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PREVALENCE OF PERIODONTAL AND ORAL MUCOSAL CHANGES IN PREDIABETIC INDIVIDUALS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Prediabetes is a metabolically active state defined by elevated glucose levels that remain below diabetic thresholds. While the American Diabetes Association (ADA) (2025) classifies prediabetes based on any one of three markers, Fasting Blood Glucose (FBG), Oral Glucose Tolerance Test (OGTT), and Glycated Hemoglobin (HbA1c). This study focuses on individuals meeting all three simultaneously, representing a higher-risk profile. Although often asymptomatic, this stage may initiate early systemic and microvascular changes. The study assesses the prevalence of periodontitis, oral mucosal lesions, and salivary dysfunction in this population.

Methods: A total of 132 prediabetic patients, identified by FBG, OGTT, and HbA1c, were included in this cross-sectional study. Oral examinations assessed Plaque Index (PI), Gingival Index (GI), Probing Depth (PD), Clinical Attachment Loss (CAL), and Bleeding on Probing (BOP), along with mucosal lesion detection and unstimulated salivary flow rate measurement. Data were analyzed using SPSS v16.

Results: Among participants, 26.5% had Periodontitis, 22.7% had Oral lesions, and 30.3% had Xerostomia. Oral mucosal lesions were recorded in 30 patients (22.7%), with candidiasis being the most frequent lesion (12 cases, 40.0%), followed by aphthous ulcers (7 cases, 23.3%), angular cheilitis (5 cases, 16.7%), Burning mouth syndrome (4 cases, 13.3%), and lichen planus (2 cases, 6.7%).

Conclusion: This is the first study to assess all three oral parameters in prediabetics. Subtle oral changes such as periodontal inflammation, mucosal alterations, or reduced salivary flow may go unnoticed yet reflect early metabolic imbalance. Incorporating dental assessments into prediabetes care could aid early detection and help prevent complications, emphasizing the importance of oral health screening in metabolic management.

KEYWORDS: Glycemic Level, Oral Findings, Salivary flow, Periodontal Findings

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INTRODUCTION

Prediabetes is a well-established metabolic state defined by elevated blood glucose levels that do not yet meet the diagnostic threshold for diabetes. As outlined by the American Diabetes Association, it is characterized by fasting plasma glucose (FPG) levels of 100– 125 mg/dL, 2-hour plasma glucose during an oral glucose tolerance test (OGTT) ranging from 140 to 199 mg/dL, or HbA1c values between 5.7% and 6.4% [1,2]. This transitional stage is considered high-risk for the progression to type 2 diabetes mellitus (T2DM), with an estimated annual conversion rate of 5% to 10% in the absence of preventive measures [3]

Prediabetes is commonly linked to obesity, particularly central or visceral obesity as well as dyslipidemia characterized by elevated triglycerides and/or reduced HDL cholesterol, and hypertension. Its diagnosis should prompt a thorough evaluation of cardiovascular risk factors [1].

Emerging evidence suggests that metabolic disturbances begin to affect oral health even before diabetes is clinically diagnosed. Hyperglycemia may impair immune regulation, disrupt the oral microbiome, and contribute to a proinflammatory environment [4]. Among the oral consequences, periodontitis has shown a strong link with impaired glycemic control. In a study by Javed et al. [5], individuals with prediabetes demonstrated significantly increased gingival inflammation, clinical attachment loss (CAL), and bleeding on probing (BOP). These observations were further reinforced by Maboudi et al.[6] , who observed a positive correlation between glycemic parameters and the severity of periodontal disease.

Beyond periodontal involvement, prediabetes has also been associated with functional changes in the salivary glands and alterations of the oral mucosa. Xerostomia and reduced salivary flow have been reported even in the early stages of metabolic dysregulation, potentially due to underlying autonomic or vascular impairments [7]. Anari et al emphasized that even minor reductions in salivary output can increase the risk for mucosal lesions, including candidiasis, aphthous ulcers, and burning mouth syndrome (BMS). Despite these observations, studies examining such manifestations within prediabetic populations remain scarce [8].

