AFMN BIOMEDICINE

ORIGINAL ARTICLE

Check for updates

ORAL HEALTH IN CHILDREN WITH TYPE 1 DIABETES MELLITUS IN RELATION TO METABOLIC CONTROL

Mirjana Djuričković **Aleksa Djuričković**

Department for Dental Medicine, University of Montenegro Faculty of Medicine, Podgorica, Montenegro

Diabetes mellitus is one of the most common chronic diseases in childhood. The aim of this study was to evaluate the oral health of children with type 1 diabetes in relation to the level of glycemic control. Eighty-seven children aged 10 to 15 participated in the study and were divided into two groups based on the value of glycosylated hemoglobin (HbA1c): 34 children with good metabolic control (HbA1c < 7.5%) and 53 children with poor metabolic control (HbA1c > 7.5%). Oral health was assessed using the index of carious, extracted, and filled permanent teeth (DMFT), plaque index (PI), and gingival index (GI). The stimulated salivary flow rate, buffer capacity of saliva, and the level of presence of *Streptococcus mutans* (*S. mutans*) and *Lactobacillus* in saliva were measured. Participants completed a questionnaire about oral hygiene habits when visiting the dentist. The t-test and chi-square test were used, with a significance level set at $p < 0.05$. Children with poor metabolic control had significantly more extracted teeth ($p = 0.002$), higher PI ($p = 0.002$), higher GI ($p = 0.001$), and a higher risk of *S. mutans* and *Lactobacillus* ($p < 0.005$). No significant differences were found in overall DMFT scores, salivary flow, saliva buffer capacity, oral hygiene habits, dental visits, and socioeconomic status ($p > 0.05$). Poor metabolic control in children with type 1 diabetes is associated with poorer oral health, lower levels of oral hygiene, increased risk of caries and periodontal disease due to the presence of pathogenic bacteria.

Keywords: children, type 1 diabetes mellitus, oral health, metabolic control, saliva

Submitted: June 3, 2025 **Accepted:** August 25, 2025
Published online: March 15, 2026

Correspondence to:
Mirjana Djuričković
Department for Dental Medicine
University of Montenegro
Faculty of Medicine
E-mail: miradjurickovic@gmail.com

INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease that most frequently affects children and adolescents, and is characterized by the selective destruction of pancreatic β-cells, resulting in absolute insulin deficiency. Insulin is a key hormone in glucose metabolism regulatory processes, and its absence leads to chronic hyperglycemia, which, without appropriate therapy, can lead to serious consequences for a child's health (1,2). In addition to the increased risk of acute complications such as diabetic ketoacidosis, long-term hyperglycemia is associated with the development of microvascular and macrovascular complications, including damage to the kidneys, eyes, nervous and cardiovascular systems (3).

The cornerstone of treatment for type 1 diabetes is lifelong insulin therapy, aimed at maintaining optimal glycemic control and preventing complications. In addition to insulin therapy, patients and their parents must be educated about the importance of self-monitoring, proper nutrition, and regular physical activity. When managed appropriately, therapy can significantly reduce the risk of systemic and oral complications. Despite the availability of various therapeutic options, many patients struggle to achieve satisfactory glycemic control, highlighting the need for further research and the development of preventive strategies targeting oral health (1–4).

In addition to systemic complications, type 1 diabetes significantly affects oral health. Oral complications of type 1 diabetes include xerostomia, periodontal disease (gingivitis and periodontitis), dental abscesses, tooth loss, soft tissue lesions, and burning mouth syndrome (1,2). Numerous studies have linked poor glycemic control to an increased incidence of caries, gingivitis, and periodontal disease (5-7). Mechanisms include decreased salivation, decreased salivary buffering capacity, increased glucose in oral fluids, and a favorable environment for the growth of cariogenic bacteria such as *Streptococcus mutans* and *Lactobacillus*. Children with T1D are thus more prone to dental plaque formation, inflammatory changes in the gingiva, and progression of periodontal destruction, especially in cases of poor metabolic regulation (elevated glycated hemoglobin -HbA1c), with hyperglycemia contributing to the creation of a favorable environment for the growth of pathogenic bacteria (8-12). Periodontal disease, recognized as the sixth clinical complication of diabetes, is also more common in children with T1DM, with vascular changes in periodontal tissues resulting from microvascular damage characteristic of diabetes (13,14). With increasing glycated hemoglobin (HbA1c), the risk of gingivitis and periodontitis increases significantly, and is clinically manifested by increased plaque indices, gingival bleeding, and inflammatory changes (9).

