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Original Article

Association between body mass index and waist circumference with periodontal health state

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Abstract

Aim: Obesity is one of the important public health concerns in both developed and developing countries, and may associate with increased risk of periodontitis. Present study aims to determine whether there is an association between periodontal disease and obesity in Turkish population.

Material and Methods: This study is consisted of 950 participants included; 551 women and 399 men aged 18 to75 years. In all patients; probing depth (PD), clinical attachment level (CAL), bleeding on probing (BOP) and plaque index (PI) were recorded and radiographic examination was performed. Obesity and overweight were assessed by body mass index (BMI) and waist circumference (WC) using World Health Organization criteria. The covariates were categorized into three groups; 1- Socio-demographic variables, 2- Oral health behaviors, 3- General health status.

Results: When the periodontal health status evaluations of 950 patients in our study were examined; 131 patients were healthy, 592 patients were diagnosed as gingivitis, and 227 patients were diagnosed as periodontitis. High waist circumference and body mass index were correlated with periodontal disease after adjusting co-varieties ($p<0.05$).

Conclusion: This positive association suggests that obesity is coherent with logically plausible role in the development periodontal disease.

Keywords: Periodontal diseases; body mass index; waist circumference.

INTRODUCTION

Obesity is a major social health problem and a multifactorial condition in developed and developing countries. Being overweight or obese is defined as having an abnormal or excessive mass of fat, which can impair general health. Obesity develops through a combination of genetic, environmental and psychosocial factors caused by an imbalance between intake and consumption of energy. It is assumed that this is caused by a transition from a lifestyle built on physical labor to a sedentary lifestyle and from a low-calorie diet to a high-calorie one as a result of industrial progress (1,2).

World Health Organization suggests the use of Body Mass Index (BMI) to define obesity in adult males and females. BMI is calculated by dividing the weight by height squared, expressed in kg/m^2, and considered equivalent to the increase in body weight. Nevertheless, people with a thin body and heavy muscles may be overweight in quantitative terms even if their fatty tissues do not increase. For adults, a BMI of 18.5 to 24.9 kg/m^2 is considered normal, and a BMI of > 30 kg/m^2 is considered obese (3,4). Since body weight has a variable distribution among different societies, making a medical distinction between thin and obese individuals yields accurate results only to a certain extent. For this reason, obesity must be defined in relation to morbidity and mortality (5).

It is found that BMI measures used to determine obesity do not fully reflect complicated obese individuals, and 1/3 to 1/4 of the obese individuals determined as such are metabolically normal. It was found in cohort studies that metabolically normal obese people do not develop the expected systemic complications (6). This caused researchers to conduct studies that characterize those individuals who are obese by their BMI values but normal in metabolic terms (7). These studies revealed that the total fat ratio is the same but the distribution of fat is important. It was found that the intra-abdominal and abdominal subcutaneous fatty tissues are more important

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than the gluteal and lower extremity subcutaneous fatty tissues in terms of morbidity. Thus, type 2 obesity was defined: abdominal obesity and gluteo-femoral obesity. It is reported that abdominal obesity has a higher risk of disease and waist circumference is decisive for such patients (3).

Obesity has many implications in dental practice. For this reason, dentists should be better informed about prevention and treatment of obesity.

The correlation between obesity and the periodontal disease has been established and it is argued that obesity is the second most critical factor in inflammatory destruction of periodontal tissues. It is also found that obesity is related to clinical parameters used to diagnosis of periodontal diseases (8). Two significant points in the studies on the relation between obesity and the periodontal disease is that most of those studies rely exclusively on BMI for measurement of obesity and use only one parameter for diagnosis of the periodontal disease. This ignores metabolically normal obese people, which cause problems in diagnosis of the periodontal disease.

The purpose of this study was to study a small part of the Turkish society to find out a correlation between the periodontal disease and obesity and determine a threshold value for neck/chest circumference, which has recently been started to be used in early diagnosis of obesity but lacks a gender-based standard value.

