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The Effect of Type 1 Diabetes Mellitus on Children's Primary Teeth: A Systematic Review

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Abstract

***Background*:** Type 1 diabetes mellitus is a chronic metabolic disease of autoimmune origin with early manifestations, which occur predominantly in childhood. Its incidence has been increasing in most European countries. Diabetes is a well-known predisposing factor for oral diseases; therefore, prevention at an early age is essential. Diabetes negatively affectsdeveloping enamel by altering the mineralization process, which can have a detrimental effect on oral health. Diabetes mellitus (DM) may affect the healing and survival of root-filled teeth with periapical lesions. ***Methods*:** An electronic search of the following databases was carried out to identify the literature evaluating the effect of type 1 diabetes on children's primary teeth: PubMed, Cochrane Library, Google Scholar, and Embase. In total, 1244 studies were identified. After removing duplicates (n = 52), then screening based on title and abstract, and then performing full-text screening, a total of nine articles were included in this systematic review. ***Conclusion*:** This systematic review revealed that type 1 diabetes does not significantly increase the risk of dental caries or periodontal lesions for children's primary teeth.

Keywords: Type 1 diabetes, oral health, primary teeth, dental caries.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by high levels of glucose in the blood. Type 1 diabetes, often referred to as T1DM, is an autoimmune disease resulting in the destruction of the insulin-producing beta cells in the pancreas, leading to insulin deficiency and impaired glucose metabolism. Juvenile diabetes (JD) is a type of type 1 diabetes that occurs in children before age 15 and accounts for 5–10% of all diabetes cases worldwide [1-3]. It has been reported that JD can have mild to severe effects on growing children's oral and dental health as well as skeletal maturation [1-5]. Periodontal disease has been identified as one of the complications of diabetes because of its involvement with the systemic vascular system [6, 7]. Because there are no experimental results from clinical trials, the molecular pathways relating to diabetes and periodontitis are not well understood [6-8]. However, the present data suggest a potentially complex relationship between diabetes and periodontitis involving immunological response, neutrophil activity, and cytokine biology [8].

Periodontitis is characterized by chronic inflammation of the surrounding tissues of the teeth, including the gingiva, connective tissues, and bones [9]. Diabetes increases children's risk of acquiring periodontal disease [6-10], and adolescents' risk of accelerated tooth eruption [6-11]. In the oral cavity, diabetes tends to alter the flow rate and buffering capacity of saliva, leading to increased glucose levels in saliva [6-12]. Experimental evidence suggests that the dyselectrolytemia and transmineralization caused by

diabetic-induced disturbance of homeostasis alter the mineral composition of bone and teeth [1-13]. In addition, diabetes alters the mineralization process of developing enamel, which can be harmful to oral health. According to Syed et al., children with diabetes are more likely to have primary teeth with enamel surface defects. The most common enamel defects include altered ultrastructure, whitish areas, degenerative lesions, and enamel hypoplasia [1-16]. Thus, people with diabetes usually have poor oral health, which involves increased plaque accumulation and calculus formation, and are at higher risk for dental cavities.

The rates of caries progression in patients with diabetes is demonstrated to be higher than average, and their pulp's defence system is weaker, which results in early tooth loss [1-17]. Although diabetes mellitus has been said to not directly induce gingivitis or periodontal pockets, most studies report that patients with type 1 diabetes have a much higher incidence of chronic gingivitis than the general population, and this incidence increases with age. There are many indications that diabetes may change the reaction of periodontal tissues to environmental variables. Dental calculus, reported to be promoted by poorly controlled diabetes, may be one of the local variables that predispose people to the onset and progression of gingival inflammation [18]. It has been demonstrated that poor metabolic control of diabetes is associated with a higher incidence and severity of gingivitis. Increased glucose levels in the blood and gingival fluid of people with diabetes have been hypothesized to alter the microfloraenvironment and cause qualitative changes in bacteria, which could explain the severity of periodontal diseases seen in people with poorly controlled diabetes [19]. The impact of diabetes on primary teeth in children remains controversial due to variations in methodology and the complex etiologies of most oral pathologies. Therefore, the aim of this systematic review is to systematically summarize the currently available information on the effect of type 1 diabetes on children's primary teeth.

