinal decay (D1,D2,D3). Any surface that was restored and carious was recorded as carious. Clear distinction was made between teeth that were extracted due to orthodontic reasons or following trauma. Only teeth that were missing due to caries were included in the analysis. Filled surfaces/teeth as a result of dental trauma were also not included in the analysis. Decayed (DS/ds), filled (FS/fs), and missed (MS/ms) surfaces were calculated, and the means of the indices were used in analyses. The dental care level (restorative index) was expressed as $[(F/D+F)*100, (f/d+f)*100]$ at tooth level. The restorative index expressed the proportion of the decayed and filled teeth that have been treated restoratively.

Radiographic examinations. At the end of the clinical examination, bitewing radiographs were taken after the participant's and/or their parent's consent was obtained. The exclusion criteria for taking bitewing radiographs were:

- Radiographs taken shortly before by the home dentist.
- Unwillingness to participate or lack of time.
- Children with only primary dentitions and open contacts.

The radiographic examination evaluated the caries status from mesial surface of the first premolar or first primary molar to the distal surface of the first or second permanent molar. All the bitewing radiographs were taken using a beam aligning device (Kwik-Bite®, Kerr-Hawe, Bioggio, Switzerland) and a dual-packed film (Kodak, insight IP-02, F-E Speed) with Soredex Minray Intra Oral X-ray Unit (Trophy®, Kodak, Milwakee, WI, USA). Film type 35 mm × 45 mm or 35 mm × 22 mm E-F-speed intraoral X-ray film (Kodak®, Rochester, NY, USA) was used with a 0.10 s exposure time.

The X-rays were viewed and scored by one examiner at the end of the study all on the same day, using a standard viewing box with each radiograph masked with black paper to reduce extraneous light.

The mesial, distal, and occlusal surface of each erupted teeth visible on the radiograph were examined for the presence of caries. The modified criteria and codes of Pitts (1996) were used[27]. Any surface that was restored and carious was recorded as carious.

Oral hygiene assessment. Level of oral hygiene was assessed using the plaque index[28]. The plaque index scores were recorded from the buccal tooth surface of six index teeth in the permanent and primary dentitions. Each index tooth was given a score from 0 to 3 as described by Sillness and Löe (1964). Based on individual needs oral hygiene instructions were given.

Inter/intra examiner reproducibility

The investigator was trained at baseline in an *in vitro* calibration exercise. Clinical calibration exercises were also carried out at baseline and during the study period. A group of children was examined by the investigator and the results compared with the examination results of the benchmark examiner (L.M). Inter-examiner and intra-examiner kappa's values were 0.92 and 0.80, respectively. Inter-examiner reproducibility kappa value of the BWs radiography was 0.69.

Diabetes related variables

Information related to the subjects' diabetes, was collected from medical records. Data on the type of diabetes, duration (years since diagnosis), age at diagnosis, insulin regimen (multiple daily insulin injections or continuous subcutaneous insulin infusion), and laboratory data, including measurements of HbA1c were collected. Metabolic control of diabetes was determined by calculating the mean of several glycosylated haemoglobin HbA1c values determined on the day of oral examinations, 3 months and 6 months before oral examination. Good metabolic control of diabetes was considered for HbA1c values not exceeding 7.5%, and moderate metabolic control was considered for values between 7.5% and 8.5%. HbA1c values more than 8.5% indicated a poor metabolic control of the disease.

All subjects were treated according to a standard protocol with rapid-acting or very rapid- acting daytime insulin (Actrapid® or NovoRapid®, NOVO NORDISK, Bagswaerd, Denmark) administrated as multiple daily insulin injections combined with long/medium-acting insulin for night-time use, or through continuous subcutaneous insulin infusion (pump therapy).

