

# ORIGINAL ARTICLE

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# The Link Between Body Mass Index and Periodontitis: Unhealthy Eating Habits and Poor Oral Hygiene According to a Compelling Survey Study

## Vücut Kitle İndeksi ve Periodontitis Arasındaki Bağlantı: Kapsamlı Anket Çalışması Sonucuna Göre Sağlıksız Beslenme Alışkanlıkları ve Kötü Ağız Hijyeni

### ABSTRACT

#### Objective:

To investigate the relationship between body mass index and periodontal diseases by conducting a comprehensive survey to assess daily eating habits and self-care of oral hygiene.

#### Material and Methods:

We recruited 357 patients from the outpatient clinic of the Periodontology Department at Baskent University Hospital. All the patients completed a comprehensive survey after their periodontological examination. The questionnaire asked about their daily eating habits and oral hygiene self-care during the last six months.

#### Results:

Patients with periodontitis had higher body-mass-index (BMI) than those with gingivitis ( $26.9 \pm 4.3 \text{ kg/m}^2$  vs  $24.7 \pm 3.8 \text{ kg/m}^2$ , respectively,  $p=0.000$ ). The periodontitis group had higher tea consumers than those with gingivitis (46,7% vs. 30,3%, respectively,  $p=0.001$ ). The group with gingivitis had higher coffee consumers than those with periodontitis (17.7% vs 3.8 %, respectively,  $p=0.000$ ). There were more diabetic patients in the periodontitis group (10.9% vs. 2.9%, respectively,  $p=0.003$ ). The percentage of cases with periodontitis was 71.4% in obese patients. The frequency of periodontitis was significantly correlated with the BMI (Pearson correlation 0.2229,  $p=0.000$ ).

#### Conclusion:

Individuals with a higher BMI were more likely to have periodontitis, consume more tea, and have diabetes.

#### Key Words:

Periodontitis, Body mass index, Obesity, Tea consumption

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## ÖZ

### Amaç:

Vücut kitle indeksi ile periodontal hastalıklar arasındaki ilişkiyi, beslenme alışkanlıkları ve kişinin kendi ağız bakım uygulamalarını irdeleyen detaylı anket sorgulaması ile ortaya koymayı amaçladık.

### Gereç ve Yöntemler:

Çalışmamıza Başkent Üniversitesi Periodontoloji Bölümüne başvuran 357 hasta dahil edilmiştir. Çalışmaya dahil olmak isteyen hastalar periodontal muayene öncesi son altı ay içerisinde yeme alışkanlıkları ve ağız bakım uygulamalarına yönelik soruları cevaplamışlardır.

### Bulgular:

Periodontitis grubu hastaların gingivitis grubu hastalara göre daha yüksek vücut kitle indeksine (VKI) sahip olduğu görüldü (sırası ile  $26,9 \pm 4,3 \text{ kg/m}^2$  ve  $24,7 \pm 3,8 \text{ kg/m}^2$ ,  $p=0.000$ ). Periodontitis grubundaki hastalarda çay içme alışkanlığı gingivitis grubuna göre daha yüksek oranda idi (sırası ile % 46,7 ve % 30,3,  $p=0.001$ ). Gingivitis grubu hastaların periodontitis grubuna göre daha fazla oranda kahve içtikleri bulgulanmıştır (sırası ile %17,7 ve %3,8,  $p=0.000$ ). Periodontitis grubunda diyabetik hasta oranı gingivitisli gruba göre daha fazla idi (sırası ile % 10,9 ve % 2,9). Obez hastalarda periodontitis oranının % 71,4 olduğu bulgulanmıştır. Periodontitis sıklığı vücut kitle indeksi ile anlamlı oranda ilişkilidir (Pearson korelasyonu 0.2229,  $p=0.000$ ).

### Sonuç:

VKI değeri yüksek olan bireylerin, periodontitis hastası olma, daha fazla çay tüketme ve diyabet hastası olma olasılığı daha yüksek idi.

### Anahtar Kelimeler:

Periodontitis, Vücut kitle indeksi, Obezite, Çay tüketimi

## INTRODUCTION

Periodontal diseases are inflammatory conditions that impact the gums and other tissues supporting the teeth. They typically start with gingivitis. If left untreated, gingivitis can progress to periodontitis, causing damage to the connective tissue and alveolar bone that support the gums and teeth. These diseases are quite common and are responsible for about 70% of tooth loss in adults (1-3).

