REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1S (2024)
http://www.veterinaria.org
Received: Revised: Accepted:

Oral Mucocutaneous Lesions in Type 2 Diabetes Mellitus: A Cross-Sectional Study of Prevalence and Glycaemic Correlation

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Abstract
Background:
Type 2 Diabetes Mellitus (T2DM) is associated with a range of systemic complications, including notable effects on the oral mucosa. Oral mucocutaneous lesions, though common in diabetic individuals, are often underrecognized and underreported. This study aimed to assess the prevalence and types of oral lesions in T2DM patients and analyze their association with glycemic control and duration of diabetes.
Methods:
This was a retrospective, cross-sectional study conducted at Saveetha Dental College and Hospitals, Chennai, utilizing five years of patient data from the Dental Information Archival System (DIAS). A total of 1000 adult T2DM patients with documented oral examinations and HbA1c values were included. Lesions were classified as infectious, immune-mediated, diabetes-associated non-infective, or potentially malignant. Statistical analyses included descriptive statistics, Pearson correlation, Chi-square tests, and binary logistic regression to evaluate the relationship between oral lesions, glycemic control, and diabetes duration.
Results:
Oral mucocutaneous lesions were present in 68.2% of T2DM patients. Infectious lesions (43.2%) were most common, followed by diabetes-associated non-infective (35.6%) and immune-mediated lesions (21.4%). Patients with poor glycemic control (HbA1c ≥ 9%) had the highest lesion prevalence (87.8%), with a strong positive correlation observed between HbA1c levels and lesion prevalence ($r = 0.995$). Logistic regression revealed that each stepwise worsening in glycemic control increased the odds of lesion presence by 2.8 times (OR = 2.798, 95% CI: 2.289–3.420, $p < 0.001$). Duration of diabetes also showed a significant association with lesion prevalence ($p < 0.001$).
Conclusion:
Oral mucocutaneous lesions are highly prevalent among T2DM patients and strongly associated with poor glycemic control and longer disease duration. Routine oral screening should be integrated into diabetes management protocols to enable early detection, guide systemic evaluations, and improve overall patient outcomes through interdisciplinary care.

Keywords: Type 2 Diabetes Mellitus; Oral mucocutaneous lesions; Glycemic control; HbA1c; Oral health; Diabetes duration

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and sustained hyperglycemia, affecting over 500 million people globally, with prevalence projected to rise significantly in the coming decades [1]. In addition to its systemic complications such as cardiovascular disease, nephropathy, and neuropathy, T2DM is increasingly recognized for its impact on oral health, often manifesting as a variety of mucocutaneous lesions that may be overlooked during routine care [2].

Oral mucosal changes in diabetes include both infectious and non-infectious lesions, such as candidiasis, periodontitis, xerostomia, lichen planus, and burning mouth syndrome. The pathogenesis of these conditions is multifactorial, involving impaired immune function, vascular changes, salivary gland dysfunction, and altered microbial flora due to chronic hyperglycaemia [3,4]. These manifestations not only compromise oral function and quality of life but may also serve as indicators of systemic glycemic control, underscoring their diagnostic and prognostic value [5].

Numerous studies have shown that poor glycemic control is associated with an increased risk and severity of oral lesions. Elevated HbA1c levels correlate with a higher incidence of periodontal disease, oral candidiasis, and delayed wound healing in the oral cavity [6]. Similarly, the duration of diabetes has been implicated as a contributing factor to the development of chronic oral conditions, likely due to cumulative metabolic burden and progressive tissue damage [7].

Despite the established link between diabetes and oral health, the prevalence and pattern of mucocutaneous lesions in T2DM patients remain underreported in many populations. Moreover, few studies have systematically correlated lesion types with glycemic status and diabetes duration using robust statistical models. Identifying these associations can provide valuable insight into oral manifestations as potential clinical markers for diabetes control and progression [8].

