Comparing the Oral Health Status of Diabetic and Non-Diabetic Children from Puerto Rico: a Case-control Pilot Study

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Objective: Children with type 1 diabetes have infrequently been the subjects of studies examining oral health status (caries and gingival diseases); in addition, no study of this type has ever been on Puerto Rican children. The purpose of this study was to evaluate the oral health status of Puerto Rican children (ranging in age from 6 to 12 years) either with or without type 1 diabetes and compare the two groups with regard to that status.

Methods: This was a matched case-control study. A convenience sample of 25 children with type 1 diabetes (cases) and 25 non-diabetic children (controls), all ranging in age from 6 to 12 years and matched by age and gender, was evaluated by a calibrated dentist for caries, bleeding on probing, and plaque and calculus indexes. A sample of saliva was taken from each subject and analyzed to determine *Streptococcus mutans* and *Lactobacillus* counts. Descriptive statistics, chi-square test, and t-test were used to describe and assess the data.

Results: We used the caries index to evaluate the teeth of the children participating in our study; we found significant differences in the number of lesions in the permanent teeth of diabetic children compared to the number found in the permanent teeth of non-diabetic children (1.43 and 0.56, respectively; p = 0.05). The mean number of sites of bleeding on probing for diabetic children was 23.9; for non-diabetic children it was 4.2. Diabetic children had more plaque than did the control children (plaque index = 2.5 vs. 0.8; p = 0.007) and more bleeding on probing (p = 0.001). High levels of glycosylated hemoglobin in diabetic children were statistically significantly associated with a greater number of sites with bleeding on probing.

Conclusion: Diabetic children are at higher risk for caries and gum disease than are non-diabetic children. [*P R Health Sci J 2011;30:123-127*]

Key words: Children, Periodontal disease, Diabetes type 1

Diabetes mellitus (DM) is a chronic metabolic disorder caused by an absolute or relative deficiency of insulin, an anabolic hormone. Insulin is produced by the beta cells of the islets of Langerhans, which are located in the pancreas. The absence, destruction, or other loss of these cells results in type 1 diabetes (insulin-dependent diabetes mellitus [IDDM]). Most children with diabetes have IDDM, which leads to permanent dependence on exogenous insulin. The other type of DM is type 2 diabetes (non–insulin-dependent diabetes mellitus [NIDDM]); it is a chronic disease that affects the lives of millions of Americans and is a heterogeneous disorder. Most patients with NIDDM have insulin resistance, and their beta cells lack the ability to overcome this resistance. Other patients may have inherited disorders of insulin release leading to maturity-onset diabetes of the young (MODY).

Approximately 200 million individuals in the world have diabetes. In the United States, 23.6 million people (7.8% of the US population) have been diagnosed with diabetes. There has been a 50% increase in diabetes incidence in the last 2 decades. Of the 23 million US residents who have diabetes, 17.9 million have been diagnosed with the condition, while 5.7 million do not know they have it. Annually, 798,000 Americans are diagnosed with diabetes. National statistics report that 10.7% of adults older than 20 years, 23.1% of adults older than 60 years, 11.2% of the men living in the United States, and 10.2% of the women living in the United States suffer from diabetes. Statistics compiled by the National Institute of Diabetes and Digestive and Kidney Diseases report that in the United States, 9.8% of whites, 14.7% of African Americans, 7.5% of Asian Americans,

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and 10.4% of Hispanics have diabetes. It has been established that Hispanics have a high prevalence of diabetes: 8.2% for Cuban Americans, 11.9% for Mexican Americans, and 12.6% for Puerto Ricans (1).

Diabetes is prevalent in children and adolescents. One out of 600 school-aged children has the condition, and 186,300 children and adolescents under the age of 20, representing 0.02% of the young population, have diabetes. Type 1 diabetes is the most prevalent in American white children, whereas type 2 diabetes is the most prevalent among minorities and Hispanics. Statistics show that 50% of children diagnosed with diabetes die of renal disease 25 years after having been diagnosed.

Diabetes affects the periodontal tissues in children as early as in the sixth year of life; nevertheless, there are no studies regarding the presence of periodontal disease in diabetic children younger than 6 years of age. Diabetes in children and adolescents increases the risk of periodontal tissue destruction at an early age, depending on the duration of the disease (2, 3).