METHODS

Search Strategy

A comprehensive search of relevant scientific literature was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [20], using the following databases: PubMed, Cochrane Library, Google Scholar, and Embase. The search strategy employed a combination of keywords and Medical Subject Headings (MeSH) terms to identify the relevant studies. The following keywords, combined with Boolean operators, were used to identify the relevant studies: ('Type 1 Diabetes Mellitus' OR 'Type 1 Diabetes' OR 'Childhood Diabetes') AND ('Primary Teeth' OR 'Deciduous Teeth' OR 'Baby Teeth' OR 'Milk Teeth') AND ('Effect' OR 'Impact' OR 'Influence' OR 'Consequence' OR 'Association' OR 'Relation' OR 'Correlation' OR 'Dental Health' OR 'Oral Health' OR 'Tooth Decay' OR 'Caries' OR 'Periodontal Health' OR 'Dental Development' OR 'Eruption' OR 'Dental Anomalies' OR 'Tooth Growth' OR 'Tooth Structure'). These keywords were strategically combined with relevant MeSH terms, such as 'Diabetes Mellitus', 'Type 1/', 'Dental Enamel/', 'Tooth', 'Deciduous/', 'Child/', and 'Pediatric/', to further refine the search scope and ensure a thorough exploration of the literature. Truncation and wildcards were not used to maintain precision. This methodological approach was designed to identify and encompass a wide range of studies while maintaining precision and relevance throughout the systematic review process.

The search was limited to articles published between January 2008 and September 2023, ensuring coverage of recent research while allowing for a substantial historical perspective. No language restrictions were applied in this study. Non-English articles were included to minimize language bias. Translation resources were used as needed during the screening process.

ELIGIBILITY CRITERIA

Inclusion Criteria

- Studies involving children aged 0-18 years diagnosed with type 1 diabetes.
- Investigations focused on the impact of diabetes on primary teeth, including but not limited to caries, enamel defects, and periodontal health.

Exclusion Criteria

- Studies not related to the effect of diabetes on primary teeth in children.
- Studies involving adult populations exclusively.
- Review articles, case reports, and conference abstracts were excluded during the initial search but were considered in the review of references from selected studies.
- Studies on non-human subjects.

Data Extraction

According to the specified inclusion criteria, the studies were first screened based on their titles and abstracts, followed by full-text screening. Duplicate studies were identified using Endnote X7 (Clarivate Analytics, PA). The full texts of the articles that met the eligibility criteria were carefully examined. The outcomes were contrasted side-by-side, and disagreements were settled through consensus. The data extracted from these studies covered numerous characteristics. This included information on the study author, the year it was published, the study's setting and design, the sample size, the specifics of the follow-up period, the findings, and demographic data of the participants, including their age and oral health.