Obesity is a prevalent and rapidly increasing disease in many countries, affecting both children and adults. It leads to various complications, such as cardiovascular diseases, diabetes mellitus, pulmonary diseases, and an increased risk of malignancies. Recent epidemiological studies have suggested a link between obesity and periodontitis. Clinical studies have also reported a correlation between body mass index (BMI) and serum lipids and periodontitis risk. While there's no definitive scientific explanation for the relationship between obesity and periodontitis, it is believed to be linked to obesity-induced insulin resistance and increased proinflammatory and pro-atherogenic adipokines. It is thought that these adipokines, originating from excess fatty tissue in obese individuals, accelerate inflammatory disease in the gingiva and periodontal tissue (4-8).

The etiopathogenesis of periodontal diseases in obese patients is not well understood. Obesity is associated with unhealthy eating habits, often leading to the consumption of high-energy foods and late-night snacking (9-10). Inadequate oral hygiene self-care may also contribute to the high frequency of periodontitis in obese individuals.

Our study aims to explore the association between body mass index and periodontal diseases, emphasizing the impact of unhealthy eating habits and oral hygiene on periodontal health. To achieve this, we conducted a comprehensive survey after assessing the patients' periodontal health.

## MATERIAL and METHODS

Between 2020 and 2022, 357 patients were enrolled from the Periodontology clinic at Baskent University. All participants provided informed written consent before participating in the study. The study received approval from the Başkent University Institutional Review Board (Project No: D-KA20/25) and was supported by the Baskent University Research Fund.

The study participants included male and female individuals aged between 18 and 65 who met the inclusion criteria and signed an informed consent form. They were recruited consecutively from the periodontology clinic.

Exclusion criteria were as follows: history of cancer, malabsorption syndrome, previous gastrointestinal surgery for obesity treatment, pregnancy, surgery within the last three months, medical treatments for obesity (including glucagon-like peptide-1 analogs), treatment with steroids

or other hormonal medications, and any medications that could impact general metabolism and oral health.

Participants' heights were measured in centimeters, and their weights were assessed using a calibrated mechanical scale that measures kilograms. Body mass index (BMI) was calculated using the formula weight divided by height squared ( $\text{kg}/\text{m}^2$ ). The World Health Organization (WHO) defines BMI categories as follows: BMI  $< 18.5 \text{ kg}/\text{m}^2$  is considered underweight, BMI 18.5-24.9  $\text{kg}/\text{m}^2$  is classified as normal weight, BMI 25-29.9  $\text{kg}/\text{m}^2$  as overweight, and BMI  $\geq 30 \text{ kg}/\text{m}^2$  as obesity (11).

After their periodontological examination, all the patients were asked to complete a 37-question survey. The survey included questions about their daily eating habits, such as meal frequency, snack consumption, timing, and oral hygiene practices like tooth brushing over the past six months.

#### **The questionnaire was divided into three parts:**

The first part was related to the patient's oral hygiene self-care. This section had eight questions and examined the daily tooth brushing frequency, time during the day, and habit of additional tooth brushing if an extra snack was taken.

The second part of the questionnaire evaluated the eating habits of the patient. Regular eating schedule of the day, night-time extra snacks (both after dinner and late at night), and consumption of tea, coffee, alcohol, or soft drinks during the day were asked. There were a total of ten questions in this section.

No scientifically established healthy upper limits for daily tea or coffee consumption exist. However, most studies exploring the impact of coffee and tea on depression and cognitive disorders indicate that drinking more than 400 ml of these beverages daily, or increasing daily intake by more than 300 ml is considered as high consumption (12, 13). In our study, individuals consuming more than 400 ml of coffee and tea daily were classified as high consumers of coffee and/or tea.

In the third part of the questionnaire, chronic medical problems like diabetes mellitus, hypoglycemic symptoms leading to excess carbohydrate consumption, hyperlipidemia, hypertension, and the presence of chronically taken regular medications were asked (a total of 19 questions). A pilot group of 30 patients validated the questionnaire, and modifications were made where necessary to resolve ambiguities.