Previous researches have largely examined these oral outcomes in isolation, focusing on either periodontal parameters or salivary gland function. However, a comprehensive evaluation that simultaneously addresses periodontal status, salivary flow, and mucosal health is lacking. To our knowledge, no prior study has investigated the coexistence of all three conditions in a single prediabetic cohort. The present cross-sectional study was therefore designed to fill this gap by assessing the prevalence of periodontitis, oral mucosal lesions, and salivary dysfunction in individuals with confirmed prediabetes, and to explore their possible interrelations.

MATERIALS AND METHODS

This cross-sectional study included a total of 132 prediabetic patients, both male and female, aged between 35 and 65 years, who were recruited from the outpatient clinic of the Oral Medicine and Periodontology Department, Faculty of Dental Medicine, Zagazig University.

Eligible participants were required to have a confirmed diagnosis of prediabetes and at least 14 natural teeth to allow for proper periodontal assessment. Individuals were excluded if they had a history of smoking, diabetes mellitus, pregnancy, systemic diseases, recent use of antibiotics (within the previous three months), alcohol intake, or medications known to induce xerostomia.

Prediabetes was diagnosed in accordance with (ADA) 2025 guidelines [1], which stated that fasting blood glucose (FBG) between 100–125 mg/dL, 2-hour plasma glucose following an oral glucose tolerance test (OGTT) between 140–199 mg/dL, and HbA1c levels ranging from 5.7% to 6.4%. this study

adopted a more stringent approach by requiring that all three criteria—FBG (100–125 mg/dL), 2-hour OGTT (140–199 mg/dL), and HbA1c (5.7–6.4%)—be concurrently met to ensure diagnostic accuracy and homogeneity of the study population.

Ethical Approval

Prior to the initiation of data collection, the study protocol was thoroughly reviewed and approved by the Institutional Ethics Committee at Zagazig University (Ethical Approval No.:ZU-IRB#1510/9-7-2025, ensuring compliance with established ethical standards for human research". All participants were thoroughly informed about the study's objectives, and written informed consent was obtained before enrollment. Participant confidentiality and privacy were strictly maintained throughout all phases of the study, in full accordance with the ethical principles outlined in the Declaration of Helsinki WMA, 2024 [9]. Sample size was calculated based on power analysis for prevalence studies (Maboudi et al. 2019) [6] with a 95% confidence level and 80% power. The minimum required sample was 123, and 132 participants were enrolled tocompensate for potential dropouts

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Data Collection

Data were collected using a structured questionnaire and clinical oral examination. A chart specifically adapted from the World Health Organization Oral Health Assessment Form for Adults (2013) was used and scored accordingly (OHS WHO 2013) [10]. The questionnaire covered comprehensive history taking, including personal and demographic data, medical and drug history, smoking status, family history of diabetes, and level of education. All participants were also queried about the following oral symptoms:1) pain on chewing (yes/no); 2) dryness in mouth (yes/ no); and 3) burning sensation in mouth (yes/no)

To confirm prediabetes, all participants underwent a standardized glycemic evaluation. After an overnight fast of at least 8 hours, fasting blood glucose (FBG) was measured using the enzymatic glucose oxidase method in the university's laboratory. A 75-gram oral glucose solution was administered for the OGTT, followed by a venous blood sample taken precisely two hours later. HbA1c levels were assessed using high performance liquid chromatography (HPLC). All tests were interpreted based on the ADA 2025 diagnostic criteria [1].

Periodontal Examination

Periodontal diagnosis was established according to the 2018 EFP/AAP classification criteria. Patients were considered to have periodontitis if they presented with: Interdental clinical attachment loss (CAL) at ≥2 non-adjacent teeth, or Buccal/ lingual CAL ≥3 mm with probing pocket depth (PPD) ≥4mm at ≥2 teeth [11,12]. Periodontal parameters assessed included: Plaque Index (PI), Gingival Index (GI), Probing Depth (PD), Clinical Attachment Loss (CAL), Bleeding on Probing (BOP).All measurements were performed using a UNC-15 periodontal probe at six sites per tooth. Radiographic examination was also performed using periapical or panoramic radiographs to confirm interproximal bone loss as part of the diagnostic process for periodontitis, following the 2018 EFP/ AAP classification criteria."Only values consistent with periodontitis criteria were included in the final analysis.