Regular and proper oral hygiene, along with frequent preventive dental examinations, plays a key role in preventing the development of caries and periodontal disease in children with type 1 diabetes. Interestingly, studies have also shown a feedback loop: adequate oral health can contribute to better metabolic control, confirming the importance of dental care in a multidisciplinary approach to T1D treatment (8–10).

Given the growing incidence of T1DM (1,2) in the pediatric population and the association between metabolic control and oral health (8-12), it is necessary to integrate dental assessment and care into the comprehensive treatment of this disease.

The aim of this paper was to evaluate the state of oral health in children with type 1 diabetes in relation to the level of glycemic control.

METHODS

An epidemiological case-control study was conducted on 87 children with type 1 diabetes mellitus (47 boys and 40 girls), aged 10–15 years, who were treated at the Institute for Children's Diseases, Clinical Center of Montenegro. The study was conducted in accordance with the Declaration of Helsinki and adhered to the principles of good clinical practice. The research protocol was approved by the Ethics Committee of the Clinical Center of Montenegro (No. 03-5/23), and the study was conducted from June 2017 to December 2018. A qualified and calibrated dental team was responsible for the clinical measurements. Intra-examiner reliability was rated as excellent, with a kappa coefficient value of 0.94. Children were included in the study only after their parents provided signed informed consent and after they received a detailed explanation of the study's aims and procedures.

Subjects were divided into two groups according to their level of metabolic control. Data on glycosylated hemoglobin (HbA1c) values from the previous three months were taken from medical records. According to the criteria of the American Diabetes Association, good metabolic control was defined as an HbA1c value < 7.5% (58 mmol/mol), while values>7.5% were considered an indicator of poor metabolic control (15). Accordingly, two groups were formed: a group with good metabolic control

(HbA1c < 7.5%; n = 34) and a group with poor metabolic control (HbA1c >7.5%; n = 53). General exclusion criteria for all participants were the need for antibiotic prophylaxis and refusal of children to cooperate. All of the participants and their families lived in the same geographical area.
All dental examinations were performed in the Dental Clinic of the Faculty of Medicine, University of Montenegro in Podgorica, after regular endocrinological check-ups, in the presence of parents.

Dental examination
The presence of caries on permanent teeth was recorded following the DMFT index (number of decayed, extracted, and filled teeth), in accordance with the standards of the World Health Organization (WHO) (16). Caries was diagnosed by visual inspection using standard dental instruments. Lesions with cavities were registered as caries, while initial changes without cavitation were registered as healthy teeth.
Oral hygiene was assessed using the Plaque Index (PI) according to Silness and Löe (17). The assessment was performed on four surfaces of each tooth: mesiobuccal, distobuccal, mesiolingual, and distolingual.
For clinical assessment of the gingival condition, the Gingival Index (GI), proposed by Loe and Silness (17), was employed. The condition of the gingiva was assessed from the vestibular, oral, mesial, and distal surfaces of each present tooth. The total gingival index was calculated by summing up the scores from all surfaces of all teeth and then dividing the obtained sum by four. This value was then divided by the number of examined teeth. Individuals with a gingival index of 0.1–1.0 were classified as having mild gingival inflammation, while those with an index of 1.1–2.0 were classified as having moderate inflammation. If the mean value of the gingival index was 2.1–3.0, the inflammation of the gingiva was assessed as severe, that is, very pronounced.

Saliva sample collection
Children had not received antibiotic therapy for at least 15 days prior to sampling and were not undergoing dental treatment. Stimulated saliva samples were collected at least two hours after the last meal (between 10:00 and 11:00 am). Saliva secretion was stimulated by chewing a paraffin tablet, and samples were collected in graduated containers for five minutes, excluding foam bubbles. The saliva rate flow was expressed in mL/min.

Buffer capacity and saliva volume were determined using the Dentobuff Strip system (Orion Diagnostica, Espoo, Finland). Scoring, or results of saliva buffer capacity, was performed as follows:
0—blue color, the test strip immediately turned this color; it indicated very high buffer capacity (pH > 6);
1—blue color, the test strip changed color within five minutes; it indicated a high buffer capacity (pH = 6);
2—green color, it represented medium buffer capacity (pH = 4.5-5.5);
3—yellow color, represented a low buffer capacity (pH = 4, or less than 4).
The blue color of the test strip, i.e., the values 0 and 1, indicated a high buffer capacity (18).

