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Original Article

The Relationship between Insulin-dependent Diabetes Mellitus (Type 1 Diabetes) and Dental Caries: A Meta-Analysis

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CLINICAL SIGNIFICANCE

Individuals with insulin diabetes mellitus may be at an elevated risk of experiencing dental caries in their permanent teeth. Due to this increased susceptibility, healthcare professionals must exercise additional caution when treating and caring for these patients.

ABSTRACT

Objectives: The objective of this study was to perform a meta-analysis by combining the findings of studies that examined the link between insulin-dependent diabetes mellitus (IDDM) and dental caries in both permanent as well as deciduous teeth.

Materials and Methods: The PRISMA statement guide was utilized in order to conduct a thorough meta-analysis. This involved conducting searches across electronic databases to select relevant studies, as well as collecting pertinent data. A comprehensive evaluation of biases was also performed, both on an individual and collective level. For the purposes of comparing results, mean differences (MD) were implemented as the primary metric for measuring effect estimates.

Results: The study consisted of 42 qualitative and 32 quantitative analyses. The DMFT score was significantly higher in the IDDM group compared to the control group (MD=1.24, CI: 0.74,1.74; p<0.001), but there was no significant difference in the dmft score (MD=-0.40, 95% CI: -0.82, 0.02; p=0.06). The statistical outcomes for DMFT (Tau^2=1.75, Chi^2=1420.50, I^2=98%, p<0.001) and dmft (Tau^2=0.36, Chi^2=75.01, I^2=84%, p<0.001) showed considerable heterogeneity.

Conclusion: Research suggests that individuals with IDDM may have an increased risk of developing dental caries in their permanent teeth. However, this association between IDDM and dental caries does not appear to be present in deciduous teeth.

1. Introduction

Diabetes mellitus (DM) is a widely prevalent metabolic disorder that is characterized by hyperglycemia and numerous complications. This disease encompasses four types: Type 1 or insulin-dependent diabetes (IDDM), type 2 or non-insulin-dependent diabetes (NIDDM), gestational diabetes, and specific types (e.g., maturity onset diabetes of the young).[1] IDDM is a complex autoimmune disorder that results in the deficient production of insulin from pancreatic beta cells. It is more commonly diagnosed in children and adolescents, with the highest incidence occurring during puberty. The clinical manifestations of IDDM are complex and involve numerous complications associated with hyperglycemia. This can lead to damage to various organs, such as the kidneys, retina, and nerves that have capillary vessels. The consequences of this disease can be severe and long-lasting, which is why it is critical to manage DM properly to avoid or minimize its complications.[2]

According to recent research[3-5], there appears to be a connection between the secretion of saliva and the onset of various metabolic disorders. Capillaries are small blood vessels that are present in various tissues throughout the body, including the oral tissues. Individuals who suffer from IDDM may experience complications in their oral tissues in addition to other organs. Complications may arise in various ways, such as a reduction in salivary flow rate, which can lead to dental caries and periodontal diseases.[4,6] The effects of IDDM on the oral tissues can be attributed to several factors, including different dietary habits of IDDM patients, alterations in salivary flow rate, and variations in saliva composition. These factors can lead to changes in the oral microflora, potentially linking IDDM to dental caries. It is important to address these complications early on to prevent more severe oral health issues from developing.[7]

Over the years, researchers have conducted several studies to investigate the correlation between IDDM and oral complications, particularly dental caries. However, dental caries is a complex disease that is influenced by various factors such as lifestyle, diet, and oral hygiene, among others. This has resulted in inconsistencies in the findings of previous studies that have attempted to establish a link between dental caries and IDDM.[8-13] Therefore, the primary objective of this study is to conduct a comprehensive analysis of both qualitative and quantitative outcomes of past research in order to provide a conclusive report on the impact of IDDM on dental caries.

2. Materials and Methods

2.1. Guidance and Eligibility criteria

This meta-analysis adhered to the guidelines set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[14] The inclusion criteria of the studies were (1) Studies which investigated dental caries in the primary or permanent dentition, (2) Studies which presented DMFT/dmft or DMFS/dmfs or DFS/dfs as caries indexes clearly, (3) Studies which investigated IDDM population (NIDDM was not included), (4) Observational studies. The exclusion criteria of the studies were (1) Studies which did not include a healthy subject (control) group, (2) Studies which combined IDDM and NIDDM population, (3) Studies which did not report standard deviations (Although their primer outcome was continuous), (4) Studies which combined dental caries scores, (5) Studies which did not report caries index values clearly, (6) Studies in which the full text could not be found, (7) Short communication, review, case report or case series (8) Language of publication other than English. We did not impose

any restrictions with respect to time of publication, sex, or age.

