Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1179-1183 | ISSN:2251-6727

Oral Health Status and Its Association with Hba1c, Salivary Ph in Individuals with Type 2 Diabetes

Surapaneni Keerthi Sai[1], Deepthi G[1], Shyam Prasad Reddy D[1], Mary Oshin K X[2].

Department of Oral Pathology and Microbiology, Kamineni Institute of Dental Sciences, Telangana.[1]

Department of Oral Pathology and Microbiology, Indhira Gandhi Institute of Dental Sciences, Kerala.[2]

(Received: 16 January 2026 Revised: 25 February 2026 Accepted: 17 March 2026)

KEYWORDS

Type 2 Diabetes, HbA1c, Salivary pH, Oral health

ABSTRACT:

Introduction: Diabetes mellitus (DM) with poor glycemic control is often linked to oral manifestations. Dental caries (DC), periodontitis are more prevalent in individuals with diabetes than in healthy individuals. Diabetes also leads to the reduction of salivary pH helping in multiplication of harmful microorganisms in the oral cavity causing deleterious effect on oral health status.

Aim: The aim of the present study was to assess the relationship between oral health status and HbA1c levels, salivary pH among adults with type 2 diabetes (T2D).

Materials and methods: A total of 148 T2D individuals were included. Case proforma has been made to record demographic data, DMFT (Decayed, Missing, Filled Teeth), OHIs (Oral Hygiene Index-Simplified), and PMA (Papillary-Marginal-Attached) indices. After obtaining ethical clearance, the HbA1c levels were estimated, and salivary pH was measured using a digital pH meter. The data was statistically analysed.

Results: The individuals were divided into two groups. Group 1(n=62) having HbA1c levels 6.5 – 7.9% and Group 2 (n=86) having ≥ 8%. Group 2 showed significantly lower salivary pH and higher DMFT and OHIs scores compared to Group 1. Additionally, the duration of diabetes was significantly associated with increased HbA1c, reduced salivary pH, and worsening scores across all oral health indices.

Conclusion: As there are no specific criteria for referring a diabetic patient to a dentist by general physicians unless they are showing any symptoms, we suggest that HbA1c, salivary pH can be considered as a criterion to motivate patients with poor glycemic control to have a regular dental checkup.

1. Introduction

Diabetes mellitus (DM) is a major global health problem with an alarming increase in the number of people being affected worldwide.[1] The regulation of blood glucose is a key factor for an effective immune response against infections and that is the main reason why diabetics have 4.4 times greater risk of infections than nondiabetics.[2] Diabetes was also known to affect the human oral cavity and its structures, with a wide range of oral manifestations including periodontal diseases, tooth loss, salivary dysfunction, taste impairment, xerostomia, *Candida* infection, neurosensory disorder, and fluctuations in the prevalence of dental caries (DC).[3] Diabetes mellitus (DM) significantly impact oral health, particularly by influencing the composition and pH of saliva.[4] Saliva is a unique fluid essential for maintaining normal oral health, and its pH plays a crucial role in the growth and survival of oral bacteria. An acidic salivary pH can promote the proliferation of aciduric bacteria while creating an environment that is unfavourable for beneficial oral bacteria, ultimately disrupting the microbial balance. This imbalance can contribute to various oral health issues, making salivary pH regulation particularly important for individuals with diabetes.[4,5]

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Despite worldwide recognition of the deleterious effects of diabetes, the awareness of diabetic patients toward their increased risk for oral diseases has not been fully addressed. HbA1c is a biomarker with a central role in the diagnosis and follow-up of patients with diabetes.[2] However, no studies have compared the association of HbA1c and salivary pH with oral health status in patients with well- or moderately controlled Type 2 DM and poorly controlled Type 2 DM. So the present study was conducted to assess the relationship between oral health status and HbA1c levels, salivary pH among adults with Type 2 Diabetes Mellitus (T2DM).

2. Materials And Methods

The present study is a cross-sectional study which meticulously adhered to the guidelines outlined in the WMA declaration of Helsinki to ensure confidentiality and experiments on the human subjects. Institutional ethical committee (KIDS/IEC/FACULTY/OP/2023/01) approval was obtained and written informed consent was taken from the participants of the study. A total of 148 Type 2 diabetic individuals were included in the present study. Individuals with any other systemic diseases like hypertension, renal and cardiac problems etc were excluded from the study. Case proforma **(Figure 1)** has been made to record demographic data, DMFT (Decayed Missing Filled teeth index), OHIs (Oral Health Index Simplified), PMA (Papillary Marginal Attached Gingiva index) and MNI (Met Need Index) indices. The participants were divided into two groups based on the HbA1c levels i.e; Group 1- HbA1c levels ranging from 6.5% to 7.9% and Group 2- HbA1c levels of 8.0% or higher. The HbA1c levels were estimated by analysing the blood samples taken from the participants using biochemistry autoanalyser – BA200. The salivary pH was recorded by asking the individual to rinse his/her mouth thoroughly and then spit unstimulated saliva repeatedly over 5 minutes into a sterile plastic container. The collected saliva is then estimated for pH within 5 minutes using a digital pH meter. The collected data was tabulated in a Microsoft Excel sheet. The results were then calculated using the IBM SPSS Statistics for Windows, Version 20.0 (Released 2011; IBM Corp., Armonk, New York, United States). A p-value of less than 0.01 was considered statistically significant.