Microbiological analysis
The presence of *Streptococcus mutans* (SM) and *Lactobacillus* (LB) was determined by the Dentocult SM Strip mutans and Dentocult LB System (Orion Diagnostica, Espoo, Finland) CRT bacterial test on saliva pre-stimulated by chewing paraffin. The number of bacteria was recorded as colony-forming units per milliliter (CFU/mL) of saliva. According to the manufacturer's scorecard, the bacterial colony count for *Streptococcus mutans* was scored as follows: Class 0: < 10,000 CFU/ml; Class 1: < 100,000 CFU/ml; Class 2: 100,000-1,000,000 CFU/ml; Class 3: > 1,000,000 CFU/ml. The *Lactobacillus* colony count was scored as follows: Class 0 (0–10^3 CFU/mL); Class 1 (10^4 CFU/mL); Class 2 (10^5 CFU/mL); Class 3 (10^6 CFU/mL). Findings indicating low risk of caries were classes 0 and 1, while findings indicating high risk of caries development were classes 2 and 3.

Questionnaire
The parental questionnaire consisted of two parts. The first part included questions about socioeconomic data (municipality, school, class, gender, date of birth, parents' education and employment, parents' marital status, number of children in the household, family income).
The second part was about children and included questions about their oral hygiene habits (tooth brushing frequency and use of fluoride toothpaste). Each question had two options related to participants' tooth-brushing habits (twice a day or more; once a day) and frequency of dental visits (every 6 months; once a year or less).
An assessment of socioeconomic status was also conducted. It was classified as low, moderate, or high,

based on household income, with nationally defined thresholds according to Eurostat (19). After the examination, each child was trained in proper tooth brushing.

Statistical analysis

Statistical data processing was performed using SPSS 19 (SPSS Inc, Chicago, Illinois, USA). Descriptive and analytical statistics methods were used to describe the results. Descriptive statistical methods used were: mean value, standard deviation, and percentages. Differences in individual parameters between the examined groups were tested using Student's t-test and Chi-square test (χ^2 test). P-values less than 0.05 were considered statistically significant.

RESULTS

This study was conducted on 87 subjects with type 1 diabetes, of whom 34 had well-controlled metabolic disease control (HbA1c < 7.5%), and 53 had poor metabolic control (HbA1c > 7.5%). The average age of children with poor metabolic control was 11.4 ± 1.53, while the average age of children with good metabolic control was 10.7 ± 1.42 (p = 0.283). In the total sample, 10.34% (n = 9) of children had all permanent teeth healthy. The percentage of children with all healthy permanent teeth in the children group with well-controlled diabetes was 6.8%, while in the group with poorly controlled diabetes, it was 4.5%. Statistical analysis did not show significant differences in the values of this index (χ^2, p > 0.05).

The results show that subjects with poor metabolic control (HbA1c > 7.5%) had significantly more extracted teeth (t-test, p < 0.05), dental plaque (t-test, p < 0.05), and gingivitis (t-test, p < 0.001) compared to subjects with good metabolic control (HbA1c < 7.5%) (Table 1).

However, the average DMFT index values, the number of carious and repaired teeth, and the speed of stimulated saliva flow and buffer capacity did not show significant differences between the two groups of children with diabetes (t-test, p > 0.05) (Table 1).

The differences in comparisons in stimulated salivary flow rate, salivary buffering capacity, DMFT index, DMF components, plaque index, and gingival index between groups based on metabolic control are shown in Table 1.

Analysis of the gingival condition in children with good and poor metabolic control (Table 2) showed significant differences in the distribution of gingival inflammation between the groups. In the group of children with HbA1c < 7.5%, most children had moderate inflammation (73.5%), while only 2.9% had severe inflammation. In contrast, the group of children with HbA1c > 7.5% showed a significantly higher percentage of respondents with severe gingival inflammation (28.3%).

The Chi-square test confirmed a statistically significant difference in the distribution of gingival inflammation between the tested groups (χ^2 test, p < 0.05). These results indicate a significantly more pronounced gingival inflammation in children with poor metabolic control (Table 2).

There was a significant difference in SM (χ^2 test, p < 0.05) between groups regarding caries risk. It is evident from the findings that a group of children with poor metabolic control had a predisposition to a high risk of caries (60.4%). However, there were no significant differences between the two groups for SM colonies (divided into classes) (χ^2 test, p > 0.05) (Table 3).

There was a significant difference in LB (χ^2 test, p < 0.05) between groups regarding caries risk. It is evident from the findings that a group of children with poor metabolic control had a predisposition to a high risk of caries (64.2%).

