Article published online: 2022-12-15



# Alveolar Bone Loss in Diabetic Patients: A Case–Control Study

Afsheen Tabassum[1]

[1] Department of Preventive Dental Sciences, College of Dentistry, Imam Abdulrahman Bin Faisal University, Dammam, Kingdom of Saudi Arabia

**Address for correspondence** Afsheen Tabassum, PhD, College of Dentistry, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31411, Kingdom of Saudi Arabia (e-mail: atabassum@iau.edu.sa).

Eur J Dent 2024;18:168–173.

## Abstract

**Objectives** Based on literature, very few case–control studies have been executed to confirm the relationship between diabetes mellitus and the severity of mean alveolar bone loss. Therefore, the aim was to assess the differences in mean alveolar bone loss among diabetic (type 2) and nondiabetic patients in the Saudi population.

**Materials and Methods** Nine-hundred eighty-two patient records were seen in this retrospective study. Patient demographic data and medical records were examined. The mean alveolar bone loss was measured in posterior teeth by calculating the distance from the base of cementoenamel junction to the alveolar crest using the bitewing radiographs. SPSS 20.0 was used for data analysis. An unpaired *t*-test was utilized to analyze the mean alveolar bone loss across multiple variables. *p*-Value less than or equal to 0.05 was contemplated as significant.

**Results** The overall mean alveolar bone loss for all 124 patients was $2.83 \pm 1.13$ mm. Diabetic patients had greater mean alveolar bone loss measured in millimeters than nondiabetic patients ($3.07 \pm 1.14$mm vs. $2.59 \pm 1.08$mm, respectively), and the difference was significant ($p = 0.018$). In terms of the severity of mean alveolar bone loss, diabetic patients experience statistically higher mean alveolar bone loss as compared with nondiabetic patients.

**Conclusion** In our study population, the overall mean alveolar bone loss prevalence was greater in diabetes patients than in nondiabetic individuals. According to the severity of bone loss, the distribution of moderate and severe periodontitis was higher in diabetic patients. To enhance patients' quality of life, the awareness and education among patients regarding the association among diabetes mellitus and oral health, particularly periodontal disease, should be promoted.

**Keywords**
- periodontitis
- alveolar bone loss
- diabetes mellitus
- case–control study

## Introduction

Diabetes mellitus (DM) is considered a major public concern.[1,2] Diabetes is categorized into two main types: type 1 (Insulin-dependent) and type 2 (Noninsulin-dependent).[3] Type 2 DM represents approximately 95% of diabetic cases.[4] Based on the International Diabetes Federation data, DM prevalence has sharply increased worldwide during the last few years and will triple in the following decade.[1] It is estimated that between 1992 and 2022, type 2 DM prevalence among Saudi adults aged 25 and older will increase significantly, from 8.5 to 39.5%.[5,6] Comorbid symptoms like nephropathy, neuropathy, and cardiovascular complications are ultimately brought on by DM.[7] Additionally, DM has been

**article published online**
December 15, 2022

**DOI** https://doi.org/10.1055/s-0042-1758071.
**ISSN** 1305-7456.



Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

linked to several oral health-related disorders, including periodontal disease (PD), xerostomia, halitosis, fungal infections, and oral mucosal lesions.[3,8,9]

PD is an oral infection that is distinguished by the loss of alveolar bone support around teeth.[10,11] Severe periodontitis can lead to tooth loss and affects approximately 5 to 20% of the world's adult population. The association between DM and periodontitis has been reported in the literature.[12–14] DM is linked to alveolar bone loss and is known as a risk factor for PD.[15] A higher clinical attachment loss (CAL), alveolar bone loss, a greater percentage of furcation lesions and tooth mobility are correlated with diabetes.[14–16]

Persistent hyperglycemia causes extravagant immune responses in the presence of periodontal pathogens and is expected to be accountable for the increased risk and severity of alveolar hone loss in diabetic patients.[17,18] Diabetes has a significant impact on osteoclastogenesis and increases osteoblast apoptosis.[19] Nevertheless, a bidirectional relationship has been reported between periodontitis and DM.[20] PD negatively affects the glycemic control of the patients and it has been reported that host-derived inflammatory mediators released due to increasing bacterial load in PD play a vital role.[15]