In order to establish the parameters for the studies that were deemed appropriate for inclusion, we utilized the PICOs models as outlined below.

Population (P): Healthy individuals and those with IDDM
Indicator (Cases) (I): DMFT, dmft of individuals with IDDM
Comparison (Control) (C): DMFT, dmft of healthy individuals
The outcome (O): Association with the presence of IDDM
Study design (S): Observational studies

2.2. Information sources and search strategy

In June 2019, one of the researchers (T.S.) searched through electronic databases including Web of Science, PubMed, Scopus, Cochrane Library, and Open Grey Databases. The search strategies used can be found in Table 1. Two authors (S.S. and A.M) also carefully looked through the reference lists of the gathered papers and reviews to find any additional studies. Additionally, the authors accessed recent articles that referenced the obtained studies.

2.3. Study selection and data collection process

Two independent analysts (S.S and A.M) evaluated the titles and abstracts of the studies we obtained. To eliminate duplicate references, we used a reference management software (EndNote® X9 Thomson Reuters, Philadelphia, PA, USA). We also reached out to authors to obtain texts of studies that didn't allow full-text access. The final decision on which studies to include in the meta-analysis was unanimous among the two reviewers (S.S. and A.M).

2.4. Risk of bias in individual studies

To determine the risk of bias in the study, the Joanna Briggs Institute Critical Appraisal Checklist was employed, which is specially designed for cross-sectional studies.[15] Two independent reviewers, namely S.S. and A.M., conducted the assessment and arrived at a consensus. In case of any disagreements, they consulted a third author, T.S. The Joanna Briggs guidelines were adhered to for scoring and established cutoff points to classify studies into different risk of bias categories. Studies with up to 49% of questions scored as "yes" were deemed to have a high risk of bias, those with scores ranging from 50 to 69% as moderate risk, while those with more than 70% as low risk.

2.5. Summary Measures

The primary outcome parameters of interest were “DMFT” and “dmft”. Mean differences (MD) and its respective 95% confidence intervals (95% CI) were used in measuring the effect estimate in the comparisons.

2.6. Synthesis of results

The meta-analysis software of the Cochrane Collaboration (RevMan 5.3, The Nordic Cochrane Centre, Copenhagen, Denmark) was used to estimate the overall effects and to produce the forest plots. The level of significance was set at $p < 0.05$.

2.7. Risk of bias across studies

To assess clinical heterogeneity, we compared the variations between cases, controls, and study outcomes. We utilized Chi-squared, Tau-squared, and Higgins I^2 tests to evaluate statistical heterogeneity. The I^2 statistic was used to measure heterogeneity among the studies, and was classified as follows: less than 30% was considered insignificant, 30% to 50% was moderate, 50% to 75% was substantial, and 75% to 100% was considerable. We opted for the random effects model with 95% confidence intervals as the meta-analysis model, due to the presence of heterogeneity among studies.

2.8. Sensitivity Analysis

To assess the strength of the combined findings, a sensitivity analysis was carried out using the leave-one-out methodology.

2.9. Publication Bias

To assess publication bias, we employed the Egger Regression statistical analyses and Funnel Plot. We visually inspected the funnel plots to evaluate the risk of bias across studies and tested their asymmetry using Egger's test.

2.10. Grade Analysis

To rate the quality of evidence and the strength of recommendations, we utilized the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) system. We developed a summary of findings (SoF) table with the help of the GRADE Working Group's online software, GRADEpro GDT.[16]

3. Results

3.1. Study Selection

The parameters mentioned earlier were used to scan the databases, resulting in a total of 39963 records. These records were obtained from various sources, such as Pubmed (n= 1867), Web of Science (n= 1304), Scopus (n= 36765), Cochrane Library (n= 18), and Open Grey (n= 9). After eliminating repetitive studies, the number was reduced to 7032. These studies were then screened, and only 124 were left after title and abstract screening. After thoroughly reviewing the remaining studies, 82 more were excluded due to eligibility criteria. Finally, 42 cross-sectional studies were included in the qualitative synthesis (Fig 1). All the references of the included studies can be found in Appendix 1.