#### **Periodontal assessment :**

The same experienced periodontist examined all of the study subjects. The periodontal examination was evaluated by plaque and gingival bleeding scores, probing depth, mobility, and periodontal attachment loss. Plaque levels

were scored on the buccal surfaces of all-natural teeth using a previously reported approach (14). Two methods were employed to assess gingival inflammation. The Gingival Index was used to determine gingival inflammation for each tooth, with scores ranging from zero (indicating normal gingiva) to three (indicating severe inflammation) (15). The Gingival Index was used to assess the buccal surface of each tooth. To evaluate the presence of inflammation in the gums, we used a method called gingival bleeding on probing (BOP). During both exams, all teeth were thoroughly checked on six surfaces. The score was obtained by inserting a periodontal probe no more than two mm into the sulcus at the gingival border, namely at the mesiobuccal line angle, and then advancing it down the buccal surface to the distobuccal line angle. After inspecting each tooth in a quadrant, we documented the presence (1) or absence (0) of blood. The bleeding-on-probing score was determined by adding together the total number of teeth that showed bleeding areas for each person.

The periodontal pocket depth scores at six points of each tooth were evaluated using a periodontal probe, UNC-15. Individuals with probing pocket depth (PPD) ranging from 4 to 6 millimeters and clinical attachment level (CAL) of up to 4 millimeters are diagnosed with chronic periodontitis, indicating a mild to moderate loss of periodontal support. Clinical attachment level (CAL) denotes the distance between the cemento-enamel junction and the attached periodontal tissues (16). The diagnosis of advanced chronic periodontitis was made for patients with a CAL greater than 4 mm and PPD  $\geq 6$  mm due to significant loss of periodontal support (17).

Tooth mobility was assessed and categorized as degrees 1, 2, and 3 (18). Additionally, evaluations were conducted for tooth loss, diastemas (the space between two teeth), malocclusion, and radiographic examinations.

#### **Statistical analysis**

Descriptive statistics for the study group are presented as the means and standard deviations for continuous variables and as proportions for categorical variables such as gender, gingivitis, periodontitis, and diabetes. Clinical characteristics of the patients were compared using the Student's t-test and the Chi-square method as appropriate. Statistical significance was determined by a two-sided p-value of 0.05 or lower. PASW statistical software was utilized for the analysis.

## **RESULTS**

This study reviewed the data of 357 patients. The patients were categorized into two groups to test our hypothesis. The first group comprised patients diagnosed with gingivitis, while the second group comprised those with periodontitis. There were 175 patients diagnosed with gingivitis and 182 with periodontitis. There were no gender differences between the groups. Patients with periodontitis were slightly older than those with gingivitis (44.2

$\pm 9.9$  years vs.  $36.2 \pm 8.8$  years, respectively,  $p=0.000$ ). Patients with periodontitis had higher BMI than those with gingivitis ( $26.9 \pm 4.3$  kg/m<sup>2</sup> vs  $24.7 \pm 3.8$  kg/m<sup>2</sup>, respectively,  $p=0.000$ ). We defined individuals consuming more than 400 ml of coffee and/or tea as high consumers. The definition is based on existing studies documented in the literature that explore the health effects of these beverages (12, 13). The periodontitis group had a higher percentage of tea consumers than those with gingivitis (46.7% vs. 30.3%, respectively,  $p=0.001$ ). Interestingly, the group with gingi-

vitis had more coffee consumers to those with periodontitis (17.7% vs 3.8 %, respectively,  $p=0.000$ ) (Table I).

The percentage of diabetic patients in the periodontitis group was higher compared to the gingivitis group. Specifically, there were 20 diabetic patients in a population of 182, which amounts to 10.9% of the periodontitis group. In contrast, the gingivitis group had 5 diabetic patients out of 175, representing 2.9%. The difference was statistically significant ( $p = 0.003$ ) (Table I).

