Oman Medical Journal [2015], Vol. 30, No. 1: 36–41

The Relationship between Body Mass Index and Periodontitis in Arab Patients with Type 2 Diabetes Mellitus

Manal Awad[1]*, Betul Rahman[1], Haidar Hasan[2] and Houssam Ali[3]

[1]College of Dental Medicine, University of Sharjah, Sharjah, United Arab Emirates
[2]College of Health Sciences, University of Sharjah, Sharjah, United Arab Emirates
[3]Rashid Center for Diabetes and Research, Ajman, United Arab Emirates

ARTICLE INFO

Article history:
Received: 20 January 2014
Accepted: 22 February 2015

Online:
DOI 10.5001/omj.2015.07

Keywords:
Type 2 Diabetes Mellitus; Obesity; Periodontal Diseases; Cross-Sectional Studies.

ABSTRACT

Objective: Our study sought to evaluate the association between periodontitis and body mass index (BMI) among patients with type 2 diabetes mellitus. ***Methods:*** In this cross-sectional case control study analysis of 186 diabetic patients, 112 patients had a body mass index >30kg/m^2 and 74 control patients had BMI <30kg/m^2. All participants underwent oral examinations including a full mouth recording of clinical attachment level (CAL). Information regarding HbA_{1c} levels and high-sensitivity C-reactive protein (hs-CRP) were also gathered. ***Results:*** Over half (61%) of patients had a BMI >30. Of these 52% had CAL less than 2mm. Multivariate logistic regression analysis showed that there was no association between BMI and CAL. In addition, hs-CRP levels were significantly and positively associated with CAL (OR:1.06, 95% CI: 1.01, 1.12; p=0.007). ***Conclusion:*** Among patients with type 2 diabetes mellitus, there was no association between periodontitis and BMI. More studies are needed to further explore this relationship taking into consideration additional lifestyle factors.

The prevalence of obesity continues to increase worldwide. Obesity is now regarded as a significant health problem and a major contributor to the development of several chronic diseases including type 2 diabetes mellitus (T2DM).[1-5] In the United Arab Emirates (UAE) approximately 25% of the population was reported to be diabetic.[3] In addition, the age-standardized rates for prevalence of diagnosed and undiagnosed T2DM among 30–64 years olds were 29.0% and 24.2%, respectively.[4] Thus, the prevalence of T2DM in the UAE is one of the highest worldwide.[3,4] The most consistent explanation for this high rate of T2DM was obesity, which appears to be on the rise in the UAE.[5] Obesity leads to immunoinflammatory modifications and the condition has also been linked to periodontitis.[6-8] Periodontal disease is an infection of the structures around the teeth, which include the gums, periodontal ligament, and alveolar bone.[9-11] Clinical signs and symptoms of periodontal disease include redness, swelling, and formation of periodontal pockets between the gingiva and tooth roots. The presence of these pockets promotes the overgrowth of anaerobic bacteria and subsequent ulceration of the epithelium and destruction of collagen, periodontal ligament, and the bone that forms the attachment between the jaw and tooth root.[9,10]

Gingivitis is the first category of periodontal disease in which the inflammation is limited to the gingiva,[9] and is usually determined by gingival bleeding. In some cases the inflammation can extend to the periodontium resulting in destruction of the dental attachment apparatus and the occurrence of periodontitis. Clinical attachment level (CAL) and pocket depth (PD) are the clinical measures used to diagnose periodontitis.[10]

An analysis of the Third National Health and Nutrition Examination Survey (NHANES III) showed that body mass index (BMI) was significantly associated with periodontal disease. This led to the suggestion that abnormal fat metabolism may be an important factor in the pathogenesis of periodontal disease.[9]

The presence of periodontitis in a diabetic patient is considered to be a health hazard, as this chronic infection could worsen the patient's diabetic status.[10,11] Alteration in host immunity, including

*Corresponding author: awad@sharjah.ac.ae

increase secretion of adipokines has been proposed as the biological association between obesity, diabetes, and periodontitis.[10]

Some studies reported a positive association between being overweight/obese and periodontal disease,[12,13] while others have either reported moderate or no association between severity of periodontitis and BMI.[14,15]

Therefore, the aim of this study was to assess the relationship between BMI and periodontal disease, measured by CAL, in an Arab diabetic population. Additionally, the association between CAL and diabetic status was also evaluated.

