

Obesity and Periodontal Disease in Young, Middle-Aged, and Older Adults

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Background: The growing prevalence of increased body weight and obesity in the United States has raised significant public health concerns. Obesity has been implicated as a risk factor for several chronic health conditions, as well as being associated with increased mortality. Recently, an association between obesity and periodontal disease was found in a Japanese population. The purpose of the present study is to examine the relation between body weight and periodontal disease in a representative United States sample.

Methods: Participants in the third National Health and Nutrition Examination Survey (NHANES III) who were ≥ 18 years and had undergone a periodontal examination were selected for the analysis ($n = 13,665$). Body mass index (BMI) and waist circumference (WC) were used as measures of overall and abdominal fat content, respectively. Univariable and multivariable logistic regression models were used to estimate the association between increased body weight and periodontal disease. BMI and WC were assessed independently in a multivariable logistic model containing the following variables: gender, race, education, poverty index, smoking, diabetes, and time elapsed since last dental visit. Significant interactions with age were found and analyses were then stratified by age: younger (18 to 34 years old), middle-aged (35 to 59 years old), and older (60 to 90 years old) adults.

Results: A significant association between the measures of body fat and periodontal disease was found among the younger adults, but not middle or older adults. The adjusted odds ratios (OR) for having periodontal disease were 0.21 (0.080 to 0.565), 1.00 (0.705 to 1.407), and 1.76 (1.187 to 2.612) for subjects with BMI < 18.5 kg/m², 25–29.9 kg/m², and ≥ 30 kg/m², respectively. Young subjects with high WC had an adjusted OR of 2.27 (1.480 to 3.487) for having periodontal disease.

Conclusions: In a younger population, overall and abdominal obesity are associated with increased prevalence of periodontal disease, while underweight (BMI < 18.5) is associated with decreased prevalence. Obesity could be a potential risk factor for periodontal disease especially among younger individuals. Promotion of healthy nutrition and adequate physical activity may be additional factors to prevent or halt the rate of progression of periodontal disease. *J Periodontol* 2003;74:610-615.

KEY WORDS

Epidemiology; National Health and Nutrition Examination Survey III; obesity/epidemiology; periodontal diseases/epidemiology; risk factors.

Obesity is a major public health concern in both developed and developing countries.¹ It has been implicated as a significant risk factor for several conditions including diabetes, cardiovascular disease, hypertension, stroke, and osteoarthritis.¹⁻⁴ The impact of obesity on health status has the same effect as 20 years of aging and has been suggested to exceed the impact of smoking or alcohol abuse.⁵ In addition, the incidence of obesity has steadily increased over the last 2 decades.^{6,7}

Periodontal disease is one of the most common chronic diseases. It has been estimated that at least 35% of the United States adults aged 30 to 90 have periodontal disease.⁸ Several systemic factors are associated with increased risk of periodontal disease, including smoking, diabetes, osteoporosis, stress, and age.⁹ Obesity has been found to contribute significantly to periodontal disease severity on experimental animals.¹⁰ A recent study in apparently healthy Japanese adults found a significant association between obesity and increased risk of periodontitis.¹¹ The purpose of the present study is to examine whether or not there is an association between obesity and periodontal disease in the United States population using body mass index (BMI) and waist circumference (WC) as measures of total body fat and abdominal obesity, respectively.

MATERIALS AND METHODS

Data Source and Study Population

Data for the present study were a subset of the third National Health and Nutrition Examination Survey (NHANES III), a cross-sectional survey conducted by the National

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Center for Health Statistics (NCHS) from 1988 to 1994. The sample represented a United States civilian, non-institutionalized population ≥ 2 months of age.¹² The survey consisted of a home interview followed by a comprehensive medical and dental examination. A total of 31,311 subjects were examined, 30,818 in a mobile examination center and 493 in their homes. Subjects who were ≥ 13 years ($n = 19,810$) were eligible for the periodontal examination. For the current study, only subjects who were ≥ 18 years and had undergone the periodontal examination were included ($n = 13,665$), as was the case in similar studies.^{13,14}

