

## ASSOCIATION BETWEEN PERIODONTITIS AND GLYCEMIC CONTROL OF TYPE 2 DIABETES MELLITUS: A CASE CONTROL STUDY

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### Abstract

**Background:** Periodontitis, a chronic inflammatory disease of the supporting structures of the teeth, has been recognized as a potential contributor to the management and progression of Type 2 Diabetes Mellitus (T2DM). T2DM is a metabolic disorder characterized by elevated blood glucose levels, and its control is vital in preventing complications. **Objective:** To evaluate the association between glycemic control and periodontitis in type-2 diabetes mellitus patients and evaluate their self-management compliance. **Methodology:** A case-control study was conducted at Dr. Ruth K. M. Pfau Civil Hospital in Karachi to examine the connection between periodontitis and diabetes. The cases and controls were matched for age and gender in a 1:1 ratio. Periodontitis was defined using specific oral health criteria. The participants were interviewed about their self-management pertinent to diabetes followed by periodontal and oral examination. Periodontitis was considered as  $\geq$  two sites with periodontal probing depth  $>4$ mm or attachment loss  $\geq 4$ mm and bleeding on probing gums grade=2. Their current HbA1c level was recorded from their medical history. The data was analyzed using SPSS v.21. Logistic regression was performed to assess the odds of glycemic control and self-management compliance in diabetic patients suffering from periodontitis than among those who did not have periodontitis. Odd ratios (ORs) were considered significant at 95% confidence interval. **Results:** The unadjusted odds ratio for poor glycemic control (HbA1c  $>7\%$ ) was 6.73 [CI=1.410, 32.173]. However, when adjusted for history of smoking and other addictions, the OR improved by 3.04 [CI= 0.494, 18,699] in cases as compared to controls. **Conclusion:** Poor periodontal condition appears to be associated with poor

*glycemic control in diabetics suffering from periodontitis. Improving self-compliance and addressing confounding factors like smoking may have the potential to positively impact both periodontal health and glycemic control in diabetic individuals with periodontitis.*

**Keywords:** Periodontitis, Glycemic Control, Periodontal Probing Depth, Type-2 Diabetes Mellitus.

## INTRODUCTION

Type 2 diabetes mellitus is a prevalent non-communicable global epidemic. With an ever-increasing number of diabetics, 26 out of 100 people in Pakistan are found at risk of diabetes mellitus.<sup>1</sup> This risk is known to increase with age, an unhealthy lifestyle, stress, lack of physical activity, and exposure to infectious diseases.<sup>1, 2</sup> Over the past two decades, researchers have proposed that soft tissue infectious diseases, including periodontitis, may serve as predictive factors for the sustained progression of hyperglycemia.<sup>3,4</sup> Patients with poorly controlled Type 2 Diabetes (T2DM), as indicated by elevated HbA1c levels, are expected to have a two to three times higher risk of developing periodontitis compared to those with better metabolic control, and vice versa.<sup>5, 6</sup>

Recent studies suggest that improving poor periodontal health can help regulate glycemic levels in diabetes mellitus patients.<sup>7, 8</sup> The importance of engaging dental manpower to identify undiagnosed diabetics has been highlighted by the researchers.<sup>9</sup> However, it is also evident that periodontal infections, metabolic disorders, and obesity are linked to excessive sugar consumption. High-sugar snacks, such as confectionery, cakes, and biscuits, contribute more to the consumption of free sugars and energy in middle-aged and older persons than sugar-sweetened drinks. The timing and size of the meal have an impact on blood glucose metabolism.<sup>10</sup> Snacking accounts for a significant portion of a person's daily energy intake especially snacks ingested between lunch and dinner.<sup>11</sup> Snacking may raise the risk of diabetes and concurrently affects periodontitis in T2DM individuals. Researchers have suggested that healthy diet contributes to controlling diabetes, especially among those who are not found involved with poor lifestyle-associated factors such as smokers and are overall better quality of life.<sup>12</sup> Hence, it is not only essential to engage both medical and dental professionals in diabetes management, but also crucial to emphasize the significance of self-management by individuals with diabetes to mitigate the condition. This study aimed to assess the association between glycemic control and periodontitis in patients with Type 2 diabetes mellitus and evaluate their compliance with self-management practices.

