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# Diabetes and Dental Caries in Relation to Oral Health – An Empirical Review

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## Abstract

**Objective:** This review was undertaken to determine whether diabetes and its associated factors has an impact on prevalence of dental caries. **Methods:** The review considered the articles included in Pubmed, Scopus, Cochrane, Google scholar & Web of Science from 2011 to 2022 that focused on diabetes and dental caries. Articles covered in editorials and abstracts were excluded. The articles were searched using the **keywords:** diabetes, dental caries & oral hygiene. The data required for the review was extracted from section such as result, discussion and conclusion. **Findings:** The review states that good metabolic control & oral hygiene in diabetic patients plays a vital role in prevalence of dental caries. Other factors such as physical disabilities, inactivity, low socioeconomic status, lack of oral health education, stress, psychological problems also contributes to the quality of oral health. **Novelty:** This review evaluates the association of other additional contributing factors such as stress, obesity, physical disabilities, psychological problems affecting the oral health. This review discussed more about additional contributing factors. **Conclusion:** The review gives the advance outcome of present diabetic patients' condition. Apart from good metabolic control and good oral hygiene, stress, depression, psychological problems commonly found in diabetic patients affects the oral health.

**Keywords:** Diabetes; Dental Caries; Oral hygiene; Plaque; Streptococcus mutans

## 1 Introduction

Diabetes is a metabolic disease characterized by hyperglycemia due to insufficient insulin secretion and abnormal lipid, carbohydrate and protein metabolism. 1) IDDM; insulin dependent diabetes mellitus 2) non-IDDM; non-insulin dependent diabetes mellitus are the two basic kinds of diabetes mellitus<sup>(1)</sup>. Prevalence of diabetes in India is high & it is considered as "Diabetic capital of the World"<sup>(2)</sup>. It has been estimated that individuals in India those who were affected by diabetes was 366 million in the year

2011 and that may be 439 million by the end of 2030. Survey reports had given statistical results such that 80% individuals belong to low income countries suffer from this condition<sup>(3)</sup>. A study had reported that 32.3% of diabetic population had dental caries when compared to normal individual at 13.6%<sup>(4)</sup>. Urbanization, industrialization and changes in lifestyle contributed to increase in diabetes in India. Low socioeconomic status (45.2%), poor education, physical inactivity, sugar sweetened beverages also contribute to diabetic status<sup>(5)</sup>.

However, the relationship between dental caries and diabetes is contradictory. Diabetes causes structural changes in the salivary glands resulting in xerostomia and drymouth affecting the oral health and favoring the progression of dental caries<sup>(6)</sup>. Certain factors including salivary flow, buffering action, salivary glucose level contributes for the initiation and progression of caries. Other contributing factors such as cariogenic diet, oral hygiene awareness, plaque deposits, low education status influence in caries prevalence. Physiological changes that occurs in aged patients such as gingival recession that favors senile caries which is most common in type II diabetic patients. Apart from diabetic patients with poor oral hygiene, physically disabled are at a higher risk for developing dental caries when compared to physically active diabetic patients with good oral hygiene<sup>(7)</sup>.

Authors have stated that diabetic patients are at high risk for the coronal/root caries, erosion and candidiasis<sup>(8)</sup>. Smooth surface caries begins as white spot lesions in the enamel which appears as small areas of subsurface demineralization. It initiates as demineralization in the root surfaces and then the region becomes softened and facilitates further bacterial penetration. Based on this, review study reported that there is a complex relationship between dental caries and type 2 diabetes. However, this review results were contradictory when compare to other research and reviews<sup>(9)</sup>. Therefore, this present review was to know the impact of diabetes on prevalence of dental caries in association with other contributing factors.

## 2 Methodology

An empirical review was done based on the articles included in Pubmed, Scopus, Cochrane, Google Scholar & Web of Science. The articles were searched using the key words Diabetes, Dental caries & oral hygiene. This review included the studies related to diabetes that had an impact on oral health and dental caries prevalence and also the studies that had proven that other factors that affects diabetic condition and indirectly affecting the oral health. The data required for the review was extracted from the result, discussion and conclusion part favoring the hypothesis of the study such that diabetes had a significant role in prevalence of dental caries in diabetic patients. Figure 1 shows flow diagram of the study selection process. After applying inclusion and exclusion criteria 20 articles were selected for review.