MATERIAL and METHODS

The Clinical Research Board of Ethics of Gazi University, Faculty of Medicine (12122012/387), approved the research protocol. A total of 950 patients (399 males and 551 females), who admitted to Gazi University, Faculty of Dentistry, had periodontal problems, were included in the present study. Informed written consent forms prepared in accordance with the Declaration of Helsinki were obtained for all participants before their participation.

The patients who were included in the study were not >18 years of age, had 18 natural teeth, had not undergone any periodontal treatment in the last 6 months, and had not used antibiotics in the last 3 months, were not pregnant or in their lactation period. Those patients who failed to fulfill these criteria were left out.

Clinical Assessment

Socio-economic statuses, educational backgrounds and general oral health conditions of all individuals who took part in the study were registered in special forms.

In order to identify the periodontal health conditions of patients; Plaque index (PI) (9), Bleeding on probing (BOP), Pocket depth (PD) and Clinical attachment level (CAL) were measured. These measurements were made on 4 surfaces - mesial, distal, buccal, lingual/palatinal - of the Ramfjord teeth (upper right molar 1, upper premolar 1, lower left molar 1, lower left central, lower left premolar 1). In case of a missing Ramfjord tooth, the one distal to the missing tooth was measured. Third molar teeth were not included in the study. In order to identify the DMFT index (Decayed, Missing, Filled Teeth Index) of all individuals that participated in the study, the number of decayed, filled, and missing teeth among all of the teeth (except the third molar teeth) were recorded. The sum of all these three values was determined as the DMT value for an individual. For all patients, the average DMT value was calculated by adding up the DMFT values of all subjects and dividing it by the number of subjects, which was 6.3. Depending on their DMFT values, the patients were recorded as below 6.3 or above 6.3.

In order to identify the general health conditions of the patients; their height, weight, waist circumference (WC), neck circumference (NC) and chest circumference (CC) were taken. A digital scale weighed patients in the morning, fasting, in kilograms, and with a precision of 0.1 kg. Potential sources of extra weight (e.g. coat, jacket, shoes) on patients were removed while their weight was measured. Two people whose weights were known were weighed each day throughout the study to ensure standardization for identifying in advance the faults that may arise in the scale over time. Height was measured with a 2.2-meter measuring tape affixed on the wall, and the measurements were recorded in meters. Waist circumference was measured with the patient upright, hands on sides, in horizontal plane, and measuring tape running in tangent to the "crista iliaca", and recorded in centimeters. 94 cm for males and 80 cm for females, as suggested by World Health Organization (WHO) were taken as threshold values. The values above these thresholds were considered abdominal obese. Neck circumference was measured with the patient upright, holding head high and looking straightly forward, in horizontal plane with the measuring tape placed just below the "thyroid cartilage". Chest circumference was measured with the patient upright, in horizontal plane, and measuring tape running in tangent to nipples, and those were recorded in centimeters. Individuals were asked to remove their shoes while their height and weight were measured.

Body Mass Index (BMI): Calculated in kg/m^2 by dividing the body weight (kg) to height squared (m^2). Based on the classification of World Health Organization (10), the following classification was used;

BMI <18.5 kg/m^2: Underweight
BMI: 18.5-24.9 kg/m^2: Normal weight
BMI: 25-29.9 kg/m^2: Overweight
BMI: 30-34.9 kg/m^2: Obese 1
BMI: 35-39.9 kg/m^2: Obese 2
BMI >40 kg/m^2: Obese 3

For the purposes of our study, patients with BMI >30kg/m^2 were considered obese. Non-obese patient groups were considered control groups of the study.