Table 1. *The values of DMFT components, DMFT index, plaque index, gingival index, stimulated salivary flow rate, and buffer capacity saliva in the study groups*

Groups	HbA1c < 7.5% (N = 34)	HbA1c > 7.5% (N = 53)	
Variable	Mean ± sd	Mean ± sd	p (t-test)
D	1.41 ± 1.48	1.52 ± 1.65	0.775
M	0.11 ± 0.32	0.26 ± 0.61	0.002
F	2.26 ± 1.62	2.55 ± 1.58	0.434
DMFT	3.88 ± 1.78	4.30 ± 1.68	0.457
Plaque index (PI)	1.03 ± 0.57	1.27 ± 0.49	0.002
Gingival index (GI)	1.00 ± 0.61	1.36 ± 0.46	0.001
Salivary flow rate (ml/min)	1.00 ± 0.11	0.98 ± 0.18	0.802
Buffer capacity saliva	1.14 ± 0.74	1.32 ± 0.76	0.280

HbA1c < 7.5%—children with type 1 diabetes mellitus with good metabolic control of glycated hemoglobin
HbA1c > 7.5%—children with type 1 diabetes mellitus with poor metabolic control of glycated hemoglobin
N = sample size; SD = standard deviation; p = p level
DMFT— decayed (D), missing (M), filled (F), teeth (T)

Table 2. *Gingival index in the study groups*

Gingival index (GI)	Group			
	HbA1c < 7.5%		HbA1c > 7.5%	
	N	%	N	%
Normal gingiva	2	5.8	3	5.6
Mild inflammation	6	17.6	8	15.1
Moderate inflammation	25	73.5	27	50.9
Severe inflammation	1	2.9	15	28.3
p (Chi test)	Chi = 9.44; p = 0.024			

Table 3. *General and specific distribution of Streptococcus mutans between groups*

Parameters	Groups				p (Chi test)
	HbA1c < 7.5%		HbA1c > 7.5%		
Streptococcus mutans (SM)	N	%	N	%	
Class 0 (<10^3 CFU/mL)	3	8,8	3	5,6	Chi = 6.60 p > 0.05
Class 1 (<10^4 CFU/mL)	20	58,8	18	33,9	
Class 2 (10^4–10^5 CFU/mL)	10	29,4	30	56,6	
Class 3 (>10^5 CFU/mL)	1	2,9	2	3,7	
SM values in CFU/mL saliva (Caries risk test for SM)					
Low (0 and 1)	23	67.6	21	39.6	Chi=5.43 p < 0.05
High (2 and 3)	11	32.4	32	60.4	
Total	34	100.0	53	100.0	

However, there were no significant differences between the two groups for LB colonies (divided into classes) (χ^2 test, p > 0.05) (Table 4).

Regarding tooth brushing habits and visits to the dentist, the study did not show a significant difference between the examined groups (Table 5). Most children from both groups brushed their teeth only once a day, and visited the dentist only when necessary (χ^2 test, p > 0.05). Family socioeconomic status was similar in both groups (χ^2 test, p > 0.05). The oral hygiene habits and socioeconomic status of the studied groups are shown in Table 5.

Table 4. *General and specific distribution of Lactobacillus between groups*

Parameters	Groups				p (Chi test)
	HbA1c < 7.5%		HbA1c > 7.5%		
Lactobacillus (LB)	N	%	N	%	
Class 0 (0–10^3 CFU/mL)	5	14.7	3	5.6	Chi = 7.31 p > 0.05
Class 1 (<10^4 CFU/mL)	17	50.0	16	30.2	
Class 2 (10^5 CFU/mL)	11	32.4	32	60.4	
Class 3 (10^6 CFU/mL)	1	2.9	2	3.8	
LB values in CFU/mL saliva (Caries risk test for LB)					
Low (0 and 1)	22	64.7	19	35.8	Chi = 5.81 p < 0.05
High (2 and 3)	12	35.3	34	64.2	
Total	34	100.0	53	100.0	

Table 5. *Oral hygiene habits, dental visits, and socioeconomic status of the examined patients*

Parameters	HbA1c < 7.5%	HbA1c > 7.5%	p (Chi test)
Daily brushing			
1 daily	22	33	n.s.
≥ 2 daily	12	20	n.s.
Using fluoridated toothpaste	34	53	
Dental visits			
Once every 6 months	10	13	n.s.
≥ once a year	24	40	n.s.
Socioeconomic status			
Low	7	11	n.s.
Medium/high	27	42	n.s.

DISCUSSION

This study evaluated the oral health status of schoolchildren with type 1 diabetes mellitus in Montenegro in relation to metabolic control. To our knowledge, this is the first study of its kind conducted in Montenegro.

The results of this study show that children with good metabolic control had lower DMFT values compared with children with poor glycemic control; however, this difference was not statistically significant.

The DMFT components were similar in both groups. Specifically, filled teeth predominated in both groups, followed by untreated caries, with extractions representing the smallest proportion. No statistically significant differences were observed when analyzing the caries and filling components separately. However, significantly more extracted teeth were recorded in children with uncontrolled diabetes compared to children with good metabolic control. Previous studies conducted in Montenegro, involving both healthy children and those with diabetes, reported similar dental caries prevalence in diabetic children (10,12).