3.2. Risk of bias within studies

Out of the 19 studies reviewed, 16 were deemed to have low risk of bias while the remaining 3 were classified as high risk. However, when it came to assessing whether confounding factors were identified and strategies to address them were stated (questions 5

Table 1. Search strategies employed in different information databases

Database	Search strategy
PubMed	((Diabetes Mellitus) OR (Diabetes Complications) OR (Type 1 Diabetes Mellitus) OR (Type 1 Diabetes) OR (Diabetes Mellitus, Insulin-Dependent) OR (Insulin-dependent Diabetes Mellitus)) AND ((Dental Caries) OR (Dental Caries Susceptibility) OR (Cariogenic Bacteria) OR (decay) OR (caries))
Web of Science	TS=((Diabetes Mellitus OR Diabetes Complications OR Type 1 Diabetes Mellitus OR Type 1 Diabetes OR Diabetes Mellitus, Insulin-Dependent OR Insulin-dependent Diabetes Mellitus) AND (Dental Caries OR Dental Caries Susceptibility OR Cariogenic Bacteria OR decay OR caries))
Scopus	((diabetes AND mellitus) OR (diabetes AND complications) OR (type 1 diabetes AND mellitus) OR (type 1 diabetes) OR (diabetes AND mellitus, AND insulin-dependent) OR (insulin-dependent AND diabetes AND mellitus)) AND ((dental AND caries) OR (dental AND caries AND susceptibility) OR (saliva) OR (cariogenic AND bacteria) OR (decay) OR (caries))
Cochrane Library	#1 ("diabetes mellitus type 1") AND ("dental caries")
Open Grey	((Diabetes Mellitus) OR (Diabetes Complications) OR (Type 1 Diabetes Mellitus) OR (Type 1 Diabetes) OR (Diabetes Mellitus, Insulin-Dependent) OR (Insulin-dependent Diabetes Mellitus)) AND ((Dental Caries) OR (Dental Caries Susceptibility) OR (Cariogenic Bacteria) OR (decay) OR (caries))

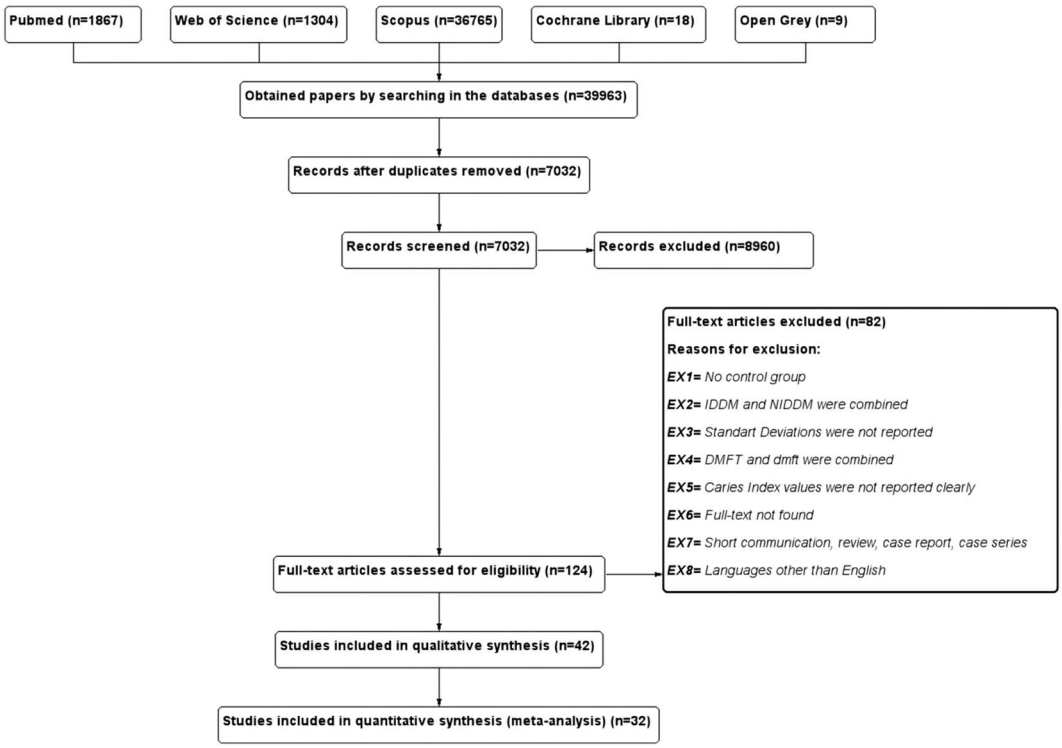

Fig. 1. Flow diagram of the studies involved in the qualitative and quantitative analyses

and 6, respectively), most studies were found to have high risk of bias. On the other hand, with regards to the 8th question regarding the use of appropriate statistical analysis, almost all studies were considered to have low risk of bias (Table 2).