Oral Lesion Assessment Oral mucosal examination was carried out by trained oral medicine specialist under adequate illumination using mouth mirrors and sterile gauze. Oral mucosal findings were categorized as either normal variants or pathological changes. Pathological lesions were grouped into six types: white, red-white, vesiculoulcerative, ulcerative, exophytic, and pigmented. All lesions were recorded and analyzed for type, distribution, and frequency. Diagnostic

criteria for each lesion were based on clinical appearance and location, with reference to standard WHO oral lesion classification [13].

Salivary Flow Assessment Unstimulated saliva was collected between 9–11 AM following the Navazesh protocol [14], with patients avoiding food, drink, and oral hygiene for at least 90 minutes beforehand. While seated and leaning slightly forward, saliva was passively collected by spitting methods into a sterile container over 5 minutes [15]. Flow rates below 0.1 mL/min were considered indicative of hyposalivation.

To enhance diagnostic accuracy, the Xerostomia Inventory (XI) was also administered to assess patients' subjective perception of dry mouth. This validated Spanish version consists of 11 items rated on a 5-point Likert scale (1 = never, 5 = very frequently). Including this tool allowed for a more comprehensive evaluation by combining objective salivary flow data with self-reported symptoms. Questionnaires were completed on paper and collected immediately after completion [16,17].

Statistical Analysis Data were analyzed using SPSS version 16. Descriptive statistics were presented as means ± standard deviations for continuous variables and as frequencies and percentages for categorical variables. Group comparisons were performed using the student's t-test for continuous variables and the chi-square test for categorical variables. A p-value less than 0.05 was considered statistically significant. To assess the association between prediabetic diagnostic markers (FBG, OGTT, HbA1c) and oral manifestations (including periodontitis, oral lesions, and xerostomia), Spearman's rank correlation coefficient was employed due to the non-parametric nature of the data. Correlation coefficients (r) were interpreted in terms of strength and direction of association, with statistical significance set at $p < 0.05$.

RESULTS

Of the 132 prediabetic participants, 61.4% were female and 38.6% male. Urban residents comprised 59.8% of the sample. Educational levels varied, with 28% illiterate, 39.4% having secondary education, and 32.6% university-educated. Clinically, 26.5% had periodontitis, 22.7% presented with oral lesions, and 30.3% reported xerostomia as shown in figure 1.

Association Between Demographic Factors and Oral Health Outcomes:as shown in figure 2As illustrated in Figure 2, statistical analysis revealed no significant associations between demographic factors (sex, residence, and education) and the presence of periodontitis, oral lesions, or xerostomia. All p-values for these comparisons exceeded the conventional significance threshold ($p = 0.05$), as indicated by the red dashed line.

TABLE (1) Mean Blood Glucose Test Values (n=132)

Test	Mean ± SD
FBG (mg/dL)	111.9 ± 7.4
OGTT (mg/dL)	169.9 ± 17.5
HbA1c (%)	6.05 ± 0.20

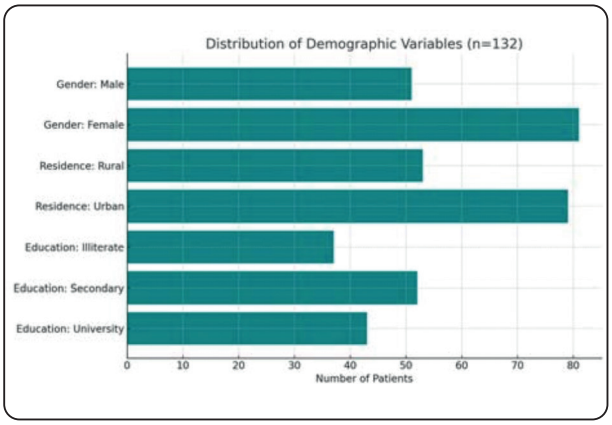

Fig. (1) Showing Distribution of Demographic Characteristics Among Prediabetic Patients (n = 132)