METHODS

All 186 participants in this study were recruited from the Rashid Center for Diabetes and Research in Ajman, UAE. The case group (n=113) was composed of a random sample of patients with T2DM and a BMI greater than 30kg/m^2. The control group (n=73) included patients of similar age with T2DM and a BMI less than 30kg/m^2. This sample size was adequate to observe a 25% difference in the proportion of patients with periodontal disease between the cases and the controls.[16] The inclusion criteria was that patients must have a confirmed diagnosis of T2DM and must have at least eight teeth present in their oral cavity. The study was approved by the University of Sharjah Research Ethics Committee and participants signed consent forms prior to enrollment in the study.

Participants underwent a full-mouth clinical periodontal examination at six sites per tooth (third molars were excluded) carried out by two calibrated dentists using a manual periodontal probe with Williams markings and a tip diameter of 0.45mm. The oral examinations were carried out at the Rashid Diabetes & Research Center using portable dental chairs and appropriate lighting. The periodontal parameters included the following assessments: (i) pocket depth: the distance of the free gingival margin to the base of the probable pocket, recorded to the nearest millimeter and (ii) gingival recession, the location of the free gingival margin in relation to the cementoenamel junction (positive if located apical to the cementoenamel junction and negative if located coronal to the cementoenamel junction). The algebraic sum of pocket depth and gingival margin were used to compute the CAL. Measurements were made in millimeters and were rounded off to the nearest millimeter.[17,18]

Periodontitis was operationalized using methods that are currently used in literature studying the association between periodontitis and other diseases. All measurements were calculated using conventional clinical measurements obtained during the full-mouth periodontal examination. Mean CAL was also calculated.[19]

Blood samples were obtained from all of the participants. The samples (10ml) were collected in the morning between 10am–12pm by venous puncture and analyzed for glycated hemoglobin (HbA_{1c}) and high sensitivity C-reactive protein (*hs*-CRP).

Fasting glucose level was measured by enzymatic reference method with hexokinase and *hs*-CRP was measured by immunoturbidimetry. All samples were processed by the same laboratory, using principles of good laboratory practice. Glycemic control was assessed by HbA_{1c} for which values greater than 6.5% were considered as good control and less than 6.5% as unsatisfactory control.

Participant's weight and height were measured, with subjects wearing light clothing and no shoes, by an experienced nurse. Weight and height were measured using a portable digital scale and a portable stadiometer. BMI was calculated as the ratio of weight (kilograms) to the square of height (meters). According to the WHO guidelines, obesity for men and women was defined as a BMI of 30kg/m^2 or more.[20]

Assuming that obesity causes greater periodontal disease, and hence tooth loss, the remaining teeth could appear healthier. Accordingly, the number of remaining teeth is a potential confounder and was controlled for in the analysis.

Data were also collected on participants' age, sex, and smoking status.

The statistical package SPSS (version 20) was used for data processing and analysis. Participants' characteristics were described using frequency distribution for categorical variables and mean and standard deviation for continuous variables. Clinical attachment levels (mm) were calculated for each individual and then averaged across participants in each group. Differences in CAL (>2mm vs. <2mm) according to BMI were assessed using the Chi-square test. Multiple logistic regression analysis was used to assess the association of BMI and CAL adjusted

Table 1: Participants' characteristics and clinical characteristics according to body mass index (BMI).