3.3. Results of Individual Studies

DMFT scores were significantly higher in IDDM populations compared to control groups in 14 out of 32 studies ($p<0.05$). However, in 2 studies, the control group had significantly higher DMFT scores ($p<0.05$). In terms of dmft index, dental caries scores were lower in 3 studies and higher in 2 studies compared to control groups ($p<0.05$). In 3 out of 11 studies, IDDM populations had significantly higher dental caries scores than control groups based on DMFS index ($p<0.05$), but no association was found in the others ($p>0.05$). In 2 out of 5 studies using dmfs index, control groups had significantly higher dental caries scores than IDDM populations ($p<0.05$). In terms of DFS index, control groups had significantly higher dental caries scores in 2 studies and lower scores in 1 study compared to IDDM populations. However, no significant association was found for dfs index ($p>0.05$) (Appendix 1).

3.4. Synthesis of Results

The IDDM group had a significantly higher DMFT score than the control group (MD=1.24, 95% CI: 0.74, 1.74; $p<0.001$). Fazlić, et al. [12] found the highest mean difference (MD = 5.3, 95% CI: 4.10, 6.50)

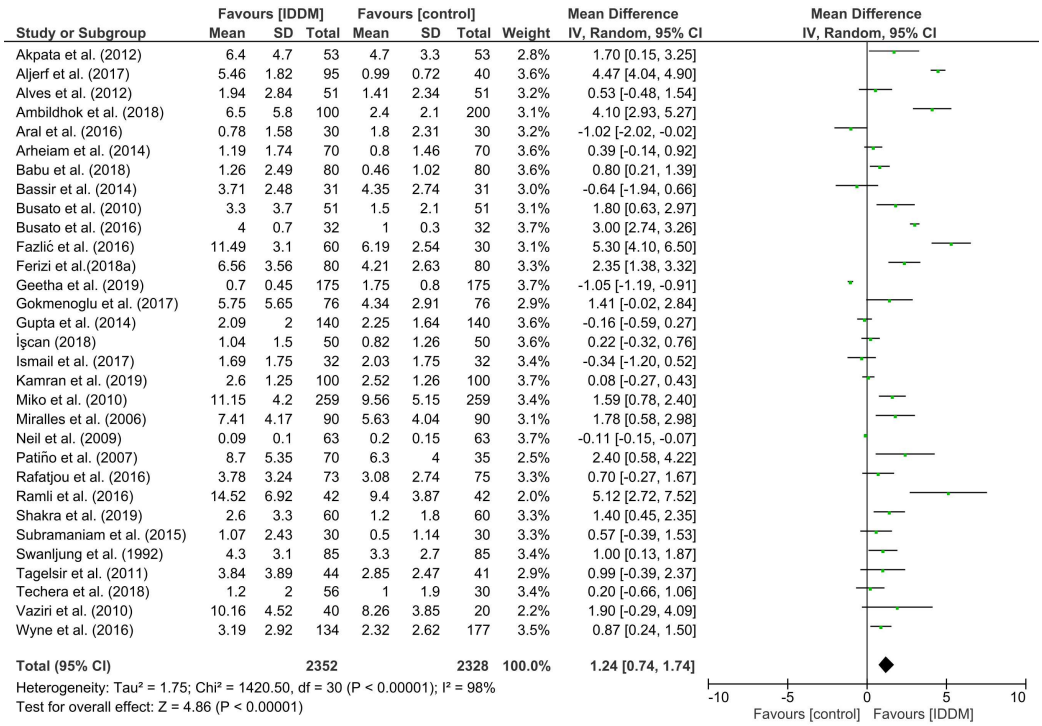

Fig. 2. Forest plot presentations of DMFT outcomes

in favor of the IDDM group (Fig 2). While the control group had a tendency towards a higher dmft score, there was no significant difference observed between the IDDM and control groups (MD=-0.40, 95% CI: -0.82, 0.02; p=0.06). Rafatjou, et al. [17] found the highest mean difference (MD=-2.84, 95% CI: -4.48, -1.20) in favor of the control group (Fig 3).