Furthermore, Heji et al reported that periodontal examination findings can help to identify patients at risk of undiagnosed diabetes or prediabetes.[21] By performing a comprehensive radiographic and periodontal examination, dental practitioners can identify patients who have a risk factor for diabetes, particularly if they have a family history of diabetes, and earlier referral to the medical can be established. This relationship must be understood not only by dentists but also by physicians who work to improve the lifestyle and well-being of diabetic patients. Matrooshi et al demonstrated that, despite having good knowledge, physicians seldom refer diabetic patients for appropriate periodontal care.[22]

Based on the literature, very few case–control studies have been executed to confirm the relationship between DM and the severity of mean alveolar bone loss (MABL). Furthermore, no such study has been conducted in Saudi Arabia's Eastern province. There is a substantial need to investigate the differences in MABL among diabetic and nondiabetic individuals. This study aimed to evaluate the mean differences in alveolar bone loss among diabetic (type 2) and nondiabetic patients in the Saudi population.

## Materials and Methods

### Ethical Approval

Ethical approval for this retrospective study was acquired from the Institutional review board of Imam Abdulrahman bin Faisal University (IAU), Dammam, Saudi Arabia (IRB approval number: IRB:2020-02-109). This study was conducted according to the Helsinki Declaration guidelines.

### Patient Selection

The College of Dentistry, IAU, database was searched for patients who had a clinic visit in the last 3 years. Inclusion criteria for patient records were availability of complete intra, extraoral, and radiographic examinations of the patient.

#### Inclusion Criteria

Patient inclusion criteria for this study were (1) patient age (18 years old or older), (2) complete medical and dental records of the patients, and (3) Bitewing (BW) radiographs of the patients.

#### Exclusion Criteria

Following were the study's patient exclusion criteria: (1) patients with an incomplete medical history, (2) the patient's whose BW radiographs were missing, and (3) patients who did not have at least two adjacent teeth or whose interproximal space between teeth was narrow, and the crest of the bone was not visible. The information gathered includes the patient's age, gender, medical history, nationality, and radiographs.

### Radiographic Examination

In this study, BW radiographs were utilized to assess MABL. The BW radiographs were used to reduce angular distortion. Alveolar bone loss was calculated on the mesial and distal surfaces of the mandibular and maxillary posterior teeth using ImageJ software (Wayne Rasband, version 1.47, National Institutes of Health, Bethesda, Maryland, United States). Mean of mesial and distal bone loss was calculated and used for further analysis as MABL. All of the measurements were standardized using a radiograph of an implant of known diameter as a reference.

To calculate alveolar bone loss, a line was drafted along the long axis of tooth on the mesial and distal sides from apical part of the cementoenamel junction (CEJ) to the top of the alveolar crest (►**Fig. 1**). A distance greater than or equal to 2 mm between the CEJ and the alveolar crest was contemplated as a radiographic sign of interproximal bone

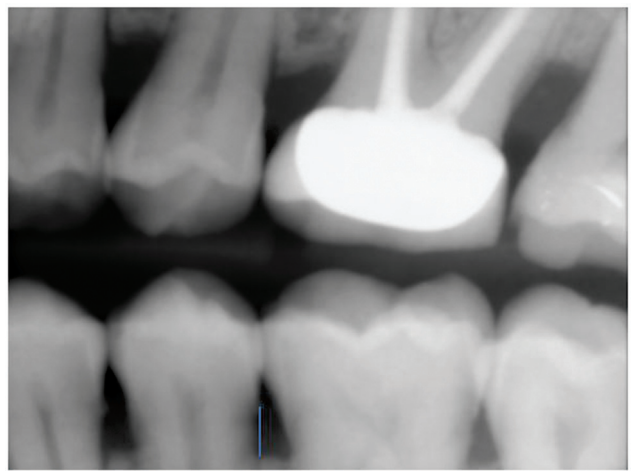

**Fig. 1** A bitewing radiographs of the patient for alveolar bone loss measurements. A straight line was sketched on the mesial and distal side of the tooth parallel to the long axis of each tooth from the most apical part of cementoenamel junction to the alveolar crest to measure the mean alveolar bone loss. A blue line is drawn at the distal aspect of the second premolar.

loss.[13–15,17] The severity was categorized based on case definition by task force classification from the American Academy of Periodontology into normal (MABL< 2mm), mild (MABL >2mm ≤3mm), moderate (MABL >3mm ≤5mm), and severe periodontitis (MABL >5mm).[13]

All the BW radiographs were examined in a dark room for accurate measurements. The convenient sample size was considered for this study.