Diabetes mellitus can increase susceptibility to dental caries. Numerous studies have investigated the influence of metabolic control on dental caries (20-27). Hyperglycemia is associated with reduced salivary secretion and elevated glucose concentrations in saliva and gingival crevicular fluid. Elevated HbA1c levels and periods of hyperglycemia may increase caries risk in individuals with poorly controlled diabetes mellitus (28-31). Additionally, these individuals are more susceptible to infections such as dental abscesses and tooth loss, often resulting from progressive caries (5,32-34). Some studies, however, have found no correlation between caries and HbA1c levels (35,36). It is important to emphasize that caries risk is influenced not only by metabolic control but also by factors such as fluoride exposure, oral hygiene practices, diet, salivary flow, overall health, and socioeconomic status. Habits and behaviors of patients and their parents are also of great importance. Poor glycemic control may reflect a negligent attitude toward overall health, which can also manifest as inadequate oral hygiene and care (23). In our study, children with poor metabolic control had significantly more missing teeth, likely resulting from progressive, untreated caries. This finding suggests a late diagnosis and possible inadequate or delayed dental interventions, highlighting the need for more frequent preventive examinations and timely treatment in this vulnerable population.

The results also showed that patients with poor metabolic control had significantly higher Plaque Index (PI) and Gingival Index (GI) values compared to those with good metabolic control. Similarly, children with poor metabolic control exhibited significantly more pronounced gingival inflammation. A key etiological factor contributing to increased plaque accumulation on tooth surfaces is inadequate or ineffective oral hygiene. Additionally, children in this age group often lack the habit of maintaining regular and proper daily oral care. Most studies conducted in children with diabetes have reported high plaque and gingival index values (9,10,12,37,38), which aligns with our findings.

Diabetes increases the risk of both gingivitis and periodontitis. Poor glycemic control is frequently associated with a higher incidence of gingivitis, as shown in our previous research. (9,37,38,39,40). Specifically, elevated glucose levels in the gingival crevicular fluid and blood of poorly controlled diabetic patients can alter the microbial environment, leading to qualitative changes in the bacterial composition that contribute to periodontal disease (41–43). Disturbed glucose metabolism in diabetics is directly correlated with the degree of gingival inflammation (44). Increased gingival bleeding associated with hyperglycemia may be explained by immunological alterations and reduced immune response. However, some authors have not observed a clear association between gingival inflammation and levels of metabolic control in diabetic patients (29,30).

Patients who have well-controlled diabetes and a high level of oral hygiene, who follow the usual periodontal maintenance procedures as well as a very strict schedule of control examinations at the dentist, have the same risk for periodontal alteration as non-diabetic people (45).

In our study, the average stimulated saliva flow was similar in both groups. Although children with poor metabolic control showed a lower salivary buffer capacity, the difference was not statistically significant. Similar findings have been reported in other studies (8,9).

Streptococcus mutans (SM) is the primary microorganism responsible for dental caries in humans. In our study, salivary levels of SM and *Lactobacillus* (LB) were significantly higher in children with elevated HbA1c values. Similar findings have been reported in previous studies (9, 20, 29, 46). Elevated glucose concentrations in saliva alter the biofilm structure, facilitating faster colonization of SM and LB in individuals with poor metabolic control. Combined with reduced saliva flow, lower buffering capacity, and inadequate oral hygiene, this can increase the risk of caries in children with poorly controlled diabetes (8,20,29,46–48), consistent with our results. However, some authors do not observe this association, noting that caries is a multiphasic, multicausal infectious disease largely influenced by nutrition (8, 22, 36, 39, 47, 49).

Proper oral hygiene habits, such as regular tooth brushing and routine dental checkups, are key components in preventing oral diseases, including dental caries and gingivitis. However, the results of this study indicate a

worrying pattern: most children with type 1 diabetes brush their teeth only once a day, and visits to the dentist are infrequent, once a year or less.

These results are consistent with findings from other studies reporting inadequate oral hygiene routine among children with type 1 diabetes (9, 12, 50, 30). In some exceptions, some studies have shown better oral hygiene, with a higher percentage of children with T1DM brushing their teeth two to three times daily (51, 52), suggesting that several factors—such as education, socioeconomic status, parental support, and the health care system—may influence the formation of healthy habits.

Furthermore, the frequency of dental examinations in our study was also low, which has been previously confirmed by numerous studies (9, 12, 24). Such a pattern of behavior can be partly explained by the fact that attention in children with diabetes is primarily focused on controlling the underlying disease, while oral health is often put on the back burner. On the other hand, there are also works that show a more positive trend, stating that children with diabetes regularly visit the dentist (53, 54), which may be the result of a better integrated healthcare approach in certain environments.