Variables	Total	BMI <30kg/m²	BMI >30kg/m²
Sex (n)	**185**	**73**	**113**[a]
Female (%)	61(33)	33(45)	28(25)
Male(%)	124(67)	40(55)	85(75)
Age (n)	**186**	**74**	**112**[b]
mean, SD	54.3, 10.8	55.4, 9.6	55.2, 9.9
Education (n)	**185**	**73**	**112**[a]
School	145(78)	18(25)	90(80)
University	40(22)	18(25)	22(20)
Smoking (n)	**185**	**73**	**112**[a]
No	19(10)	10(14)	9(08)
Yes	166(90)	63 (86)	103(92)
Number of teeth (n)	**185**	**73**	**112**[b]
mean, SD	20.8, 6.7	20.6, 7.4	21.2, 6.4
CAL (n)**	**185**	**73**	**112**[a]
<2 n (%)	84 (45)	30 (41)	54 (47)
>2 n (%)	101 (55)	43 (59)	58 (52)
hs*-CRP (n)*	**185**	**73**	**112**[b*]
mean, SD	(7.43, 11.2)	(4.7, 1.5)	(9.2, 12.3)
HBA$_{1c}$ n(%)**	**185**	**73**	**112**[a]
<6.5	50 (27)	24 (33)	26 (24)
>6.5	135 (73)	49 (67)	86 (76)

a: based on chi-square test; b: based on independent T-test
**Significant p-value <0.050*

***CAL: clinical attachment level; hs-CRP: high sensitivity C reactive protien; HBA$_{1c}$: glycated hemoglobin*

for the independent variables in this study; diabetic status, HbA$_{1c}$ (%), *hs*-CRP (mg/L), number of teeth present, smoking status (0: no, 1: yes), age, sex, and level of education (school education complete/incomplete and university education complete/incomplete). In addition, multivariate logistic regression was also used to assess the relationship between CAL and diabetic status adjusted for the independent variables in the study.

RESULTS

Table 1 displays the demographic characteristics of the study participants, BMI, *hs*-CRP, HbA$_{1c}$ levels, and smoking status. Most patients (78%) were school level education, non-smokers (90%), and obese (60%).

Chi-square test revealed that the association between clinical attachment loss and BMI was

Table 2: Multivariate logistic regression analysis for the association between body mass index and clinical attachment level (CAL) when adjusted for participants' characteristics.

Variables	Odds Ratio	95% confidence interval	*p*-value
Sex			
Female	1		
Male	0.39	0.19, 0.77	0.007
Age	1.04	0.97, 1.04	0.820
Education			
School	1		
University	1.11	0.50, 2.47	0.800
Smoking			
No	1		
Yes	0.50	0.17, 1.50	0.680
Number of teeth	**1.20**	**0.93, 1.04**	**0.600**
HbA$_{1c}$*			
<6.5	1		
>6.5	0.66	0.31, 1.29	0.470
hs-CRP*	1.06	1.01, 1.12	0.007
CAL			
<2mm	1		
>2mm	1.20	0.59, 2.43	0.520

**hs-CRP: high sensitivity C reactive protien; HBA$_{1c}$: glycated hemoglobin*

Table 3: Multivariate logistic regression analysis for the association between clinical attachment levels and HbA$_{1c}$, adjusted for participants variables.

Variables	Odds Ratio	95% Confidence Interval	*p*-value
Sex			
Female	1		
Male	0.36	0.17, 0.78	0.010
Age	**1.06**	**1.03, 1.11**	**0.001**
Education			
School	1		
University	0.69	0.29, 1.60	0.690
Smoking			
No	1		
Yes	1.07	0.30, 3.78	0.910
Number of teeth	**0.90**	**0.85, 0.96**	**0.001**
HbA1c*			
<6.5	1		
>6.5	0.66	0.61, 2.86	0.470
hs*-CRP	**1.06**	**1.01, 1.11**	**0.047**

**hs-CRP: high sensitivity C reactive protien; HBA$_{1c}$: glycated hemoglobin* not statistically significant (p>0.050). This lack of association was also observed in the multivariate logistic regression analysis [Table 2]. However, in this model a significant positive association was observed between *hs*-CRP levels and BMI (OR=1.06, 95% confidence interval (CI): 1.01, 1.12; p=0.007). In addition, Table 3 shows that increase in age was associated with increase in odds of having CAL >2mm (OR:1.07, 95% CI: 1.03, 1.12; p<0.001). More teeth was also associated with less likelihood of having CAL greater than 2mm (OR: 0.90, 95% CI: 0.84, 0.96; p<0.050).

