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Clinical Severity of Periodontal Disease in Patients with Type 2 Diabetes Mellitus: A Case-Control Investigation

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ABSTRACT

Purpose: This study aimed to examined the clinical severity of periodontal disease among diabetic individuals in Zawia, Libya.

Materials and Methods: A case-control investigation was carried out involving 151 participants (101 diabetic patients and 50 healthy controls) at Zawia Diabetes and Endocrinology Center and Zawia Central Dental Clinic during the period of June through August 2024. Clinical periodontal evaluation was undertaken utilizing the Miller Mobility Index (MMI) and Modified Bleeding Index (MBI). Subgingival plaque specimens were obtained for microbiological analysis. Glycemic regulation was assessed through HbA1c measurements.

Results: Diabetic participants displayed markedly elevated MMI scores (M=1.19, SD=0.737) in comparison to control subjects (M=0.420, SD=0.480), t=7.698, p<0.001. Similarly, MBI scores were heightened among diabetics (M=42.31, SD=25.09) relative to controls (M=27.94, SD=21.42), t=3.468, p<0.001. Suboptimal glycemic control (HbA1c >7%) was correlated with significantly elevated MBI scores (p=0.001). Diabetes duration demonstrated a positive association with MMI severity (p=0.049), with individuals possessing diabetes for >10 years exhibiting the highest mobility scores (M=1.40, SD=0.670).

Conclusion: Diabetic patients manifest significantly more pronounced periodontal disease severity in comparison to non-diabetic individuals. Inadequate glycemic control and extended diabetes duration constitute critical determinants of periodontal degradation, highlighting the necessity for coordinated diabetes and periodontal management. (*Open J Biomed Res 2026;5:27-33*)

Keywords: Diabetes Mellitus, Periodontal Disease, Miller Mobility Index, Modified Bleeding Index, Glycemic Control.

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INTRODUCTION

Diabetes mellitus (DM) stands as one of the most formidable global health challenges of the contemporary era, impacting approximately 537 million adults worldwide according to the International Diabetes Federation.[1] This metabolic disturbance, distinguished by

persistent hyperglycemia arising from deficiencies in insulin secretion, insulin action, or both, produces systemic complications affecting numerous organ systems, including the oral cavity.[2]

The association between diabetes and periodontal disease has progressed from being regarded as merely correlational to being acknowledged as bidirectional and mutually dependent.[3] Periodontal disease, comprising inflammatory conditions affecting the supporting structures of dentition, demonstrates particularly exacerbated severity within diabetic populations. The periodontium, consisting of gingiva, periodontal ligament, cementum, and alveolar bone, functions simultaneously as a target for diabetic complications and a potential origin of systemic inflammation that may exacerbate glycemic regulation.[4]

The pathophysiological mechanisms underlying periodontal deterioration associated with diabetes encompass multiple pathways. Hyperglycemia facilitates advanced glycation end-product (AGE) formation, compromises neutrophil function, modifies collagen metabolism, and generates a hyperinflammatory response to bacterial challenge.[5] Furthermore, diabetes-induced microvascular alterations impair blood supply to periodontal tissues, undermining their defensive and regenerative capacities.[6]

Within Libya, the prevalence of diabetes has increased substantially over the preceding decade, with the Zawia region documenting approximately 13,500 diabetes cases in recent years. Despite this escalating burden, investigations examining the oral health complications of diabetes remain scarce in the Libyan context. Comprehension of the specific clinical manifestations of periodontal disease within this population is essential for the development of targeted prevention and therapeutic approaches.

This investigation sought to quantitatively evaluate periodontal disease severity employing standardized clinical indices and to examine the influence of glycemic control and diabetes duration on periodontal health outcomes within a Libyan population.