Statistical data analysis

The outcome variables considered were the mean DMF-s/dmf-s, the mean decayed, missing and filled teeth (DMF-t/dmf-t), the mean dental care index, and the mean plaque index. The normality assumption of the collected data was tested by using QQ-plots and by the Shapiro–Wilk test. Statistical testing between groups (diabetics and their non-diabetic controls) was carried out using the independent sample *T*-test for continuous data. In case of a non-normal distribution, statistical analysis was performed using non-parametric tests (Mann–Whitney test and Kruskal–Wallis tests). Statistical significance was considered when $P < 0.05$. Multivariate logistic regression analysis was carried out to reveal possible factors determining caries experience in both primary and permanent dentitions.

Results

Analysis within the diabetic group

The sample characteristics of the diabetics group ($n = 52$) are shown in Table 1. More than 70% of the diabetic patients had well to moderate controlled diabetes (38.5% with good metabolic control (HbA1c < 7.5%) and 42.3% with moderate metabolic control (HbA1c 7.5–8.5%)). Only 19.2% had poor metabolic control of diabetes (HbA1c > 8.5%). Regarding the method of insulin administration, 73.1% of the subjects used daily insulin injections while 26.9% used insulin pump; 63.5% used rapid-acting daytime insulin, 9.6% used very rapid-acting daytime insulin and 26.9% used very rapid continuous insulin.

Diabetics versus non-diabetics

Dental caries. Comparison of the caries experience between the diabetics and the non-diabetics in the group of children with permanent teeth (mean age 11.44 ± 2.55 in the diabetics and 11.63 ± 2.58 in the non-diabetics) showed that the diabetic children had higher DMF-s/DMF-t values than the non-diabetic controls although the difference was not statistically significant ($P > 0.05$).

In the group of children with primary teeth (mean age 9.10 ± 2.62 in the diabetics and 8.69 ± 2.66 in the non-diabetics), however, dmf-s/dmf-t values were higher in the non-diabetics than in the diabetics yet with no statistically significant difference. It should be stated here that decay scores (*D*) were recorded at both cavitation (D3) and non-cavitation levels (D1,D2). D1 & D2 were not excluded from the final analysis.

Dental care. The dental care level of the study groups was assessed according to the mean restorative index values expressed as (*F/D+F*) and the pattern of dental attendance. The mean restorative index of diabetic patients was 19.6 ± 32.2 in the group of permanent teeth and 21.54 ± 29.27 in the group of primary teeth. This implies that almost 80% of the decay in primary and permanent dentition in the diabetic group remained untreated. When comparing the restorative index of the primary teeth (21.54 ± 29.27) of the diabetics to that of the non-diabetics (33.31 ± 37.40), it was evident that particularly the primary teeth of the diabetic children are less 'cared for' than those of the non-diabetics. Nevertheless, no statistical significant difference of the mean dental care index of both groups was revealed. The same holds for the permanent teeth.

The mean values and the standard deviations of the DMF-s/DMF-t, the dmf-s/dmf-t, and the dental care index for the permanent as well as for the primary dentitions of diabetics and healthy non-diabetic controls are presented in Table 2.

With respect to dental attendance (Fig. 1), regular dental attendance, represented by one/two dental visits per year, was demonstrated in more than 60% in both diabetics and non-diabetics. About one fourth of the diabetic children, however, visit the dentist rarely or never. Dental attendance frequency was significantly lower in diabetic children ($P = 0.037$).

Plaque index. The mean plaque index score was higher in the diabetic group than that of

Table 1. Sample characteristics of the diabetic group (*n* = 52).

Variable	Mean ± SD
Age (years)	9.84 ± 3.52
Gender	29 males, 23 females
Mean HbA1c (%)	7.85 ± 0.82
Mean duration of diabetes (years)	4.61 ± 3.37
Mean age at onset of diabetes (years)	5.20 ± 3.075
Mean plaque index	1.69 ± 0.81

Table 2. Caries experience and dental care index for the permanent as well as for the primary dentition of diabetics and healthy non-diabetic controls (expressed as the mean, SD).

