REVIEW ARTICLE

# Oral Health Implications and Dental Management of Diabetic Children

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## Abstract

**Aim:** To review the effect of diabetes mellitus (DM) on the oral health status of children.

**Background:** Diabetes mellitus (DM) is one of the most severe chronic diseases in children and adolescents. It appears as type 1 DM and type 2 DM. Children are mainly diagnosed with type 1 DM. Genetic, as well as environmental factors, contribute to disease risk, indicating a multifactorial etiology. Early symptoms may vary from polyuria to anxiety or depression disorders.

**Review results:** A variety of signs and symptoms have been reported regarding the oral health of DM children. Both dental and periodontal health is compromised. Qualitative and quantitative changes in saliva have also been reported. Moreover, there is a direct effect of type 1 DM on oral microflora and increased sensitivity to infections. A variety of protocols have been developed regarding the dental treatment of diabetic children.

**Conclusion:** Children with diabetes, due to the increased risk of periodontal disease and dental caries, are recommended to follow an intensive prevention program and a diet with strict instructions.

**Clinical significance:** The dental care provided to children with DM should be personalized, and all patients should follow a strict program of reexaminations. Moreover, the dentist may evaluate oral signs and symptoms of inadequately controlled diabetes and, in coordination with the patient's physician, can play a crucial role in maintaining oral and general health.


**Keywords:** Children, Dental management, Diabetes mellitus type 1, Oral health.

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## Introduction

Diabetes mellitus (DM) is one of the most prevalent chronic diseases in children.[1,2] DM manifests itself in two main types: type 1 DM and type 2 DM. In type 1 DM, there is an absolute deficiency in insulin secretion due to total damage of the β-cells. In type 2 DM, there is a clinical range from predominant insulin resistance with relative insulin deficiency to a predominant defect in insulin secretion accompanied by insulin resistance.[1] Other types of DM are the result of genetic defects of the β-cells, genetic defects in insulin action, diseases of the exocrine pancreas, endocrinopathies, drugs or other chemicals, infections, the Stiff-person syndrome, and other genetic syndromes.[3] Children and adolescents are mainly diagnosed with type 1 DM.[2] Nevertheless, nowadays, more and more children suffer from type 2 DM and obesity-mediated insulin resistance due to the rising epidemic of childhood obesity.[1]

In recent years, the incidence of type 1 DM has been steadily increasing, probably due to rapid changes in the environment, the modern lifestyle, and its harmful effects.[2] In the USA, the incidence of type 1 DM in children is about 1.9/1000, while in Europe, the prevalence of the disease varies from 0.6 to 2.6%, and its incidence is from 9.7 to 49/100,000 person-years.[4,5] Young white people, especially those from Northern Europe, reveal the highest incidence of type 1 DM.[2] The lowest levels are reported in Japan.[6] The peak incidence rates of type 1 DM are at ages 5–9 years and 10–14 years, with males and females being at the same risk.[4] Over the age of 15 years, there isn't a remarkable rise in the incidence of type 1 DM in young adults.[5]

Type 1 DM is the result of a deficiency in insulin production due to the autoimmune destruction of pancreatic β-cells, mediated by T-cells. The destruction doesn't affect pancreatic α and δ-cells and is caused mostly by tumor necrosis factor-α, interleukin-1, and other cytokines, as well as macrophages, dendritic cells, and T-lymphocytes. As soon as clinical symptoms appear, almost most of the β-cell insulin secretory capacity is withered.[6,7] Expanded β-cell workload and increased levels of cytokines expedite ongoing β-cell destruction.[6] Different interactions between genetic and environmental factors are responsible for the multifactorial etiology of type 1 DM. The main susceptibility genes responsible are the human leukocyte antigen (HLA) class II alleles, which are located in chromosome 6. The B*39 allele is the most important among HLA class I genes for type 1 DM. Numerous non-HLA loci lead to

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disease risk with smaller effects. The risk genes may vary among different populations, a fact that confirms (indicates) a polygenic mode of inheritance.[6,7] Some risk determinants for type 1 DM are the cold environment, the frequency of food intake containing nitrosamine, fetal viral infections, maternal-child blood group incompatibility, delivery by cesarean section, low gestational age, reduced intrauterine growth, diagnosis of neonatal respiratory disease, short duration of breastfeeding, high growth rate, and stressful life events.[6]