Few studies have been performed regarding the relationship between diabetes and the early signs of gingival or periodontal disease in children. Dakovic et al (4), in a case-control study with a sample of 187 cases of children with type 1 diabetes and 178 non-diabetic controls, all of whom ranged in age from 6 to 18 years, found that diabetic children had more dental plaque accumulation, gingival inflammation, and periodontal tissue destruction than did the controls. In this study, diabetic children had 2.8 times more risk of being in the initial stage of gingival or periodontal disease in comparison to the non-diabetic controls, and the severity of periodontal destruction was associated with the degree of glycemic control as measured by levels of HbA1c. Lal et al (5), in a case-control study with a sample of 270 diabetic children and 320 non-diabetic controls, all ranging in age from 6 to 14 years, found that diabetic children had more gingival inflammation and exhibited earlier dental eruption than did their non-diabetic counterparts. In that same study, it was found that diabetic patients had greater gingival bleeding (both in the deciduous and in the permanent teeth), with a 33% incidence of bleeding on probing for primary teeth and a 57% incidence of bleeding on probing for permanent teeth.

As is the case with other complications of diabetes, gum disease is linked to glycemic control. People with poor blood sugar control suffer from gum disease more frequently and to a greater degree, losing more teeth than persons with good glycemic control. In fact, people whose diabetes is well controlled have no greater levels of periodontal disease than do non-diabetics. This outcome is based on inflammatory mechanisms mediated by cytokines and other inflammatory mediators as well as by immune response. Children with IDDM (insulin-dependent diabetes mellitus) are also at risk for gum disease. There are few studies regarding the prevalence of periodontal disease in diabetic children, especially in Hispanic children and no studies at all of Puerto Rican diabetic children.

The main objective of this study was to investigate the dental and gingival health status of a group of children diagnosed with type 1 diabetes and to compare that status with that of healthy non-diabetic children (the control group). Specifically, we explored the differences in the oral health status (as assessed by caries index and gingival status) of children with diabetes mellitus who visited the University Pediatric Hospital during the years of 2008 and 2009 and non-diabetic children from the Dental Clinic of the University of Puerto Rico School of Dental Medicine.

Methods

This was a case-control study. A convenience pilot sample of 25 children with type 1 diabetes and ranging in age from 6 to 12 years who visited the Pediatric Endocrinology clinic at the University Pediatric Hospital and 25 non-diabetic children, also ranging in age from 6 to 12 years, who visited the University of Puerto Rico (UPR) School of Dental Medicine Pediatric Dentistry Clinic were recruited. Prior to participating in the study, each participant was asked to provide his or her consent and assent by signing a written consent form that had been approved by the University of Puerto Rico Medical Science Campus (UPR-MSC) Institutional Review Board (IRB). The small sample size amassed at the Endocrinology clinic can be attributed to the age range chosen and to the relatively small number of individuals who agreed to participate. The study sample (with a targeted sample size of 113) was to consist of children ranging in age from 6 to 12 years. This number was based on population estimates from the 2008 Census (564,347 children between the ages of 5 and 14 years and a 0.02% estimated general prevalence of type 1 diabetes in PR and worldwide). The actual number of participants for the study that came from the Pediatric Endocrinology Clinic is fewer than 113 children because not all children who have type 1 diabetes visit this clinic. The sample of diabetic children was matched by age and gender with non-diabetic children. Subjects in the samples, both cases and controls, shared the same ages and low socioeconomic level, as determined by the principal investigator (PI) on the recruitment of these individuals into the study.

The inclusion criteria for non-diabetic children were their being from 6 to 12 years of age, that they had never been diagnosed with diabetes, that they had no history of systemic illness, and that both they and their parents agreed and assented to their participation. Exclusion criteria for diabetic children and non-diabetic children alike were that they were unable to provide informed consent or assent or to cooperate with the study protocol and that they may be placed at medical risk as a result of their participation. Cases were children diagnosed with type 1 diabetes mellitus who were visiting the Pediatric University Hospital at the time of the study recruitment. Controls were non-diabetic children aged 6 to 12 who visited

the UPR School of Dental Medicine Clinic at the time of the study recruitment.

The study was conducted at the same time that participating children had their appointments at the Endocrinology Clinic at the University Pediatric Hospital. Also, a medical history of each study participant was taken prior to his or her dental exam. A questionnaire was administered to parents that collected information on socioeconomic variables as well as on behavioral practices. Each child's height and weight was taken in order to determine his or her body mass index (BMI). An oral health quality-of-life instrument was answered by participants in order to determine the impact of oral health on the participating children.