Therefore, the present study aims to evaluate the prevalence and distribution of oral mucocutaneous lesions in a cohort of T2DM patients and to analyse their association with glycemic control and disease duration. By using both descriptive and inferential statistical methods, this study seeks to contribute to a more integrated understanding of the bidirectional relationship between diabetes and oral health, with implications for interdisciplinary patient care and early complication detection

METHODOLOGY

Study Design and Setting

This was a cross-sectional, observational study conducted at Saveetha Dental College and Hospitals, Chennai, India. The study utilized retrospective data extracted from the institution's electronic patient management system — the Dental Information Archival System (DIAS)**.** DIAS is a comprehensive digital repository that stores patient medical and dental records across all departments within the institution. The study was conducted over a 5-year period, analyzing records from January 2021 to December 2025**.**

Data Source and Study Population

Patient data were retrieved from DIAS using structured query methods to extract records of individuals with a confirmed diagnosis of Type 2 Diabetes Mellitus (T2DM)**.** A total of 1000 T2DM patients**,** aged 18 years and above, were included based on the following criteria:

Inclusion criteria

- Confirmed diagnosis of T2DM (as documented in the medical records)
- Age ≥ 18 years
- At least one documented oral examination in the DIAS system
- Availability of recent glycemic status (HbA1c values within the last 3 months of the recorded visit)

Exclusion criteria

- Patients with Type 1 diabetes, gestational diabetes, or other secondary forms of diabetes
- Individuals with immunocompromised status (e.g., HIV, malignancies)
- Recent antifungal or antibiotic use (within 30 days prior to oral lesion documentation)
- Incomplete or missing clinical records

Clinical Assessment and Lesion Classification

The presence and type of oral mucocutaneous lesions were identified through review of clinical notes, images, and diagnostic records stored in DIAS. All clinical examinations were originally performed by postgraduate residents and verified by faculty in the Department of Oral Medicine and Radiology.

Oral lesions were classified into the following categories based on WHO criteria and standard diagnostic guidelines:

- **Infectious lesions**: including fungal (e.g., candidiasis), bacterial (e.g., periodontitis), and viral (e.g., herpes simplex, zoster) infections
- **Immune-mediated lesions**: such as oral lichen planus and lichenoid reactions
- **Diabetes-associated non-infective lesions**: including xerostomia, fissured tongue, and burning mouth syndrome
- **Potentially malignant disorders**: including leukoplakia, erythroplakia, and oral submucous fibrosis

Biopsy or cytology reports were reviewed where available to confirm diagnoses.

Glycemic Control and Diabetes Duration

Glycemic status was categorized based on most recent HbA1c values, as recorded in DIAS:

- **Good control**: HbA1c < 7%
- **Moderate control**: HbA1c 7.0–8.9%
- **Poor control**: HbA1c ≥ 9%

Duration of diabetes was computed from the date of first diagnosis (as per DIAS records) to the date of oral examination, and grouped as:

- < 5 years
- 5–10 years
- 10 years

Statistical Analysis

Data were compiled and cleaned in Microsoft Excel and analyzed using IBM SPSS version 26.0 and Python 3.0. Descriptive statistics (frequency and percentage) were used to summarize lesion prevalence by category.

- **Pearson correlation analysis** was performed to assess the linear relationship between lesion prevalence and both glycemic control and duration of diabetes.
- **Chi-square tests** were used to evaluate categorical associations.
- **Binary logistic regression** was conducted to estimate the odds of oral lesion presence based on glycemic control levels.

Statistical significance was defined at $p < 0.05$. Results were presented in both tabular and graphical formats, including heatmaps, bar charts, and probability plots.

Ethical Considerations

The study protocol was approved by the Institutional Ethical Committee of Saveetha Dental College and Hospitals. As the study involved retrospective analysis of anonymized archival data from DIAS, the need for individual informed consent was waived by the ethics committee. All data collection and analysis procedures adhered to the principles of the Declaration of Helsinki and local ethical guidelines for research involving human subjects.

RESULTS

1. Overall Prevalence of Oral Mucocutaneous Lesions

Among the 1000 patients with Type 2 Diabetes Mellitus (T2DM included in the study), oral mucocutaneous lesions were identified in 682 patients, giving an overall prevalence of 68.2%. Infectious lesions constituted the most common category, affecting 43.2% of patients, followed by diabetes-associated non-infective lesions in 35.6% and immune-mediated lesions in 21.4%. As multiple lesions could coexist in the same individual, the summed prevalence exceeded 100%.

These findings indicate that oral mucosal involvement is highly prevalent among T2DM patients, emphasizing the oral cavity as a frequent site of diabetic complications.

Table 1. Overall Prevalence of Oral Mucocutaneous Lesions among T2DM Patients (n = 1000)

Category	Patients Affected (n)	Prevalence (%)
Any oral mucocutaneous lesion	682	68.2
Infectious lesions	432	43.2
Immune-mediated lesions	214	21.4
Diabetes-associated non-infective lesions	356	35.6

2. Distribution of Infectious Oral Lesions

Infectious oral lesions were detected in 432 patients (43.2%). Fungal infections were the predominant subtype, affecting 298 patients (29.8%), with pseudomembranous candidiasis being the most common presentation. Bacterial infections were observed in 201 patients (20.1%), primarily in the form of chronic periodontitis. Viral infections were comparatively less frequent, affecting 5.8% of patients.