The typical symptoms that lead to the diagnosis of type 1 DM in children are polyuria, polydipsia, weight loss, constant hunger, hyperglycemia, blurred vision, and extreme fatigue. Further clinical signs may also include abdominal pain, shortness of breath, or vomiting.[8] Younger age at the manifestation of type 1 DM is associated with an increased risk of ketoacidosis, which can lead the patient to the hospital, as well as an increased risk of chronic microvascular and macrovascular complications.[2] Moreover, as puberty is characterized by a high growth velocity, it may result in increased peripheral insulin resistance evoked by growth hormones. As a result, children diagnosed with diabetes were taller than nondiabetic children at the onset of the disease.[6] Nevertheless, the annual growth velocity decreases after diagnosis, reaching a lower-than-normal final height. Sexual maturation is delayed in both girls and boys. Menarche occurs at a mean age of 15.1 years, remarkably later than normal (13.3 years), while full sexual maturation in boys occurs at a mean age of 17.2 years instead of 15.0 years.[9] Furthermore, the psychological care of children with DM is of paramount importance. Stress-related mental disorders, anxiety disorders, depression, and eating disorders emerge more often in children and adolescents with type 1 DM than in metabolically healthy people of the same age. It is proven that psychological support and a healthy family environment play a major role in controlling vital parameters related to diabetes.[8]

The oral health status of children with DM can also be compromised, and changes may be observed at multiple levels, including the amount and composition of saliva, dental caries, periodontal health, oral microflora, dental growth, teeth eruption, and microbial oral Infections. *Vice versa*, it has been stated that some of the factors referred to above may also affect diabetes progression too. Moreover, specific dental considerations should not be neglected when treating a DM patient. The aim of this literature review is to give insight into the effect of DM on the oral health status of children and also provide an overview of all considerations regarding the dental treatment of children with DM.

## Oral Health Implications

### *Saliva*

Both qualitative and quantitative changes in the saliva of children with DM have been reported. It has been shown that salivary flow and buffer capacity is reduced in children with DM, irrespectively of metabolic control, leading to an increased incidence of dental caries.[10,11] Moreira et al. reported a significant reduction in the mean flow rate of resting saliva between DM children (0.15 ± 0.1 mL/minute) and healthy controls (0.36 ± 0.2 mL/minute).[12] In accordance, Siudikiene et al. reported that both stimulated and resting saliva was reduced in children with DM.[13] However, other studies could not confirm that the flow rate of stimulated saliva in DM children is reduced.[12,14] According to Hoseini et al., hyperglycemia and glycosuria are among the many reasons that reduce the rate of saliva flow in diabetes.[15] As for the qualitative parameters, some studies reported that buffering capacity and pH (6 ± 0.8) of saliva were reduced in children with DM.[12] In addition, other studies confirm that the viscosity of children with DM saliva was increased, as well as carbohydrates, glucose, and total protein levels.[13,14] Moreover, the immunoglobulin (Ig) A levels and IgG antibodies were found higher,[13,16,17] whereas the levels of antimicrobial proteins (lactoferrin and lysozyme) were lower in children with DM.[18] The results are controversial regarding salivary calcium levels.[14] Siudikiene et al. reported a relationship between dental caries and glucose levels in the saliva of children with DM.[13]

### *Dental Caries*

Dental caries is the most common reason for children visiting a pediatric dentist. As it is well known, dental caries is a polymicrobial disease with multiple factors playing a crucial role, the most important of which is the frequency of fermentable carbohydrate consumption, oral hygiene, saliva, and fluoride intake.[10] A variety of studies have been conducted, and the results about the relationship between DM and dental caries are ambiguous. Increased levels of *Streptococcus mutans (S. mutans)* and *Lactobacillus* were reported in DM patients.[19] Additionally, higher levels of *Lactobacillus* in combination with poor metabolic control were reported in children with DM.[20] However, other studies could not establish an association between *Lactobacillus* levels and DM,[21–23] or even reported a negative association between them.[24] Moreover, the everyday diet of children with DM mainly includes more complex carbohydrates, such as fiber and meat, and this may lead to a reduction of cariogenic bacteria as well as the risk of developing dental caries.[25]

Some studies have shown that inadequate metabolic control is a significant factor in the development of dental caries in children with DM. This study has compared the levels of *S. mutans* and the prevalence of dental caries in diabetic children with poor metabolic control based on hemoglobin A1 levels.[12] Additionally, the results of some studies have shown that there is a higher risk of cervical, interproximal, and root caries. This may be attributed to higher levels of glucose in saliva and cervical fluid of patients with DM.[26] Poor metabolic control, reduced salivary flow rate, and affected composition of saliva may increase the incidence of dental caries, especially in children with DM with poor oral hygiene and high intake of fermentable carbohydrates.