		N	Mean	SD	*P*-value*
Mean DMF-s	Non-diabetics	41	4.46	3.98	0.49
	Diabetics	44	5.61	5.97	
Mean DMF-t	Non- diabetics	41	2.85	2.47	0.35
	Diabetics	44	3.84	3.89	
Mean dmf-s	Non-Diabetics	35	7.03	7.33	0.08
	Diabetics	39	3.89	3.81	
Mean dmf-t	Non- diabetics	35	3.51	2.76	0.27
	Diabetics	39	2.86	2.52	
Dental care index primary teeth	Non- diabetics	29	33.31	37.40	0.27
	Diabetics	29	21.54	29.27	
Dental care index permanent teeth	Non- diabetics	34	21.68	29.11	0.55
	Diabetics	36	19.60	32.23	

*$P < 0.05$ were considered statistically significant (Mann –Whitney U Test).

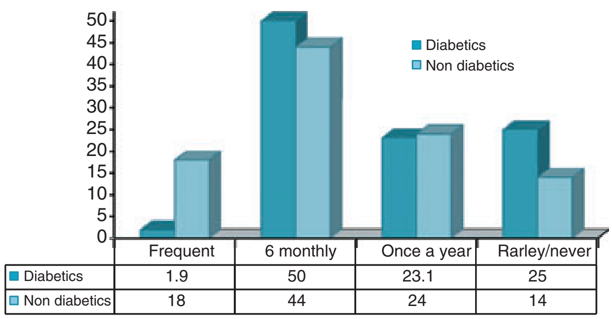

Fig. 1. Frequencies (%) of dental attendance in the diabetic group and the healthy controls. Difference considered significant at $P < 0.05$ (Chi-square test).

the control group (Diabetics 1.69 ± 0.81, Non-diabetics 1.41 ± 0.73). Nevertheless, no significant difference was disclosed in plaque index between the diabetics and non-diabetics in both dentitions. Frequency of tooth brushing was also not significantly different ($P = 0.278$) between the diabetics and the non-diabetic controls with more than two thirds of the children in both groups brushing one to two times daily (Fig. 2)

Dental caries and diabetes-related factors

Although the mean DMF-s/DMF-t was slightly higher in diabetic patients with poor metabolic control in the group of children with permanent teeth (when compared with those with moderate and good metabolic control), Kruskal–Wallis test failed to disclose any statistical significance ($P > 0.05$). In the group of primary teeth, children with moderate metabolic control displayed slightly higher dmf-s/dmf-t than those with good metabolic control although no statistical significant difference was evident. In children with poor metabolic control, no consistent relation was found between metabolic control of diabetes and dmf-s/dmf-t values. There was no significant difference between the different methods of insulin administration (Mann–Whitney test), the type of daytime insulin treatment (Kruskal–Wallis test), or the duration of diabetes (Mann–Whitney test) and caries scores in both permanent and primary dentitions (Tables 3, 4).

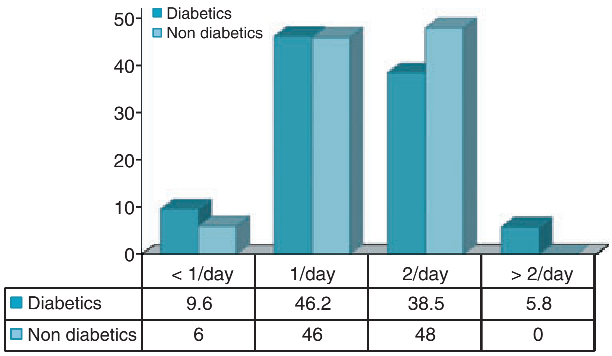

Fig. 2. Frequency (%) of tooth brushing in the diabetic group and healthy controls. Difference considered significant at $P < 0.05$ (Chi-square test).

Multivariable linear logistic regression analysis

Multivariable linear logistic regression analysis was carried out to identify factors determining caries experience in both primary and permanent dentition (caries experience was dichotomized in 'yes' for children with a history of caries and 'no' for caries-free children).

