**Original Article**

# Relation between Periodontitis and Prediabetic Condition

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**ABSTRACT**

**Statement of the Problem:** Prediabetic condition, which is characterized by impaired glucose tolerance, impaired fasting blood glucose, and hemoglobin A1c (HbA1c) higher than normal might be associated with periodontitis. Early diagnosis of this condition might decrease consequent tissue damage caused by periodontitis.

**Purpose:** The present study aimed to evaluate the association between prediabetes and periodontitis.

**Materials and Method**: This cross-sectional study was conducted on 108 prediabetic patients screened by primary fasting blood sugar (FBS) test (100-125 mg/dL). Three subsequent blood tests including FBS, HbA1C, and oral glucose tolerance test (GTT) were performed for ultimate diagnosis of these patients. The periodontal health was evaluated by employing bleeding on probing (BOP), clinical attachment loss (CAL), and plaque index (PI), Löe-Silness gingival index (GI), and pocket depth (PD). Data were analyzed by SPSS version 16, using t-test, ANOVA, and chi-square tests.

**Results**: The sample included 20 (19%) male and 88 (81%) female individuals with mean age of 49 years and mean BMI of 27.5. The mean FBS, GTT, and HbA1C were 107 MG/DL, 137MG/DL, and 5.9%, respectively. Clinical evaluation showed 33% of patients involved with periodontitis. The mean CAL, BOP, PI, PD, GI was 3.7, 0.62, 1.9, 2.1, 1.5, respectively ($p< 0.05$). A significant difference in periodontal index was found among patients with prediabetes. Moreover, in the patients with periodontitis, a statistically significant relationship between FBS and BMI, BOP and GTT, and finally between CAL and $HbA_1C$ was detected.

**Conclusion:** Periodontitis is associated with prediabetic condition. While diabetes is an important risk factor for periodontitis, the risk of periodontitis would be greater if glycemic control is poor. Glycemic control in prediabetic patients can reduce the severity of periodontal disease. Early diagnosis and prevention is crucial to avoid the largely irreversible tissue damage that occurs in periodontitis.

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## Introduction

Periodontal diseases are multi-agent infections caused by a number of anaerobic bacteria living on the tooth surface. Lipopolysaccharide and microbial agents in gingival tissues cause primary and permanent inflammation and subsequent increased levels of pre-inflammatory cytokine followed by the destruction of tooth supporting structures [1]. It is suggested that peri-

odontal infections can affect the general health of the body and prone the patient to coronary heart disease, stroke, diabetes, preterm delivery, low birth weight, and respiratory diseases [2]. Diabetes mellitus is a common metabolic disease characterized by hyperglycemia and impaired carbohydrate, protein, and lipid metabolism [3-5].

According to the world health organization (WHO), the number of diabetics will reach from the present over 180 million to 552 million in 2030 worldwide. Moreover, numerous studies suggest that the risk of developing type 2 diabetes mellitus is 5-15 times higher in prediabetic patients compared to in people with normal glucose levels [6-7]. Prediabetes is defined as a disorder of altered glucose metabolism, which does not conclude the formal definition of diabetes but deliberates an increased risk of progression to diabetes and/or vascular disease. According to WHO, prediabetics have a condition where blood glucose levels are higher than normal, but not the level to be categorized as diabetes [8]. In Iranian population, the prevalence of type2 diabetes was estimated to be 7.7% and that of impaired fasting glucose (IFG) was reported to be about 16.8% [9]. Diabetics are at higher risks of infections and periodontal diseases compared to other people. These infections can impair the ability to produce or use insulin and may therefore make diabetes more difficult to be controlled. Diabetes mellitus is a major hormone disease in terms of its demonstrated relationship with periodontitis. Diabetes constitutes a risk factor for periodontal diseases [10]. An increase in the prevalence and intensity of periodontitis in diabetics, especially in those with uncontrolled diabetes, has made periodontitis the sixth most common complication of diabetes mellitus [11]. Oral inflammatory diseases such as gingivitis and periodontitis are present in over 47.1% of patients with diabetes mellitus [12], and the periodontal tissue destruction is four times as prevalent in diabetics as in non-diabetic cases [13]. If type 2 diabetes remains undiagnosed for more than five years, the periodontal tissue destruction significantly increases [14-15]. Hyperglycemia contributes to the mechanism causing the oral complications of diabetes mellitus, which impairs gingival fibroblast synthesis and causes the loss of periodontal fibers that protect alveolar bone [16], ultimately followed by tooth loss. Persistent hyperglycemia can cause periodontal diseases in prediabetics by increasing the number of pre-inflammatory factors such as cytokines in periodontal tissues [17-22]. The studies conducted on periodontitis and prediabetic condition have targeted different subjects, and the prevalence of gingival problems in prediabetics has been reported in literature as 73%-91% based on different intensities and indices [23].