### Statistical Analysis

SPSS 20.0 was used for data analysis (IBM product, Chicago, Illinois, United States). Gender, nationality, and age were among the categorical variables that were provided as frequencies and percentages. Age and bone loss measurements were included in the numerical data, which were displayed as mean standard deviation. Unpaired *t*-test was used to compare the MABL in different groups of teeth and maxilla versus mandible between diabetic patients and nondiabetic individuals. To evaluate effect of categorical variables, the MABL was compared in relation to gender, nationality, and age between the groups by employing unpaired *t*-test. A *p*-value less than or equal to 0.05 was considered significant.

## Results

The 982 patient records were examined and out of which 264 were excluded due to incomplete records. Seven-hundred eighteen records were examined and only 62 of these individuals, as indicated by their medical histories, had type 2 DM (►**Fig. 2**). Patients in the control group ($n = 62$) were chosen randomly from age and gender-matched computer-generated table with no prior history of DM. The secondary matching criterion was nationality. The average age of all the patients was $48.02 \pm 12.90$. In the diabetic group, there were 40 Saudi (67%) and 22 non-Saudi nationals (33%). The patients' average age was $48.21 \pm 13.03$ years. There were 44 Saudi (71%) and 18 non-Saudi nationals (29%) in the control group. The patients' average age was 47.8 12.9 years. In both diabetic and control groups, there was 42 male (67.7%) versus 20 female patients (32.3%).

The overall MABL for all 124 patients was $2.83 \pm 1.13$ mm. Diabetic patients had greater MABL loss measured in millimeters than nondiabetic patients ($3.07 \pm 1.14$ mm vs. $2.59 \pm 1.08$mm, respectively), and the difference was significant ($p = 0.018$). In terms of the severity of MABL, diabetic patients experience statistically higher bone loss compared with nondiabetic patients. ►**Table 1** represents the variations in MABL based on severity among diabetic and nondiabetic patients. The average prevalence of MABL was significantly greater in diabetic (85.5%) than nondiabetic patients (71%).

The MABL in various groups of teeth in diabetic patients versus nondiabetic patients is shown in ►**Fig. 3A** and ►**Table 2**. There was a significantly greater MABL in both premolar ($p = 0.039$) and molar ($p = 0.003$) groups of teeth in diabetic versus nondiabetic subjects. When the teeth were divided into groups of maxillary and mandibular teeth, a statistically significant difference was observed showing that diabetic patients had a higher MABL in both the maxilla ($p = 0.002$) and the mandible ($p = 0.006$) (►**Fig. 3B**).