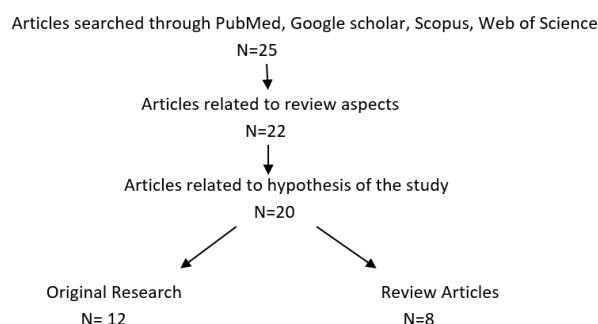


Fig 1. The flow diagram of article selection process (N indicates the number of articles)

### 2.1 Inclusion Criteria

Studies published only in English related to diabetes and dental caries

Studies focused on oral health related to diabetic condition

### 2.2 Exclusion criteria

Abstracts and editorials were excluded from the study

**Table 1.** Indicates original and review articles included in this review related to diabetes and dental caries

Ref No	Author	Clinical Findings	Year	Conclusion
(1)	Maresh Shenoy, Nishath Sayed Abdul, Pushpraj Singh, G C Shivakumar, S Sahana	Streptococcus mutans microorganisms increase in diabetic condition	2022	Diabetic's age, blood sugar level and DMFT values rise dental caries faster in diabetic's when compare to non diabetics.
(2)	Inderjith Murugendrappa Gowdar, Mohammed Almuhaiza [Review]	Association between metabolic control & dental caries in diabetic patient's is reported	2016	Diabetic patients with poor metabolic control are at high risk for dental caries
(3)	Sridevi N, Jaya Prakash Thumu, Kiran Kumar P, A. V. Rajanikanth, Vinay Kumar Mishra	Diabetic patients showed increase in colony count in streptococcus mutans and lactobacilli with inferior oral habits when compare to non diabetics	2019	Poor oral hygiene contributes to the increase in microorganisms colonial count in diabetes compared to non diabetics
(4)	Divine Nathalie Prato, Dr Mamatha Shetty [Review]	Diabetic condition influence on the oral health of the patient	2022	Proper oral hygiene, oral health education significantly reduce the caries initiation and progression
(5)	Dipshikha Das, Ritu Gupta, Ipseeta Meneon, Anubhav Sharma, Vikram Arora, Iram Ahsam	Socioeconomic status, Oral health knowledge, obesity, Oral hygiene practice influence on caries prevalence in diabetic patients	2022	Proper oral hygiene practice, educating the patients regarding oral health and oral hygiene practices significantly reduces the caries prevalence in diabetic individuals.
(6)	Haoran Chen, Robert Hill, Aylin Bysan [Review]	T2 DM is one of the risk factor for hyposalivation In addition the quality of saliva might also be affected	2022	Oral health education interdental cleaning aids like mouth wash, gels, salivary substitutes helps in management of dental caries in T2 DM patients
(7)	Paras Ahmad, Usman Akhtar, Ahmed Chaudhry, Usman Rahid, Sarmad Saif, Jawaad Ahmed Asif [Review]	Prevalence of dental caries increases in diabetic patients as increase in age	2019	Due to physiological changes in aged patients senile caries prevalence is high in diabetic when compare to non diabetics
(8)	BJ Garton, PJ Ford [Review]	Diabetic patients are at an increased risk for coronal & root caries	2012	Diabetes mellitus patients are at more risk for dental caries
(9)	Mageshwari M Manjula [Review]	Insufficient salivary flow and composition in diabetic patients results increased dental caries prevalence	2018	Complex relationship between type II diabetes mellitus & dental caries
(10)	Muhammad Jawed, Syed M, Shahid, Shah A. Qader	Decrease in salivary pH in diabetic patients significantly increase caries incidence compare to control	2011	Salivary factors play a vital role against dental caries in diabetic patients
(11)	Amarpreet Singh, Susan Thomas, Rushab Dagli	Correlation between salivary factors and dental caries among diabetic patients	2014	Decrease in salivary component in saliva creates a favorable environment for the dental caries
(12)	Pavitra Vibhakar, Sangeeta	Significant difference between DMFT & Salivary glucose	2014	Salivary glucose level increase with increasing DMFT index and plays a significant role in high caries prevalence.
(13)	Rahnuma Ahmad Mainul Haque [Review]	Diabetic condition affects the salivary secretion and oral health which favors bacteria responsible for dental caries	2021	Oral complications harm the quality of life of diabetic individuals
(14)	Stefano Lai, Maria Grazia Cagetti, Fabio Cocco, Dina Cossellu, Gianfranco Meloni, Guglielmo Campus, Peter Lingstrom	Diet and oral hygiene habits contributes to the prevalence of dental caries in diabetic patients	2017	Low carbohydrate diet, low sugar/sweet intake, good oral hygiene reduce the caries prevalence in diabetic patients
(15)	George K, Stookey	Incidence of caries is reduced in stimulated salivary group	2008	Saliva plays an important role in remineralization and demineralization