Caries-free was considered when decay score was zero at both cavitation (D3) and non-cavitation levels (D1, D2). Exposure variables included age, diabetes, parental occupation, between-meals snacks, tooth brushing frequency, and dental attendance. The analysis demonstrated that only 'age' was statistically significantly ($P = 0.013$) associated with

Table 3. The caries experience (DMF-s/DMF-t) and dental care index for the group of diabetics with permanent teeth (*n* = 44), (expressed as Mean ± SD) according to the metabolic control of diabetes, method of insulin administration, type of daytime insulin, and duration of diabetes.

Permanent teeth		DMF-s	*P**-value	DMF-t	*P**-value	Care index	*P**-value
Metabolic control	Good	5.0 ± 6.76	0.48	3.16 ± 3.55	0.33	14.44 ± 28.78	0.58
	Moderate	6.12 ± 5.94		4.18 ± 4.49		27.25 ± 38.14	
	Poor	6.0 ± 4.41		4.75 ± 3.45		15.35 ± 27.42	
Method Insulin	Daily injections	5.85 ± 6.13	0.52	3.97 ± 3.95	0.661	22.48 ± 34.14	0.22
	Pump	4.80 ± 5.65		3.40 ± 3.84		7.70 ± 20.35	
Type insulin	Rapid	5.41 ± 5.88	0.51	3.48 ± 3.24	0.54	22.79 ± 36.11	0.35
	Very rapid	8.40 ± 7.64		6.80 ± 6.61		20.48 ± 21.11	
	Very rapid continuous	4.8 ± 5.65		3.40 ± 3.84		7.69 ± 20.35	
Duration diabetes	Short (<4 years)	4.61 ± 4.25	0.50	3.17 ± 2.91	0.53	15.812 ± 30.19	0.40
	Long (>4 years)	6.30 ± 6.91		4.30 ± 4.43		22.31 ± 34.08	

*$P < 0.05$ were considered statistically significant.

Table 4. The caries experience (dmf-s/dmf-t) and dental care index for the group of diabetics with primary teeth (*n* = 39), (expressed as Mean ± SD) according to the metabolic control of diabetes, method of insulin administration, type of daytime insulin, and duration of diabetes.

Primary teeth		dmf-s	*P**-value	dmf-t	*P**-value	Care index	*P**-value
Control diabetes	Good	3.93 ± 3.54	0.23	2.75 ± 1.98	0.16	23.04 ± 30.62	0.92
	Moderate	5.31 ± 4.09		3.39 ± 2.88		18.76 ± 21.46	
	Poor	0.57 ± 0.53		0.57 ± 0.53		25.0 ± 50.0	
Method Insulin	Daily injections	4.46 ± 4.17	0.15	3.14 ± 2.68	0.23	20.8 ± 26.84	0.98
	Pump	2.45 ± 2.21		2.09 ± 1.97		23.81 ± 38.31	
Type insulin	Rapid	4.38 ± 4.27	0.27	3.04 ± 2.72	0.33	18.73 ± 27.19	0.31
	Very rapid	5.5 ± 3.54		4.5 ± 2.12		41.67 ± 11.79	
	Very rapid continuous	2.45 ± 2.21		2.09 ± 1.97		23.81 ± 38.32	
Duration diabetes	Short (<4 years)	2.04 ± 2.32	0.29	1.36 ± 1.49	0.31	13.63 ± 32.33	0.26
	Long (>4 years)	3.70 ± 4.37		2.47 ± 2.92		27.34 ± 39.83	

*$P < 0.05$ were considered statistically significant.

Table 5. The multiple logistic regression analysis of the predictors of caries experience [Odds ratios (ORs) with 95% confidence intervals (CIs) and *P*-value].