**Table I.** Patients' Clinical Characteristics

	<b>Gingivitis</b>	<b>Periodontitis</b>	<b>p</b>
<b>Number</b>	175	182	-
<b>Age (years)</b>	36.2 $\pm$ 8.8	44.2 $\pm$ 9.9	0.000
<b>Gender (F/M)</b>	106/68	93/89	NS
<b>Body Mass Index (kg/m<sup>2</sup>)</b>	24.7 $\pm$ 3.8	26.9 $\pm$ 4.3	0.000
<b>Regular toothbrushers (at least once per day)</b>	165 (94.3%)	165 (90.6%)	NS
<b>Nonbrushers (less than once per week)</b>	10 (5.7%)	17 (9.3%)	NS
<b>Black tea consumption (more than 400 ml/day)</b>	53 (30.3%)	85 (46.7%)	0.001
<b>Coffe consumpition (more then 400 ml/day)</b>	31 (17.7%)	7 (3.8%)	0.000
<b>Soft drinks (more than 400 ml/day)</b>	15 (8.6%)	10 (5.5%)	NS
<b>Snacks lafter dinner</b>	98 (56.0%)	117 (64.3%)	NS
<b>Snacks late at night ( or at midnight)</b>	14 (8.0%)	16 (8.8%)	NS
<b>Tooth brushing after snacks at night</b>	6 (3.4%)	4 (2.2%)	NS
<b>Smoking (more than 5 cigars per day)</b>	36 (20.6%)	46 (25.3%)	NS
<b>Presence of Diabetes Mellitus</b>	5 (2.9%)	20 (11.0%)	0.003
<b>Presence of hyperlipidemia</b>	5 (2.9%)	7 (3.8%)	NS
<b>Presence of hypertension</b>	10 (5.7%)	17 (9.3%)	NS

F: Female M: Male; NS: non-significant

Analyzing the data concerning diabetes, there were 25 diabetic patients and 332 non-diabetic patients. Among the diabetic group, 20 individuals had periodontitis, which accounts for 80% of the diabetics. In comparison, 162 non-diabetic patients had periodontitis, representing 48.8% of this group ( $p=0.003$ ).

The patients were categorized into four groups based on their BMI: underweight, normal weight, overweight, and obese. This resulted in the following distribution: 6 patients were classified as underweight (BMI < 18.5 kg/m<sup>2</sup>), 160 patients were normal weight (BMI between 18.5 and 24.9 kg/m<sup>2</sup>), 142 patients were overweight (BMI between 25 and 29.9 kg/m<sup>2</sup>), and 49 patients were classified as obese (BMI  $\geq$  30 kg/m<sup>2</sup>) (Table II).

There was a significant difference in gender among the groups ( $p=0.021$ ). The proportion of females was higher in those with normal or underweight individuals. Also, there was a significant difference in age between the groups ( $p=0.000$ ). The patients were older in overweight and obese groups (Table II).

Periodontitis prevalence differed significantly in the groups ( $p=0.000$ ). The obese group revealed the highest

percentage of patients with periodontitis (71.4% of the obese). Two of the six underweight patients (33.3%) had periodontitis. Among patients with normal weight, 61 had periodontitis (38.1%). Among overweight patients, 84 were diagnosed with periodontitis (59.2%), while among obese patients, 35 had periodontitis (71.4%). The frequency of periodontitis was significantly correlated with BMI ( $p=0.000$ ) (Table II). As the BMI increased, the percentage of periodontitis cases increased.

Our data revealed that people who brushed their teeth at least once daily (regular toothbrushers) differed significantly among groups ( $p=0.002$ ). The percentage of regular toothbrushing decreased as the BMI increased. The obese group had a substantially lower toothbrushing practice (79.6%) than the normal weight (95,6%) and overweight individuals (92.9%) (Table II). Notably, most patients with normal or overweight body types continued to practice regular tooth-brushing habits.

Additionally, when it came to tooth brushing after a late-night snack, those with normal weight and underweight revealed the highest percentage of individuals brushing their teeth after an extra snack late at night (5% and