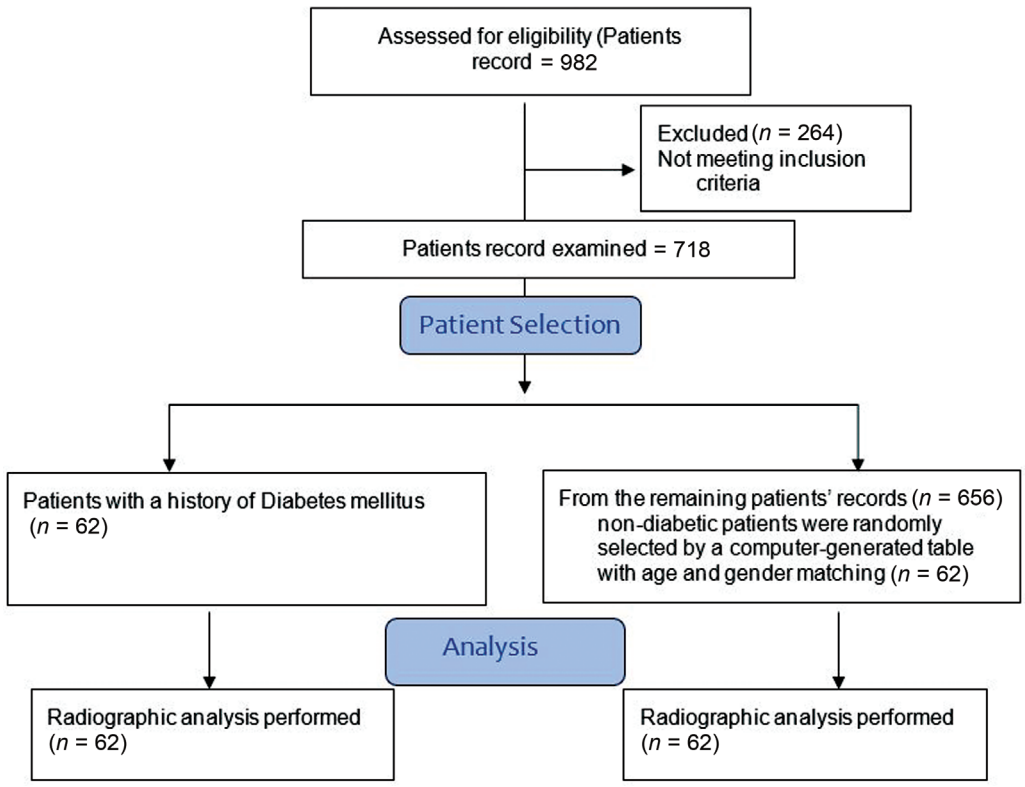


**Fig. 2** Flow diagram for patient selection.

**Table 1** Severity and prevalence of mean alveolar bone loss in diabetic and nondiabetic patients

| The severity of alveolar bone loss | Nondiabetic ($n = 62$) | Diabetic ($n = 62$) | *p*-Value |
|---|---|---|---|
| | *n* (%) | *n* (%) | |
| Normal ($n = 27$) | 18 (29) | 9 (14.5) | 0.043[a] |
| Mild ($n = 59$) | 31 (50) | 28 (45.2) | |
| Moderate ($n = 31$) | 10 (16.1) | 21 (33.8) | |
| Severe ($n = 7$) | 3 (4.8) | 4 (6.5) | |
| Alveolar bone loss prevalence | | | 0.028[a] |
| Normal | 18 (29) | 9 (14.5) | |
| Alveolar bone loss | 44 (71) | 53 (85.5) | |

*The severity of bone loss: normal (<2 mm), mild (2–3 mm), moderate (>3–5 mm), severe (>5 mm).*
[a]Statistically significant results at a 5% level of significance.

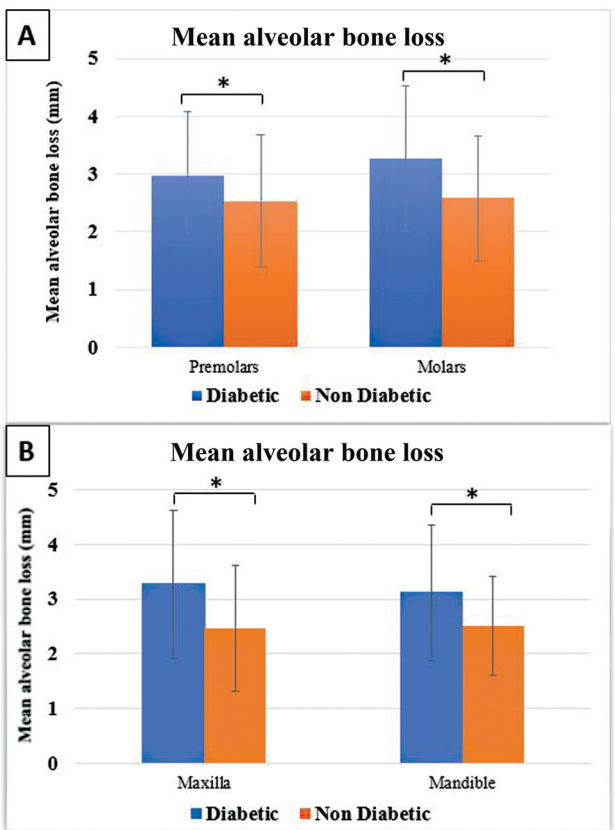


**Fig. 3** (A) Differences in mean alveolar bone loss in premolars and molars among diabetic and nondiabetic patients. (B) Differences in mean alveolar bone loss in maxillary and mandibular teeth among diabetic and nondiabetic patients. *Statistically significant results at a 5% level of significance.