*Continued on next page*

Table 1 continued

(16) Haq Qin, Guangyue Li, Xiaohui Xu, Chuangwei Zhang, Wenjie Zhong, Shihan Xu, Yuanyuan Yin, Jinlin Song [Review]	Uncontrolled diabetes mellitus affects the oral health	2022	Diabetes mellitus changes the oral microbiome from symbiosis state to dysbiosis state.
(17) Nadia Khalifa, Betul Rahman, Marianna D, Gaintantzopoulou, Suhail Al-Amad, Manal M Awad	Physical disability, psychological disability and discomfort influence on oral health irrespective of diabetic condition	2020	Physical and psychological disabilities had an impact on oral health related quality of life
(18) Lulejeta Ferizi, Farmir Dragidella	Buffer capacity of saliva is reduced in diabetic patients	2018	Low salivary flow rate and buffer capacity of saliva results in high caries incidence
(19) Al Qusalbi B, Mosil H, Kattan W	Psychological stresses activates the counter regulatory hormones which hinders insulin activation resulting in increase blood glucose level	2022	Psychological stresses, depression are contributing factors to increase diabetic associated complications
(20) Siddhartham GM, Mahendra M Reddy, Bagepally N Sunil	Perceived stress was high in diabetic patients. Contributes to increase glucose level in diabetics	2021	Stress management is necessary for diabetic patients.

### 3 Results and Discussion

The present review reported that poor metabolic control, poor oral hygiene, high carbohydrate diet intake, physical disabilities and inactivity, low education level, low socioeconomic status, stress, psychological problems favors an environment for the progression of caries among diabetic individuals. Well controlled diabetic patients had low caries prevalence when compared to control group.

Dental caries is a multifactorial disease and remains as a major public health problem. Accumulation of plaque and colonization of microorganism are found to be severe in diabetic patient's than control<sup>(10)</sup>.

Diabetes mellitus affects the salivary composition and function which eventually impacts on the health of oral cavity. Saliva reduces initiation of caries by cleansing action which decreases the accumulation of plaque & has buffering action, antibacterial property and facilitates in remineralization. It maintains the pH which inhibits the demineralization. Calcium in saliva is the main electrolyte which prevents demineralization. Calcium levels are severely affected by uncontrolled diabetes and it creates a suitable environment for progression of caries<sup>(11)</sup>.

Glucose is a small molecule that diffuses through the membrane of blood vessels passing through the blood serum into the gingival fluid by way of the gingival sulcus and making its way into the saliva. A study reported that in diabetes, dental caries prevalence was high but other study reported that there was no such difference. Therefore the statement regarding this was contradictory<sup>(12)</sup>. Due to damage to microvasculature basement membranes of salivary glands changes resulting in increase glucose leakage from cells of ducts resulting in increase glucose level in saliva and crevicular space. As a result, fibroblasts changes their activities resulting in plaque formation consequently favors initiation of caries in diabetes<sup>(13)</sup>.