These contradictory data in the literature indicate the need for standardized education and the inclusion of dental prevention as an integral part of care for children with diabetes (55). By introducing systematic dental examinations and targeted preventive programs within diabetes clinics, both the oral and general health conditions of these patients could be improved.

Although this study has some limitations, including a relatively small sample size, particularly few children with well-controlled diabetes, its findings are valuable. For the first time, they provide insight into the oral health of children with type 1 diabetes mellitus in relation to metabolic control in Montenegro, highlighting the importance of additional parameters, such as saliva analysis, in oral risk assessment. Furthermore, our results open the way for future large-scale research to develop targeted preventive programs and integrate dental care into the routine care of children with chronic diseases.

The findings of this study show that children with poor metabolic control of type 1 diabetes show a tendency towards reduced salivary flow, lower buffering capacity, increased plaque accumulation, more pronounced gingivitis, and a higher risk of caries. These changes in the oral cavity are associated with an increase in the number of pathogenic bacteria, which further impairs oral health.

The high average DMFT index in both groups indicates a lack of effective preventive measures and an inadequate curative dental policy in Montenegro.

These findings suggest the need to develop and implement an organized preventive plan, including education for children with diabetes and their parents, as well as the introduction of individualized prophylactic measures in routine dental practice.

Acknowledgements

This study was not supported by any sponsor or funder.

Author's contribution

Conceptualization and investigation: M.DJ. and A.DJ.; Writing – original draft, review, & editing: M.DJ. and A.DJ. Both authors have read and approved the published version of the manuscript.

Statement of Ethics

The study protocol was reviewed and approved by the Ethics Committee of the Clinical Center of Montenegro (No. 03-5/23). Written informed consent was obtained from the parents of all patients for the publication of this study.

Statement of Competing Interest

The authors declare no relevant conflicts of interest.

Statement of Data Availability

Not applicable.

Statement of Generative AI Use

No generative AI was used.

Conflicts of interest

The authors declare no conflict of interest.

REFERENCES

1. Samardžić M, Martinović M, Nedović-Vuković M, Popović-Samardžić M. Recent Incidence of type 1 diabetes mellitus in Montenegro: a shift toward younger age at disease onset. Acta Clin Croat 2016; 55(1): 63-8. [CrossRef]

2. Samardžić M, Popović N, Terzić N, Popović-Samardžić M, Nedović-Vuković M. Rising incidence of childhood type 1 diabetes in Montenegro. Srp Arh Celok Lek 2016; 144(7-8): 408-12. [CrossRef]

3. . DiMeglio LA, Evans-Molina C, Oram RA. Type 1 diabetes. Lancet. 2018;391(10138):2449-62. [CrossRef]

4. Saberzadeh-Ardestani B, Karamzadeh R, Basiri M, Hajizadeh-Saffar E, Farhadi A, Shapiro AMJ, et al. Type 1 Diabetes Mellitus: Cellular and Molecular Pathophysiology at A Glance. Cell J. 2018;20(3):294-301.

5. Moore PA, Guggenheimer J, Etzel KR, Weyant RJ, OrchardT. Type 1 diabetes mellitus, xerostomia, and salivary flow rates. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001;92(3):281-91. [CrossRef]

6. Ismail AF, McGrath CP, Yiu CKY. Oral health status of children with type 1 diabetes: a comparative study. J Pediatr Endocrinol Metab 2017; 30(11): 1155-9. [CrossRef]

7. Mobasseri M, Shirmohammadi M, Amiri T, Vahed N, Hosseini Fard H, Ghojazadeh M. Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis. Health Promot Perspect. 2020;10(2):98-115. [CrossRef]

8. Nassar M, Nassar O, Abosheaishaa H, Elhakim N. Association between type 1 diabetes mellitus and dental caries: A systematic review and meta-analysis - Dentistry Review, 2024;4 (2. [CrossRef]

9. Ferizi L, Bimbashi V, Kelmendi J. Association between metabolic control and oral health in children with type 1 diabetes mellitus. BMC Oral Health 2022; 22: 502. [CrossRef]

10. Djuričković M, IvanovićM. Dental health status in children with type 1 diabetes mellitus in Montenegro. Vojnosanit Pregl 2021; 78(2): 171-8. [CrossRef]

11. Saes Busato IM, Bittencourt MS, Machado MA, Grégio AM, Azevedo-Alanis LR. Association between metabolic control and oral health in adolescents with type 1 diabetes mellitus. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109(3):e51-6. [CrossRef]

12. Djuričković M, IvanovićM, Samardžić M, Jovičić O, Popović Z. Periodontal health in children with diabetes mellitus type 1 in Montenegro. Serbian Dent J. 2018; 65(3): 119-25. [CrossRef]