Gender-wise differences in overall MABL among the diabetic and nondiabetic individuals were found to be significant for male patients, but nonsignificant for female patients (►**Table 3**). Age-wise differences in MABL among the diabetic and nondiabetic individuals were found to be higher for diabetic patients in both age groups; however, statistically it was determined to be nonsignificant (►**Table 3**). Furthermore, nationality-wise differences of mean bone loss among the diabetic and nondiabetic patients were higher in the Saudi diabetic population; however, the differences were observed to be nonsignificant (►**Table 3**).

**Table 2** Mean alveolar bone loss in different groups of teeth in nondiabetic and diabetic patients

| Groups of teeth | Diabetic ($n = 62$) | Nondiabetic ($n = 62$) | *p*-Value |
|---|---|---|---|
| Maxillary molars | $3.21 \pm 1.34$ | $2.42 \pm 1.75$ | 0.003[a] |
| Mandibular molars | $2.9 \pm 1.28$ | $2.36 \pm 0.91$ | 0.022[a] |
| Maxillary premolars | $3.4 \pm 1.51$ | $2.54 \pm 1.29$ | 0.006[a] |
| Mandibular premolars | $3.27 \pm 1.33$ | $2.5 \pm 0.89$ | 0.002[a] |

[a]Statistically significant results at a 5% level of significance.

**Table 3** Gender, age, and nationality wise differences of mean alveolar bone loss among diabetic and nondiabetic patients

| Groups of teeth | Diabetic Mean ± SD (*n*) | Nondiabetic Mean ± SD (*n*) | *p*-Value |
|---|---|---|---|
| **Gender** | | | |
| Male | $3.11 \pm 1.18$ (41) | $2.42 \pm 0.86$ (40) | 0.003[a] |
| Female | $2.96 \pm 1.02$ (21) | $2.9 \pm 1.36$ (22) | 0.88 |
| **Age** | | | |
| Below 50 | $3.0963 \pm 1.20$ (30) | $2.5830 \pm 1.15$ (30) | 0.10 |
| Above 50 | $3.0573 \pm 1.10$ (32) | $2.6041 \pm 1.03$ (32) | 0.09 |
| **Nationality** | | | |
| Saudi | $3.20 \pm 1.15$ (40) | $2.7070 \pm 1.19$ (44) | 0.061 |
| Non-Saudi | $2.85 \pm 1.09$ (22) | $2.3172 \pm 0.69$ (18) | 0.078 |

Abbreviation: SD, standard deviation.
[a]Statistically significant results at a 5% level of significance.

## Discussion

This study found a link between type 2 diabetes and MABL in a cohesive study population. This relationship remained consistent regardless of the severity of mean alveolar bone loss, its prevalence, site (maxilla or mandible), or position of the teeth. Gender, age, and ethnicity statistical analyses were performed in this study to account for the effect of age, gender, and ethnicity. This allowed for a more accurate assessment of the relationship between MABL and type 2 diabetes compared with nondiabetic subjects.

In this study, a case–control study design was used due to its distinct advantages over other study designs. Case–control studies are relatively reliable and low cost. The controls were chosen with age and gender as primary matching criteria and nationality as a secondary matching criterion' between the test and control groups. Marginal bone loss was

assessed using BW radiographs. Other diagnostic tools, such as periapical and panoramic radiographs, have been used to detect bone loss, but they provide limited diagnostic information. Several studies have confirmed that BW radiography is still the most effective diagnostic radiography for crestal bone examination.[23,24] It is a faster, less expensive method with a lower radiation dose.