TABLE (2) Comprehensive periodontal & Oral Health values for Prediabetic Patient

Category	Parameter / Lesion Type	Value	Percentage
Periodontitis	Number of Patients	35	26.5%
Periodontitis	Plaque Index (mean ± SD)	1.86	± 0.28
Periodontitis	Gingival Index (mean ± SD)	1.76	± 0.26
Periodontitis	Probing Depth (PD)	5.55 mm	± 0.37
Periodontitis	Clinical Attachment Loss (CAL)	4.55 mm	± 0.37
Periodontitis	Bleeding on Probing	Present	48.6%
Summary (Means)	Plaque Index / GI / PD / CAL	1.86 / 1.76 / 5.55 mm / 4.55 mm	± 0.28 / ± 0.26 / ± 0.37 / ± 0.37
Oral Lesions	Total Patients with Lesions	30	22.7% of total sample
Oral Lesions	Candidiasis	12	40.0%
Oral Lesions	Aphthous Ulcers	7	23.3%
Oral Lesions	Angular Cheilitis	5	16.7%
Oral Lesions	Burning Mouth Syndrome (BMS)	4	13.3%
Xerostomia	Total Xerostomia Cases	40	30.3%
Xerostomia	Normal Salivary Flow	92 patients	69.7%

Specifically, among sexes, the p-values were 0.38 for periodontitis, 0.60 for oral lesions, and 0.96 for xerostomia. Similarly, no significant differences were observed based on residence (periodontitis: $p = 0.44$; oral lesions: $p = 0.51$; xerostomia: $p = 0.72$). Educational level also showed no statistical impact on these outcomes, with p-values of 0.60, 0.92, and 0.70, respectively.

Association Between Demographic Variables and Glycemic indices;

As illustrated in Figure 3, Spearman's correlation analysis revealed no statistical associations between glycemic markers (FBG, OGTT, and HbA1c) and demographic variables including sex, residence, and education. All correlation coefficients were weak, ranging from approximately -0.07 to +0.06, suggesting negligible relationships. Gender showed minimal positive correlation with FBG ($r \approx 0.04$), while residence and education similarly displayed weak or near-zero associations across all glycemic indices. Suggesting in this prediabetic cohort, glycemic control appears to be largely independent of basic demographic characteristics.

The mean glycemic values among participants confirmed their prediabetic status, with average FBG, OGTT, and HbA1c readings of 111.9±7.4mg/dL, 169.9±17.5mg/dL, and 6.05±0.20%, respectively. OGTT values showed the greatest variability among the three measures as shown in Table 1.

Among the 132 examined prediabetic patients, a total of 35 individuals (26.5%) were diagnosed with periodontitis based on clinical criteria. Periodontal parameters revealed moderate tissue destruction, with a mean plaque index of 1.86±0.28 and gingival index of 1.76±0.26. The average Probing Depth (PD) was 5.55±0.37mm, and the mean Clinical Attachment Loss (CAL) was 4.55±0.37mm. Bleeding on probing (BOP) was observed in 48.6% of the affected cases Among the 35 individuals (26.5%) diagnosed with periodontitis and according to the 2018 EFP/AAP classification, none of the

cases met the criteria for Stage I or Stage IV. Among the affected patients, 25 (71.4%) were classified as Stage II (moderate periodontitis), while 10 (28.6%) were categorized as Stage III (severe periodontitis). Based on grading, all cases were assigned to Grade B, considering their prediabetic status as a systemic risk factor.

Oral mucosal lesions were recorded in 30 patients (22.7%), with candidiasis being the most frequent lesion (12 cases, 40.0%), followed by aphthous ulcers (7 cases, 23.3%), angular cheilitis (5 cases, 16.7%), Burning mouth syndrome (4 cases, 13.3%), and lichen planus (2 cases, 6.7%). The diagnosis of lichen planus was confirmed by prior clinical records and patient history, suggesting a varied presentation of soft tissue manifestations among prediabetic individuals.

Regarding salivary gland function, 40 patients (30.3%) were found to have hyposalivation, while 92 patients (69.7%) maintained normal salivary output.