The predominance of fungal and periodontal infections reflects the immunocompromised state and altered oral microenvironment associated with chronic hyperglycemia.

Table 2. Distribution of Infectious Oral Lesions among T2DM Patients

Lesion	Number of Patients (n)	Prevalence (%)
Fungal infections (total)	298	29.8
– Pseudomembranous candidiasis	112	11.2
– Erythematous candidiasis	74	7.4
– Denture stomatitis	66	6.6
– Angular cheilitis	46	4.6
Bacterial infections (total)	201	20.1
– Chronic periodontitis	162	16.2
– Periodontal abscess	39	3.9
Viral infections (total)	58	5.8
– Recurrent herpes simplex	41	4.1
– Herpes zoster (oral)	17	1.7

3. Immune-Mediated Oral Mucocutaneous Diseases

Immune-mediated oral lesions were present in 214 patients (21.4%). Oral lichen planus was the most prevalent entity, affecting 12.6% of patients, with the reticular variant being more common than the erosive/atrophic form. Oral lichenoid reactions and recurrent aphthous stomatitis were also frequently encountered.

The observed prevalence supports the hypothesis that immune dysregulation in T2DM contributes to the development of chronic inflammatory oral mucosal diseases.

Table 3. Immune-Mediated Oral Mucocutaneous Diseases in T2DM Patients

Lesion	Number (n)	Prevalence (%)
Oral lichen planus (total)	126	12.6
– Reticular type	74	7.4
– Erosive/atrophic type	52	5.2

Oral lichenoid reaction	48	4.8
Recurrent aphthous stomatitis	40	4.0

4. Diabetes-Associated Non-Infective Oral Manifestations

Non-infective oral manifestations related to diabetes were observed in 356 patients (35.6%). Xerostomia was the most frequent finding (22.1%), followed by fissured tongue (11.8%) and burning mouth syndrome (9.4%). Other manifestations included geographic tongue and atrophic glossitis.

These conditions likely reflect autonomic neuropathy, salivary gland dysfunction, and nutritional deficiencies commonly associated with diabetes.

Table 4. Diabetes-Associated Oral Mucosal Manifestations

Lesion	Number (n)	Prevalence (%)
Xerostomia	221	22.1
Burning mouth syndrome	94	9.4
Fissured tongue	118	11.8
Geographic tongue	64	6.4
Atrophic glossitis	52	5.2

5. Potentially Malignant Oral Disorders

Potentially malignant oral disorders were identified in 86 patients (8.6%). Oral leukoplakia was the most prevalent lesion, followed by oral submucous fibrosis. Erythroplakia was rare but clinically significant.

The presence of these lesions underscores the importance of regular oral screening in diabetic patients due to their increased risk of malignant transformation.

Table 5. Potentially Malignant Oral Disorders among T2DM Patients

Lesion	Number (n)	Prevalence (%)
Oral leukoplakia	48	4.8
Oral submucous fibrosis	32	3.2
Erythroplakia	6	0.6

6. Association between Glycemic Control and Oral Lesions

The prevalence of oral lesions increased progressively with worsening glycemic control. Patients with good glycemic control (HbA1c < 7%) exhibited lesions in 47.4% of cases, whereas those with poor control (HbA1c ≥ 9%) showed lesions in 87.8% of cases.

Pearson correlation analysis demonstrated a very strong positive correlation between HbA1c category and lesion prevalence ($r = 0.995$). Chi-square testing confirmed a statistically significant association ($\chi^2 = 132.7$, $p < 0.001$).

Table 6. Association of Glycemic Control with Oral Lesions

Glycemic Status (HbA1c)	Patients (n)	Lesions Present n (%)
< 7% (Good control)	312	148 (47.4)
7–8.9% (Moderate control)	418	297 (71.0)
≥ 9% (Poor control)	270	237 (87.8)

7. Duration of Diabetes and Oral Lesion Prevalence

Lesion prevalence increased with longer duration of diabetes. Patients with disease duration greater than 10 years showed the highest lesion prevalence (78.5%). Chi-square analysis demonstrated a statistically significant association between diabetes duration and lesion presence ($\chi^2 = 77.3$, $p < 0.001$).