Outcome Variable

Periodontal disease was defined based on the presence of one or more periodontal sites with both an attachment loss (AL) of ≥ 3 mm and probing depth PD of ≥ 4 mm. The use of these criteria was based on previous studies utilizing NHANES III data.^{8,13,14} Combining PD and AL has the advantage of classifying those subjects with true periodontal pockets as diseased and those with recession only as non-diseased. Furthermore, Tomar and Asma¹⁴ reported that the use of this definition eliminated age confounding. Periodontal examination for NHANES III was performed around the teeth of a randomly assigned half-mouth, one upper and one lower quadrant. Third molars, partially erupted teeth, and retained roots were excluded. The distance from the free gingival margin to the bottom of the sulcus (probing depth) and the distance from the free gingival margin to the cemento-enamel junction (CEJ) were recorded at the mesio-facial and mid-facial aspects of each tooth. The level of the periodontal attachment was computed from the above measurements to represent the distance from the CEJ to the bottom of the sulcus (attachment loss).

Obesity

Two indicators of obesity were used: body mass index and waist circumference. BMI, used as an indicator of overall adiposity, was computed from weight in kilograms divided by square height in meters, and divided into 4 categories: underweight (< 18.5 kg/m²), normal (18.5 to 24.9 kg/m²), overweight (25 to 29.9 kg/m²), and obese (≥ 30 kg/m²). Waist circumference (WC), used to assess visceral adiposity, was divided into 2 categories using the cutoff point of > 102 cm for men and > 88 cm for women. The cutoff points for both BMI and WC were based on the guidelines of the National Heart, Lung, and Blood Institute and World Health Organization (WHO).^{15,16}

Covariates

Socio-demographic variables and periodontal disease risk factors were selected as covariates. The selected variables were age, race, gender, poverty index, education, time elapsed since the last dental visit, smok-

ing, and diabetes. Race was obtained from the NHANES III examination file variable race-ethnicity, which identifies the following categories: non-Hispanic white, non-Hispanic black, Mexican American, and others.¹² The poverty index in NHANES III represents the family income divided by the poverty threshold. For our analysis, it was categorized into high (> 2.75 to 11.89), medium (> 1.29 to 2.75), and low (0 to 1.29) income. Smoking status was defined as current smoker, former smoker, or never smoker. History of diabetes was obtained from the household adult file variable "have you ever been told by a doctor that you have diabetes or sugar diabetes." Women who reported to have diabetes only during pregnancy were considered non-diabetics. Education attainment was assessed as 3 categories, those who have less than, equal to or greater than 12 years of schooling. The time elapsed since last dental visit was categorized into 4 categories (≤ 1 year, 2 to 3 years, > 3 years, and never visited).

Data Analysis

Data analyses entailed basic descriptive approaches using statistical software,[†] and estimation and testing utilizing a specialized statistical package[‡] that adjusts for complex sample design. The final sample weight variable for the mobile examination center and the replicate weights provided by the NCHS were used to produce nationally representative estimates.

The association between the exposure variables (BMI and WC) and periodontal disease was assessed using 2 separate multi-variable logistic regression models. The full model included BMI or WC and all the covariates, as well as the 2-way interaction between the exposure variables and 3 demographic covariates: age, gender, and race. The interaction terms were removed one by one from the model if their significance level was > 0.1 . The main effect terms were kept in the model regardless of their effects on the *P* value or on the odds ratio for exposure variables.

RESULTS

There were 17,752 subjects in the NHANES III examination data file aged ≥ 18 years. Of these, 13,665 subjects had periodontal examination, 1,342 were excluded from periodontal exam for medical reasons, and 2,745 subjects had no information on their periodontal condition. Our analysis was limited to those NHANES subjects ≥ 18 years old who had the periodontal assessment ($n = 13,665$).

Characteristics of the study population and prevalence of periodontal disease are shown in Table 1. Based on our weighted sample, 42.4% of the participants were 18 to 34 years old (young), 42.4% were 35 to 59 years old (middle-aged), and 15.2% were 60 to 90 years

† SAS, Version 8.2, SAS Institute, Inc., Cary, NC.