Our findings are consistent with previous research. Diabetes is a known risk factor for PD. PD is common (34–68%) in diabetic patients, as well as increased pocket probing depths and CAL.[25,26] Patients whose glycemic control is poor have a higher risk of PD compared with healthy individuals.[27] Periodontitis is considered a sixth oral manifestation of diabetes.[15] In addition, diabetic patients have a greater susceptibility to periodontitis development and advancement in comparison to healthy individuals.[28,29]

Antibodies produced against microorganisms in periodontal tissues and predisposing genetic factors lay the foundation for an autoimmune role in PD pathogenesis.[30] Diabetes causes autoimmunity because of a breakdown in the normal defense process caused by by-products of tissue breakdown and chronic infection. PD and diabetes are linked epidemiologically because both conditions have autoimmune components.[31] Because PD and diabetes have a bidirectional relationship, proper periodontal care can improve metabolic control in DM patients.[32] The results of a meta-analysis that included nine randomized clinical trials confirmed the effectiveness of nonsurgical periodontal therapy in glycemic control and a moderate decrease in hemoglobin A1c among diabetic patients was observed.[33]

Concerning the severity and prevalence of MABL, this study showed that 50 and 45.2% of participants had mild, 16.1 and 33.8% had moderate, and only 4.8 and 6.5% had severe mean alveolar bone loss among nondiabetic and diabetic individuals, respectively. Correspondingly, Zahid et al observed a prevalence of mild, moderate, and severe alveolar bone loss comparable to our results, that is, 57.4% of the participants with mild, 36.6% moderate, and 4.95% severe alveolar bone loss.[34]

Furthermore, the nationality-wise differences in overall mean bone loss among diabetic and nondiabetic patients were higher in Saudi diabetic patients, but the differences were not significant. The non-Saudis nationals were mainly from Pakistan, India, Bangladesh, and Philippines. Delgado-Angulo et al discovered a complex link between ethnicity, socioeconomic status, and PD.[35] The role of variables in determining ethnic disparities in oral health, however, has not been assessed.[35] Further research should be conducted to examine the comparative roles of various factors that might aid in identifying variables which are more appealing to take necessary actions to reduce ethnic disparities in adult oral health care.[35]

The gender-related differences in mean alveolar bone loss among diabetic and nondiabetic patients were found to be significant for male patients but nonsignificant for female patients in this study. These findings are consistent with previous research that found males to be more likely to suffer from alveolar bone loss or periodontitis.[14,40] The causes of these gender differences are unknown; however, they may be related to males' poor compliance with oral hygiene practices.[43,44]

Our study's limitations were that our sample size was relatively small and the fact that we only studied patients who visited a single dental hospital. As a result, future multicenter studies should be conducted, with a larger study population. In addition, the relationship between clinical parameters of periodontitis such as periodontal probing depth (PPD) and CAL was not investigated in this study. More research is needed to determine the relationship between clinical parameters (PPD and CAL), DM severity, and radiographic alveolar crestal bone loss.

## Conclusion

In our study population, the overall mean alveolar bone loss prevalence was greater in diabetic patients than in nondiabetic individuals. According to the severity of bone loss, the distribution of moderate and severe alveolar bone loss was higher in diabetic as compared with nondiabetic patients. Oral complications of DM are numerous and alveolar bone loss or PD is one of them. It is possible to avoid PD and enhance patients' quality of life by raising awareness and education among patients regarding the relationship between DM and oral health. Diabetic patients should be motivated to practice good oral hygiene and manage their blood sugar levels appropriately to prevent oral problems.

Conflict of Interest
None declared.

Acknowledgment
The authors would like to express their gratitude to Mr. Intisar Ahmad Siddiqui for his assistance with data analysis. The researcher would like to acknowledge the perio postgraduate students and interns who assisted me in data collection.