Given the importance of prediabetes and its prevention, the fact that few studies have addressed prediabetes and its relationship with periodontal status and that dentists play a key role in screening these patients, the present study was conducted to determine the frequency of periodontitis in diabetics referred to Tooba Clinic and Imam Khomeini Hospital in Sari, Iran in 2014-15.

## Materials and Method

### The study population

The present cross-sectional descriptive and analytical study was enrolled on a population comprised of 108 prediabetic patients referred to Tooba endocrinology clinic and Imam Khomeini Hospital in Sari, Iran in 2014-15. With the help of following equation, the sample size was calculated as 108 with a confidence interval of 95% and a statistical significance of 73.8%.

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}}\right)^2 P(1-P)}{d^2}$$

### Inclusion and exclusion criteria

The inclusion criteria comprised age of over 20 years, having at least 14 teeth, not receiving antibiotics within the previous three months and developing prediabetes based on the initial FBS test (100-125 mg/dL). The exclusion criteria consisted of smoking, consuming any antidiabetic medication or alcohol, having acute infections, ketoacidosis, or a positive history of chronic inflammatory and rheumatic diseases, taking glucocorticoid or immunosuppressive medicines and unwillingness to participate in the study.

### Data collection

After briefing the eligible patients on the study objectives, they completed informed consent forms and checklists including data on demographic information, a family history of diabetes, and a history of smoking, level of education. Moreover, the height and weight of each participant were measured for calculating body mass index (BMI).

**Periodontal examinations**

The patients diagnosed with prediabetes (screened by FBS test) underwent periodontal examinations conducted by a dentist using mouth mirrors and William's periodontal probes (Medisporex, Pakistan). Periodontal examination included measures of clinical attachment loss (CAL), pocket depth (PD), Löe-Silness gingival index (GI), plaque index (PI) and bleeding on probing (BOP) of all teeth [24-26].

The periodontal status was recorded as healthy, gingivitis or periodontitis. Before conducting the study, CAL, PD, GI, PI and BOP were calculated in five patients with periodontitis twice with a one-week interval, and the pairwise correlation coefficient of measurements was calculated as 0.84, confirming the measurements reliability [27]. Periodontitis was confirmed in a site with a minimum involvement and with a PD of at least 3 mm and a CAL of at least 2mm [28].

**Blood glucose tests**

A nurse conducted a two-stage blood sampling in the place where periodontal examinations were performed. The samples were immediately transferred to the laboratory, since blood, glucose drops by 0.7mg / (dL.h) might cause false results. Seventy-five gram of pure glucose was then dissolved in water and consumed by the patient and blood sampling was repeated 2 hours later. Serum was immediately isolated in the laboratory and underwent FBS and GTT tests. $HbA_1C$ was also performed after complete blood count (CBC) test on the blood samples. The samples were then tested using a blood glucose meter (Hitachi 911, Japan) [23].

**Statistical analysis**

The data collected were analyzed in SPSS-16 using the independent t-test for comparing quantitative variables between two groups and ANOVA for comparing them among several groups. The qualitative variables were also compared using the Chi-squared test and Fisher's exact test. The odds ratio of developing periodontitis was calculated with a confidence interval of 95%. In this study, $p< 0.05$ was set as the level of statistical significance.

## Results

The participants consisted of 20(19%) male and 88 (81%) female individuals. The mean BMI of the patients was 27.5 and their mean age was 49 years. The results showed that the screening test of FBS alone is not accurate enough to diagnose prediabetes due to misdiagnoses of 13 patients as normal and 30 as diabetic.

Table 1 presents the mean values of the study variables. The maximum mean attachment loss in the lower left quadrant was found to be 3.86 associated with the periodontitis group ($p< 0.05$). Separate comparison of mean values of three blood glucose tests in the periodontitis and normal groups (without periodontitis) suggested significant relationships between FBS and BMI, BOP and GTT, and between CAL and $HbA_1C$ in patients with periodontitis ($p< 0.05$) (Table 2).