TABLE (3) Correlation Between Glycemic Markers and Oral Conditions

Glycemic Marker	Oral Condition	Spearman r	p-value
FBG	Periodontitis	0.106	0.2279
FBG	Oral Lesions	0.338	0.0001
FBG	Xerostomia	-0.098	0.2633
OGTT	Periodontitis	0.535	0.0
OGTT	Oral Lesions	0.059	0.5048
OGTT	Xerostomia	0.595	0.0
HbA1c	Periodontitis	-0.055	0.5291
HbA1c	Oral Lesions	0.021	0.8124
HbA1c	Xerostomia	0.002	0.9779

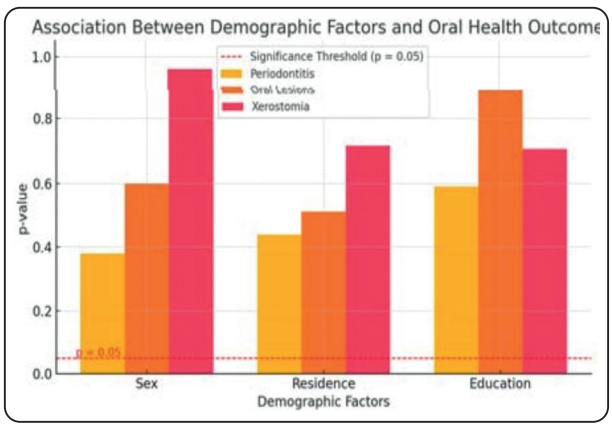

Fig. (2) Association between demographic factors and Oral health

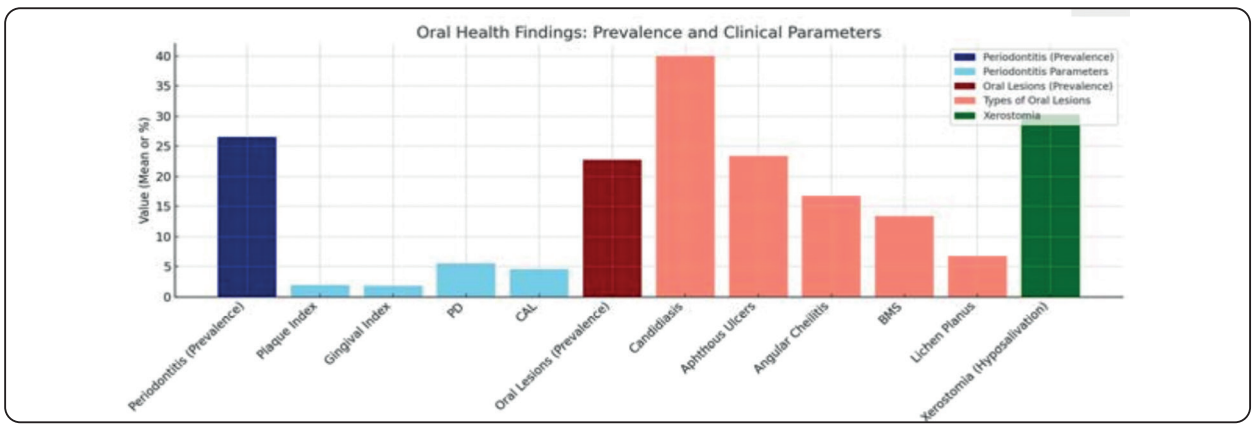

Fig. (3) Clinical parameters of Periodontal &Oral Changes

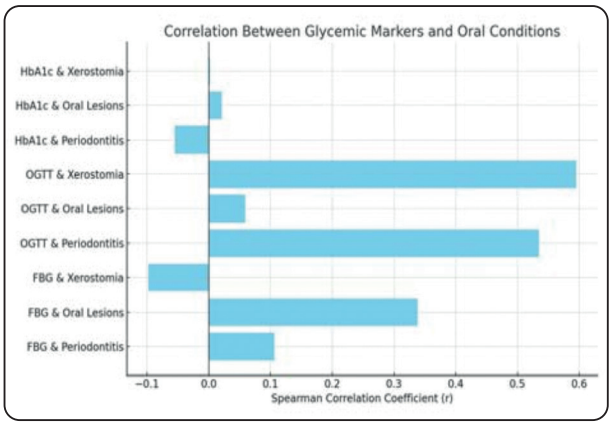

Fig. (4) Correlation Between Glycemic Indices and Oral Health Conditions

Figure 4: Spearman's correlation analysis revealed variable relationships between glycemic indices and oral health conditions. The strongest association was observed between OGTT and xerostomia ($r = 0.595$, $p < 0.001$), followed by OGTT and periodontitis ($r = 0.535$, $p < 0.001$), both indicating moderate positive correlations. FBG showed a statistically significant correlation only with oral lesions ($r = 0.338$, $p = 0.0001$). In contrast, correlations involving HbA1c were minimal and not statistically significant across all oral parameters, suggesting limited predictive value of this marker in this sample.