13. Frantzis TG, Reeve CM, Brown AL Jr. The ultrastructure of capillary basement membranes in the attached gingiva of diabetics and nondiabetics patients with periodontal disease. J Periodontol. 1971;42:406-11. [CrossRef]

14. Löe H. Periodontal disease. The sixth complication of diabetes mellitus. Diabetes Care. 1993;16(1):329-34. [CrossRef]

15. American Diabetes Association. Children and adolescents: Standards of medical care in diabetes-2018. Diabetes Care. 2018;41(1):126-36. [CrossRef]

16. World Health Organisation. Oral Health Surveys, Basic Methods, 5th ed.; World Health Organisation: Geneva, Switzerland, 2013. https://www.who.int/publications/i/item/9789241548649

17. Loe H. The Gingival Index, the Plaque Index and the Retention Index Systems. J Periodontol. 1967; 38:610-6. [CrossRef]

18. Sanpei S, Endo T, Shimooka S. Caries risk factors in children under treatment with sectional brackets. Angle Orthod. 2010; 80(3):509-14. [CrossRef]

19. EUROSTAT-Income, Social Inclusion and Living Conditions. http://epp.eurostat.ec.europa.eu/portal/page/portal/income_social_inclusion_living_conditions/introduction [updated September 21, 2015].

20. Twetman S, Johansson I, Birkhed D, Nederfors T. Caries incidence in young type 1 diabetes mellitus patiens in relation to metabolic control and caries- associated risc factors. Caries Res. 2002;36:31-5. [CrossRef]

21. Canepari P, Zerman N, Cavalleri G. Lack of correlation between salivary Streptococcus mutans and lactobacilli counts and caries in IDDM children. Minerva Stomatol. 1994;43(11):501-5. [PubMed]

22. Edbald E, Lundin SA, Sjodin B, Aman J. Caries and salivary status in young adults with type 1 diabetes. Swed Dent J 2001;25:53-60. [PubMed]

23. Stojanović N, Krunić J, Cicmil S, Vukotić O. Oral health status in patients with diabetes mellitus type 2 in relation to metabolic control of the disease. Srp Arh Celok Lek 2010;138(7-8):420-4. [CrossRef]

24. Syrjala AM, Niskanen MC, Ylostalo P, Knuuttila ML. Metabolic control as a modifier of the association between salivary factors and dental caries among diabetic patients. Caries Res 2003 Mar-Apr;37(2):142-7. [CrossRef]

25. Jones RB, McCallum RM, Kay EJ, Kirkin V, McDonald P. Oral health and oral health behaviour in a population of diabetic outpatient clinic attenders. Community Dent Oral Epidemiol 1992;20:204-7. [CrossRef]

26. Narhi TO, Meurman JH, Odont D, Ainamo A, Tilvis R. Oral health in the elderly with non-insulin-dependent diabetes mellitus. Spec Care Dentist 1996;16:116-22. [CrossRef]

27. Bakhshandeh S, Murtomaa H, Vehkalahti MM, Mofid R, Suomalainen K. Dental findings in diabetic adults. Caries Res 2008;42:14-8. [CrossRef]

28. 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):142-7. [CrossRef]

29. 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. [CrossRef]

30. Sadeghi R, Taleghani F, Mohammadi S, Zohri Z. The Effect of Diabetes Mellitus Type I on Periodontal and Dental Status. J Clin Diagn Res. 2017;11(7):ZC14-ZC17. [CrossRef]

31. Twetman S, Petersson GH, Bratthall D. Caries risk assessment as a predictor of metabolic control in young Type 1 diabetics. Diabet Med. 2005;22(3):312-5. [CrossRef]

32. Arheiam A, Omar S. Dental caries experience and periodontal treatment needs of 10- to 15-year old children with type 1 diabetes mellitus. Int Dent J. 2014; 64(3):150-4. [CrossRef]

33. Vidya K, Shetty P, Anandakrishna L. Oral health and glycosylated hemoglobin among type 1 diabetes children in South India. J Indian Soc Pedod Prev Dent. 2018; 36:38-42. [CrossRef]

34. Babu KLG, Subramaniam P, Kaje K. Assessment of dental caries and gingival status among a group of type 1 diabetes mellitus and healthy children of South India - a comparative study. J Pediatr Endocrinol Metab. 2018; 31(12):1305-10. [CrossRef]

35. Collin HL, Uusitupa M, Niskanen L, Kaivisto AM, Makkanen H, Meurman JH. Caries in patients with non-insulin-dependent diabetes mellitus. Oral Surg Oral Med Oral Radiol Endodon 1998;85:680-5. [CrossRef]