The bidirectional relationship between diabetes and periodontal disease has been comprehensively documented in international literature. Taylor and Borgnakke (2008) established that periodontal disease constitutes the sixth complication of diabetes, alongside retinopathy, nephropathy, neuropathy, macrovascular disease, and impaired wound healing.[7]

Large-scale epidemiological investigations have consistently demonstrated heightened prevalence and severity of periodontal disease among diabetic patients. Data from the National Health and Nutrition Examination Survey (NHANES) revealed that diabetic adults possessed significantly greater odds of severe periodontitis compared to non-diabetic individuals, with odds ratios escalating alongside poor glycemic control.[8] Similarly, nationwide survey data from Korea demonstrated that patients with suboptimal glycemic control exhibited significantly elevated rates of gingivitis, periodontitis, and tooth loss.[9]

The Miller Mobility Index (MMI), originally developed by Miller in 1950 and subsequently refined, offers a standardized approach for evaluating tooth mobility, a critical indicator of periodontal support compromise. The index categorizes mobility from 0 (absence of mobility) to 3 (severe mobility in horizontal and vertical planes).[10] Recent validation investigations by Kim et al. (2023) confirmed MMI's dependability as a diagnostic instrument for periodontitis severity evaluation. [11]

The Modified Bleeding Index (MBI), adapted from the Gingival Index by Lobene et al, provides quantitative assessment of gingival inflammation through standardized probing and bleeding evaluation. This index has demonstrated exceptional reproducibility and responsiveness to periodontal intervention.[12]

The relationship between glycemic control and periodontal health has been quantified through HbA1c measurements. Investigations consistently demonstrate that HbA1c levels exceeding 7% correlate with increased periodontal attachment loss, deeper periodontal pockets, and greater alveolar bone destruction.[13] The Diabetes Control and Complications Trial (DCCT) and Epidemiology of Diabetes Interventions and Complications (EDIC) study demonstrated that intensive glycemic control diminished the risk of periodontal disease progression by approximately 30%.[14]

In the Middle East and North Africa region, Al Ghazal and Werfully (2018) conducted a seminal investigation in Benghazi, Libya, demonstrating that non-surgical periodontal therapy substantially reduced HbA1c levels in type 2 diabetic patients over three months, confirming the bidirectional relationship.[15] Similarly, Alhaseek et al. (2024) in Al-Khoms, Libya, identified elevated frequency and severity of periodontal inflammation among diabetic patients, with older individuals demonstrating increased susceptibility.[16]

Longitudinal investigations indicate that periodontal disease severity escalates with diabetes duration. The Wisconsin Epidemiologic Study of Diabetic Retinopathy demonstrated that each 5-year increment in diabetes duration was associated with a 20% increase in the odds of severe periodontal disease.[17] This cumulative effect likely stems from sustained hyperglycemic damage to periodontal tissues and prolonged exposure to diabetes-induced immune dysfunction.

MATERIALS AND METHODS

Study Design and Setting

This case-control investigation was conducted from June through August 2024 in Zawia, Libya, a coastal municipality situated approximately 48 km west of Tripoli with an estimated population of 357,631. The study was executed at Zawia Diabetes and Endocrinology Center, Zawia Central Dental Clinic, and Zawia Biolab Medical Center.

Sample Size and Participants

A total of 151 participants were enrolled: 101 type 2 diabetic patients (cases) and 50 healthy non-diabetic individuals (controls). Sample size was determined based on power analysis assuming 80% power and 5% significance level to detect clinically meaningful differences in periodontal indices.

Inclusion Criteria

- Cases: Confirmed type 2 diabetes mellitus, age ≥18 years, capacity to provide informed consent.
- Controls: Absence of diabetes history, normal fasting blood glucose (<100 mg/dL), age ≥18 years.

Exclusion Criteria

- Individuals below 18 years of age.
- Pregnant women.
- Individuals with dental implants or fixed prostheses.
- Patients with systemic conditions affecting periodontal health (other than diabetes in case group).

Clinical Assessment

Standardized periodontal examination was performed following WHO guidelines employing dental mirror, tweezers, gauze, explorer, and Williams periodontal probe. Two validated indices were utilized:

Miller Mobility Index (MMI): Tooth mobility was evaluated using two metallic instruments applied to the buccal and lingual surfaces. Mobility was graded as: 0 (absence of mobility), 1 (slight horizontal displacement), 2 (moderate horizontal with possible axial displacement), and 3 (severe horizontal and axial displacement). Six Ramfjord index teeth (16, 21, 24, 36, 41, 44) were examined.

