Original Article

Evaluation of Periodontal Health in Diabetic Patients: Influence of Glycemic Control and Diabetes Duration Using the Community Periodontal Index – A Longitudinal Study

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Abstract

Background: Diabetes is a long-term metabolic disease with consequences for periodontal health. However, various studies have established a link between diabetes and periodontal health. In this regard very limited research has been done to investigate the impact of duration of diabetes and glycemic index on periodontal health.

Objective: To evaluate glycemic control (HbA1c levels) and diabetes duration on periodontal health using the Community Periodontal Index (CPI).

Methods: The duration of the study was one year and six months after the approval of synopsis from ethical review board. Based on their glycemic control, 225 diabetic patients were split into three groups: effectively controlled (HbA1c <7%), mildly controlled (HbA1c between 7 and 9%), and inadequately controlled (HbA1c >9%). Periodontal health assessment was performed using the CPI at three time points: baseline, six months, and twelve months.

Results: The study sample was 225 participants. The severity of periodontal disease was higher in diabetic patients with poor glycemic control. Over 12 months, CPI of the poorly controlled group increased to 85%, while the mildly controlled group increased to 55%, and the well-controlled group increased to 30%. A significant correlation was found between HbA1c levels and CPI scores ($r=0.72$, $p<0.001$), and between diabetes duration and CPI scores ($r=0.68$, $p<0.001$).

Conclusion: The present study suggests a significant effect of glycemic control (HbA1c levels) and diabetes duration on periodontal health assessed by using the Community Periodontal Index (CPI).

Keywords: Diabetes mellitus, periodontal disease, Glycated hemoglobin A, Community Periodontal Index (CPI), longitudinal study.

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Introduction

Diabetes mellitus (DM) is a worldwide health concern, currently over 537 million adults are being affected with this problem, and its incidence is expected to rise in the coming decades. A

73% prevalence of periodontitis was reported in diabetic study population, with a statistically significant association found with age.[1] It is a systemic metabolic disorder characterized by high blood sugar levels that may result from inadequate insulin synthesis or insulin resistance. Uncontrolled diabetes leads to a myriad of complications, including neuropathy, nephropathy, retinopathy, cardiovascular diseases, and periodontal disease.[2,3] Beyond its systemic effects, diabetes mellitus has significant implications for oral health. Individuals with diabetes commonly experience xerostomia (dry mouth), altered taste perception, an increased risk of dental caries, gingival inflammation, and delayed wound healing.[4,5] Periodontal disease, is a common chronic inflammatory condition. It is one of the most serious oral health issues among diabetic patients. It affects the gingiva, periodontal ligament, and alveolar bone.[6] At the time of onset, it appears as gingivitis, but if treatment is not received, it can develop into periodontitis and result in tooth loss. Research has indicated that diabetes and periodontitis share a bidirectional relationship, where poorly controlled diabetes exacerbates periodontal disease.[7-9]

The evaluation of periodontal health in both diabetic and non-diabetic populations, standardized tools such as the Community Periodontal Index (CPI) are widely utilized. Developed by the World Health Organization (WHO) in collaboration with the FDI World Dental Federation, the CPI serves as an effective and globally recognized method for assessing periodontal status in epidemiological studies[10]. Its simplicity, cost-effectiveness, and reproducibility make it a valuable tool for large-scale evaluations of periodontal disease prevalence.[11,12] Various studies have demonstrated that people with diabetes have a high risk of periodontal disease as compared to non-diabetic individuals, and poor glycemic control has been particularly linked to a greater likelihood of periodontal complications, including deeper periodontal pockets, higher attachment loss, and more extensive alveolar bone resorption.[13,14] Despite the well-established association between diabetes and periodontitis, there are limited studies reporting the incidence and severity of periodontal disease in relation to glycemic control in diabetic patients within local populations.[15] Although several cross-sectional studies have demonstrated a link between diabetes and periodontal disease, few investigations have examined how periodontal disease develop over time in patients with diabetes.[16] The impact of glycemic control and diabetes duration on periodontal disease severity has not been investigated adequately. This research attempts to close this gap by conducting a longitudinal evaluation of periodontal health in diabetic patients, using the Community Periodontal Index (CPI) over a period of twelve months.

Methods

The study was carried out in Madina Teaching Hospital Faisalabad in the periodontology department from 1st Nov 2022 to 30th April 2024 (total duration 1year and six months after ethical approval). Patients were observed and followed over a 12-month period. The data was collected using non-probability convenient sampling technique. The Community Periodontal Index (CPI) was used to evaluate the course of periodontal disease in patients with diabetes. Ethical Consideration: Ethical approval was obtained under **IBR reference: TUF/IBR/148/2022.** Informed written consent was obtained from the participants and confidentiality was maintained. Cochran's formula for prevalence studies was used to calculate the study's size of the sample. The initial calculated sample size was 369, assuming a 60% prevalence of periodontal disease in diabetic patients, a 95% confidence level ($Z = 1.96$), and a 5% margin of variation ($d = 0.05$)[17]. However, considering feasibility, study duration, and patient availability at the study site, the final size of sample was adjusted to 225 participants with a statistical power of 80% to detect significant differences in periodontal disease progression across glycemic control.