Next, children were examined by a calibrated dentist using the International Caries Diagnosis and Assessment System (ICDAS) criteria for caries. Bleeding on probing was measured on a 0 to 3 severity scale following the Löe-Silness gingival index. Dental plaque, calculus, and gingival indices were measured using the modified Quigley-Hein Plaque Index, the NIDCR criteria for calculus index, and Löe-Silness criteria for gingivitis index. Paraffin tablets were used to induce salivation, after which, a stimulated saliva sample was taken. Five ml of saliva was collected in sterile cups and stored at -80°C for the quantification of inflammatory mediators, which analysis was done by the Puerto Rico Clinical and Translational Research Consortium (PRCTRC) laboratory and formed the second part of the study. One ml of saliva was used to determine counts of *Streptococcus mutans* and *Lactobacillus* using the CRT Ivoclar Vivadent kit. Based on the outcomes of these tests, participants were classified as being at high or low risk for caries. The CRT kit was incubated at 37°C for 48 hours after collection of the saliva sample, at which point the PI read the bacterial count.

Matched-pair statistical analysis was performed using the SPSS and the EPI-INFO programs to run tests as chi-square and OR to measure the association between diabetes, glycemic control, and the presence of gingival or periodontal disease in diabetic children; a matched analysis was done. The relative risk of gingival and periodontal disease in diabetic children in comparison with a like risk in non-diabetic children was determined using McNemar's corrected chi-square test.

Results

As shown in Table 1, the mean age of the participating children was 10.0 years, and 60% of the sample members were female. Mean body weight was similar for cases and controls. Mean caries indexes for permanent teeth were 1.43 for cases and 0.56 for controls, showing a statistically significant difference (p = 0.01). The number of filled and missing teeth was statistically different for the diabetic children compared with the controls. The diabetic children had more filled teeth and fewer missing teeth than did the controls (Table 2).

Regarding the presence of bacteria in the saliva of the participant children indicating caries risk, there was no statistical difference in the salivary counts of *Streptococcus mutans* and *Lactobacillus* for diabetic and non-diabetic children (p = 0.60) (Table 3).

Table 1. Distribution by age, gender, weight and body mass index (BMI) between diabetic and non diabetic children

	Diabetic children (n=25)	Control children (n=25)
Mean age	10.0 years (range 6-12)	10.0 years (range 6-12)
Percent of females	60	60
Mean actual weight, lbs	67	69
Mean body mass index	16.9	17.1

Table 2. Distribution of mean caries indexes for diabetic children and non-diabetic children

	Mean indexes for diabetic children (n=25)	Mean indexes for control children (n=25)	*p*-value
Mean number of white spot lesions on primary teeth d1-2*	1.21	1.13	0.98
Mean number of carious lesions in primary teeth d3-6*	1.00	0.69	0.96
Mean number of white spot lesions on permanent teeth D1-2*	3.34	1.04	0.01
Mean number (standard deviation) of carious lesions in permanent teeth D3-6*	1.43 (1.80)	0.56 (1.0)	0.01
Mean number of filled teeth	1.4	0.21	0.01
Mean number of missing teeth	0.0	1.42	<0.01

*d1-2: white spot lesions in the enamel of primary teeth; d3-6: dental decay from the enamel to the dentin in primary teeth; D1-2: white spot lesions in the enamel of permanent teeth; D3-6: dental decay from the enamel to the dentin in permanent teeth.

As shown in Table 4, diabetic children presented greater plaque and calculus indexes and a higher number of sites with bleeding on probing than did the children in the control group.

There was a statistically significant association between the number of bleeding on probing sites in diabetic children and the

levels of HbA1c. ($p < 0.001$). The probability (OR) of diabetic children exhibiting bleeding on probing and some evidence of gum disease was 6 to 1 (based on matched pairs, 95% confidence interval 1.3-38.8, $p = 0.016$).

Diabetic children had more plaque than did the control children ($p = 0.007$). They also had more calculus and more bleeding on probing ($p = 0.001$).

Table 3. Percent distribution of levels of *Streptococcus mutans* and *Lactobacilli* for diabetic and non-diabetic children

	Diabetic children with positive culture (n=25)	Non-diabetic children with positive culture (n=25)	*p*-value
Streptococcus mutans	30%	21%	0.60
Lactobacillus	35%	50%	0.48
High-caries-risk	17%	14%	0.98

Table 4. Mean distribution of dental plaque and calculus indexes and number of sites of bleeding on probing

	Diabetic children (n=25)	Non-diabetic children (n=25)	*p*-value
Mean plaque index	2.5	0.8	0.007
Mean calculus index	0.3	0.0	0.550
Mean number of sites with bleeding on probing	23.9 (Range 2-52)	4.2 (Range 0-13)	0.001
Percentage of sites with bleeding on probing	29 (Range 4-72)	7 (Range 4-24)	0.001
Percentage of children with more than a 20% incidence of bleeding on probing (gingivitis)	35	0	<0.001

Discussion

A new finding regarding a higher caries rate for diabetic children was found in this study. Other studies of diabetic children have not reported any differences in caries risk, although a recent study of diabetic adults by Svensson and Joshipura (6) found a difference in caries risk and rates for diabetic patients vs. non-diabetic patients. This finding may be due to related xerostomia or the decreased salivary flow caused by the diabetes condition and the lack of preventive and regular dental care in diabetic children. Also, according to other studies, diabetes can be a risk factor for caries due to increased glucose in the saliva and increased glucose in the gingival cervical fluid (7).