DISCUSSION

The findings of the present study show that there is no relationship between BMI and CAL among diabetic patients. This lack of association persisted after adjustment for possible confounding variables. Our results are in contrast to those previously reported,[13,18] where high BMI was significantly associated with an increased risk of periodontitis, but they are in agreement to those reported by other researchers who found no association or negative relationship between BMI and periodontal disease.[21,22] For example, Saito et al,[18] reported that obese individuals had a three-fold increase in risk of periodontitis compared to non-obese individuals. Genco et al,[12] suggested that an inflammatory pathway could explain the relationship between obesity and periodontitis and that tumor necrosis factor-α (TNFα) and soluble tumor necrosis factor α receptors could be elevated in obese people. Conversely, de Castilhos et al,[21] reported that among a group of 720 individuals, aged 24 years old, no association was observed between obesity, (measured by waist circumference) and periodontitis, (measured by periodontal pockets). The authors explained that the lack of association could be due to the younger age of their participants in which obesity may not be related to periodontitis. They also added that they only used periodontal pocket depth to assess the presence of periodontitis, which may have underestimated the presence of the disease due to possible attachment levels loss without the presence of pockets. Although the results of our studies are in agreement with findings reported by de Castilhos et al,[21] this explanation does not apply to our study results because older patients were included and CAL were used to assess periodontitis. Interestingly, Al Zahrani et al,[14] reported that high waist circumference was positively associated with periodontal disease in 18–34 year olds, but not in older patients.

Suvan and colleagues,[23] at the time of their systematic review, concluded that the association between body composition and periodontitis is inconclusive and more prospective studies are needed to establish the temporal relationship between body composition and periodontal disease. Moreover, the use of several criteria for the definition of periodontal disease by different researchers could contribute to the current lack of consensus regarding the above mentioned association.

Consistent with previous reports,[24] in this study *hs*-CRP was significantly and independently associated with BMI. In addition, the results from this study and other reports findings that also showed a relationship between C-reactive protein and periodontal disease[14,24,25] suggesting that this relationship could be of public health relevance. For example, if one of the objectives of a weight reduction program is to reduce a proinflammatory state then evaluation of the patient's periodontal status is important to effectively reduce *hs*-CRP levels. Results of several randomized clinical trials corroborate the current view that periodontal treatment is effective in reducing *hs*-CRP levels;[26] this underlines the importance of good oral health in maintaining systemic health.[25] Accordingly, health promotion programs that are designed to assist obese patients to lose weight and reduce the risks of cardiovascular disease should include oral health promotion.

In this study a high percentage of participants (73%) had uncontrolled diabetes (HbA_{1c} >6.5), these findings are similar to previous reports in the UAE, in which the percentage of patients with poorly controlled diabetes ranged from 68% to 73%.[27] However, the glycemic status of the patients (controlled vs. uncontrolled) in this study was not related to the patients' periodontal condition. These results are in agreement with other research findings that have also found no significant relationship between HbA_{1c} levels and periodontal disease measured by CAL.[28] On the contrary, other researchers have demonstrated that glycemic control worsens with the increase in the severity of periodontal disease.[29,30] For example, Lim et al,[29] results depict a positive association between

HbA_{1c} levels and the percentage of sites with PD >5mm. The reason suggested by the authors for poorer periodontal health among patients with poor glycaemic control was that the hyperglycaemic state results in accumulation of advanced glycated end products. These products in turn lead to several inflammatory reactions leading to the release of inflammatory mediators like interleukins 1 and 6, TNF-α and *hs*-CRP, thereby enhancing the periodontal breakdown process.[29] Santos el al,[28] suggested that a possible explanation for the inconsistency of findings between the association of patients' glycemic control and periodontal condition was the severity of periodontitis in the samples of patients selected in different studies. They argued that, compared to previous studies, their study included a large number of subjects with a relatively high mean CAL (>5mm) and periodontal PD, suggesting that a threshold above which periodontitis severity and HbA_{1c} level are not associated. Our study findings do not support this hypothesis because the percentage of subjects with a CAL above 5mm was only 8% (data not shown), yet our findings are in agreement with those of the authors.