Exposure variables	Odds ratio	95.0% CI	*P*-value
Age	1.58	1.102–2.278	0.01
Diabetes	0.64	0.100–4.049	0.63
Fathers occupation	1.36	0.338–5.502	0.66
Mothers occupation	0.30	0.066–1.370	0.12
Frequency of between meals snacks	1.97	0.715–5.428	0.19
Chewing gum	0.44	0.127–1.533	0.19
Frequency of tooth brushing	0.82	0.206–3.259	0.78
Electrical brushing	5.48	0.245–122.715	0.28
Toothpaste	1.21	0.269–5.425	0.81
Dental attendance	2.89	0.949–8.846	0.06
Constant	0.12		0.34

caries experience whereas in this study group, no association was found with diabetes, father occupation, mother occupation, frequency of tooth brushing, or frequency of between-meals snacks (Table 5).

Further two variables (in order of entry: age and dental attendance) were entered in a conditional forward step-wise regression analysis. The results of the model indicated that the factor ‘age’ (OR = 1.529 + 95%CI) continued to be positively related to the caries experience. The factor ‘dental attendance’ (OR = 2.401 + 95%CI) was also found significant.

Discussion

In this study, diabetic patients showed no significant difference in the mean DMF-S/DMF-T, dmf-s/dmf-t in both groups of children with permanent or primary dentitions. Our results are similar to both earlier findings[14,17,18,20] as well as findings of relatively recent cross-sectional case control studies[9,24].

The results of the present study, however, contradict those of Karjalainen *et al.*[16] and Lopez *et al.*[7] who reported higher DMF values among diabetic children compared with healthy controls. It is worth mentioning that the subjects in the study of Karjalainen *et al.*[16] were older (with mean age of 14.5 years) and with longer mean duration of diabetes (mean duration of 6 years) than the subjects of this study.

Furthermore, this study failed to reveal any association between poor metabolic control of diabetes and high caries experience, which is in disagreement with the findings reported by Twetman *et al.*[4] and those reported by Siudikiene *et al.*[9]. It should be pointed out that comparison with the findings of Twetman *et al.*[4] may not be justified because of the longitudinal design of the latter study and the cross-sectional design of our study. On the other hand, the study of Siudikiene *et al.*[9] employed a sample of diabetic children with overall poor glycemic control and with severe medical complications at onset of diabetes. The cut off point for poor metabolic control in their study was higher (HbA1c $> 9\%$) than in our study. Our findings, however, are in agreement with the results reported by other cross-sectional studies that failed to reveal any association between poor metabolic control and dental caries[15,24–26]. A possible explanation for the conflicting results concerning the role of HbA1c in determining dental caries may be differences in prevalence of *S. mutans* and lactobacilli[15]. One of the important limitations of our study is the lack of data about the prevalence of salivary S. *mutans* and lactobacilli among the study group.

The dental care (restorative index) was low in both the diabetic group and the control group with no statistically significant difference between the two groups. It was, however, exceptionally remarkable that the children with primary teeth had a pronounced level of untreated dental disease. The difference, however, was not significant but it should be taken into account that the control group was recruited from a dental hospital-based population that may not reflect completely the community population. Furthermore, the relatively high untreated decay in the study population can partly be explained by the inclusion of the non-cavitated caries scores (D1 and D2) and the use of interproximal radiographs. Furthermore, dental attendance frequency was significantly lower in diabetic children. In this respect, the authors are aware of the fact that dental compliance is probably higher in children attending a hospital-based paediatric dental clinic compared with those attending a private practice. Despite the limitations of this study, it must be emphasized that there is a clear treatment need in diabetic children. The fact that dental care in children with chronic disease is often perceived as a low priority and parents are usually confronted with other essential aspects of their child's health including regular life-long health care visits can be a critical factor. Another factor could be the low motivation of parents due to lack of awareness about the significance of oral health. Some parents mistakenly believe that young children do not have to visit the dentist because children's teeth are not permanent. All these factors can be potential explanations for the high level of untreated decay in diabetic children. Since dental care affordability is an important barrier to dental care, it is noteworthy that all children in this study were under full dental insurance coverage. There is sparse information in the literature regarding the dental care level of diabetic children and adolescents. Karjalainen[25] reported that the need for prophylaxis and frequent dental examinations among children and adolescents with type 1 diabetes is greater for the patients with poor metabolic control than for those with good or moderate control of the disease. Our study, however, found no significant difference in the dental care index between the diabetic patients with different metabolic controls. These results are consistent with those reported by Siudikiene *et al.*[9].