## METHODOLOGY

A case-control study was conducted on diabetic patients attending the Diabetic OPD of Dr. Ruth K. M. Pfau Civil Hospital Karachi. Participants were categorized based on the presence or absence of periodontitis, with cases and controls respectively. The initial sample size was determined considering the expected percentages of cases and controls with exposure to periodontitis, which were 45% and 15%, respectively. The minimum required sample size was calculated to be 84, with a 95% confidence interval, a 5% level of significance, 80% power, and a 5% margin of error. However, to account for potential missing data, the sample size was increased to 102 by adding 15%, resulting in 51 participants in each group. Cases and controls were age- and gender-matched at a 1:1 ratio.

Participants in each group were allocated using a consecutive sampling technique. Individuals were diagnosed with periodontitis if they exhibited two (2) or more sites with a periodontal probing depth >4mm, a clinical attachment loss (CAL) of ≥4mm, and a bleeding on probing (BOP) grading of 2.<sup>7,13</sup> Patients who had undergone any periodontal treatment in the past six months, had a history of antibiotic administration within the last three months, or were pregnant and post-menopausal women were excluded from the study. Written informed consent was obtained from all study

participants. The questionnaire included demographic information, as well as details about smoking and addiction profiles of the participants. Additionally, a self-compliance diabetes questionnaire was included to assess diabetes-related factors.<sup>14</sup> Before the study commenced, the questionnaire's reliability was established with a Cronbach's alpha coefficient of 0.90.

The periodontal examination involved assessing periodontal probing depth (PPD), clinical attachment loss (CAL), and bleeding on probing (BOP) to determine the presence or absence of periodontitis. Consistent with previous studies, the diagnostic criteria required a minimum of two affected sites. A single examiner conducted the clinical examination after achieving a moderate level of intra-examiner reliability agreement exceeding 70%. Data analysis was performed using SPSS version 21. Chi-square and independent t-tests were conducted to calculate p-values ( $\leq 0.25$ ) for variables significantly associated with periodontitis.

Odds ratios (ORs) were calculated at a 95% confidence interval (CI) for self-management variables in cases and controls. All significant variables were subjected to multivariate logistic regression analysis with a p-value threshold of  $\leq 0.05$  to determine their impact on cases (diabetics with periodontitis) compared to controls (diabetics without periodontitis).

## RESULTS

Glycemic control measured through HbA1c, education, BMI, smoking and other tobacco related addiction were found important predictors significantly effecting the cases as compared to control group (Table-1). Table-2 shows that glycemic control was significantly good [ $p < 0.05$ ] in diabetics without periodontitis as compared to the cases (diabetics with periodontitis).

Similarly, oral hygiene was found significantly fair in controls than cases and poor in cases than in control group [ $p < 0.05$ ]. Based on the self-management questionnaire responses, participants in both groups who regularly consumed more snacks and less meals were 72% more likely to have periodontitis [OR= 0.28 (CI= 0.100, 0.783), p-value= 0.015]. More than 50% of the cases were never doing self-blood sugar testing and therefore were twice more likely to present with periodontitis as compared to those without periodontitis where comparatively more patients (16% vs. 6%) were testing their blood sugar level themselves [OR= 2.68 (CI= 1.024, 7.029), p-value= 0.045].

Participants who were habitual in carrying sweets, drinks, and candies were found to have more chances of periodontitis as compared to those who were not carrying any sweets along with them [OR= 0.22 (CI= 0.052, 0.991)] (Table 3).

With reference to the good glycemic control (HbA1c), the likelihood of poor glycemic control was 6-times significantly reported [Crude OR= 6.73 (CI= 1.410, 32.173)] in diabetics with periodontitis than in diabetics without periodontitis. However, when adjusted for other variables such as smoking, other tobacco related addictions, frequent snacking and sweet/ candies the likelihood reduced to 3-times [AOR= 3.04 (CI= 0.494, 18.699)]. With reference to non-smokers, the current smokers were 12-times more significantly at risk of having periodontitis [Crude OR= 12.13 (CI= 3.336, 44.154)]. This risk remained almost same even after adjusting for other variables as seen in table-4 [AOR= 10.93 (CI= 1.912, 62.571)].