Participants were enrolled based on inclusion and exclusion criteria. The **inclusion criteria** required participants to have a confirmed diagnosis of Type II diabetes mellitus for at least one year, between 30 to 75 years of age, have a minimum of 20 remaining teeth, divided into six sextants and the CPI recording was performed on the index teeth that is No. 17-16, 11, 26-27, 36-37, 31, 46-47. It was made sure that participants have not undergone any periodontal treatment in the past six months. **Exclusion Criteria:** Individuals who were pregnant or lactating, undergoing radiotherapy or immunosuppressive therapy, diagnosed with autoimmune diseases, or had

taken antibiotics in the past three months were eliminated from the study. A maximum of 225 participants were recruited and categorized according to their glycemic control and diabetes duration. Glycemic control was determined using HbA1c levels, with participants classified into three groups: well- controlled diabetes (HbA1c <7%), mildly controlled diabetes (HbA1c 7–9%), and inadequately controlled diabetes (HbA1c >9%). Additionally, patients were stratified into 3 groups on the basis of duration of diabetes less than five years, between five to ten years, and greater than ten years.[18]

Patients were observed and followed up over a 12-month period. Periodontal health assessment was performed using the CPI at three time points: baseline, six months, and twelve months. The oral cavity was divided into six sextants, and index teeth (17, 16, 11, 26, 27, 36, 37, 31, 46, 47) were inspected to determine the periodontal status. The CPI scoring system included five categories: Code 0 (healthy gingiva), Code 1 (gingival bleeding), Code 2 (appearance of calculus), Code 3 (shallow periodontal pockets of 4–5 mm), and Code 4 (deep periodontal pockets of ≥6 mm).[19] SPSS version 24 was used for data analysis. The Chi-Square test was applied to assess the gender distribution across the three groups and to analyze the prevalence of CPI Codes 3 and 4 at baseline, six months, and twelve months. While repeated-measures ANOVA was utilized to examine the evolution of periodontal disease over time. Additionally, the relationship between HbA1c levels, the length of diabetes, and periodontal disease was investigated using Pearson correlation analysis.

Results:

The study cohort consisted of 225 participants, categorized into four age groups: under 40, 40-49, 50-59, and 60+. The overall gender distribution shows a slight male predominance, with 56.4% males and 43.6% females. The male-to-female ratio is consistent across the age groups, ranging from 1.17:1 to 1.38:1 in various age groups. Despite the variations, the overall male-to-female ratio remains approximately 1.3:1, with 127 males and 98 females. The age distribution highlights a relatively balanced representation across all age categories while introducing subtle differences across age groups. (Table I)

Table I: *Demographic Data (Age and Gender Distribution) (n=225)*

Age Group (Years)	Total (n)	Male (%)	Female (%)	Male (n)	Female (n)	Male-to-Female Ratio
<40	50	57	43	29	21	1.38:1
40-49	70	58	42	41	29	1.41:1
50-59	55	54	46	30	25	1.20:1
60+	50	53.5	46.5	27	23	1.17:1
Total	225	56.4	43.6	127	98	1.30:1

n=Number of Participants, %=percentage

The study cohort of 225 participants was divided into three groups based on glycemic control. The mean age of participants was 50.2 ± 7.5 years in the well-controlled group (HbA1c <7%), 52.8 ± 8.2 years in the mildly controlled group (HbA1c 7–9%), and 54.1 ± 9.3 years in the inadequately controlled group (HbA1c >9%) and it was not statistically different

Table II: *Diabetes Duration and Age Across Glycemic Control Groups (n=225)*

Group	Mean Age (yrs) & SD	Diabetes Duration (0–5 yrs) & SD	Diabetes Duration (5–10 yrs) &SD	Diabetes Duration (>10 yrs) & SD
Well-Controlled (HbA1c <7%)	50.2 ± 7.5	Mean: 2.3 ± 1.2	Mean: 7.1 ± 1.5	Mean: 12.0 ± 2.5
Mildly Controlled (HbA1c 7–9%)	51.8 ± 8.2	Mean: 2.7 ± 1.4	Mean: 7.3 ± 1.8	Mean: 12.3 ± 2.8
Inadequately Controlled (HbA1c >9%)	53.1 ± 9.3	Mean: 2.5 ± 1.6	Mean: 7.6 ± 2.1	Mean: 13.0 ± 3.2
p value	0.08			

n=Number of Participants, SD=standard deviation, yrs= years, p value calculated by ANOVA, p value < 0.05 considered significant

across the three groups (p value = 0.8). The diabetes duration for each glycemic control group spans three categories: 0–5 years, 5–10 years, and more than 10