## References

1 Saeedi P, Petersohn I, Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract 2019;157:107843 https://doi.org/10.1016/j.diabres.2019.107843
2 Ali Hassan S, Pratyusha F. Diabetes and oral diseases- a review. IP J Nutr Metab Heal Sci 2020;3(01):6–9
3 Al-Maskari AY, Al-Maskari MY, Al-Sudairy S. Oral manifestations and complications of diabetes mellitus: a review. Sultan Qaboos Univ Med J 2011;11(02):179–186 https://pubmed.ncbi.nlm.nih.gov/21969888/
4 Ramachandran A. Know the signs and symptoms of diabetes. Indian J Med Res 2014;140(05):579–581
5 Aljulifi MZ. Prevalence and reasons of increased type 2 diabetes in Gulf Cooperation Council Countries. Saudi Med J 2021;42(05):481–490
6 Al-Quwaidhi AJ, Pearce MS, Sobngwi E, Critchley JA, O'Flaherty M. Comparison of type 2 diabetes prevalence estimates in Saudi

Arabia from a validated Markov model against the International Diabetes Federation and other modelling studies. Diabetes Res Clin Pract 2014;103(03):496–503
7 Stumvoll M, Goldstein BJ, van Haeften TW. Type 2 diabetes: principles of pathogenesis and therapy. Lancet 2005;365 (9467):1333–1346
8 Indurkar MS, Maurya AS, Indurkar S. Oral manifestations of diabetes. Clin Diabetes 2016;34(01):54–57
9 Orbak R, Simsek S, Orbak Z, Kavrut F, Colak M. The influence of type-1 diabetes mellitus on dentition and oral health in children and adolescents. Yonsei Med J 2008;49(03):357–365
10 Graves DT, Li J, Cochran DL. Inflammation and uncoupling as mechanisms of periodontal bone loss. J Dent Res 2011;90(02): 143–153
11 Borrell LN, Papapanou PN. Analytical epidemiology of periodontitis. J Clin Periodontol 2005;32(Suppl 6):132–158
12 Genco RJ. Current view of risk factors for periodontal diseases. J Periodontol 1996;67(10):1041–1049
13 Genco RJ, Graziani F, Hasturk H. Effects of periodontal disease on glycemic control, complications, and incidence of diabetes mellitus. Periodontol 2000 2020;83(01):59–65
14 Madi M, Tabasum A, Elakel A, et al. Periodontal risk assessment in a teaching hospital population in Saudi Arabia's Eastern Province. Saudi Dent J 2021;33(08):853–859
15 Nazir MA, AlGhamdi L, AlKadi M, AlBeajan N, AlRashoudi L, AlHussan M. The burden of diabetes, its oral complications and their prevention and management. Open Access Maced J Med Sci 2018;6(08):1545–1553
16 Gupta N, Gupta ND, Gupta A, Goyal L, Garg S. The influence of type 2 diabetes mellitus on salivary matrix metalloproteinase-8 levels and periodontal parameters: a study in an Indian population. Eur J Dent 2015;9(03):319–323
17 Graves DT, Oates T, Garlet GP. Review of osteoimmunology and the host response in endodontic and periodontal lesions. J Oral Microbiol 2011;3:3
18 Chapple IL, Genco Rworking group 2 of the joint EFP/AAP workshop. Diabetes and periodontal diseases: consensus report of the Joint EFP/AAP Workshop on Periodontitis and Systemic Diseases. J Periodontol 2013;84(4, Suppl):S106–S112
19 Wu YY, Xiao E, Graves DT. Diabetes mellitus related bone metabolism and periodontal disease. Int J Oral Sci 2015;7(02):63–72
20 Preshaw PM, Alba AL, Herrera D, et al. Periodontitis and diabetes: a two-way relationship. Diabetologia 2012;55(01):21–31
21 Heji ES, Bukhari AA, Bahammam MA, Homeida LA, Aboalshamat KT, Aldahlawi SA. Periodontal disease as a predictor of undiagnosed diabetes or prediabetes in dental patients. Eur J Dent 2021; 15(02):216–221
22 Matrooshi KA, Raeesi SA, Tawfik AR, et al. Knowledge of physicians about the interrelationship between diabetes mellitus and periodontitis in the United Arab Emirates. Eur J Dent 2022;10.1055/s-0042-1746413
23 Ivanauskaite D, Lindh C, Rangne K, Rohlin M. Comparison between Scanora panoramic radiography and bitewing radiography in the assessment of marginal bone tissue. Stomatologija 2006;8 (01):9–15