Modified Bleeding Index (MBI): Following drying of gingival tissues with gauze, a graduated periodontal probe was gently introduced into the gingival sulcus. Bleeding was scored as: 0 (absence of bleeding) or 1 (bleeding upon probing). Scores were expressed as percentages of bleeding sites.

Laboratory Procedures

Fasting blood glucose and HbA1c levels were measured for diabetic participants. HbA1c <7% indicated controlled diabetes; ≥7% indicated uncontrolled diabetes.

Statistical Analysis

Data were analyzed utilizing SPSS software. Independent t-tests compared continuous variables between groups. One-way ANOVA evaluated differences across diabetes duration subgroups. Pearson correlation examined relationships between continuous variables. Statistical significance was established at $p<0.05$.

RESULTS

Demographic Characteristics

The diabetic group demonstrated older age distribution compared to controls, with 58.4% aged 50-69 years versus 10% in the control group. Gender distribution revealed female predominance in both groups (68.3% in cases, 82% in controls), attributed to elevated healthcare-seeking behavior among women in the study population.

Among diabetic patients, 38.6% possessed diabetes duration of 1-5 years, 28.7% had 6-10 years, and 32.7% had >10 years. Glycemic control assessment showed 39.6% had HbA1c <7% (controlled) and 60.4% had HbA1c ≥7% (uncontrolled).

Clinical Periodontal Assessment

Miller Mobility Index (MMI): Diabetic patients demonstrated significantly elevated tooth mobility compared to controls (Table 1). The mean MMI in diabetics was nearly threefold higher than controls, indicating substantially compromised periodontal support.

Table 1: Comparison of MMI and MBI between groups.

Variable	Group	N	Mean	SD	t-value	p-value
MMI	Control	50	0.420	0.480	7.698	<0.001
	Case	101	1.19	0.737		
MBI	Control	50	27.94	21.42	3.468	<0.001
	Case	101	42.31	25.09		

Modified Bleeding Index (MBI): Similarly, diabetic patients showed significantly elevated gingival bleeding compared to controls, with mean MBI scores 51% higher in the diabetic group.

Glycemic Control Analysis

Comparison of periodontal indices between controlled (HbA1c <7%) and uncontrolled (HbA1c ≥7%) diabetic patients revealed (Table 2):

Table 2: Periodontal indices by glycemic control.

Variable	Group	N	Mean	SD	t-value	p-value
MMI	Control	40	1.03	0.748	-1.818	0.072
	Uncontrol	61	1.30	0.716		
MBI	Control	40	32.69	21.152	-3.267	0.001
	Uncontrol	61	48.61	25.623		

While MMI demonstrated borderline non-significant difference ($p=0.072$), MBI exhibited significantly worse gingival inflammation in uncontrolled diabetics ($p=0.001$).

Diabetes Duration Analysis

Analysis across diabetes duration subgroups revealed progressive deterioration in tooth mobility (Table 3):

Table 3: Periodontal indices by diabetes duration.

Variable	Duration	N	Mean	SD	F-value	p-value
MMI	1-5 years	39	0.98	0.733	3.081	0.049
	6-10 years	29	1.24	0.764		
	>10 years	33	1.40	0.670		0.771
MBI	1-5 years	39	40.03	25.322	0.261	
	6-10 years	29	43.39	26.153		
	>10 years	33	44.04	24.440		

MMI increased significantly with diabetes duration (p=0.049), while MBI showed no significant variation across duration groups.

Correlation Analysis

Fasting blood glucose demonstrated weak positive correlations with both MMI (r=0.147, p=0.142) and MBI (r=0.091, p=0.366), though neither achieved statistical significance.

DISCUSSION

This investigation provides compelling evidence of substantially inferior periodontal health in Libyan diabetic patients compared to non-diabetic controls. The demonstration of elevated MMI and MBI scores in diabetics corresponds with international literature establishing diabetes as a principal risk factor for periodontal disease.[7,9]

The nearly threefold higher MMI scores in diabetic patients indicate substantial compromise of periodontal supporting structures. This finding aligns with pathophysiological understanding that diabetes accelerates periodontal attachment loss through multiple mechanisms including impaired collagen synthesis, increased matrix metalloproteinase activity, and altered bone remodeling.[5] The clinical significance of this finding is considerable, as tooth mobility represents an advanced stage of periodontal disease frequently necessitating complex intervention or extraction.