Table III: *Association between Gender Distribution and Prevalence of CPI Code 3 or 4 with HbA1c Groups*

Group	Male (%) (n)	Female (%) (n)	Total (n)	Prevalence at Baseline (%)	Prevalence at 6 Months (%)	Prevalence at 12 Months (%)	p-value (Gender Distribution)	p-value (Baseline)	p-value (6 Months)	p-value (12 Months)
Well-Controlled (HbA1c < 7%)	60(45)	40(37)	82	20	25	30	0.93	0.2	0.047	0.015
Mildly Controlled (HbA1c 7–9%)	61.3(46)	38.7(35)	81	40	50	60	-	0.2	0.047	0.015
Inadequately Controlled (HbA1c > 9%)	65.3(36)	34.7(26)	62	60	75	85	-	0.2	0.047	0.015

n=Number of Participants, CPI= Community Periodontal Index, p value calculated by Chi square test, p value < 0.05 is considered significant

years, with varying means and standard deviations reflecting the diversity in how long participants have had diabetes (Table II).

The Chi-Square test was applied to assess the gender distribution across the three glycemic control groups: The male-to-female ratios were relatively consistent across the groups, with 60% males in the well-controlled group, 61.3% in the mildly controlled group, and 65.3% in the inadequately controlled group, while females made up 40%, 38.7%, and 34.7% in each group, respectively. The Chi-Square test for gender distribution yielded a p-value of 0.93, indicating no significant difference in gender across the groups. (Table III). Additionally, the Chi-Square test was used to analyze the prevalence of CPI Codes 3 and 4 at baseline, six months, and twelve months. The prevalence of CPI Codes 3 or 4 was 20%, 40%, and 60% at baseline, 25%, 50%, and 75% at six months, and 30%, 60%, and 85% at twelve months for the well-controlled, mildly controlled, and inadequately controlled groups, respectively. The Chi-Square test results showed no significant difference at baseline, but significant differences in CPI Code 3 or 4 prevalence at both six and twelve months (Figure I).

There was a significant increase in periodontal disease severity over time, with an elevated rate of progression in patients with poorly controlled diabetes. At baseline, 20% of the well-controlled group had CPI Code 3 or 4, which increased to 25% at six months and 30% at twelve months. In the mildly controlled group, the prevalence of CPI Code 3 or 4 was 40% at baseline, rising to 50% at six months and 60% at twelve months. The poorly controlled group exhibited the most severe periodontal deterioration, with 60% of patients showing CPI Code 3 or 4 at baseline, escalating to 75% at six months and 85% at twelve months (Figure-I).

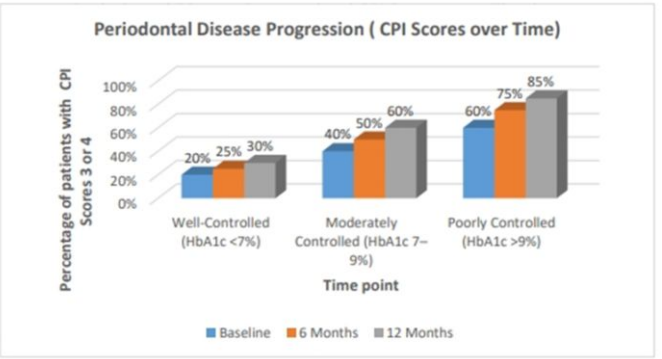

Figure I: *Periodontal Disease Progression Over 12 Months.*

The degree of periodontal disease was found to be

Table IV: *Correlation Analysis Between Variables*

Variable	Correlation Coefficient (r)**	p-value***
HbA1c and CPI Score	0.72	<0.001
Diabetes Duration and CPI*	0.68	<0.001

**CPI: Clinical Periodontal Index.*
***calculated by Pearson correlation,*
****Significant p-values, p value < 0.05 considered significant.*

strongly positively correlated with HbA1c levels. With a p-value of less than 0.001, Pearson correlation ratio (r) between HbA1c levels and CPI score was 0.72, suggesting a statistically significant association. With a p-value of less than 0.001 and an R-value of 0.68, the correlation between diabetes duration and CPI was likewise significant, indicating that a prolonged time span of diabetes is linked to an increased severity of periodontal disease (Table IV).