In conclusion, our findings show that even though children with type 1 diabetes mellitus could be expected to run a potential high caries risk taking into account the diabetes-associated biological and behavioural alterations, no significant differences were observed in our study regarding the caries experience between diabetic children and healthy controls. On the other hand, our results suggest that the level of untreated dental decay among the diabetic children is considerably high indicating that the diabetic patients as well as their parents lack important knowledge about oral health problems.

What this paper adds

- No significant difference was found in caries experience and dental care level in children with type 1 diabetes mellitus when compared with healthy controls.
- No significant difference was found between the level of metabolic control, the methods of insulin administration, the type of daytime insulin treatment, or the duration of diabetes and caries scores in both permanent and primary dentitions.

Why is this paper important to paediatric dentistry

- The paediatric dentist should realise that children with a chronic medical condition such as diabetes mellitus show a low dental attendance and compliance, which apparently results in a considerably high amount of untreated tooth decay.

References

1 WHO Consultation Report. Definition, diagnosis and classification of diabetes mellitus and its complications. Report of a WHO Consultation, Part 1: Diagnosis and Classification of Diabetes Mellitus, Geneva, 59 p., WHO/NCD/NCS/99.2.

2 Lalla E, Cheng B, Lal S *et al.* Diabetes mellitus promotes periodontal destruction in children. *J Clin Periodontol* 2007; **34**(4): 294–298.

3 Lalla E, Cheng B, Lal S *et al.* Periodontal changes in children and adolescents with diabetes: a case-control study. *Diabetes Care* 2006; **29**(2): 295–299.

4 Twetman S, Johansson I, Birkhed D, Nederfors T. Caries incidence in young type 1 diabetes mellitus patients in relation to metabolic control and caries-associated risk factors. *Caries Res* 2002; **36**(1): 31–35.

5 Lamster IB, Lalla E, Borgnakke WS, Taylor GW. The relationship between oral health and diabetes mellitus. *J Am Dent Assoc* 2008; **139**(Suppl): 19S–24S.

6 Iughetti L, Marino R, Bertolani MF, Bernasconi S. Oral health in children and adolescents with IDDM–a review. *J Pediatr Endocrinol Metab* 1999; **12**(5): 603–610. Review.

7 López ME, Colloca ME, Páez RG, Schallmach JN, Koss MA, Chervonagura A. Salivary characteristics of diabetic children. *Braz Dent J.* 2003;**14**(1):26–31. Epub 31 July 2003

8 Mata AD, Marques D, Rocha S *et al.* Effects of diabetes mellitus on salivary secretion and its composition in the human. *Mol Cell Biochem* 2004; **261**(1–2): 137–142.

9 Siudikiene J, Machiulskiene V, Nyvad B, Tenovuo J, Nedzelskiene I. Dental caries and salivary status in children with type 1 diabetes mellitus, related to the metabolic control of the disease. *Eur J Oral Sci* 2006; **114**(1): 8–14.

10 Siudikiene J, Machiulskiene V, Nyvad B, Tenovuo J, Nedzelskiene I. Dental caries increments and related factors in children with type 1 diabetes mellitus. *Caries Res*. 2008;**42**(5):354–362. Epub 26 August 2008.

11 Aren G, Sepet E, Ozdemir D, Dinççağ N, Güvener B, Firatli E. Periodontal health, salivary status, and metabolic control in children with type 1 diabetes mellitus. *J Periodontol* 2003; **74**(12): 1789–1795.