The 51% higher MBI scores in diabetics reflect the hyperinflammatory state characteristic of diabetes. Hyperglycemia promotes pro-inflammatory cytokine production and impairs neutrophil function, resulting in exaggerated inflammatory responses to bacterial plaque.[6] The significant difference in MBI but not MMI between controlled and uncontrolled diabetics suggests that gingival inflammation may be more responsive to glycemic control than structural periodontal damage, which may represent cumulative irreversible alterations.

The borderline association between glycemic control and MMI (p=0.072), combined with the highly significant association with MBI (p=0.001), supports the concept that while glycemic control importantly influences periodontal inflammation, structural damage may require extended periods of optimal control to manifest measurable improvement. This finding is consistent with Sato et al. (2024), who demonstrated that periodontal therapy improved glycemic control, but structural periodontal improvements required sustained intervention.[18]

The progressive increase in MMI with diabetes duration represents a novel finding in the Libyan context. Patients with >10 years diabetes demonstrated 43% higher mobility scores than those with 1-5 years duration. This cumulative effect likely reflects sustained exposure to hyperglycemic damage, repeated cycles of inflammation and repair, and potentially inadequate periodontal care throughout the disease course. The absence of significant MBI variation across duration groups suggests that while inflammation may fluctuate, structural damage is cumulative and irreversible.

The weak correlations between fasting blood glucose and periodontal indices, contrasted with the stronger associations with HbA1c, underscore the importance of long-term glycemic control assessment. Single glucose measurements may be influenced by recent dietary intake, stress, or medication timing, whereas HbA1c reflects glycemic exposure over 2-3 months, better capturing the chronic hyperglycemia that drives periodontal pathology.

Comparison with regional investigations reveals consistent patterns. Al Ghazal and Werfully (2018) in Benghazi demonstrated similar periodontal deterioration in diabetic patients and showed that periodontal intervention improved glycemic control.[15] Alhaseek et al. (2024) in Al-Khoms similarly identified elevated periodontal disease frequency and severity among diabetics, with

age and duration effects comparable to our findings.[16]

The predominance of female participants in both groups reflects healthcare access patterns in Libyan society, where women demonstrate elevated health-seeking behavior. While gender-based analysis showed no significant differences in periodontal indices, the limited male sample size constrains definitive conclusions regarding potential gender effects.

These findings carry substantial implications for diabetes care in Libya. The elevated prevalence of uncontrolled diabetes (60.4% with HbA1c ≥7%) combined with considerable periodontal disease burden suggests inadequate integration of oral health into diabetes management. The demonstration that periodontal health deteriorates progressively with diabetes duration emphasizes the necessity for early intervention and regular periodontal monitoring.

The significant association between poor glycemic control and gingival inflammation suggests that periodontal health could serve as a readily assessable indicator of diabetes management quality. Conversely, periodontal therapy may offer adjunctive benefit for glycemic control, as demonstrated in intervention studies.[15,18]

This investigation's cross-sectional design constrains causal inference regarding diabetes duration effects. The convenience sampling approach may introduce selection bias, and the female predominance limits generalizability. Absence of data on oral hygiene practices, smoking status, and other potential confounders represents additional limitations. The single geographic location (Zawia) may not reflect national patterns.

CONCLUSION

This investigation demonstrates significantly greater periodontal disease severity among Libyan diabetic patients compared to non-diabetic controls, as evidenced by elevated Miller Mobility Index and Modified Bleeding Index scores. Suboptimal glycemic control and extended diabetes duration constitute critical determinants of periodontal deterioration, with tooth mobility demonstrating progressive worsening over time. These findings underscore the urgent necessity for integrated diabetes and periodontal care in Libya, including regular oral health assessment as a standard component of diabetes management and enhanced patient education regarding the oral complications of diabetes.

Conflicts of Interest

The authors declare no conflicts of interest.

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