Discussion

The present study underscores the significant impact of glycemic control and diabetes duration on periodontal health, as measured by the Community Periodontal Index (CPI) over a 12 month period. Our findings reveal that poorly controlled diabetes (HbA1c >9%) and longer disease duration (>10 years) are strongly correlated with the progression of periodontal disease. In contrast to 40% in the mildly controlled group and 20% in the well-controlled group, 60% of diabetics with poorly controlled diabetes had CPI codes 3 or 4 at baseline. The severity of periodontal disease progression with poor glycemic control was highlighted by these numbers, which rose over time and reached 85% in the poorly controlled group at 18 months. In 2021, Stoicescu et al. studied 182 type 2 diabetes patients with generalized chronic periodontitis, assessing glycemic control through HbA1c levels and various periodontal parameters. The study found that patients with poor glycemic control (HbA1c ≥7%) had significantly worse periodontal health, including higher plaque accumulation, probing depth, and clinical attachment loss.[19] In comparison, our study of 225 participants found a significant correlation between HbA1c levels, diabetes duration, and periodontal disease severity. Over 12 months, the poorly controlled group increased to 85%, while the mildly controlled group increased to 55%, and the well-controlled group increased to 30%. Moreover, a significant correlation was found between HbA1c levels and CPI scores, and between diabetes duration and CPI scores. Wu et al., in a meta-analysis, reviewed 53 observational studies and found a higher prevalence of periodontitis among Type II Diabetes patients(T2DM), as reflected in a 0.61 mm deeper periodontal pocket, a 0.89 mm higher attachment loss and approximately 2 more lost teeth, than those without T2DM. They found that T2DM could elevate the risk of developing periodontitis by 34%. The glycemic control of T2DM patients might result in different periodontitis outcomes.[20] This study parallels our finding that diabetic patients with poor glycemic control exhibit worse periodontal outcomes.

In 2023, Nabila et al. reported that individuals who had good glycemic control had better periodontal health compared to those with poor oral hygiene practices.[21] This is in accordance with the results of current study. Santonocito et al. investigated how patients with type 2 diabetes's metabolic status and glycemic control were affected by periodontitis. Researchers found that patients with severe periodontitis had a worse lipid profile and significantly higher HbA1c levels than those with mild or no periodontitis.[22] This aligns with our findings that poor periodontal health is associated with suboptimal glycemic control. Furthermore, studies highlighted the bidirectional association between periodontal disease and diabetes. The researchers found that poor glycemic control in diabetic patients exacerbates periodontal inflammation, leading to increased severity of periodontitis. Conversely, the presence of periodontal disease negatively affects glycemic control, creating a cyclical relationship that complicates disease management. Chen et al. included 23 RCTs in their systematic review and meta-analysis. They reported that after 3 and 6 months, periodontal therapy significantly reduced glycosylated hemoglobin (HbA1c) level (3-month: weighted mean difference [WMD] - 0.514, 95% confidence interval [CI] - 0.730, - 0.298, p = 0.000; 6-month: WMD - 0.548, 95% CI - 0.859, - 0.238, p = 0.000).[23,24] This underscores the necessity for integrated care approaches that address both conditions simultaneously.

The longitudinal design of the current study provides a comprehensive view of periodontal disease progression in diabetic patients over time. By stratifying participants based on HbA1c levels and diabetes duration, the role of poor glycemic control was identified as a risk factor contributing to periodontal deterioration. The correlation analysis

further reinforced the results, with HbA1c levels showing a strong positive correlation with CPI scores, and diabetes duration similarly correlating with periodontal severity. These results are in line with previous research and emphasize the value of including periodontal examinations in regular diabetes care from a clinical standpoint.[25]

Conclusion

This study highlights the significant link between poor glycemic control, longer duration of diabetes, and worsening periodontal health. The findings underscore the importance of recognizing periodontal disease as a common and serious complication of diabetes. Integrating dental professionals into multidisciplinary diabetes care teams is essential to ensure comprehensive management and improved health outcomes. Collaborative care models should prioritize routine periodontal evaluation and intervention as part of standard diabetes management protocols.

Limitations and Recommendations: This was an observational study; therefore, it limits causal inferences. Self-reported data on diabetes management and oral hygiene may introduce bias, and the study did not account for all potential confounders, such as genetic factors or comorbidities. Larger, longitudinal studies are needed to fully comprehend how diabetics' periodontal health and glycemic control are related.

Conflict of Interest: None

Funding Disclosure: None

Ethical Consideration: The study was approved by the ethical review board (IBR reference: TUF/IBR/148/2022). Informed written consent was obtained and confidentiality was maintained.

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Authors Contribution: All the authors made substantial contributions equally in accordance with ICMJE guidelines as described below and are accountable for the integrity of the study.

AS: Conception of Idea, Literature Review, Data Acquisition and Analysis, and Final Draft.

SAK: Literature Review, Data Analysis, Final Review.

MM: Literature Search, Data Collection, Draft and Review.

NK: Literature Search, Data Analysis, Drafting the Manuscript and Revision

SI: Literature Search, Data Collection, Draft and Review.

NUH: Literature Search, Data Analysis, Drafting Manuscript and Revision

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