**Table 1: Baseline characteristics of cases (n=51) and controls (n=51)**

Variables	Cases n (%)	Controls n (%)	p-value*
<b>Age in years (Mean ±SD)</b>	47.64 ± 9.16	48.11 ± 9.49	0.799
<b>HbA1c % (Mean ±SD)</b>	9.68 ± 0.86	7.80 ± 0.79	<b>&lt;0.001</b>
<b>Gender</b>			
Male	35 (68.6)	35 (68.6)	0.58
Female	16 (31.4)	16 (31.4)	
<b>Educational Status</b>			
No education	32 (62.4)	22 (43.1)	<b>0.122</b>
Primary/Secondary	11 (21.6)	19 (37.3)	
Higher education	8 (15.7)	10 (19.6)	
<b>Marital Status</b>			
Unmarried	2 (3.9)	3 (5.9)	
Married	39 (76.5)	39 (76.5)	0.852
Divorced/Widow/Widower	10 (19.6)	9 (17.7)	
<b>BMI Status</b>			
Normal weight	5 (9.8)	7 (13.7)	<b>0.094</b>
Overweight + Obese	46 (90.2)	44 (86.3)	
<b>Smoking Status</b>			
Current/ Ex-Smoker	23 (44.2)	3 (5.9)	<b>&lt;0.001</b>
Non-Smoker	29 (56.9)	48 (94.1)	
<b>Frequency of smoking (n=25)</b>			
≥1 packet	14 (63.3)	2 (66.7%)	0.713
<1 packet	8 (36.4)	1 (33.3)	
<b>Other tobacco related Addiction</b>			
Yes	21 (41.2)	11 (21.6)	<b>0.027</b>
No	30 (58.8)	40 (78.9)	

\*p-value <0.25

**Table 2: Glycemic and periodontal status in cases (n=51) and controls (n=51)**

Variables	Cases (with periodontitis)	Controls (without periodontitis)	p-value
<b>Glycemic control</b>			
Good (≤ 7%)	2 (3.9)	11 (21.6)	<b>0.008</b>
Poor (> 7%)	49 (96.1)	40 (78.4)	
<b>Oral Hygiene</b>			
Good	4 (7.8)	10 (19.6)	<b>0.001</b>
Fair	20 (39.2)	32 (62.7)	
Poor	27 (52.9)	9 (17.6)	
<b>PPD (in mm)</b>	2.43 ± 0.78	1.83 ± 0.52	<b>&lt;0.001</b>
<b>CAL (in mm)</b>	5.13 ± 0.97	0.7 ± 1.7	<b>&lt;0.001</b>
<b>BOP</b>	1.02 ± 0.43	0.5 ± 0.41	<b>&lt;0.001</b>

**Table 3: Crude odds ratios [95% confidence intervals] for self-responded diabetes compliance in cases (with periodontitis=1) and controls (without periodontitis=0)**

Variables	Crude OR [95% CI]	p-value
I do frequent snacking or refreshments regularly every day	0.28 [0.100,0.783]	<b>0.015</b>
I do a self-blood sugar test according to doctor's recommendations only	2.68 [1.024,7.029]	<b>0.045</b>
I am carrying food like sweet drink, candy or chocolate just in case of hypoglycemia	0.22 [0.052,0.991]	<b>0.049</b>

**Table 4: Unadjusted and adjusted odds ratios in cases (with periodontitis=1) and controls (without periodontitis=0)**

Variables	Crude		Adjusted*	
	OR [95% CI]	p-value	AOR [95% CI]	p-value
Years of Education	0.93 [0.870, 1.010]	<b>0.090</b>	0.94 [0.844, 1.057]	0.322
BMI Status				
Normal	Ref.		--	--
Over-weight	0.35 [0.050, 2.407]	0.286		
Obese	1.71 [0.500, 5.849]	0.393		
Smoking				
No	Ref.		Ref.	
Yes	12.13 [3.336, 44.154]	<b>&lt; 0.001</b>	10.93 [1.912, 62.571]	<b>0.007</b>
Any Other Addiction				
No	Ref.		Ref.	
Yes	0.39 [0.164, 0.937]	<b>0.035</b>	0.13 [0.033,0.554]	<b>0.005</b>
Glycemic Control				
Good (HbA1c ≤ 7%)	Ref.		Ref.	
Poor (HbA1c > 7%)	6.73 [1.410, 32.173]	<b>0.017</b>	3.04 [0.494,18.699]	0.230
Frequent snacking	--		0.20 [0.082, 0.490]	<b>&lt; 0.001</b>
Check sugar on doctor's recommendation	--		1.30 [0.689, 2.454]	0.417
Carry sweets drinks, candies and chocolates	--		0.23 [0.061, 0.890]	<b>0.033</b>