3. Results

The study population was divided into two groups based on their glycemic control, as determined by HbA1c levels, which serve as an indicator of long-term blood glucose regulation. Group 1 (n=62): This group consisted of individuals with moderately controlled Type 2 Diabetes Mellitus (DM), having HbA1c levels ranging from 6.5% to 7.9%. Group 2 (n=86): This group included individuals with poorly controlled Type 2 DM, having HbA1c levels of 8.0% or higher. The demographic data obtained was depicted in Table 1.

The comparison of HbA1c between group 1 & 2 (Table 2) revealed that the mean HbA1c levels are high in group 2 (Mean(m) = 8.16) and is statistically highly significant (P value< 0.00001). The salivary pH decreased in group 2 (m=6.46) compared to group 1(m=6.67) which is highly significant statistically (P value< 0.00001). The DMFT and OHIs indices were increased in group 2 (m= 8.2 and m=2.27 respectively) and were also highly significant statistically (P value< 0.00001). However, no significant difference was observed in relation to MNI and PMA indices between the two groups.

When duration of diabetes is taken into consideration (Table 3) the HbA1c levels, salivary pH, DMFT index, OHIs index, MNI index and PMA index has shown statistically significant difference (P value <0.01; P value <0.00001). Salivary pH was notably lower in the >5 years group (m=6.4; $p < 0.00001$) and this aligns with a significantly higher DMFT score (m=7.5; $p < 0.00008$) as well in them. The Met Need Index (MNI) was significantly higher in the >5 years group (m=63; $p < 0.00001$). Although oral hygiene status (OHIs) was slightly worse in the >5 years group (m=2.02) the difference was not statistically significant ($p = 0.07$). However, gingival inflammation (PMA) was significantly higher in this group (m=22.7; $p = 0.01$).

Multiple linear regression analysis revealed a significant correlation of HbA1c, DMFT, OHIs indices (P value 0.01; P value < 0.0004) in group 1 and PMA index (P value <0.012) in group 2. (Table 4,5,6).

Multiple Linear Regression analysis showed a significant relationship between Salivary pH with DMFT (P value <0.003) and OHIs (P value < 0.010) indices in group 1 patients and with PMA index (P value < 0.0006) in Group 2 (Table 7).

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4. Discussion

Glucose can bind irreversibly to hemoglobin through a non-enzymatic reaction, forming glycosylated hemoglobin (HbA). Hemoglobin A1c (HbA1c) is the primary subfraction of HbA. HbA1c is considered as a beneficial indicator of long-term homeostasis, reflecting an average blood glucose concentration for the past 2-3 months.[6] HbA1c is a key biomarker essential for the diagnosis and monitoring of patients with diabetes.[2]

Diabetes and its complications have become a significant health hazard across the world, especially in India. Prevention and treatment of diabetes require persistent daily self-care. Among adults, regular dental visits are an opportunity for professional assistance in prevention, early diagnosis, and treatment of various oral manifestations associated with diabetes.[7]

The main objective of this study was to assess the relationship between diabetes and oral health status and how well HbA1c levels can be used as a predictor for various oral diseases. Our findings revealed the following: a) The median age for Group 1 is at 52 years (range: 22–78) compared to 55 years (range: 35–73) in Group 2. This difference might reflect the progression of diabetes with increasing age, as higher HbA1c levels are often associated with longer disease duration and potentially older age groups which correlated with Eun kyong K et al.[8] However Deepasree M et al[9], Satoru Y et al[10] and Abir M et al[11] reported that individuals with HbA1c ranging from 6.5 – 7.9% are more. b) Both groups show a higher prevalence of male participants, with Group 1 having 42 males and 20 females, while Group 2 has 55 males and 31 females. This male predominance could suggest either a higher prevalence of diabetes in males or a greater likelihood of male participation in this study. Similar distribution was given by Deepasree M et al[9], Satoru Y et al[10], Eun kyong K et al[8] and Ashish A et al[1]. c) Participants in Group 2, with higher HbA1c levels, demonstrated suboptimal oral hygiene habits, such as infrequent brushing and reliance on horizontal brushing techniques. (Table 1). Studies by Abir M et al[11], Deepasri M et al[9], and Ashish A et al[1] similarly observed a higher prevalence of individuals brushing only once per day. The association between poor glycemic control and infrequent toothbrushing suggests that dental health education is important, especially in diabetic patients with higher HbA1c levels.[1]