‡ WesVar PC, Version 4.0, Westat, Inc. Rockville, MD.

Table 1.
Characteristics of the Study Population by Periodontal Disease Status (n = 13,665)*

	N	Prevalence of Periodontal Disease (%)	(SE)
Age (years)			
18-34	5,608	42.36	(0.559)
35-59	5,092	42.41	(0.490)
60-90	2,965	15.23	(0.275)
Gender			
Female	7,199	51.22	(0.285)
Male	6,466	48.78	(0.285)
Race and ethnicity			
Non-Hispanic white	4,964	74.31	(0.917)
Non-Hispanic black	3,986	11.46	(0.133)
Mexican American	4,140	5.83	(0.072)
Other	575	8.40	(0.928)
Smoking status			
Never	7,164	48.76	(0.757)
Former	2,961	23.34	(0.467)
Current	3,539	27.90	(0.755)
Education			
>12	4,115	43.82	(1.038)
12	4,409	34.48	(0.776)
<12	5,047	21.70	(0.761)
Diabetes			
No	12,886	96.30	(0.181)
Yes	765	3.70	(0.181)
Poverty index[†]			
>2.75-11.89	4,379	52.56	(1.165)
>1.29-2.75	4,056	29.92	(0.911)
0-1.29	4,013	17.53	(0.798)
Time since last dental visit			
≤1 year	8,179	68.34	(0.792)
2-3 years	1,695	12.55	(0.539)
>3 years	3,118	17.05	(0.497)
Never	589	2.07	(0.171)
Body mass index (kg/m²)			
Underweight <18.5	301	2.59	(0.221)
Normal 18.5-24.9	5,289	44.19	(0.770)
Overweight 25-29.9	4,623	31.96	(0.579)
Obese ≥30	3,427	21.26	(0.606)
Waist circumference[‡]			
Normal	7,931	63.91	(0.634)
High	5,734	36.09	(0.634)
Periodontal disease			
No	11,105	86.24	(0.674)
Yes	2,560	13.76	(0.674)

* Total differs in some cells due to missing data.

† Weighted to produce nationally representative estimates.

‡ Family income divided by poverty threshold.

§ Cutoff point >102 cm for men and >88 cm for women.

(older). Fifty one percent of the participants were females. A majority of the study population were non-Hispanic whites (74%). Nearly half of the subjects had never smoked. More than 78% of the subjects had 12 years or more of schooling. Less than 4% were diabetic. Two percent had never been to a dentist or a dental hygienist and 17% had not had a dental visit for more than 3 years. More than half of the study population was either obese or overweight (BMI ≥25) and 36% had high WC.

Prevalence of periodontal disease was 14% in the total population (8% in the young, 17% in middle-aged, and 20% in the older adults). Periodontal disease was more prevalent among males, non-Hispanic blacks (followed by Mexican Americans), current smokers (compared to former or non-smokers), individuals with less education, and diabetics. Prevalence also increased based on the time since last dental visit (highest among those who had never visited a dental office or whose last visit was more than 3 years ago). Prevalence was highest among persons with a BMI of ≥30 kg/m² and increased with increasing BMI. Eighteen percent of the population with high WC had periodontal disease compared to 12% with a smaller WC.

BMI >30 kg/m² and high WC were found to be associated with the prevalence of periodontal disease in both univariable and multivariable logistic regression models (Table 2). Only the interaction between age and the exposure variables were significant. For this reason, age-stratified analyses are presented.