### *Periodontal Disease*

The relationship between DM and periodontal health is well documented. Studies have shown a higher risk of chronic gingivitis in children with DB that increased with age.[10] In accordance, Orbak et al. reported that plaque, calculus, and gingival index were increased with age.[27] Rafatjou et al. reported increased gingival indices linked with the duration of diabetes.[28] Other studies concluded that the depth of periodontal pocket was deeper in diabetic children who were diagnosed years before, while bleeding was increased in children diagnosed recently.[29] One research in Brazil has shown a correlation between periodontal disease and gender. The periodontal index was increased in girls with diabetes, but there was not any difference in the gingival index between boys and girls. Regarding periodontal pocket depth, no noticeable difference was observed between boys and girls, whereas it was increased in the palatal surfaces of the diabetic girls.[30] It has been stated that children with diabetes have a three times higher chance of developing periodontitis,[31] usually in adolescence, or even earlier,[32] and there seems to be an association, especially with poor metabolic control and periodontitis. Popławska-Kita et al.

reported that 15% of healthy people and 57.9% of DM patients had developed periodontitis. From the last group, 40% had good metabolic control, whereas the 59.5% had poor metabolic control. The results also reported worse periodontal disease in the patients with poor metabolic control than with good.[33] In addition, a study reported a relationship between the duration of diabetes and the stages of periodontitis.[34]

Regarding diabetes and periodontitis, a two-way relationship is recognized. Not only diabetes affects the periodontal structures, but, also, periodontal disease may affect diabetes. Studies revealed the effect of periodontal status on blood glucose levels due to increased insulin resistance of tissues in reaction to systemic inflammation mediators, leading to reduced glucose uptake from the cells. Finally, the possible advantage of periodontal therapy to metabolic control is not yet confirmed, and further studies are necessary.[31,35]

### *Oral Microflora*

Studies on oral microflora revealed significant differences between children with DM and the control group regarding the amount and the type of periodontal pathogens, and the levels of *S. mutans*, *lactobacillus*, and *Candida albicans*.[10,11,36,37] Although more studies are necessary to clarify the impact of DM on oral microflora, it has been stated that poor control of the disease may lead to an oral environment favorable for the development of diseases.[38]

### *Dental Growth*

Diabetic patients sometimes show malfunction of the pituitary gland, and their dental growth is affected.[39] However, one recent study has shown that there is no significant influence of diabetes on dental growth.[40] If diabetes is diagnosed before the age of 7, changes concerning the age of exfoliation of primary dentition as well as the early eruption of the successor permanent teeth can be observed. Additionally, a common finding is enamel hypoplasia, but it is not clarified whether this complication is due to diabetes or the administered medication. Moreover, there is no correlation between diabetes and orthodontic anomalies.[39]

### *Microbial Infections*

Development of oral infections, such as herpetic stomatitis, candidiasis, or other fungal diseases, are commonly observed in noncontrolled DM patients. Such infections are difficult to treat and pose a challenge to the dentist due to the existence of a chemical substrate of immune suppression,[41] but they may affect the resistance in insulin and the control of glucose, impairing healing.[42]

## Dental Management

Undoubtedly, as DM is a chronic disease, children have to be patient and mature and follow multiple and, sometimes, complex instructions. The oral health of these young patients, as an integral part of their general health, is a daily challenge for pediatric dentists. The dentist must work in coordination with the child's physician or endocrinologist in order to determine the patient's health status and plan a dental treatment that can be effectively accomplished with safety.[43] Specifically; the dentist should follow a personalized treatment, which includes the prevention and treatment of oral infections that tend to upset the metabolic control, as well as, the maintenance of healthy tissue.[42] The treatment of diabetic children includes three subcategories: the preventive program, the oral health program, and the recall program.

### *Prevention Program*

Children with diabetes, due to the risk of periodontal disease or dental caries, are recommended to follow an intensive prevention program. The oral hygiene instructions are the following:[44]

- Children should brush their teeth 2–3 times a day with fluoride toothpaste (children 2–6 years old: 1000 ppmF, children >6 years old: 1450 ppmF).
- In the case of dental caries high-risk patients, fluoridation should be done in the dental office 3–4 times a year. The daily use of fluorinated mouthwashes and special fluoride toothpaste 5000 ppmF (children >15 years old) is also recommended.
- In patients at risk or with periodontal disease, the dentist should give special oral hygiene guidelines and may prescribe oral antiseptic solutions as part of the treatment.

The diet that children with DB should follow includes strict instructions. Dentists should encourage parents and children to avoid frequent consumption of cariogenic food, food with high levels of carbohydrates, or sugar.[44]

### *Oral Health Program*

Morning appointments are preferred for children with DM due to their higher morning cortisol levels. For children under insulin therapy, the appointments should not coincide with the climax of insulin since hypoglycemia may be developed. The dentist has to be sure that the child has eaten his/her meal and taken his/her medication. In case a meal has been missed while the insulin dose has been taken, the risk of hypoglycemia is increased.[42] Sometimes, according to the patient's medical history, medication, and treatment plan, a dentist may need to measure glucose level. Thus, the dental practice should be equipped with both electric glucose meters and sources of glucose (carbohydrates) in case a hypoglycemic incidence occurs (level of glucose <70 mg/dL).