**Table 1:** The mean values of the study variables

| Study variables | Mean values |
|---|---|
| BMI | 27.52±3.75 |
| Age(years) | 49.67±10.69 |
| FBS(mg/dl) | 107.30±10.97 |
| GTT(mg/dl) | 137.07±38.82 |
| $HbA_1C$ (%) | 5.95±0.42 |
| GI | 1.43±0.27 |
| PI | 1.74±0.34 |
| PD(mm) | 1.90±0.34 |
| CAL(mm) | 3.04±0.67 |
| BOP | 0.49±0.18 |

**Table 2:** The mean values obtained from three tests associated with FBS, GTT and HbA1c in the periodontitis and normal group separately

| Study variables | | Number | Mean values |
|---|---|---|---|
| Normal | FBS(mg/dl) | 72 | 107.31±7.89 |
| Periodontitis | | 36 | 107.28±15.49 |
| Normal | GTT(mg/dl) | 72 | 137.05±38.70 |
| Periodontitis | | 36 | 137.10±39.70 |
| Normal | $HbA_1C$ (%) | 72 | 5.97±0.31 |
| Periodontitis | | 36 | 5.928±0.09 |

The patients' BMI were divided into four groups of <20, 20-25, 25-30 and >30, and the indices related to periodontal health were compared among these four groups. The relationship of BMI with CAL, PD, PI, and GI was found to be significant. The subjects were also divided the subjects into three groups of high school, high school diploma and university degree in terms of level of education, and found significant relationships between PI and CAL in these groups. Comparing CAL, PD, PI and GI in these groups suggested significant relationships between PI and CAL. Patients with lower levels of education were also found to have higher PI and CAL ($p<0.05$). Investigating the relationship between periodontal health indices and the three blood glucose tests showed significant relationships between

PI and $HbA_1C$ (Table 3). The periodontal health-associated indices were also investigated in men and women, which represented no statistically significant differences (Table 4). In the patients with periodontitis, the mean values of indices are summarized in Table 5.

**Table 3:** The relationship between periodontal indices and FBS, GTT and HbA1c measurement tests by *p* Value

| Periodontal indices | FBS *p* Value | GTT *p* Value | $HbA_1C$ *p* Value |
|---|---|---|---|
| GI | 0.36 | 0.80 | 0.46 |
| PI | 0.48 | 0.10 | 0.01 |
| PD | 0.14 | 0.39 | 0.15 |
| CAL | 0.73 | 0.34 | 0.48 |
| BOP | 0.33 | 0.43 | 0.41 |

**Table 4:** Periodontal indices in the groups of male and female

| Periodontal indices | | Number | Mean | Mean values | *p* Value |
|---|---|---|---|---|---|
| GI | Male | 20 | 1.40 | 0.254 | 0.64 |
| | Female | 88 | 1.43 | 0.274 | |
| PI | Male | 20 | 1.72 | 0.346 | 0.83 |
| | Female | 88 | 1.74 | 0.343 | |
| PD | Male | 20 | 1.92 | 0.426 | 0.81 |
| | Female | 88 | 1.90 | 0.332 | |
| CAL | Male | 20 | 3.18 | 0.766 | 0.30 |
| | Female | 88 | 3.01 | 0.656 | |
| BOP | Male | 20 | 0.47 | 0.200 | 0.76 |
| | Female | 88 | 0.49 | 0.184 | |

**Table 5:** The mean periodontal indices in the healthy group and the periodontitis group

| Periodontal indices | Periodontitis group (36 Number) | Healthy group (72 Number) |
|---|---|---|
| GI | 1.58 | 1.35 |
| PI | 1.9 | 1.66 |
| PD(mm) | 2.19 | 1.76 |
| BOP % | 0.62 | 0.42 |