## DISCUSSION

One in every 11 adults is suffering from diabetes in South-East Asia and three out of four diabetics belong to low-income countries.<sup>15</sup> The relationship between oral health and systemic well-being has long intrigued researchers and healthcare professionals. In this context, the association between periodontitis and glycemic control in Type 2 Diabetes Mellitus (T2DM) has gained significant attention. The results of this study show that diabetics with periodontitis had poorly controlled, significantly raised HbA1c level than the diabetics without periodontitis. Although this observation has become very common after multiple researches done on this topic in recent years, but the important point in this study is that the poorly controlled raised level of HbA1c, was 6-times significantly higher in diabetics suffering from periodontitis than those not having periodontitis. Similarly, Costa et al also reported significantly higher glycemic levels in relation to periodontitis [OR= 17.11].<sup>16</sup> This may be considered as an alarming situation since treating periodontitis is found to help reduce HbA1c level absolutely by 0.43% within 3 months and by 0.50% after one year.<sup>7</sup> This clinical importance is not only similar to that of adding second hypoglycemic drug but also important in preventing deaths due to complications related to diabetes.<sup>7, 17</sup>

Smoking and other tobacco-related addiction were found important predictors in this study. While adjusting for smoking and other tobacco-related addiction the odds of poor glycemic control were reduced in diabetics with periodontitis and became no different than in those with good glycemic control. However, the wider CI suggests that the sample size was small and therefore this important observation needs to be referred to with caution. On the other hand, despite controlling for other factors such as HbA1c level, frequent snacking, and carrying sweets smoking remained to have significantly 10-times increased effect (OR= 10.93) on diabetics with periodontitis as compared to those who were non-smokers. This was in accordance with the study that revealed a significantly higher OR of 5.3 among smokers with destructive periodontal health.<sup>18</sup> It is worth noting that snacking has emerged as a risk factor for the development of periodontitis; which is prominently reported in Diabetic patients. Among the self-reported statements regarding the compliance with management of diabetes, the adjusted analysis of the association between periodontitis and snacking has revealed the dominant and significant effect even though in the presence of traditional predictors (p-value < 0.001) in the current study. Possible explanation for this is that diabetic patients tried to consume more snacks in between meals to maintain their sugar levels which may turn out to have detrimental effects on their periodontal health. This was consistent with the study that reported a higher frequency of individuals consuming snacks having periodontitis (80%).<sup>19</sup> Moreover, this association is observed when periodontal disease status was expressed by > 4 teeth in multi-nominal regression analysis (PR = 1.42; 95% CI = 1.03–1.94; p = 0.030), independent of shared risk factors, corroborating our study result that periodontal disease is a systemic hyper inflammatory state induced by hyperglycemia which is consequence of snacking.<sup>20</sup> Another population-based study including diabetic patients in accordance with the results of our study, reported an association of higher values of initial periodontitis (SC = 0.134, SE = 0.05, p=0.005) with higher values of unhealthy diet (sugars, snacks, and salty/fast foods).<sup>21</sup> Our findings add to the knowledge of the topic showing that snacking leads to the high glycemic status of these diabetic patients worsening their periodontal outcomes, indicating the systemic negative effect of this type of dietary pattern on periodontal tissues. Thus, by limiting or excluding snacking, compromised periodontal health can be improved at the initial level. Thus, the above-mentioned scenario must be considered alarming for diabetic population who are habitual of consuming snacks regularly and may encounter with the severity of periodontal disease.

While the study's design enabled the quantification of multiple predictors, several limitations were observed. The retrospective nature of the case-control study design establishes correlation but not causation between exposure and outcome. Although recall bias was a concern, it was addressed through regression analysis.

## **CONCLUSION**

This study concluded that there is an association between Type 2 Diabetes (T2DM) and periodontitis. For diabetic individuals with periodontitis, improving their self-compliance with traditional risk factors like smoking and snacking is expected to lead to better glycemic control, which can help in managing both conditions.

**Ethical Statement:** Ethical approval was acquired from Institutional Review Board DUHS (IRB-1113/DUHS/Approval/2018/126) and the methodology of the research was approved by the Board of Advance Studies and Research Dow University of Health Sciences (DUHS/BASR/2018/-256).

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