12 Karjalainen KM, Knuuttila MLE, Käär ML. Salivary factors in children and adolescents with insulin-dependent diabetes mellitus. *Pediatr Dent* 1996; **18**: 306.

13 Belazi MA, Galli-Tsinopulou A, Drakoulakos D, Felva A, Papanayioiou PH. Salivary alterations in insulin – dependent diabetes mellitus. *Int J Paediatr Dent.* 1998; **8**(1): 29–33.

14 Twetman S, Aronsson S, Björkman S. Mutans streptococci and lactobacilli in saliva from children with insulin-dependent diabetes mellitus. *Oral Microbiol Immunol* 1989; **4**(3): 165–168.

15 Syrjälä AM, Niskanen MC, Ylöstalo P, Knuuttila ML. Metabolic control as a modifier of the association between salivary factors and dental caries among diabetic patients. *Caries Res* 2003; **37**(2): 142–147.

16 Karjalainen KM, Knuuttila ML, Käär ML. Relationship between caries and level of metabolic balance in children and adolescents with insulin-dependent diabetes mellitus. *Caries Res* 1997; **31**(1): 13–18.

17 Sarnat H, Eliaz R, Geiman G, Flexer Z, Karp M, Laron Z. Carbohydrate consumption and oral status of diabetic and nondiabetic young adolescents. *Clin Prev Dent.* 1985; **7**(4): 20–23.

18 Goteiner D, Vogel R, Deasy M, Goteiner C. Periodontal and caries experience in children with insulin-dependent diabetes mellitus. *J Am Dent Assoc* 1986; **113**(2): 277–279.

19 Kirk JM, Kinirons MJ. Dental health of young insulin dependent diabetic subjects in Northern Ireland. *Community Dent Health* 1991; **8**(4): 335–341.

20 Swanljung O, Meurman JH, Torkko H, Sandholm L, Kaprio E, Maenpaa J. Caries and saliva in 12 – 18 years old diabetics and control. *Scand J Dent Res* 1992; **100**(6): 310–313.

21 Vanobbergen JN, Martens LC, Lesaffre E, Declerck D. Parental occupational status related to dental caries experience in 7 year old children in Flanders (Belgium). *Community Dent Health* 2001; **18**(4): 256–262.

22 Fyffe HE, Deery C, Nugent ZJ, Nuttall NM, Pitts NB. Effect of diagnostic threshold on the validity and reliability of epidemiological caries diagnosis using the Dundee Selectable Threshold Method for caries diagnosis (DSTM). *Community Dent Oral Epidemiol* 2000a; **28**: 42–51.

23 Fyffe HE, Deery C, Nugent ZJ, Nuttall NM, Pitts NB. *In vitro* validity of the Dundee Selectable Threshold Method for caries diagnosis (DSTM). *Community Dent Oral Epidemiol* 2000b; **28**(1): 52–58.

24 Edblad E, Lundin SA, Sjödin B, Aman J. Caries and salivary status in young adults with type 1 diabetes. *Swed Dent J* 2001; **25**(2): 53–60.

25 Kaisa Karjalainen. Periodontal diseases, dental caries, and saliva in relation to clinical characteristics of type 1 diabetes. Academic Dissertation presented with the assent of the Faculty of Medicine, University of Oulu, Finland, 2000. Available at: http://herkules.oulu.fi/isbn9514256395/html/c552.html (accessed January 2009).

26 Moore PA, Guggenheimer J, Etzel KR, Weyant RJ, Orchard T. Type 1 diabetes mellitus, xerostomia, and salivary flow rates. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001; **92**(3): 281–291.

27 Pitts NB. The use of bitewing radiographs in the management of dental caries: scientific and practical considerations. *Dentomaxillofac Radiol* 1996; **25**: 5–16.

28 Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontol Scand* 1963; **21**: 533–51.