3.5. Risk of Bias Across Studies

Various studies showed serious heterogeneities in the methods used to diagnose and treat diabetes, as well as in the clinical parameters such as gender, age, and duration of diabetes. Furthermore, there were considerable heterogeneities in the statistical outcomes of DMFT (Tau^2=1.75, Chi^2=1420.50, I^2=98%, p<0.001) and dmft (Tau^2=0.36, Chi^2=75.01, I^2=84%, p<0.001). Therefore, a random effects model was utilized in all quantitative analyses to account for these considerable heterogeneities.

3.6. Sensitivity Analysis

Our research involved conducting sensitivity analyses for all outcomes. Specifically, for the DMFT outcome, we removed studies with a high risk of bias and found that the estimates remained similar (MD=1.16, 95% CI: 0.66, 1.67; p<0.001). We then proceeded to remove studies with high and moderate risk of bias and still observed similar estimates (MD = 1.12, 95% CI: 0.03, 2.21; p = 0.04), albeit with a slight reduction in the effect. For the dmft outcome, we removed studies with high and moderate risk of bias, which resulted in a significantly decreased estimate (MD = -0.26, 95% CI: -1.03, 0.50; p = 0.50). For a more detailed analysis, please refer to Appendix 2.

3.7. Publication Bias

The analysis of DMFT outcome using funnel plot revealed a possible publication bias, as observed through visual evaluation.

Table 2. Risk of bias summary, assessed by Joanna Briggs Institute Critical Appraisal Checklist for Cross-sectional (n=42): author's judgments for each included study

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total	Risk of Bias
Akpata et al. (2012)	N	Y	Y	Y	Y	Y	Y	Y	87.5%	Low
Aljerf et al. (2017)	U	Y	Y	Y	Y	N	Y	Y	75%	Low
Al-Khayoun et al. (2013)	Y	Y	Y	Y	N	N	U	Y	62.5%	Moderate
Al-Rawi et al. (2010)	N	Y	Y	Y	N	N	U	Y	50%	Moderate
Alves et al. (2012)	U	Y	Y	Y	Y	N	Y	Y	75%	Low
Ambildhok et al. (2018)	Y	Y	Y	Y	Y	Y	N	Y	87.5%	Low
Aral et al. (2016)	Y	Y	Y	Y	N	N	U	Y	62.5%	Moderate
Arheiam et al. (2014)	Y	U	Y	Y	N	N	Y	Y	62.5%	Moderate
Babu et al. (2018)	Y	U	Y	Y	N	N	Y	Y	50%	Moderate
Bassir et al. (2014)	N	U	Y	Y	Y	Y	Y	Y	62.5%	Moderate
Busato et al. (2010)	Y	Y	Y	Y	N	N	U	Y	62.5%	Moderate
Busato et al. (2016)	Y	U	Y	Y	N	N	U	Y	50%	Moderate
El-Tekeya et al. (2012)	Y	Y	Y	Y	Y	Y	U	Y	87.5%	Low
Fazlić et al. (2016)	Y	N	Y	Y	N	N	Y	Y	62.5%	Moderate
Ferizi et al. (2018)	Y	N	Y	Y	Y	Y	Y	Y	87.5%	Low
Geetha et al. (2019)	Y	Y	Y	Y	Y	Y	Y	Y	100%	Low
Gokmenoglu et al. (2017)	Y	U	Y	Y	Y	Y	Y	Y	87.5%	Low
Gupta et al. (2014)	N	U	Y	Y	N	N	Y	Y	50%	Moderate
İşcan (2018)	Y	Y	Y	Y	Y	Y	Y	Y	100%	Low
Ismail et al. (2017)	Y	Y	Y	Y	Y	U	Y	Y	87.5%	Low
Kamran et al. (2019)	N	U	Y	Y	Y	Y	Y	Y	75%	Low
Matsson et al. (1975)	Y	N	U	Y	N	N	U	U	25%	High
Miko et al. (2010)	Y	N	Y	Y	N	N	U	Y	50%	Moderate
Miralles et al. (2006)	Y	N	Y	Y	U	U	U	Y	50%	Moderate
Moore et al. (2001b)	U	Y	U	N	Y	Y	U	Y	50%	Moderate
Neil et al. (2009)	N	N	Y	Y	Y	N	N	Y	50%	Moderate
Orbak et al. (2008)	Y	Y	Y	Y	N	N	Y	Y	75%	Low
Patiño et al. (2007)	Y	Y	Y	Y	N	N	Y	Y	75%	Low
Rafatjou et al. (2016)	Y	U	Y	Y	Y	N	Y	Y	75%	Low
Ramli et al. (2016)	Y	N	U	Y	N	N	N	Y	37.5%	High
Sadeghi et al. (2017)	Y	U	Y	Y	Y	N	N	Y	62.5%	Moderate
Shakra et al. (2019)	U	U	Y	Y	N	N	Y	Y	37.5%	High
Singh-Hüsgen et al. (2016)	Y	U	Y	Y	N	N	Y	Y	62.5%	Moderate
Siudikiene et al. (2006)	N	N	U	Y	Y	Y	U	Y	50%	Moderate
Subramaniam et al. (2015)	Y	U	Y	Y	N	N	Y	Y	62.5%	Moderate
Swanljung et al. (1992)	N	N	Y	Y	N	N	Y	Y	50%	Moderate
Tagelsir et al. (2011)	Y	Y	Y	Y	Y	Y	Y	Y	100%	Low
Techera et al. (2018)	Y	Y	Y	Y	N	N	Y	Y	75%	Low
Tenovuo et al. (1986)	N	Y	Y	Y	N	N	Y	Y	62.5%	Moderate
Vaziri et al. (2010)	Y	Y	Y	Y	N	N	U	Y	62.5%	Moderate