DISCUSSION

This study is, to our knowledge, the first to investigate periodontitis, oral mucosal lesions, and salivary dysfunction collectively in individuals with confirmed prediabetes. According to the American Diabetes Association (ADA) [1], individuals may present with one or more glycemic abnormalities—impaired fasting glucose (IFG), impaired glucose tolerance (OGTT), or elevated HbA1c—without simultaneous occurrence.

However, patients who fulfill all three criteria are considered at high risk for type 2 diabetes and cardiovascular disease. Our integrated approach allows for a comprehensive evaluation of how early metabolic dysregulation might affect the oral environment. While earlier studies have explored each oral condition independently [5,6], this study highlights the combined burden of periodontal inflammation, mucosal changes, and salivary dysfunction in a prediabetic state.

We observed that 26.5% of participants had clinical periodontitis, with mean probing depth of 5.55 mm and clinical attachment loss of 4.55 mm—parameters that reflects moderate periodontal severity per AAP/EFP 2018 classification [12]. These findings are in agreement with Javed et al. [5], who noted increased gingival inflammation and loss of attachment in prediabetics. Maboudi et al. [6] further supported this with significant correlations between glycemic markers and periodontal parameters such as BOP and CAL.

Oral mucosal lesions were observed in 22.7% of the examined prediabetic individuals, with candidiasis being the most frequently encountered condition. This aligns closely with the findings of Anari et al., who reported a significantly higher prevalence of candidiasis, periodontitis, and xerostomia in prediabetic patients compared to normoglycemic controls ($P < 0.05$). demonstrating regression analysis further confirmed that the prediabetic state itself is an independent predictor of increased risk for periodontitis and xerostomia (18).

In our study, candidiasis was followed in frequency by aphthous ulcers and angular cheilitis. These patterns may reflect underlying immune dysregulation and shifts in the oral microbial environment associated with impaired glucose metabolism. Comparable trends were reported by Al-Maweri et al. [19] and Manoucher-Pour et al. [20], who documented a greater incidence of oral mucosal lesions in individuals with poor glycemic control.

In our study, prediabetic participants exhibited moderate periodontal disease, with a mean plaque index of 1.86±0.28, gingival index of 1.76±

0.26, probing depth of 5.55 ± 0.37 mm, clinical attachment loss of 4.55 ± 0.37 mm and BOP 48.6% . These findings reflect a periodontal status more compromised than that of normoglycemic individuals but less severe than in patients with overt diabetes, consistent with Lamster et al. [21]. Similarly, Javed et al. [5] reported greater gingival bleeding and inflammation in prediabetics compared to healthy controls. Other epidemiological studies have also confirmed a positive association between impaired glucose tolerance and worsening periodontal health [22]

Contrary to our findings, the SHIP Trend Study reported no significant association between periodontitis, edentulism, and either prediabetes or well-controlled diabetes [23]. Similarly, other epidemiological studies did not observe a link between prediabetes and periodontal disease [24]. It is worth noting that our study defined prediabetes based on (FBS) , OGTT and HbA1c levels, whereas the referenced studies [23,24] relied on impaired fasting glucose and impaired glucose tolerance (IGT) without incorporating HbA1c as a diagnostic criterion.

Salivary dysfunction was present in 30.3% of patients, a finding that supports Anari et al, 2019[8], who proposed that salivary hypofunction and Xerostomia in poorly controlled diabetes and prediabetes alters salivary composition and raises glucose levels. This promotes smooth surface caries, mucosal atrophy, and a higher incidence of candidiasis. Early identification is key to minimizing oral complications.

The present study demonstrated notable differences in the strength of association between various glycemic markers—HbA1c, fasting blood glucose (FBG), and oral glucose tolerance test (OGTT)—and common oral conditions in prediabetic individuals: xerostomia, oral lesions, and periodontitis.