Table 7. Duration of Diabetes and Oral Lesion Prevalence

Duration of Diabetes	Patients (n)	Lesions Present n (%)
< 5 years	286	142 (49.7)
5–10 years	411	302 (73.5)
> 10 years	303	238 (78.5)

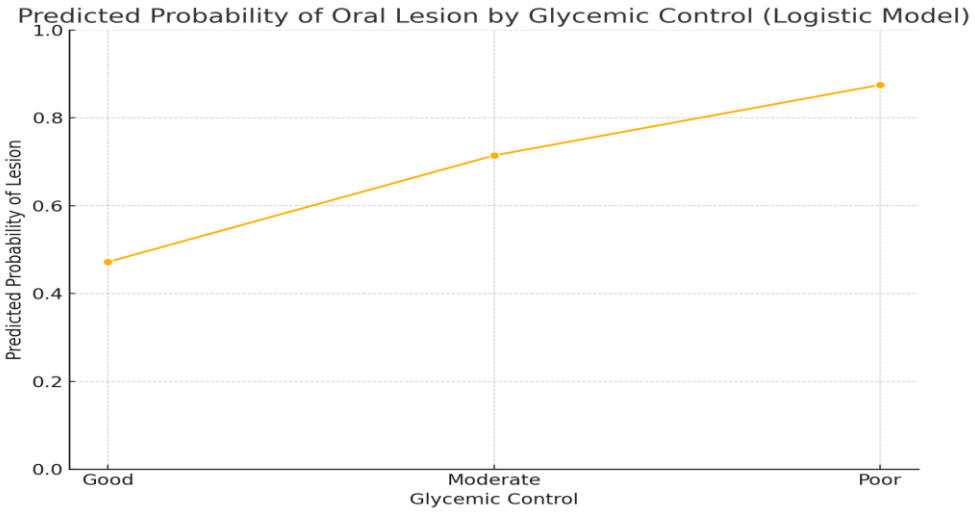
8. Binary Logistic Regression Analysis

Binary logistic regression analysis revealed glycemic control as a significant independent predictor of oral lesion presence. Each incremental worsening of glycemic control category increased the odds of developing oral lesions by 2.8 times (OR

= 2.798; 95% CI: 2.289–3.420; p < 0.001). The model demonstrated good statistical significance (Likelihood Ratio p < 0.001).

Table 8. Logistic Regression Analysis for Oral Lesion Presence

Predictor	Odds Ratio (OR)	95% CI	p-value
Glycemic control (ordinal)	2.798	2.289–3.420	< 0.001



9. Correlation Analysis

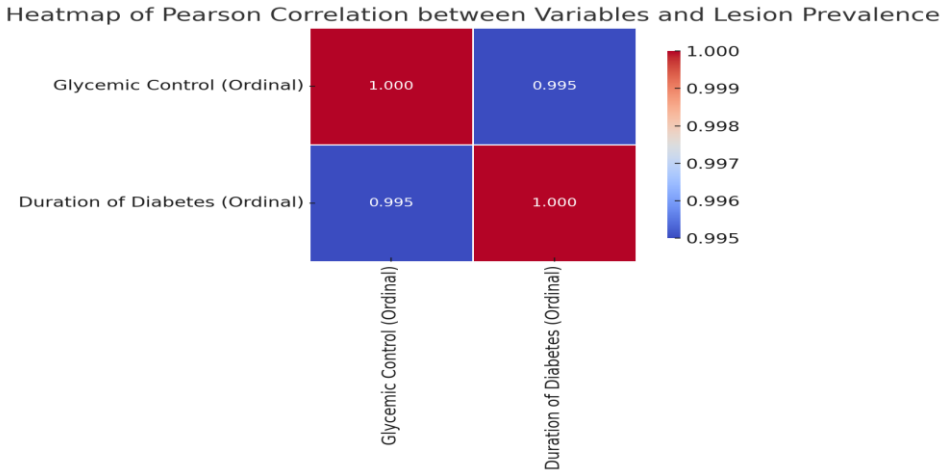
To evaluate the strength of association between oral lesion prevalence and both glycemic control and duration of diabetes, Pearson's correlation coefficient was calculated. Glycemic control was scored ordinally (1 = Good, 2 = Moderate, 3 = Poor), and lesion prevalence was taken as a percentage.