Uncontrolled diabetes favors ecological shift within the microbial biofilm due to poor glycaemic control which may influence significantly the initiation and progression of caries. Carbohydrate rich diet creates an acidic environment where aciduric bacteria predominate resulting in demineralization<sup>(14)</sup>.

Research revealed that increase flow of saliva, sodium, chloride and bicarbonate increases and neutralizes the plaque acids by diffusing bicarbonates into it and favors the remineralization process<sup>(15)</sup>. But this process is severely affected in diabetic condition.

Apart from diabetes other external factors such as puberty, poor oral hygiene, stress, hormonal imbalance results in shift of microbial communities from symbiotic state to a dysbiotic state. This results in loss of some beneficial microbes. These are important for maturation of the local immune system in the oral cavity. Excessive pathogenic microbes results in dysbiosis<sup>(16)</sup>. In the year 2020 a study reported that oral health impact profile domains such as psychological discomfort and disability, physical disability had an impact on DMFT scores and oral health irrespective of diabetic or non-diabetic status<sup>(17)</sup>. Type 1 diabetic Individuals/care taker with low and medium level education, lack of sufficient knowledge regarding oral health had high caries risk when compare to control group dominated with medium and high level of education with adequate knowledge regarding the oral health. This result interpreted that knowledge about oral health, level of education among individuals and care taker also plays a major role in caries prevalence and oral health<sup>(18)</sup>. Stress in diabetic patients alter the glucose metabolism and increases the risk of diabetes. Psychological stresses counter regulates the hormones such as dopamine, neurotransmitters,

glucocorticoids, growth hormones and glucagon that are activated. It hinders the activation of insulin resulting in increased blood glucose level. Thus impairment in glucose levels results in developing diabetic complications promoting depression and anxiety in individuals<sup>(19)</sup>.

It also results in habitual changes of an individual incorporating deleterious habits such as smoking, alcoholic intake which effects indirectly the general health and oral health of an individual's<sup>(20)</sup>. Obesity is one of the prime factors in the development of diabetes. Sedentary life style, dietary habits, physical inactivity and genetic susceptibility are the etiological factors for obesity<sup>(5)</sup>. Thus, obesity also contributes to the general and oral health of the patients.

Therefore, stress, obesity, physical inactivity, high carbohydrate diet, low socioeconomic status, lack of oral health education, psychological discomfort and disabilities significantly affect the oral health irrespective of diabetic condition. However, individuals with diabetic condition exposed to predisposing factors such as xerostomia, dry mouth favoring the progression of dental caries were also significantly affected with these factors when compare to healthy individuals.

## 4 Conclusion

This review reported that apart from diabetes other factors such as oral health impact profile domains such as psychological discomfort & disability, physical disability, stress, depression, obesity, low education, low socioeconomic status, knowledge about oral health & high carbohydrate diet plays a vital role in maintaining oral health and caries prevalence. Diabetic status also contributes for the prevalence of dental caries, but with good metabolic control and good oral hygiene reduce the prevalence of caries when compare to non- diabetics. Therefore, diabetic condition plays a partial role in prevalence of dental caries and oral health. Researchers should also consider other contributing factors affecting directly or indirectly the oral and general health of an individual. Diabetic patients who are under stress, obsessed, psychologically disturbed requires counseling, motivation and guidance from the dietician and counselor to improve the oral health and general health of an individual. Apart from that yoga and physical exercises also contribute to withstand physical and mental stresses and depression.

This review gives limited data regarding additional contributing factors stress, obesity, psychological disability and discomfort, physical inactivity related to oral health. Further research should be carried out on these domains, so that patients are sensitive to these domains which help them in maintaining the oral and general health. Apart from that, the quality of studies included in this review was not assessed.

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