24 Akesson L, Rohlin M, Håkansson J, Håkansson H, Näsström K. Comparison between panoramic and posterior bitewing radiography in the diagnosis of periodontal bone loss. J Dent 1989;17 (06):266–271
25 Llambés F, Arias-Herrera S, Caffesse R. Relationship between diabetes and periodontal infection. World J Diabetes 2015;6 (07):927–935
26 Artese HPC, Foz AM, Rabelo MdeS, et al. Periodontal therapy and systemic inflammation in type 2 diabetes mellitus: a meta-analysis. PLoS One 2015;10(05):e0128344. Doi: 10.1371/journal.pone.0128344
27 Maboudi A, Akha O, Heidari M, Mohammadpour RA, Gheblenama P, Shiva A. Relation between periodontitis and prediabetic condition. J Dent (Shiraz) 2019;20(02):83–89
28 Seppälä B, Seppälä M, Ainamo J. A longitudinal study on insulin-dependent diabetes mellitus and periodontal disease. J Clin Periodontol 1993;20(03):161–165
29 Stegeman CA. Oral manifestations of diabetes. Home Healthc Nurse 2005;23(04):233–240, quiz 241–242
30 Kaur G, Mohindra K, Singla S. Autoimmunity-basics and link with periodontal disease. Autoimmun Rev 2017;16(01):64–71
31 Koutouzis T, Haber D, Shaddox L, Aukhil I, Wallet SM. Autoreactivity of serum immunoglobulin to periodontal tissue components: a pilot study. J Periodontol 2009;80(04):625–633
32 Kudiyirickal MG, Pappachan JM. Diabetes mellitus and oral health. Endocrine 2015;49(01):27–34
33 Li Q, Hao S, Fang J, Xie J, Kong XH, Yang JX. Effect of non-surgical periodontal treatment on glycemic control of patients with diabetes: a meta-analysis of randomized controlled trials. Trials 2015;16(01):291. Doi: 10.1186/s13063-015-0810-2
34 Hossain MZ, Fageeh HN, Elagib MF. Prevalence of periodontal diseases among patients attending the Outpatient Department at the College of Dentistry, King Khalid University, Abha, Saudi Arabia. City Dent Coll J 2013Feb;10(01):9–12
35 Delgado-Angulo EK, Bernabé E, Marcenes W. Ethnic inequalities in periodontal disease among British adults. J Clin Periodontol 2016;43(11):926–933
36 Cruz GD, Chen Y, Salazar CR, Le Geros RZ. The association of immigration and acculturation attributes with oral health among immigrants in New York City. Am J Public Health 2009;99 (Suppl 2):S474–S480
37 Sanders AE. A Latino advantage in oral health-related quality of life is modified by nativity status. Soc Sci Med 2010;71(01): 205–211
38 Borrell LN, Taylor GW, Borgnakke WS, et al. Factors influencing the effect of race on established periodontitis prevalence. J Public Health Dent 2003;63(01):20–29
39 Craig RG, Boylan R, Yip J, et al. Prevalence and risk indicators for destructive periodontal diseases in 3 urban American minority populations. J Clin Periodontol 2001;28 (06):524–535
40 Gilbert GH. Racial and socioeconomic disparities in health from population-based research to practice-based research: the example of oral health. J Dent Educ 2005;69(09):1003–1014
41 Borrell LN, Crawford ND. Social disparities in periodontitis among US adults: the effect of allostatic load. J Epidemiol Community Health 2011;65(02):144–149
42 Borrell LN, Taylor GW, Borgnakke WS, Woolfolk MW, Nyquist LV. Perception of general and oral health in White and African American adults: assessing the effect of neighborhood socioeconomic conditions. Community Dent Oral Epidemiol 2004;32(05): 363–373
43 Albandar JM, Kingman A. Gingival recession, gingival bleeding, and dental calculus in adults 30 years of age and older in the United States, 1988-1994. J Periodontol 1999;70 (01):30–43
44 Slade GD, Spencer AJ. Periodontal attachment loss among adults aged 60+ in South Australia. Community Dent Oral Epidemiol 1995;23(04):237–242