Legend: Y= Yes; N= No; U= Unclear; Cross-Sectional Study Checklist: Q1- Were the criteria for inclusion in the sample clearly defined? Q2- Were the study subjects and the setting described in detail? Q3- Was the exposure measured in a valid and reliable way? Q4- Were objective, standard criteria used for measurement of the condition? Q5- Were confounding factors identified? Q6- Were strategies to deal with confounding factors stated? Q7- Were the outcomes measured in a valid and reliable way? Q8- Was appropriate statistical analysis used? Total= ΣY/Applicable Items. Risk of bias was categorized as high when the study reaches up to 49% score "yes", moderate when the study reached 50% to 69% score "yes", and low when the study reached more than 70% score "yes.

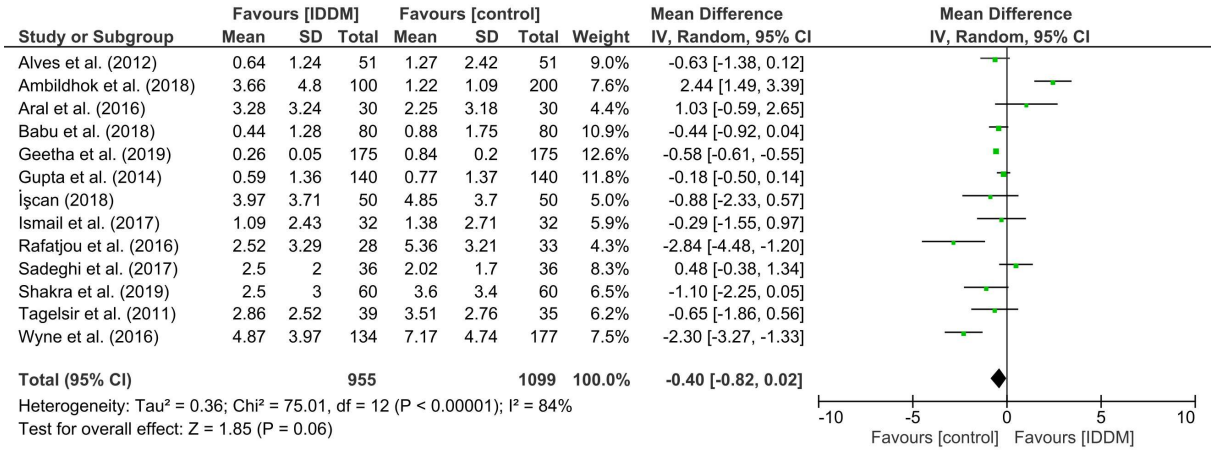

Fig. 3. Forest plot presentations of dmft outcomes

This impression was further supported by Egger's test, indicating significant results for DMFT (p<0.001). However, in dmft analysis, no such bias was observed (p=0.715). The funnel plots can be found in Fig 4.