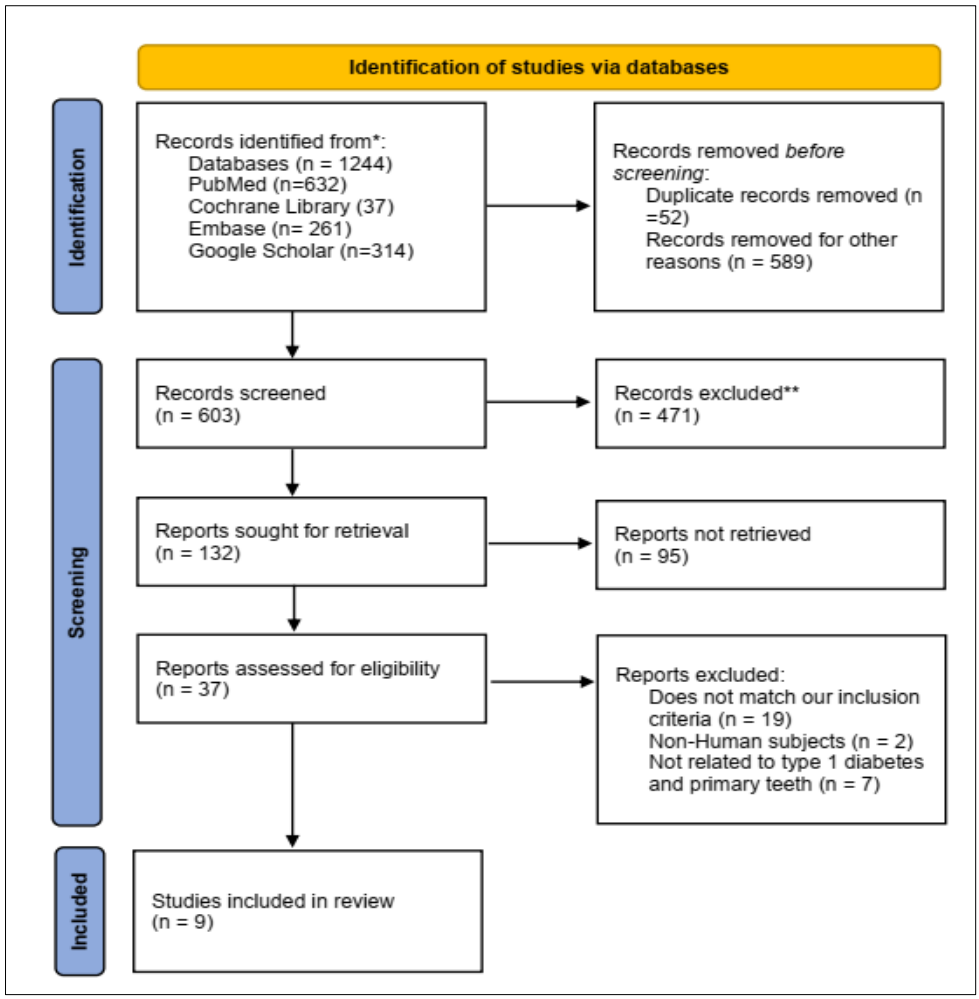

Figure 1: PRISMA flowchart showing the study selection process.

Quality Assessment

For quality assessment of non-randomized case-control studies, Newcastle-Ottawa Scale was used [21], while Newcastle-Ottawa scale adapted for cross-sectional studies was used for risk of bias assessment in cross-sectional, comparative studies. Only studies with high and moderate quality were included in this systematic review.

Table 1: Newcastle Ottawa scale of quality assessment adapted for Cross-sectional Studies

STUDY	SELECTION				COMPARABILITY	OUTCOME		QUALITY
	Representativeness of the sample	Sample size	Non-respondents	Ascertainment of the exposure/ surveillance tool	The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled	Assessment of Outcome	Statistical test	
Assiri [22]	☆	☆	☆	☆☆	0	☆☆	☆	Good
Syed [23]	0	0	0	☆☆	☆	☆	☆	Moderate
Ismail [24]	☆	☆	☆	☆☆	0	☆☆	☆	Good
Alves [25]	0	0	0	☆☆	☆	☆	☆	Moderate
Al-Badr [26]	☆	☆	0	☆☆	☆	☆☆	☆	Good
Babu [27]	☆	☆	0	☆	☆	☆	0	Good
Wyne [28]	0	0	0	☆	☆	☆☆	☆	Moderate