Early symptoms of hypoglycemia may be developed in stressful and fearful children due to adrenaline release. In such a case, the dentist should change the usual behavior management approach. In hypoglycemia, changes in the mood of the child, hunger, sweating, and weakness may be observed, followed occasionally by confusion and increased heartbeat. If such symptoms pass unnoticed and the child is left untreated, the hypoglycemia may lead to loss of consciousness, low blood pressure (hypotension), hypothermia, epileptic crisis, and even death. According to the patient's consciousness level, the clinical approach should be as follows:

*Conscious patient:* The dentist administers 15 mg of carbohydrates and repeats the glucose test through finger prick blood sugar tests. If the glucose level is >60 mg/dL, the patient is asked to drink a sugary beverage (two spoons of sugar dissolved in water or orange juice). If the glucose level is <60 mg/dL carbohydrates (15 mg/dL), administration is recommended, followed by glucose measurement after 15 minutes. The above should continue until the level of glucose is >60 mg/dL and the treating physician is informed.[43]

### *Unconscious patient*

- Intravenous administration of 5–25 50% dextrose immediately, and the treating physician is informed.
- No intravenous administration: the dentist administers gel glucose in the mouth or treatment with 1 mg of glucagon (adult dose) intramuscularly or subcutaneously. Then the measure of glucose is measured in 15 minutes, intravenous access is created, and the treating physician is informed.[43]

It is very rare for a DM child to develop diabetic ketoacidosis. It appears when the levels of circulating insulin are critically decreased, leading to the development of hyperglycemia, hyperosmolality, ketosis, and acidosis.[45] The child has to be transferred immediately to the hospital.[41]

Regarding the healing progress, adequate antibiotic coverage may be necessary for patients with oral infections and for patients undergoing surgery to reduce the risk of healing delay. After dental surgery, the pharmaceutical treatment for diabetes or insulin intake may need to be modified in consultation with the treating physician.[44]

Local anesthesia, with adrenaline level at 1:80000 or less in 2–4 mL of solution, can be used with safety. In long sessions, the insulin injection schedule should be kept in mind. General anesthesia should never be applied to a diabetic child in the dental office, but only in a hospital setting.[42]

In controlled diabetes patients, the treatment plan is no different than in healthy children. The pediatric dentist should be alert for hypoglycemia's early symptoms. Moreover, the sentimental mood of the children should be taken into consideration, and a modified psychological approach may be considered. Short dental sessions are indicated, preferably in the morning. Measurement of glucose levels should proceed with the dental appointment.[42]

Noncontrolled diabetes can be accompanied by many serious complications that have to be considered by the dentist. Noncontrolled DM patients are at risk of developing microbial infections after invasive dental procedures due to immunosuppression.[44] In such cases, only urgent dental work is performed and always in consultation with the treating physician. All necessary preventive measures (antibiotic coverage, additional hemostatic measures, and painkillers) must be taken. Ideally, any dental procedure must be postponed until the patient's metabolic control is improved. In an established infection, immediate treatment with antibiotic coverage is required so as not to progress and threaten the patient's life.[44]

Diabetic children and adolescents are often in need of dental treatment due to their general behavior and habits. Dealing with and overturning this neglecting behavior is another challenge for the pediatric dentist.

### *Recall Program*

It is essential for children and adolescents with diabetes, due to increased risk for caries, periodontitis, and oral infections, to follow an intensified preventive program of reexaminations every 3–4 months.[43]

## Conclusion

Over the years, a large number of studies have been published regarding the association between DM and oral health status in young children and adolescents. However, further studies are needed. Regarding periodontal health, most studies reported higher levels of dental microbial plaque and increased incidence of chronic gingivitis in DM children, and only a few were at high-risk for developing periodontitis. Regarding the effect of DM on the development of dental caries, the results of clinical studies seem to be controversial. For diabetic children with a high incidence of caries, it has been confirmed that some of the general risk factors for caries are more prevalent in a diabetic population compared to a nondiabetic control group. Quantitative and qualitative changes in the saliva of DM children have also been confirmed, although the results between individual studies vary. Saliva flow rates are reduced in diabetic patients, and this may increase susceptibility to oral infections.

Moreover, changes in the oral microflora of DM children have been reported that are likely to lead to the development of the diseases of the oral cavity, such as dental caries and periodontitis.

Additionally, dental growth of permanent dentition is affected, but further studies are needed to clarify this finding.

The immune suppression that is caused by the infections may affect the healing process.

Finally, DM has a significant impact on the provision of dental care. It is important for dentists to be familiar with the therapeutic management of patients who develop this disease. Moreover, it is essential for the dentist to be able to evaluate oral signs and symptoms of inadequately controlled diabetes. In coordination with the patient's physicians, they can play a crucial role in maintaining oral and general health by reducing possible general health complications due to oral diseases.

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