The evidence that this study presents coincides with that of previous studies on diabetic children that showed that diabetics are at greater risk for gum disease. Participants with type 1 diabetes presented increasing signs of inflammation in their gums as well as higher levels of bleeding on probing. Also, the glycosylated hemoglobin levels in the diabetic children were higher and associated with the oral health status of their gums. Dakovic et al (4), studied periodontal disease in children and adolescents suffering from type 1 diabetes in Serbia. The findings of this study showed that periodontal disease is more prevalent and widespread in children and adolescents with diabetes mellitus compared to children and adolescents without DM, depending on the duration of the disease, metabolic control, and severity of gingival inflammation. Findings also showed that gingival inflammation is more evident and results in periodontal destruction more often in young patients with diabetes mellitus. Other studies (8-15) have evaluated the relationship between gingival inflammation and the degree of metabolic control in diabetic children, and they concluded that diabetic children with poor glycemic control have a clear tendency towards higher gingival index scores than non-diabetic children. Studies by Lal et al (5) evaluated gingival bleeding in 6- to 13-year-old children with diabetes mellitus. They concluded that diabetic children have a significantly higher risk for gingival bleeding and that diabetes-related oral complications affect the primary periodontium as early as age 6, possibly earlier; these findings highlight the importance of emphasizing good oral hygiene in order to prevent future periodontal complications in diabetic patients. Lal et al (5) also evaluated diabetes-related parameters and periodontal conditions in children and concluded that accelerated periodontal destruction in young people with diabetes is related to the level of metabolic control. Thus, good glycemic control may be an important way to address periodontal complications in young patients with diabetes, which is similar to what is already well-established for other systemic complications of this disease.

Although the above mentioned previous studies have shown the relative risk of gum disease for diabetic children to be between 2 and 3; our study presents a greater relative risk of gingival disease or early signs of periodontal disease for diabetic children in comparison to controls (OR = 6). This difference may be due to the fact that other studies did not match the cases and controls by age and gender in their analyses.

This study had some limitations. The small sample size may have contributed to the differences in caries rates between diabetic and non-diabetic children. Plaque index differences could be due to population bias (children going to dental clinics usually brush their teeth prior to their dental appointments, which is not always the case for diabetic patients visiting endocrinology clinics). We could not match populations 2:1 as previously anticipated. Also, no match for prior dental visits in either population was performed, and a better control population needs to be selected for future studies.

In conclusion, the results from this study demonstrate that diabetics benefit from dental care that starts at an early age.

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Resumen

Objetivo: No existen estudios sobre la salud oral (caries y enfermedad gingival) en los niños con la diabetes tipo 1 en especial para los niños puertorriqueños. El objetivo de este estudio fue evaluar y comparar el estado de la salud oral de un grupo de niños puertorriqueños con o sin diabetes tipo 1 entre las edades de 6 a 12 años. Métodos: Se realizó un estudio caso-control. Una muestra de conveniencia de 25 niños con diabetes tipo 1 y 25 niños no diabéticos, entre las edades de 6 a 12 años, pareados por edad y género, fue evaluada por un dentista calibrado para caries y la presencia de sangrado en sondeo gingival, índices de placa dental y cálculo. Una muestra de saliva fue tomada y analizada para conteos de *Streptococcus mutans* y *Lactobacillus*. Se usaron estadísticas descriptivas y pruebas de chi-cuadrado y t-test para describir y comparar los grupos. Resultados: Se encontraron diferencias significativas para el índice de caries para los dientes permanentes entre los niños diabéticos (1.43) y los niños no diabéticos (0.56) ($p = 0.05$). El número promedio de sitios con sangrado en las encías para los casos fue de 23.9 y para los controles fue de 4.21. Se encontró un mayor índice de placa y sangrado en los niños diabéticos. Niveles altos de la hemoglobina glucosilada en los niños diabéticos estuvieron asociados significativamente con un mayor sangrado de las encías. Conclusión: Los niños con la diabetes tipo 1 están a mayor riesgo de caries y enfermedad de las encías que los niños no diabéticos.

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