3.8. Grade Analysis

For the outcome of DMFT, one rating down was applied due to moderate risk of bias among most studies. All outcomes showed inconsistencies, resulting in a one point rating down. For DMFT outcomes, potential bias was suspected based on Egger regression analyses and Funnel plot examination, leading to another rating down. Overall, the GRADE criteria classified the confidence in cumulative evidence assessment as very low for all outcomes (Fig 5).

4. Discussion

IDDM, or insulin-dependent diabetes mellitus, is a metabolic disease that is widely prevalent and can have detrimental effects on vascular tissues due to its ability to cause hyperglycemia. These effects can also manifest in small vessels present in oral tissues, leading to microangiopathy.[18] Given the significant implications of IDDM on oral health, researchers have taken a keen interest in investigating the impact of the disease on oral tissues.[6]

Individuals with IDDM are often advised by their healthcare providers to adhere to a specific dietary plan on a daily basis. This is because various studies have demonstrated that following such a plan can help reduce sugar intake, which, in turn, can significantly lower the risk of developing dental cavities.[11,19] However, adhering to ideal dietary limitations may not always be feasible for IDDM patients due to various factors such as geographical location, age, gender, and level of education within the family.[20] For instance, a global study conducted on sugar consumption in the form of sugary beverages revealed that North America had the highest sugar intake, while Asia had the lowest.[21] This suggests that regional differences in sugar intake can have a considerable impact on the risk of developing cavities for IDDM patients. Age is also a crucial factor that plays a vital role in IDDM patients' dietary habits, with older adults usually consuming less sugar. A survey conducted on adults aged 20 to 70 found that older adults tend to consume less sugar than their younger counterparts.[21] Multiple factors such as age, gender, and geographical region can contribute to heterogeneity in the analysis of IDDM patients' dietary habits, thereby potentially complicating the management of the condition. In conclusion, while adhering to a specific dietary plan can lower the risk of developing cavities for IDDM patients, various factors can influence their dietary habits, making the management of the condition more challenging.

The findings of this particular study have shed light on a concerning increase in caries rates among IDDM patients, which was determined based on the DMFT index. Interestingly, a slight decrease was observed in the dmft index, but it was not significant. The reasoning behind this phenomenon could be attributed to parental overprotection, which may help mitigate some of the negative oral health impacts of IDDM on deciduous teeth. With the implementation of proper dietary restrictions, it's possible that IDDM patients may actually experience fewer dental caries than healthy individuals. However, the duration of diabetes may also play a significant role in this matter. Other studies have shown that individuals with longer-term diabetes had a higher incidence of dental caries than those with shorter durations.[22,23] It's also worth noting that deciduous teeth may be less prone to being affected by DM when compared to permanent teeth. Nonetheless, the significance of the relationship between dental caries and IDDM in