**Table II.** Clinical characteristics with regard to BMI

	<b>Underweight</b> (BMI <18.5 kg/m <sup>2</sup> )	<b>Normal</b> (BMI 18.5-24.9 kg/m <sup>2</sup> )	<b>Overweight</b> (BMI 25-29.9 kg/m <sup>2</sup> )	<b>Obese</b> (BMI ≥ 30 kg/m <sup>2</sup> )	<b>p</b>
Number	6	160	142	49	-
Gender (F/M)	4/2	103/57	67/75	25/24	0.021
Age (years)	29.7 ± 7.1	38.3 ± 9.8	41.1 ± 9.8	46.1 ± 10.2	0.000
Periodontitis	2 (33.3%)	61 (38.1%)	84 (59.2%)	35 (71.4%)	0.000
Gingivitis	4 (66.7%)	99 (61.9%)	58 (40.8%)	14 (28.6%)	0.000
Regular toothbrushers (at least once per day)	6 (100%)	153 (95.6%)	132 (92.9%)	39 (79.6%)	0.002
Black tea consumption (more than 400 ml/day)	1 (16.7%)	51 (31.9%)	62 (43.7%)	24 (48.9%)	0.042
Coffee consumption (more than 400 ml/day)	3 (50.0%)	24 (15.0%)	9 (6.3%)	2 (4.1%)	0.001
Soft drinks (more than 400 ml/day)	1 (16.7%)	30 (18.8%)	22 (15.5%)	7 (14.3%)	NS
Snacks after dinner	2 (33.3%)	94 (58.8%)	85 (59.9%)	34 (69.4%)	NS
Snacks late at night (or at midnight)	1 (16.7%)	14 (8.8%)	12 (8.5%)	3 (6.1%)	NS
Tooth brushing after snacks at night	1 (16.7%)	8 (5.0%)	1 (0.7%)	None	0.013
Smoking (more than 5 cigars per day)	1 (16.7%)	36 (22.5%)	38 (26.7%)	7 (14.3%)	NS
Presence of Diabetes mellitus	None	4 (2.5%)	13 (9.2%)	8 (16.3%)	0.005
Presence of hyperlipidemia	None	6 (3.8%)	4 (2.8%)	2 (4.1%)	NS
Presence of hypertension	None	7 (4.8%)	9 (6.3%)	11 (22.4%)	0.000

F: Female M: Male; BMI: Body mass index; NS: nonsignificant

16.7%, respectively). Despite the statistical difference ( $p=0.013$ ), most patients in the four groups did not brush their teeth after a late-night snack (Table II).

The percentage of high tea consumers significantly differed among the groups ( $p=0.042$ ). The percentage of high tea consumers increased as the BMI increased. Data on high coffee consumption showed a distinctly different trend from that of tea. Significant differences were observed in the proportion of high coffee consumers among the various groups ( $p=0.001$ ). Notably, as BMI increased, the proportion of high-coffee consumers decreased (Table II).

Prevalence of diabetes mellitus differed significantly among the groups ( $p=0.005$ ). Similarly, the prevalence of hypertension was also different among the four groups ( $p=0.000$ ).

When we analyze the data concerning normal and elevated BMI, it is evident that individuals with a normal BMI compared to those with a higher BMI (including both overweight and obese categories) showed a significant difference in health outcomes. Specifically, the prevalence of diabetes was 10.9% among those with elevated BMI, compared to only 2.5% in the normal BMI group. Similarly, hypertension rates were 10.5% for those with higher BMI, while only 4.8% for those with normal BMI (Table II).

There were no statistically significant differences among

groups regarding soft drink consumption, late-night snacking, smoking, and the presence of hyperlipidemia (Table II).

## DISCUSSION

Our research found that individuals with periodontitis had a higher BMI compared to those with gingivitis. We also found that there is a significant correlation between BMI and the risk of periodontitis. Additionally, we found that periodontitis is more prevalent in obese patients with a BMI of 30 kg/m<sup>2</sup> or higher compared to those with a BMI below 30 kg/m<sup>2</sup>. These findings are consistent with previous study, which has identified obesity as a risk factor for periodontitis. Although the exact cause-and-effect relationship between obesity and periodontitis has not been fully explained, several theories exist. Most explanations focus on how the inflammatory process of obesity may affect the already inflamed area in the periodontium (19-24).

The study's primary objective was to investigate the relationship between BMI and periodontal diseases by conducting a comprehensive survey to assess daily eating habits and oral hygiene self-care. Given the limited existing literature on this topic, we sought to explore how adiposity, measured by BMI, contributes to the risk of periodontitis. Since an individual's daily eating habits influence adiposity, we also examined the eating styles of

the study participants using a detailed questionnaire. It is widely recognized that the macronutrient makeup of food and the timing of its consumption throughout the day play a crucial role in weight management (10). These factors may also impact oral hygiene and overall oral health, consequently influencing the risk of periodontitis.