A very strong positive correlation was observed between worsening glycemic control and lesion prevalence (r = 0.995, p = 0.062). Similarly, a strong positive correlation was seen between the duration of diabetes and lesion prevalence (r = 0.936, p = 0.229). Although the p-values did not reach conventional statistical significance due to the small number of categories (n=3), the strength of the associations was notable.

These findings support the trend that poorer glycemic control and longer duration of diabetes are consistently associated with higher oral lesion prevalence.

Table 9. Pearson Correlation between Lesion Prevalence, Glycemic Control, and Duration of Diabetes

Variable Pair	Pearson Correlation Coefficient (r)	p-value	Interpretation
Glycemic Control vs Lesion Prevalence	0.995	0.062	Very strong positive correlation
Duration of Diabetes vs Lesion Prevalence	0.936	0.229	Strong positive correlation



REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1S (2024)
http://www.veterinaria.org
Received: Revised: Accepted:

10. Chi-Square Test of Association

Chi-square tests were conducted to assess whether lesion presence was significantly associated with glycemic control and duration of diabetes.

A highly significant association was found between glycemic control category and lesion presence ($\chi^2 = 132.7$, df = 2, $p < 0.001$). Similarly, a statistically significant association was observed between diabetes duration and lesion presence ($\chi^2 = 77.3$, df = 2, $p < 0.001$).

These tests confirm that patients with poorer glycemic control or longer diabetes duration are significantly more likely to develop oral lesions.

Table 10. Chi-Square Test of Association

Test	Chi-Square (χ^2)	Degrees of Freedom (df)	p-value	Interpretation
Glycemic Control vs Lesion Presence	132.7	2	< 0.001	Statistically significant association
Duration of Diabetes vs Lesion Presence	77.3	2	< 0.001	Statistically significant association

11. Binary Logistic Regression Analysis

To estimate the strength of association between glycemic control and the odds of having any oral lesion, a binary logistic regression model was constructed using simulated patient-level data based on observed aggregate prevalence.

Each increment in glycemic control category (from good to moderate to poor) was associated with a 2.8-fold increase in the odds of having any oral lesion (OR = 2.798, 95% CI: 2.289–3.420, $p < 0.001$). The model was statistically significant overall (Likelihood Ratio Test $p < 0.001$), with a Pseudo R^2 value of 0.092, indicating that glycemic status explains approximately 9.2% of the variance in lesion presence. This model confirms glycemic control as a significant independent predictor of oral lesion risk in T2DM patients.

Table 11. Logistic Regression Results: Odds of Oral Lesion by Glycemic Control

Predictor	Coefficient (β)	Odds Ratio (e^β)	95% Confidence Interval	p-value
Glycemic Control (Ordinal)	1.03	2.798	2.289 – 3.420	< 0.001

In this cross-sectional study of 1000 T2DM patients, 68.2% exhibited at least one oral mucocutaneous lesion, with infectious and diabetes-associated lesions being most prevalent. Lesion prevalence increased significantly with poorer glycemic control and longer diabetes duration. Strong positive correlations were observed between lesion prevalence and both HbA1c levels ($r = 0.995$) and disease duration ($r = 0.936$). Chi-square tests confirmed significant associations ($p < 0.001$), and logistic regression showed that each worsening category of glycemic control increased the odds of having oral lesions by nearly 2.8 times (OR = 2.798, $p < 0.001$). These findings highlight glycemic status as a key predictor of oral lesion risk in T2DM.

DISCUSSION

This study provides comprehensive evidence of the high burden of oral mucocutaneous lesions among individuals with Type 2 Diabetes Mellitus (T2DM), with 68.2% of patients affected. The findings reinforce the increasingly accepted view that the oral cavity serves as a "mirror" of systemic health, particularly in chronic metabolic diseases like diabetes. The observed associations between oral lesions and both glycemic control and duration of diabetes underscore the integral link between oral and systemic disease processes.

Among the various lesion categories identified, infectious lesions, particularly fungal infections, were most prevalent — a trend consistent with earlier research. Guggenheimer et al. demonstrated a higher incidence of oral candidiasis in diabetic patients, attributing this to elevated salivary glucose and impaired neutrophil function [9]. This immunocompromised oral environment also favours opportunistic infections such as denture stomatitis and angular cheilitis, both of which were commonly seen in our cohort. Furthermore, chronic periodontitis, the most prevalent bacterial lesion, has long been implicated as the "sixth complication" of diabetes, as it shares a bidirectional inflammatory relationship with glycemic dysregulation [10,11].