Table 2: Newcastle Ottawa scale of quality assessment for Case control studies

STUDY	SELECTION				COMPARABILITY	OUTCOME			QUALITY
	Adequacy of Case Definition	Representativeness of the Cases	Selection of Controls	Definition of Controls	Comparability of Cases and Controls on the Basis of the Design or Analysis	Ascertainment of Exposure	Same method of ascertainment for cases and controls	Non-Response rate	
López del Valle [29]	☆	☆	0	☆	☆	☆	☆	☆	Good
Rafatjou [30]	0	0	☆	☆	☆☆	0	☆	0	Moderate

RESULTS

A total of nine articles were included in this review [22-30]. Seven out of nine studies were cross-sectional comparative studies [22-28] while two studies were case-control trials [29-30]. The total number of participants included in this review was 1236. The sample sizes of the included studies ranged from 50 to 311. Four of the studies were conducted in Saudi Arabia, and one each was conducted in Brazil, Hong Kong, Puerto Rico, India, and Iran. A summary of the included studies is shown in Table 3.

The study by Assiri *et al*., [22], on 80 children aged 6 to 12 years found that children with Type 1 diabetes had much less caries experience in their primary teeth and had lower buffering capacities than children without the disease. This is supported by the findings of Rafatjou *et al*., [30], who concluded that the number of primary decayed teeth was significantly higher in the control group. A higher dmf-t index, which is the sum of the number of D (Decayed), M (Missing) due to caries, and F (Filled) teeth in the primary teeth, was observed in the control group. This means the incidence of missed, decayed, or filled primary teeth is high in healthy subjects [30]. Similar findings have been reported by Ismail *et al*., [24], Babu *et al*., [27], and Wyne *et al*., [28]. According to a 2021 study by López del Valle [29], there was no statistically significant difference between the study group and the control group regarding the mean number of white spot lesions and mean number of carious lesions on primary teeth. According to one study, diabetic and non-diabetic patients had the same total def-t index values [25]. However, a microscopic examination of extracted primary teeth revealed that the enamel on the teeth of diabetic children had poor ultrastructural surface properties. Additionally, the study discovered that these flaws in the enamel surface were caused by aberrant amelogenesis activity in the primary teeth of infants with diabetes. Defects increase the susceptibility of the enamel to acid degradation, thereby increasing the risk of cavities [23].

Table 3: Summary of the included articles

First Author, Reference	Year of Publication	Study Title	Study Location	Study Design	Total Number of Subjects	Age range	Study Group	Control group	Outcome
Assiri [22]	2022	Assessment of dental caries and salivary characteristics among type 1 diabetic Saudi children	Saudi Arabia	Cross-sectional, comparative study	80	6-12 years	40 children with Type 1 diabetes	40 healthy children	The study found that children with Type 1 diabetes had remarkably lower caries experience in primary teeth and lower buffering capacity compared to healthy children.

Ismail [24]	Syed [23]	Rafatjou [30]	López del Valle [29]
2017	2022	2016	2011
Oral health status of children with type 1 diabetes: a comparative study	Structural Changes in Primary Teeth of Diabetic Children: Composition and Ultrastructure Analysis	Dental Health Status and Hygiene in Children and Adolescents with Type 1 Diabetes Mellitus	Comparing the Oral Health Status of Diabetic and Non-Diabetic Children from Puerto Rico: a Case-control Pilot Study
Hong Kong	Saudi Arabia	Iran	Puerto Rico
Cross-sectional, comparative study	Cross-sectional, comparative study	Case-control study	Case-control study
64	100	160	50
12 ± 4 years	6–12 years	5–18 years	6-12 years
32 members (16 boys and 16 girls) with Type 1 diabetes	50 extracted primary teeth from children diagnosed with Type 1 diabetes	80 children and adolescents with Type 1 diabetes	25 children with Type 1 Diabetes
32 healthy members (16 boys and 16 girls)	50 primary teeth of healthy children	80 non-diabetic children	25 non-diabetic children
31% children with diabetes had primary teeth missing due to caries, whereas no children in the control group had missing primary teeth. decayed teeth caused most of the caries experience in primary dentition of the individuals with diabetes.	Poor ultrastructural surface characteristics of enamel surface are observed in primary teeth of diabetic children. Abnormal amelogenesis activity in primary teeth of diabetic children seems to be the cause of these defects in the enamel surface. The defects make the enamel more prone to acid dissolution, thus increasing caries risk.	The number of primary decayed teeth was significantly higher in the control group. A higher dmf-t index was observed in the control group. This means that the incidence of missed, decayed, or filled primary teeth is high in healthy subjects.	There was no statistically significant difference in the mean number of white spot lesions and mean number of carious lesions on primary teeth between the study and control group.