As shown in Tables 3 and 4, respectively, body mass index >30 kg/m² and high WC were crudely associated with prevalence of periodontal disease in persons aged 18 to 34, but not in the other age groups. A negative association between being underweight and the prevalence of periodontal disease was also observed in this age group. The estimate of the association between prevalence of periodontal disease in young adults and obesity was slightly attenuated (from 1.85 to 1.76) by adjusting for all the covariates, but

Table 2.
Crude and Adjusted Odds Ratios and 95% Confidence Interval of Body Mass Index (BMI) and Waist Circumference (WC), and Periodontal Disease in Study Population

	Crude OR (95% CI)	P Value	Adjusted OR (95% CI)	P Value
Body mass index (kg/m²)				
Underweight <18.5	0.77 (0.405-1.469)	0.421	0.79 (0.420-1.489)	0.459
Normal 18.5-24.9	Reference	—	Reference	—
Overweight 25-29.9	1.31 (1.130-1.514)	0.001	1.06 (0.912-1.235)	0.434
Obese ≥30	1.64 (1.375-1.960)	0.000	1.37 (1.141-1.644)	0.001
Waist circumference†				
Normal	Reference	—	Reference	—
High	1.60 (1.375-1.853)	0.000	1.33 (1.113-1.601)	0.002

* Adjusted for age, gender, race, smoking, poverty index, education, diabetes, and time since last dental visit.

† Cutoff point >102 cm for men and >88 cm for women. BMI and WC were assessed in 2 separate logistic regression models.

Table 3.
Crude and Adjusted Odds Ratios and 95% Confidence Interval of Body Mass Index and Periodontal Disease Stratified by Age

Body Mass Index (kg/m ²)	N	Crude OR (95% CI)†	Adjusted OR (95% CI)†
18-34 years			
<18.5	181	1.49 (0.672)	0.21 (0.079-0.484)‡
18.5-24.9	2,801	7.16 (0.941)	Reference
25-29.9	1,546	7.58 (0.886)	1.06 (0.753-1.503)
≥30	1,072	12.49 (1.137)	1.85 (1.316-2.609)‡
35-59 years			
<18.5	65	19.38 (7.943)	1.27 (0.445-3.643)
18.5-24.9	1,574	15.89 (1.299)	Reference
25-29.9	1,838	17.11 (1.356)	1.09 (0.908-1.315)
≥30	1,610	19.45 (1.653)	1.28 (0.973-1.680)
60-90 years			
<18.5	55	30.28 (7.053)	1.99 (0.994-3.973)
18.5-24.9	914	17.94 (1.765)	Reference
25-29.9	1,239	20.88 (1.528)	1.21 (0.926-1.573)
≥30	745	21.76 (1.653)	1.27 (0.994-1.629)

* Adjusted for gender, race, smoking, poverty index, education, diabetes, and the time since last dental visit.

† Weighted to produce nationally representative estimates.

‡ Statistical significance, $P < 0.01$.

remained significant ($P < 0.01$). The negative association between underweight and prevalence of periodontal disease remained strong and significant in the final multivariable model for persons aged 18 to 34 (OR = 0.21 and 95% confidence interval (CI) 0.08 to 0.57). The OR for the association between WC and

prevalence of periodontal disease in persons 18 to 34 was slightly increased (from 2.14 to 2.27) by adjusting for the covariates and remained statistically significant ($P < 0.001$). In the other age categories, no association was found between periodontal disease and WC or BMI.

To confirm that the association between obesity and periodontitis was not due to residual age confounding, we further categorized the younger group into 18 to 24 years and 25 to 34 years. The association between WC and periodontitis remained strong and significant; the adjusted OR and 95% CI were 2.20 (1.131 to 4.291) and 2.10 (1.281 to 3.432) for persons aged 18 to 24 and 25 to 34, respectively.

DISCUSSION

Our findings showed a significant association between obesity and prevalence of periodontal disease, only among individuals aged 18 to 34 years. The prevalence of periodontal disease is 76% higher among young obese (BMI >30 kg/m²) individuals than in young, but normal weight individuals. Also young persons with high WC (>102 cm in men; >88 cm in women) have 2.27 times greater odds of having periodontal disease than in those with smaller WC. Furthermore, young underweight individuals were 80% less likely to have periodontal disease than young, but normal weight individuals.