36. Karjalainen KM, Knuuttila ML, Karr ML. Relationship between caries and level of metabolic balance in children and adolescents with insulin-dependent diabetes mellitus. Car Res 1997;31:3-18. [CrossRef]

37. Orbak R, Simsek S, Orbak Z, Kavrut F, Colak M. The influence of type-1 diabetes mellitus on dentition and oral health in children and adolescents. Yonsei Med J. 2008;49(3):357-65. [CrossRef]

38. Al-Khabbaz AK, Al-Shammari KF, Hasan A, Abdul-Rasoul M. Periodontal health of children with type 1 diabetes mellitus in Kuwait: a case-control study. Med Princ Pract. 2013;22(2):144-9. [CrossRef]

39. Lalla E, Cheng B, Lal S, Tucker S, Greenberg E, Goland R, et al. Periodontal changes in children and adolescents with diabetes: a case-control study. Diabetes Care. 2006;29(2):295-9. [CrossRef]

40. Rawal I, Ghosh S, Hameed SS, Shivashankar R, Ajay VS, Patel SA, et al. Association between poor oral health and diabetes among Indian adult population: potential for integration with NCDs. BMC Oral Health. 2019;19(1):191. [CrossRef]

41. Casanova L, Hughes FJ, Preshaw PM. Diabetes and periodontal disease: a two-way relationship. Br Dent J. 2014;217(8):433-7. [CrossRef]

42. Novotna M, Podzimek S, Broukal Z, Lencova E, Duskova J. Periodontal Diseases and Dental Caries in Children with Type 1 Diabetes Mellitus. Mediators Inflamm 2015; 2015: 379626. [CrossRef]

43. Siudikiene J, Machiulskiene V, Dobrovolskiene R, Nedzelskiene I. Oral hygiene in children with type 1 diabetes mellitus. Stomatologija 2005;7(1):24-7.

44. Karjalainen KM, Knuttila ML. The onset of diabetes poor metabolic control increases gingival bleeding in children and adolescents with insulin-dependent diabetes mellitus. J Clin Periodontol 1996 Dec;23(12):1060-7. [CrossRef]

45. Tervonen T, Krjalainen K. Periodontal disease related to diabetic status: a pilot study of response to periodontal therapy in type 1 diabetes. J Clin Periodontol 1997;24:505-10. [CrossRef]

46. Swanljung O, Meurman JH, Torkko H, Sandhoim L, Kaprio E, Maenpaa J. Caries and saliva in 12-18-year-old diabetics and controls. Scand J Dent Res 1992;100(6):310-3. [CrossRef]

47. Liu TMM, Yuan WMM, Zhu Y, Yang W. Caries status and salivary alterations of type-1 diabetes mellitus in children and adolescents: a systematic review and meta-analysis. J Evid Based Dent Pract. 2021;21(1):101496. [CrossRef]

48. Triebl Z, Bencze B, Bányai D, Rózsa N, Hermann P, Végh D. Poor glycemic control impairs oral health in children with type 1 diabetes mellitus - a systematic review and meta-analysis. BMC Oral Health 2024;24: 748. [CrossRef]

49. Kamran S, Moradian H, Yazdan E, Bakhsh. Comparison of the mean DMF index in type 1 diabetic and healthy children. J Dent (Shiraz). 2019;20(1):61-5. [CrossRef]

50. Siudikiene J, Maciulskiene V, Nedzelskiene I. Dietary and oral hygiene habits in children with type I diabetes mellitus related to dental caries. Stomatologija. 2005;7(2):58-62. [PubMed]

51. Alves C, Brandão M, Andion J, Menezes R. Oral health knowledge and habits in children with type 1 diabetes mellitus. Braz Dent J. 2009;20(1):70-3. [CrossRef]

52. Sohn HA, Rowe DJ. Oral Health Knowledge, Attitudes and Behaviors of Parents of Children with Diabetes Compared to Those of Parents of Children without Diabetes. J Dent Hyg. 2015;89(3):170-9. [PubMed]

53. Orlando VA, Johnson LR, Wilson AR, Maahs DM, Wadwa RP, Bishop FK, et al. Oral Health Knowledge and Behaviors among Adolescents with Type 1 Diabetes. Int J Dent. 2010; 2010:942124. [CrossRef]

54. Tagelsir A, Cauwels R, van Aken S, Vanobbergen J, Martens LC. Dental caries and dental care level (restorative index) in children with diabetes mellitus type 1. Int J Paediatr Dent. 2011;21(1):13-22. [CrossRef]

55. Moore PA, Orchard T, Guggenheimer J, Weyant RJ. Diabetes and oral health promotion: a survey of disease prevention behaviors. J Am Dent Assoc. 2000;131(9):1333-41. [CrossRef]