## Discussion

The prediabetes condition is classified as the stage before diabetes in which blood glucose is higher than the normal limit but lower than the threshold considered for diabetes in patients with prediabetes [29]. The tests that are generally employed to investigate the prediabetic status are FBS (blood glucose between 100 and 125 mg/dL) GTT (blood glucose between 140 and 199 mg/dL two hours after receiving 75 g of oral glucose), and $HbA_1C$ (between 5.7% and 6.4%) representing the blood glucose status within the previous three months [30-34]. Glucose tolerance is divided into three groups of normal glucose homeostasis, diabetes mellitus, and impaired glucose homeostasis. Glucose tolerance can be assessed through measuring FBS and $HbA_1C$. Furthermore, glycosylated hemoglobin below 5.6% is regarded as normal [30-31]. $HbA_1C$ is the most reliable and proper test for diagnosing diabetes in asymptomatic patients. IFG, impaired glucose tolerance (IGT), and $HbA_1C$ are not necessarily observed simultaneously in patients; nevertheless, patients belonging to all three groups are at higher risks of developing type 2 diabetes and cardiovascular diseases. This group of patients with positive results for all the three tests is sometimes referred to as prediabetics. The American diabetes association refers to this group of patients as increased risk of diabetes and WHO classifies them as hyperglycemic [31]. The present study showed that the screening test of FBS per se was not precise enough for diagnose of prediabetes since 13 patients were misdiagnosed as normal and 30 as diabetic.

The effects of uncontrolled diabetes on periodontitis include gingival enlargement, periodontal abscess, periodontitis, and loose teeth. The most predominant changes in uncontrolled diabetes are impaired immune mechanism and more susceptibility to infections in the host, which causes periodontitis [32]. Findings of the current study suggested prediabetic condition was associated with periodontal inflammation. The study conducted in Japan [34] confirmed the positive relationship between periodontal diseases and IGT, whereas the study of Anoop *et al.* [35] contradicts this finding. The present study examined 108 prediabetics, no significant differences were observed between the men and the women in terms of periodontal health indices. Furthermore, no significant relationships were observed between these indices and the recorded family history of diabetes ($p< 0.05$).

Hong Jw *et al.* [36] found the prevalence of periodontitis to be 29% in patients with an IFG of 100-125 mg/dL. Moreover, they found that higher IFG before developing diabetes leads to higher risk of developing periodontitis. The results of the present study supported the findings of the aforementioned study and showed that the prevalence of periodontitis is 33% and the mean IFG is 107 mg/dL. Significant relationships were also observed between CAL and $HbA_1C$ as a criterion for diagnosing prediabetes ($p<0.05$).

Youn-Hee *et al.* [37] reported positive correlations between PD and IFG and between CAL and IFG. These researchers concluded that, in American population,

there are positive relationships between IFG and chronic periodontitis, which was assessed by calculating CAL [37]. However, the present study found the mean CAL in the lower left quadrant to be 3.86 in the periodontitis group. In addition, the mean PD was obtained as 2.19 mm, the mean GI as 1.58, the mean PI as 1.90 and the mean BOP as 69%. BMI was also significantly related to both FBS and CAL in the patients with periodontitis ($p< 0.05$).

Obesity is a risk factor associated with diabetes, periodontal diseases, and cardiovascular diseases [5]. A study conducted by Robert J *et al.* [38] found the relationship of BMI with periodontitis intensity (using CAL) and diabetes to be positive, with BMI being an indicator of obesity ($p<0.01$). Likewise, in our study, the patients' BMIs were divided into four groups of <20, 20-25, 25-30 and >30, and the indices related to periodontal health were found to be significantly related to BMI in these four intervals ($p< 0.05$).

A case-control study conducted by Fawad *et al.* [33] which compared the effect of personal oral care, periodontal infection status ,and social status in prediabetics, reported a probe depth of 4-<6 in the control group and over 6 in the prediabetic group. They also found a mean tooth drop of 3.4 in the prediabetics and 1.65 in the controls. In fact, prediabetics with lower social status had higher PI [33].

The present study divided the subjects into three groups of high school, high school diploma and university degree in terms of level of education, and found significant relationships between PI and CAL in these groups. The relationship of level of education with PI and periodontal attachment loss was found to be significantly negative ($p< 0.05$); suggesting the effectiveness of educational influences in conveying oral health messages. Investigating the relationship between periodontal health indices and the three blood glucose tests suggested significant relationships between PI and $HbA_1C$. Further studies are recommended given the lack of references confirming this finding.

## Conclusion

Within the limitations of the study, the results confirm that prediabetic condition is associated with periodontal inflammation. Blood glycemic control in prediabetic patients can reduce severity of periodontal parameters. Early diagnosis and prevention are fundamentally important to avoid the largely irreversible tissue damage that occurs in periodontitis.

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## Conflict of Interest

There was no conflict of interest to declare.

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