Alves [25]	2012	Salivary flow and dental caries in Brazilian youth with type 1 diabetes mellitus	Brazil	Cross-sectional, comparative study	102	6-18 years	51 people with Type 1 diabetes	51 people without Type 1 diabetes	There was no difference in the total def-t index values in diabetics and non-diabetics
Al-Badr [26]	2021	Dental caries prevalence among Type 1 diabetes mellitus (T1DM) 6- to 12-year-old children in Riyadh, Kingdom of Saudi Arabia compared to non-diabetic children	Saudi Arabia	Cross-sectional, comparative study	209	6-12 years	69 diabetic children	140 non-diabetic children	There was no statistically significant difference in the caries rates in primary teeth between the diabetic and non-diabetic children
Babu [27]	2018	Assessment of dental caries and gingival status among a group of type 1 diabetes mellitus and healthy children of South India – a comparative study	India	Cross-sectional, comparative study	160	6–18 years	80 children with T1DM	80 children without T1DM	Dental caries in primary dentition was lower in diabetic children as compared to the control group but was not statistically significant.
Wyne [28]	2016	Caries, oral hygiene, and gingival health status in type 1 diabetic Saudi children	Saudi Arabia	Cross-sectional, comparative study	311	4-14 years	134 children with Type 1 Diabetes mellitus	177 healthy children	Compared to healthy control children, the children with type 1 diabetes had less caries in their primary teeth.

DISCUSSION

The systematic review included nine studies that were published between January 2008 and September 2023 that report the effect of type 1 diabetes on primary teeth in children. The included studies assessed the effect of diabetes on the primary teeth in children on various aspects or criteria. The dmf-t score index was higher in non-diabetic children as compared to diabetic children. It has been reported in a recent meta-analysis that the prevalence of dental caries was high among children and adolescents with type 1 diabetes [31]. The prevalence of dental caries among children and adolescents with type 1 diabetes has been the subject of numerous investigations; however, these studies have also revealed significant variation in this prevalence. According to the US National Health and Nutrition Examination Survey (NHANES), 37% of children between the ages of 2 and 8 and 58% of teenagers have dental caries in their primary teeth [32]. Another country-wide survey in Greece revealed that among children aged 5, 12, and 15, the mean dmft/DMFT values were 1.77, 2.05, and 3.19, respectively [33].

The authors identify the following limitations to the systematic review on the effect of diabetes on primary teeth in children: There are several limitations to consider in this systematic review on the effect of diabetes on primary teeth in children. First, there is a limited number of studies available specifically examining the relationship between diabetes and primary teeth in children. Second, there is a lack of standardized criteria for diagnosing and assessing dental problems in children with diabetes, which may lead to inconsistencies in the research findings. Furthermore, the included studies in this review varied in terms of sample sizes, study designs, and follow-up periods, making it difficult to draw definitive conclusions or establish a clear understanding of the effect of diabetes on primary teeth in children. Within these limitations, the available

evidence suggests that type 1 diabetes does not significantly affect primary teeth in children.

CONCLUSION

The systematic review concluded that diabetes does not significantly affect primary teeth in children. This is helpful in providing reassurance to parents and caregivers of children with type 1 diabetes that their dental health is less likely to be compromised. However, it is important to note that the evidence for this conclusion is limited due to the scarcity of studies and lack of any large clinical trials specifically investigating this relationship.

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