A comparison of the two groups revealed a statistically significant increase in the DMFT index in Group 2, indicating that individuals with higher HbA1c levels had a higher prevalence of oral diseases. Various studies reported an increase in DMFT index in individuals with higher HbA1c levels. DC development in diabetes results from interactions between cariogenic bacteria, fermentable carbohydrates, impaired salivary flow, immune response, and genetics. Poor glycemic control worsens salivary gland function, while hyperglycemia weakens enamel, increasing the risk of decay. Despite carbohydrate restrictions, reduced saliva and elevated glucose levels promote bacterial growth, making diabetic patients more prone to DC.[11] Also, the periodontal status was deprived in group 2 which was in correlation with Eun kyoung k et al[8] and Deepasri M et al[9]. Additionally, the salivary pH was markedly lower in Group 2, demonstrating an inverse association between glucose levels and salivary pH. Vera Lucia C et al[12] stated that hyposalivation is more in individuals with elevated blood glucose levels. A lower pH in saliva can lead to enamel demineralization, thereby increasing the risk of dental caries. The significant difference between the two groups suggests a strong link between glycemic control and oral acidity.[12,13] The OHIs index also significantly increased in group 2 which is in correlation with studies reported by Eun kyoung Kim et al[8], Ashish A et al[1] and Arwa b et al[14]. Although the biological mechanisms linking periodontitis to impaired glucose metabolism are not fully understood, a widely accepted theory suggests that inflammatory mediators, particularly IL-6 and TNF-α, produced in inflamed periodontal tissues or triggered by translocated oral bacteria, interfere with insulin receptor function, reducing insulin sensitivity.[6]Although the MNI and PMA indices were also higher in Group 2, these differences were not statistically significant. The lower MNI in group 2 patients suggests that they have not received dental treatment for caries to the same extent as the group 1. This emphasizes the potential benefit of timely dental intervention for decayed teeth in patients with poorly controlled T2DM. Deepasri M et al[9] and Satoru Y et al[10] also showed similar association of MNI index. (Table 2).

The duration of diabetes showed considerable variations with statistically significant increase in HbA1c levels, DMFT index, MNI index and PMA index in individuals suffering from diabetes for more than 5 years.

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Abir M et al[11] and Eun kyoung k et al[8] also concluded that as duration of diabetes increased the no of carious lesions increased and periodontal status deteriorated. Vera Lucia C et al[12] also demonstrated that as duration of diabetes increased the no of subjects with higher HbA1c levels increased which is in correlation with this study. Also, the salivary pH decreased significantly in this group indicating a more acidic oral environment. However, the OHIs index was higher in individuals with a diabetes duration exceeding 5 years, this increase was not statistically significant. (Table 3)

Multiple linear aggression analysis revealed a significant correlation of HbA1c, DMFT, OHIs indices (P value 0.01; P value < 0.0004) in group 1 and PMA index (P value <0.012) in group 2. (Table 4,5,6,7). Similar correlation was given by Abir M et al[11], Deepasri M et al[9] and Satoru Y et al[10]. Multiple Linear Regression analysis showed a significant relationship between Salivary pH with DMFT (P value <0.003) and OHIs (P value < 0.010) indices in group 1 patients (Table 8, Graph 2) and with PMA index (P value < 0.0006) in Group 2 (Table 9, Graph 3). These results are in analogue with Nurvita R et al[4] who discussed that majority of DM patients had an acidic salivary pH. This may be due to metabolic changes happening in DM patients causing a decrease in salivary pH which might be associated with the incidence of dental caries and changes in their oral health conditions.

The limitations of this study were that specific site of caries (coronal or root surface) was not considered. Also, a prospective cohort study with adjustments for confounders, including detailed dental examinations (attachment loss and alveolar bone resorption) and the biological and immunological profile of saliva, would provide deeper insights into the link between diabetes and dental caries. Furthermore, establishing a potential causal association between decayed teeth and T2DM would require a control for factors such as BMI, lifestyle habits (smoking, alcohol consumption, exercise, daily glucose intake) and regular dental visits. Additionally, confounding variables such as socioeconomic status, sugar consumption, and fluoride use can be taken into consideration.

Diabetes is a chronic condition requiring lifelong management, and patients with a longer duration of the disease often tend to neglect their oral health. Our findings highlight the need for the adoption of preventive oral hygiene practices to improve oral health among diabetics. Since many individuals with diabetes do not seek regular dental care, all healthcare professionals should be encouraged to promote comprehensive oral health care as an essential component of overall well-being. Therefore, collaboration between diabetes healthcare professionals and dentists is crucial in promoting both diabetes self-care and oral health education, particularly for patients with a prolonged history of diabetes.

In conclusion, this study suggests a significant association between DC incidence, serum HbA1c levels, and salivary pH in patients with T2DM. Raising awareness about oral health and encouraging diabetic patients to maintain proper oral hygiene and seek early dental care may help reduce oral complications contributing to better glycemic control in T2DM management.

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JCHR (2026) 16(2), 1179-1183 | ISSN:2251-6727

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