No significant association was found between body weight and periodontal disease in the middle and older age groups. These findings are consistent with other previous reports that found a stronger association between

obesity and mortality and chronic diseases other than periodontitis in younger age groups.^{3,17-21}

Several explanations for the association between obesity and periodontal disease in younger adults and not older adults are plausible. Research has shown that early-onset obesity that continues in adult-

Table 4.
Crude and Adjusted Odds Ratios and 95% Confidence Interval of
Waist Circumference and Periodontal Disease Stratified by Age

Waist Circumference Category	N	Periodontal Disease Prevalence (%)	Crude OR (95% CI) [§]	Adjusted OR (95% CI) [†]
18-34 years				
Normal	4,104	6.47 (0.770)	Reference	Reference
High	1,504	12.90 (1.273)	2.14 (1.522-3.019) [§]	2.27 (1.480-3.487) [§]
35-59 years				
Normal	2,624	16.55 (1.319)	Reference	Reference
High	2,468	18.37 (1.325)	1.13 (0.888-1.448)	1.11 (0.849-1.463)
60-90 years				
Normal	1,203	20.15 (1.678)	Reference	Reference
High	1,762	20.31 (1.505)	1.01 (0.776-1.316)	1.14 (0.858-1.502)

* Cutoff point >102 cm for men and >88 cm for women.

† Adjusted for gender, race, smoking, poverty index, education, diabetes, and time since last dental visit.

‡ Weighted to produce nationally representative estimates.

§ Statistical significance, $P < 0.001$.

hood may be more harmful than obesity that appears in adulthood.²² Since aging is associated with an increase in body fat mass,²³⁻²⁵ it is reasonable to assume that most of the obesity in younger age groups started earlier in life while some of the older obese participants gain some weight as part of the aging process. If this is true, the association of obesity and periodontal disease would be more pronounced among younger than older adults, due to the confounding metabolic changes in later life.

A second explanation could be due to the dilution of the effect of obesity in the older age groups. It may be that the influence of obesity on the periodontal condition of older participants was masked by presence of stronger risk factors (such as age). Thus, more non-obese individuals would develop periodontal disease as they age, diluting the effect of obesity toward no association. The previous assumption is supported by our observation of greater increase of periodontal disease prevalence by getting older among normal weight individuals compared to obese.

A third explanation may be an observed cohort effect. The present study is cross sectional. Younger and older study participants may have been exposed to different lifestyles. Research in dietary trends has documented a significant shift in the dietary pattern toward less healthy food among U.S. adolescents.²⁶ For example, a comparison of dietary patterns of 2 cohorts of adolescents aged 11 to 18 from 1965 and 1977, respectively, revealed a significant decrease in raw fruit and non-potato vegetables (sources of vitamin C), a decrease in total calcium intake, and a sharp increase in soft drinks and non-citrus juices among the later cohort.²⁶ This is particularly relevant

to oral health since low dietary intake of calcium and vitamin C have been associated with periodontal disease.^{27,28} The 11 to 18 year-old cohort in 1965 would be ≥ 35 years at the time of NHANES III (1988-1994), while in 1977 the cohort would be <35 years old. Thus, younger persons in our study population may have different dietary patterns than older study participants. If the cohort effect assumption is valid, the association between periodontal disease and obesity is likely to remain strong and significant as the younger cohort ages.

Finally, the social stigma associated with obesity in younger adults may be a greater source of chronic stress than in older adults, where increased body weight is considered more acceptable. Moreover, younger and older individuals may have different coping strategies.²⁹ Stress and inadequate coping behaviors have both been found to be associated with risk for periodontal disease.³⁰ The proposed mechanisms by which psychosocial factors may contribute to the pathogenesis of periodontal disease include physiological alteration of blood supply and salivary flow; modification of the immune response to periodontal pathogens; or alteration of health-related behavior such as smoking, dietary intake, and oral hygiene practice.³¹

The primary limitation of our study is its cross-sectional design. Thus, the association between obesity and periodontal disease does not imply causality. The study, however, has several strengths: the large sample size, the availability of information on many of the potential confounders, and its generalizability to the United States population. Future studies need to address the underlying question of causality to determine if obesity is a true risk factor for periodontal disease, especially among the younger population. If this proves to be the case, prevention and management of obesity may be an adjunctive approach to improving periodontal health.

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