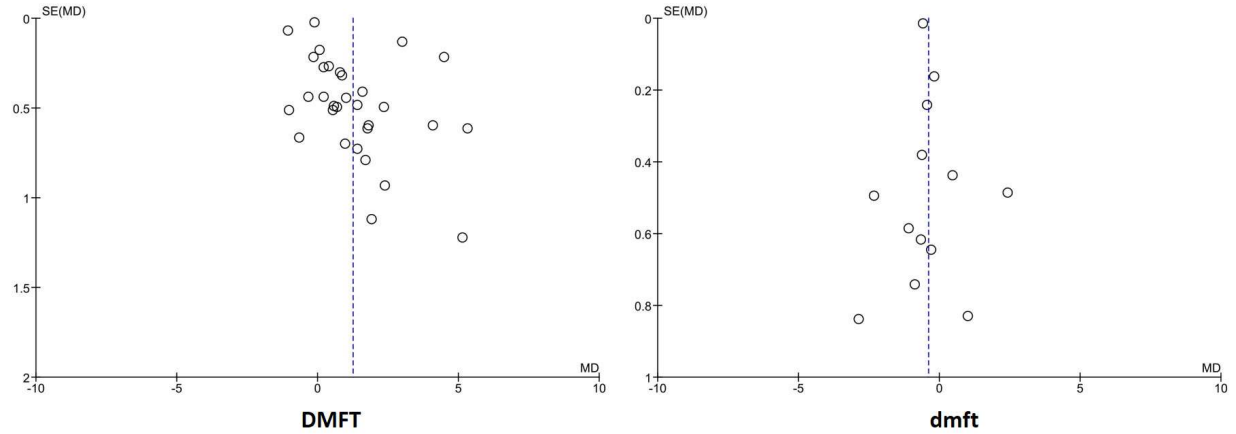

Fig. 4 Funnel Plot presentations of DMFT and dmft indexes

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with healthy group	Risk with Insulin-dependent diabetics				
Dental caries frequency assessed with: DMFT score	The mean dental caries frequency ranged from **0.2 to 9.56** DMFT score	MD **1.24 DMFT score higher** (0.74 higher to 1.74 higher)	-	4680 (31 observational studies)	⨁◯◯◯ VERY LOW a,b,c	Insulin-dependent diabetics may increase dental caries in the permanent dentition period but the evidence is very uncertain.
Dental caries frequency assessed with: dmft score	The mean dental caries frequency ranged from **0.77 to 7.17** dmft score	MD **0.4 dmft score lower** (0.82 lower to 0.02 lower)	-	2054 (13 observational studies)	⨁◯◯◯ VERY LOW a,b	The evidence is very uncertain about the effect of insulin-dependent diabetics on dental caries in the deciduous dentition period

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: Confidence interval; **MD:** Mean difference; **OR:** Odds ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Most information is from studies at moderate risk of bias
b. Confidence intervals (CIs) show minimal overlap and the I2 which quantifies the proportion of the variation in point estimates due to among-study differences is large.
c. There is suspicion of publication bias according to Egger regression analysis or Funnel Plot

Fig. 5. Grade Analysis: Summary of Findings table

the primary dentition was weakened by the sensitivity analysis, and the decline in significance value.

A meta-analysis performed by Wang, et al.[24] found that the prevalence of dental caries was high among children and adolescents with IDDM independent. However, there are some differences between the present study and that of Wang, et al.[24]. In the present meta-analysis, we evaluated the permanent and deciduous dentitions separately to decrease the heterogenity of the meta-analysis. Because there are differences between dentitions in terms of being affected by dental caries. Since index results are evaluated separately in this study, it is not an accurate approach to compare the results of these two studies. Furthermore, the results of another meta-analysis published in 2020 are in line with the findings of the present study.[25]

The flow rate of saliva plays a crucial role in maintaining oral health.[26] A decrease in saliva flow rate can lead to the development of dental caries due to secondary factors such as the proliferation of cariogenic microbial flora. These microorganisms, including Streptococcus mutans and Lactobacillus, create an environment with a low pH that accelerates the progression of dental caries. Researches have shown that individuals with IDDM tend to experience a decrease in salivary flow rate and pH, as well as an increase in Streptococcus mutans counts.[27-29] The formation of dental diseases is more associated with unstimulated saliva than stimulated saliva, which can be produced through chewing and has a shorter duration. A flow rate of 0.1-0.25 ml is considered low for unstimulated saliva, and less than 0.1 is considered very low.[30] A study by Hatipoğlu, et al.[4] revealed that individuals with IDDM have a salivary flow rate that is around 0.2 ml lower than healthy individuals. This decrease in flow rate can cause xerostomia, which can lead to the formation of dental caries and periodontal disease. It is crucial to maintain a healthy flow rate of saliva to prevent the onset and progression of dental diseases.

It is of utmost importance to acknowledge that the present study had certain limitations. While dental caries is a multifactorial condition that is impacted by various lifestyle choices, such as sugar intake, dental hygiene, dietary habits, level of education, and age, it is plausible that the results may have been influenced by these factors, which were not assessed in the studies included. Furthermore, due to the constraints of the article, factors such as saliva glucose levels, metabolic control, and duration of diabetes could not be evaluated. One of the limitations of the study was that it solely included articles written in English. This could potentially lead to language bias, as important information or perspectives from non-English sources may have been overlooked or excluded entirely. Hence, it is vital to interpret the study results with caution and consider the aforementioned limitations while drawing conclusions.

5. Conclusion

After conducting both qualitative and quantitative analyses, it appears that IDDM may have an impact on the occurrence of dental caries in permanent teeth. However, no similar effect was observed for the deciduous dentition. It's worth noting, however, that due to the heterogeneity of the analyses, a high risk of biases, and the use of observational studies, the evidence connecting IDDM to these factors is not yet conclusive and requires further investigation. Additional research is needed to confirm these findings and to better understand the potential impact of IDDM on dental health during the permanent dentition period.

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