The limitations of our study include the cross-sectional design, although the age of cases and controls were similar there was no gender balance between the obese and control group. We did not assess participants' oral hygiene habits and other life style factors[31] and therefore, the effect of variables such as frequency of brushing may have been informative.

CONCLUSION

Our findings indicate that among Arab patients with T2DM, there was no association between BMI and periodontitis assessed by CAL. The positive and significant association between BMI, CAL and *hs*-CRP is in agreement with previous findings and could have clinical implications when patients attempt weight loss. Longitudinal studies and clinical trials are needed to establish the causal association between diabetes, obesity, and periodontitis taking into consideration additional lifestyle factors to establish the impact of periodontal treatment on weight loss efforts.

Disclosure

The authors declared no conflict of interest. This study was supported by Sheikh Hamdan Bin Rashid Al Maktoum Award for Medical Sciences (Grant # MRC 09/10).

Acknowledgements

The authors wish to thank Drs Heba Madi, Asma Alemam, and Najla El Bluwi for the collection of data. We also wish to thank Dr Salah Abu Sinana, Director of Rashid Diabetes and Research Center, Ajman.

REFERENCES

1. Kopelman PG. Obesity as a medical problem. Nature 2000 Apr;404(6778):635-643.
2. Ajlouni K, Khader YS, Batieha A, Ajlouni H, El-Khateeb M. An increase prevalence of diabetes and its complications. J of Diab Complicat 2008;22:317-324.
3. Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: a review of current trends. Oman Med J 2012 Jul;27(4):269-273.
4. Alrawahi AH, Rizvi SG, Al-Riyami D, Al-Anqoodi Z. Prevalence and risk factors of diabetic nephropathy in omani type 2 diabetics in Al-dakhiliyah region. Oman Med J 2012 May;27(3):212-216.
5. Al-Riyami A. Type 2 Diabetes in Oman: Can we learn from the Lancet editorial. Oman Med J 2010 Jul;25(3):153-154.
6. Malik M, Bakir A, Saab BA, King H. Glucose intolerance and associated factors in the multi-ethnic population of the United Arab Emirates: results of a national survey. Diabetes Res Clin Pract 2005 Aug;69(2):188-195.
7. Saadi H, Carruthers SG, Nagelkerke N, Al-Maskari F, Afandi B, Reed R, et al. Prevalence of diabetes mellitus and its complications in a population-based sample in Al Ain, United Arab Emirates. Diabetes Res Clin Pract 2007 Dec;78(3):369-377.
8. Carter A, Saadi HF, Reed RL, Dunn EV. Obesity, lifestyle and reproductive health in a representative sample of women citizens of Al Ain, United Arab Emirates. J HPN 2004;22:75-83.
9. Wood N, Johnson RB, Streckfus CF; Third National Health and Nutrition Examination Survey (NHANES III). Comparison of body composition and periodontal disease using nutritional assessment techniques: Third National Health and Nutrition Examination Survey (NHANES III). J Clin Periodontol 2003 Apr;30(4):321-327.
10. Taylor GW, Borgnakke WS. Periodontal disease: associations with diabetes, glycemic control and complications. Oral Dis 2008 Apr;14(3):191-203.
11. Shlossman M, Knowler WC, Pettitt DJ, Genco RJ. Type 2 diabetes mellitus and periodontal disease. J Am Dent Assoc 1990 Oct;121(4):532-536.
12. Genco RJ, Grossi SG, Ho A, Nishimura F, Murayama Y. A proposed model linking inflammation to obesity, diabetes, and periodontal infections. J Periodontol 2005 Nov;76(11) (Suppl):2075-2084.
13. Dalla Vecchia CF, Susin C, Rösing CK, Oppermann RV, Albandar JM. Overweight and obesity as risk indicators for periodontitis in adults. J Periodontol 2005 Oct;76(10):1721-1728.
14. Al-Zahrani MS, Bissada NF, Borawskit EA. Obesity and periodontal disease in young, middle-aged, and older adults. J Periodontol 2003 May;74(5):610-615.
15. Nishida N, Tanaka M, Hayashi N, Nagata H, Takeshita T, Nakayama K, et al. Determination of smoking and obesity as periodontitis risks using the classification and regression tree method. J Periodontol 2005 Jun;76(6):923-928.
16. Ryan ME, Carnu O, Kamer A. The influence of diabetes on the periodontal tissues. J Am Dent Assoc 2003 Oct;134(Spec No):34S-40S.