Among the three markers, OGTT showed the strongest positive correlations, particularly with xerostomia ($r = 0.595$, $p < 0.001$) and periodontitis ($r = 0.535$, $p < 0.001$), suggesting that postprandial glycemic excursions may have a more immediate and damaging effect on salivary function and periodontal integrity than chronic glycemic status.

This finding is in agreement with previous studies by Javed et al. [5], Navazesh and Kumar [14], and Lopez et al. [17], who emphasized that acute glucose fluctuations could impair oral immune responses and microvascular supply, leading to early periodontal breakdown and salivary gland dysfunction. The correlation between OGTT and oral lesions, however, was weak and not statistically significant ($r = 0.059$, $p = 0.5048$).

FBG showed a moderate positive correlation with oral lesions ($r = 0.338$, $p < 0.001$), while its associations with periodontitis ($r = 0.106$, $p = 0.2279$) and xerostomia ($r = – 0.098$, $p = 0.2633$) were weak and statistically non-significant. This suggests that while fasting glucose may reflect part of the systemic metabolic burden, it lacks the dynamic predictive power seen with OGTT.

In contrast, HbA1c—the most commonly used marker for long-term glycemic control— showed the weakest correlations across all oral outcomes, including a slightly negative and non-significant association with periodontitis ($r = –0.055$, $p = 0.5291$), and negligible associations with oral lesions ($r = 0.021$, $p = 0.8124$) and xerostomia ($r = 0.002$, $p = 0.9779$). This weak relationship may be attributed to the inability of HbA1c to capture transient hyperglycemic episodes, which are increasingly implicated in inflammatory and degenerative oral changes.

Our findings align with those of Navazesh and Kumar [14], who reported no significant correlation between HbA1c and salivary flow, and with Lopez et al. [17], who found minimal or no associations between HbA1c and periodontal parameters. Javed

et al. [5] similarly highlighted that HbA1c alone is insufficient to detect early oral complications in individuals with prediabetes.

In contrary to our results, some studies, such as those by Chapple et al. [25] and Mealey and Ocampo [26], have reported stronger associations between HbA1c and periodontal disease; however, these studies were primarily conducted in patients with poorly controlled type 2 diabetes, which may not be directly comparable to our prediabetic cohort.

Overall, our results suggest that OGTT is a more sensitive and clinically relevant predictor of early oral manifestations in dysglycemic individuals, supporting its broader integration into dental and medical screening protocols for high-risk patients.

Demographic variables—sex, residence, and education—showed no significant association with either oral conditions or glycemic indices in our cohort (all $p > 0.05$; $|r| < 0.07$), suggesting that early metabolic and oral changes in prediabetes may occur independently of social background This aligns with the findings of Stancu et al. [27], who reported that education level, place of residence, and diabetes duration had no statistically significant impact on oral health–related quality of life measures—such as gingival bleeding, tooth mobility, and xerostomia—among adults with type 2 diabetes. These converging results reinforce the notion that biological and metabolic dysfunction may play a more central role in early periodontal and salivary changes than demographic variables... In contrast, this notion is bolstered by recent work by Popescu et al. (2025), who reported that lower education and rural residence were significant predictors of poor periodontal health and underutilization of dental services among adults with type 2 diabetes; notably, those with less education had nearly double the odds (OR = 1.89, $p = 0.041$) of gingival bleeding compared to their higher-educated counterparts [28]

CONCLUSION

This cross-sectional study highlights a notable prevalence of periodontitis, oral mucosal lesions, and xerostomia among prediabetic individuals, suggesting that early glycemic dysregulation may contribute to detectable oral health impairments even before the onset of overt diabetes. Among the glycemic markers assessed, postprandial glucose levels (OGTT) showed the strongest correlations with both periodontal parameters and salivary dysfunction, emphasizing the clinical relevance of monitoring glucose excursions rather than relying solely on fasting glucose or HbA1c. Furthermore, the lack of significant associations between demographic variables and oral conditions suggests that biological mechanisms—rather than socioeconomic background—may play a more dominant role in the early stages of oral deterioration in prediabetes. These findings underscore the importance of routine oral evaluations and interprofessional collaboration in the early identification and management of systemic metabolic disorders. However, the absence of a healthy control group limits direct comparison, and further studies with matched controls are warranted to confirm these associations.

Article Information

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