In our study of 357 patients, we found significant differences in BMI, age, tea and coffee consumption, and diabetes mellitus prevalence between individuals diagnosed with gingivitis and those with periodontitis. Specifically, we observed that individuals with a higher BMI were more likely to have periodontitis, consume more tea, and have diabetes mellitus. Furthermore, the normal BMI group had approximately twice as many females as males. However, the female preponderance decreased in the high BMI group, and no gender difference was noted. Interestingly, while most subjects did not brush their teeth after an additional night-time snack, almost none of the patients, except one in the overweight group, brushed their teeth after an extra snack at night.

The research findings suggest that tea consumption can directly or indirectly impact body weight and periodontal tissue. Although very scarce in the literature, long-term green tea consumption in males and black tea consumption in females were associated with good oral health. However, a study by Huang and colleagues found that tea consumption alone does not affect oral health if you do not have good brushing habits (25). In Turkey, tea is a popular beverage often enjoyed with sugar and biscuits. Although the questionnaire did not specifically address this, tea consumption may contribute to weight gain due to the extra calories consumed with it, or it may directly affect oral health. Further clinical studies are needed to understand better the relationship between tea consumption, periodontal health, and body weight.

Our study found that coffee consumption was more prevalent among individuals with gingivitis and normal BMI. Frequent tea drinkers are likely to consume less coffee. A recent meta-analysis that investigated the relationship between coffee consumption and periodontitis found no relationship between coffee consumption and periodontitis (26). However, more research is required to explore the potential link between coffee consumption, lower BMI, and reduced frequency of periodontitis.

Most diabetic patients had a high BMI, which is not surprising, as Type 2 Diabetes mellitus is typically diagnosed in individuals with insulin resistance related to obesity. Similarly, it's not surprising to find more cases of periodontitis in the group of diabetic patients. Diabetes mellitus is a leading risk factor for periodontitis, but until now, the underlying molecular mechanisms remain unclear. In individuals with diabetes, the diabetic milieu with hyperglycemia, increased oxidative stress, microangiopathy, and increased susceptibility to local infections may ele-

vate the risk of periodontitis (27).

In conclusion, our study explores the connection between periodontitis and increased BMI, particularly emphasizing unhealthy eating habits that lead to higher levels of body fat and inadequate oral hygiene practices after meals and snacks. We reaffirmed the strong association between BMI and periodontitis, highlighting additional findings regarding the negative effects of high tea consumption (more than 400 ml per day) and poor self-care in oral hygiene on the risk of periodontitis.

The primary limitation of our study is that it is based on survey data. Responses may reflect current lifestyles, whereas the development of obesity and periodontitis typically occurs over a longer period. As a result, our findings may differ when considered over an extended timeframe.

## CONCLUSION

Our study provides a foundation for future research involving a large patient population to investigate the correlation between tea consumption, BMI, and periodontitis.

### Ethics Committee Approval:

This research complies with all the relevant national regulations and institutional policies, is in accordance with the tenets of the Helsinki Declaration, and has been approved by the Başkent University Faculty of Medicine Ethical Committee (Approval number: D-KA20/25 -05/09/2020).

### Informed Consent:

All the participants' rights were protected and written informed consents were obtained before the procedures according to the Helsinki Declaration. The study is a cross sectional survey study.

### Author contributions:

Concept – S.B., Y.B., A.S.K., N.B.T.; Design- S.B., Y.B., A.S.K., N.B.T.; Supervision – S.B., Y.B., A.S.K., N.B.T.; Resources – S.B., Y.B., A.S.K., N.B.T. ; Materials – S.B., Y.B., A.S.K., N.B.T.; Data Collection and/or Processing – S.B., Y.B., A.S.K., N.B.T.; Analysis and/ or Interpretation – S.B., Y.B., A.S.K., N.B.T.; Literature Search – S.B., Y.B., A.S.K., N.B.T.; Writing Manuscript – S.B., Y.B., A.S.K., N.B.T.; Critical Review – S.B., Y.B., A.S.K., N.B.T.

### Conflict of Interest:

The authors have no conflict of interest to declare.

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