17. Grossi SG, Genco RJ. Periodontal disease and diabetes mellitus: a two-way relationship. Ann Periodontol 1998 Jul;3(1):51-61.
18. Saito T, Shimazaki Y, Sakamoto M. Obesity and periodontitis. N Engl J Med 1998 Aug;339(7):482-483.
19. 0. Sheiham A. Steele JG, Marcenes W, Finch S, Walls AW. The relationship between oral health and body mass index among older people: A national survey of older people in Great Britain. Br Dent J 2008; l192:703-706.
20. WHO Obesity and overweight factsheet. From www.who.int/mediacentre/factsheets/fs311/en/. Accessed 9 February 2015.
21. <unknown>221. de Castilhos ED, Horta BL, Gigante DP, Demarco FF, Peres KG, Peres MA. Association between obesity and periodontal disease in young adults: a population-based birth cohort. J Clin Periodontol 2012 Aug;39(8):717-724.
22. Kongstad J, Hvidtfeldt UA, Grønbaek M, Stoltze K, Holmstrup P. The relationship between body mass index and periodontitis in the Copenhagen City Heart Study. J Periodontol 2009 Aug;80(8):1246-1253.
23. Suvan J, D'Aiuto F, Moles DR, Petrie A, Donos N. Association between overweight/obesity and periodontitis in adults. A systematic review. Obes Rev 2011 May;12(5):e381-e404.
24. Gomes-Filho IS, Freitas Coelho JM, da Cruz SS, Passos JS, Teixeira de Freitas CO, Aragão Farias NS, et al. Chronic periodontitis and C-reactive protein levels. J Periodontol 2011 Jul;82(7):969-978.
25. Slade GD, Ghezzi EM, Heiss G, Beck JD, Riche E, Offenbacher S. Relationship between periodontal disease and C-reactive protein among adults in the Atherosclerosis Risk in Communities study. Arch Intern Med 2003 May;163(10):1172-1179.
26. Freitas CO, Gomes-Filho IS, Naves RC, Nogueira Filho GdaR, Cruz SS, Santos CA, et al. Influence of periodontal therapy on C-reactive protein level: a systematic review and meta-analysis. J Appl Oral Sci 2012 Feb;20(1):1-8.
27. Al-Maskari F, El-Sadig M, Al-Kaabi JM, Afandi B, Nagelkerke N, Yeatts KB. Knowledge, attitude and practices of diabetic patients in the United Arab Emirates. PLoS One 2013;8(1):e52857.
28. Santos VR, Lima JA, Miranda TS, Feres M, Zimmermann GS, Nogueira-Filho GdaR, et al. Relationship between glycemic subsets and generalized chronic periodontitis in type 2 diabetic Brazilian subjects. Arch Oral Biol 2012 Mar;57(3):293-299.
29. Lim LP, Tay FB, Sum CF, Thai AC. Relationship between markers of metabolic control and inflammation on severity of periodontal disease in patients with diabetes mellitus. J Clin Periodontol 2007 Feb;34(2):118-123.
30. Takeda M, Ojima M, Yoshioka H, Inaba H, Kogo M, Shizukuishi S, et al. Relationship of serum advanced glycation end products with deterioration of periodontitis in type 2 diabetes patients. J Periodontol 2006 Jan;77(1):15-20.
31. Al-Lawati JA, Barakat MN, Al-Maskari M, Elsayed MK, Al-Lawati AM, Mohammed AJ. HbA1c Levels among Primary Healthcare Patients with Type 2 Diabetes Mellitus in Oman. Oman Med J 2012 Nov;27(6):465-470.