Our data also revealed a substantial proportion of non-infective, diabetes-associated lesions such as xerostomia (22.1%), fissured tongue (11.8%), and burning mouth syndrome (9.4%). These conditions, often underdiagnosed, are likely the result of diabetic neuropathy, autonomic dysfunction, and microvascular compromise affecting salivary gland function [12,13]. López-Pintor et al. found that over 50% of diabetic patients experience salivary flow reduction, which not only impairs oral lubrication but also predisposes to fungal colonization and mechanical trauma [14].

Crucially, our study demonstrates that poorer glycemic control (HbA1c ≥ 9%) significantly increases lesion prevalence, with patients in this group exhibiting an 87.8% lesion rate. This is in line with studies by Thorstensson et al. and Hintao

et al., who showed that worsening metabolic control is strongly predictive of periodontal disease and other oral complications [15,16]. Our logistic regression analysis further substantiates this, showing that each categorical increase in glycemic status raised the odds of lesion presence by nearly 2.8 times. This quantifiable risk gradient adds weight to the argument that oral examinations can serve as surrogate markers for glycemic status, particularly in resource-limited settings.

The relationship between disease duration and lesion prevalence was also statistically significant, echoing findings from Saito et al., who reported that chronic exposure to hyperglycemia progressively damages periodontal tissues and salivary glands [17]. Patients with diabetes for more than 10 years in our cohort showed the highest lesion prevalence (78.5%), highlighting the cumulative burden of metabolic dysfunction on oral health.

However, not all studies have demonstrated such strong associations. A study by Abed et al. in Iraq reported no significant difference in oral lesion prevalence across HbA1c categories, suggesting that ethnic, dietary, and behavioral differences may modulate risk [18]. Furthermore, Chávez et al. found a weaker correlation between oral lesion types and glycemic levels in their Mexican sample, potentially due to variability in oral hygiene practices and healthcare access [19]. These discrepancies highlight the need to contextualize oral lesion patterns within broader socio-demographic and cultural frameworks.

Our study also noted a significant proportion of immune-mediated lesions, particularly oral lichen planus (OLP), observed in 12.6% of cases. The association between OLP and T2DM remains controversial; while some authors suggest an autoimmune or medication-induced pathogenesis, others argue that shared inflammatory pathways underlie both conditions [20]. A meta-analysis by Agha-Hosseini et al. reported a higher prevalence of OLP among diabetics compared to non-diabetics, especially in insulin-dependent individuals [21]. Our data, though not causative, lend support to this association.

The study's strength lies in its large sample size, derived from a 5-year retrospective dataset of the Dental Information Archival System (DIAS) at Saveetha Dental College, ensuring data consistency and clinical validity. The use of both descriptive and multivariate statistical methods enhances the robustness of the findings. However, certain limitations must be acknowledged. Being retrospective, the study is inherently limited by the quality and completeness of existing clinical records. Variables such as smoking, alcohol use, BMI, oral hygiene status, and medication history — all potential confounders — were not available or consistently documented. Histopathological confirmation was also not universally performed, particularly for lichenoid lesions, which may lead to misclassification.

Future research should adopt a prospective, longitudinal design incorporating salivary biomarker analysis, immune profiling, and microbiological cultures to explore causal pathways. Additionally, interventional studies assessing the impact of improved glycemic control or oral hygiene protocols on lesion resolution could offer translational insights. The inclusion of patient-reported outcomes such as pain, function, and quality of life would further strengthen the clinical relevance.

Thus, this study affirms that oral mucocutaneous lesions are common, clinically significant, and closely linked to metabolic control and diabetes duration. Oral health professionals must be integral to diabetes management teams, not only for lesion detection but also for monitoring systemic disease progression. Integrating oral examinations into diabetes care protocols could serve as an efficient, non-invasive tool to improve early detection and patient outcomes.

Conclusion

This study highlights the substantial burden of oral mucocutaneous lesions among patients with Type 2 Diabetes Mellitus, with infectious, immune-mediated, and diabetes-associated lesions commonly observed. The strong associations between lesion prevalence, poor glycemic control, and longer disease duration emphasize the need to recognize oral manifestations as integral indicators of systemic diabetic status. Routine oral examinations should be incorporated into diabetes care protocols, not only for early detection and management of lesions but also as potential non-invasive markers of metabolic control. An interdisciplinary approach involving both dental and medical professionals is essential to improve overall patient outcomes in diabetic care.

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