Statistical Analysis

The data derived from this study were analyzed using the SPSS 20 package software. Mann-Whitney U and Kruskal Wallis-H tests were used to analyze the differences between the groups. Since there are more units than

20, standardized z values were assigned to the Mann-Whitney U test. Where significant differences were seen in the Kruskal Wallis-H test, the groups with differences with the Pos-Hoc Multiple Comparison Test were determined. Chi-Square analysis was used to examine the relations between the groups of nominal variables. Monte Carlo Simulation performed a Pearson Chi-Square analysis if the expected values in the cells in RxC tables did not have the sufficient volume. While interpreting the results, the level of significance was taken 0.05, and p<0.05 was considered a significant difference/correlation.

RESULTS

When the socio-economic statuses of the patients were examined, it was found that 42% were male, 38.6% were single, 61.4% were married, 41.7% were aged 18 to 29, 24% were aged 20 to 39, 17.1% were aged 40 to 49, 13.6% were aged 50 to 59, and 3.7% were aged over 60. While 42.4% of the patients were university graduates, 32% were primary school graduates. An examination of the household monthly income of the patients revealed that 10% earned less than 1000 TL, 34.5% earned 1000 to 2000 TL, 25.9% earned 2000 to 3000 Turkish Liras (TL), and 29.5% earned more than 3000 TL (Table 1).

808 individuals in the patient population were systemically healthy. It was found that 71.5% of the subjects did not smoke and 86% used medications. Of the subjects, 52.4% brushed their teeth regularly once a day, 27.3% brushed their teeth regularly 2 or 3 times a day, and 19.2% brushed their teeth irregularly (occasionally). The patients who did not use interproximal brush/dental floss made up 94.3% of the study group, and the ratio of those who applied to a dentist when they have a complaint was 94.9%. The reasons for the patients to come to the clinic were as follows: 27.4% to have a tooth filled, 18.6% to have a tooth out, 15.6% for gingival treatment, 14.6% for toothache, 9.6% to have a prosthesis, 9.2% for general checkup, 3.2% for a joint problem, and 1.9% for orthodontic treatment (Table 1).

The subjects had an average weight of 166.32 cm, average weight of 73.24 kg, BMI value of 26.30, and an average waist circumference of 81.59 cm (min. 39, max. 134 cm) (Table 2).

According to the BMI categories of WHO, 43.2% of the patients were normal, 31.1% were overweight and only 2.2% were included in the obese-3 group. According to the distribution of the patients, 44 patients were underweight, 410 were normal, and 295 were overweight. Distributions of the obese patients to the groups were as follows: 126 patients were obese-1, 54 patients were obese-2, 21 patients were obese-3, and the total population of the obese group was 201 (Table 2).

Neck circumference was 25.26 cm for normal-weight women, 30.75 cm for normal-weight men, and 29.70 cm for obese women and 36.24 cm for obese men (Table 3). The values by genders in the classification for cut-off values (88.5 cm for women, 95.5 cm for men) for the chest circumference values of the patients were given in the Table 4.

A statistically significant correlation was found between the BMI values and the genders of the patients (p<0.05). While 79.5% of the underweight patients were female and 60.7% of the normal-weight patients were female, 52.5% of the overweight patients were male. 63.2% of the obese patients were female. A statistically significant correlation was found between the BMI values educational backgrounds of the patients (p<0.05). According to the BMI values, 45.5% of the underweight patients were high school graduates, 52.9% of the normal-weight patients were university graduates, and 54.2% of the obese patients were primary school graduates. This was found to be statistically significant (p<0.05). The monthly income of the patients was 2000 to 3000 TL for 38.6% of the underweight patients, 1000 to 2000 TL for 36.6% of the overweight patients, and 1000 to 2000 TL for 36.3% of the obese patients. According to the BMI classification, 65.9% of the underweight patients were single while 79.3% of the overweight patients and 78.1% of the obese patients were married. While 84.1% of the underweight patients and 62% of the normal-weight patients were aged 18 to 29, 27.8% of the overweight patients were aged 30 to 39, and 29.9% of the obese patients were aged 40 to 49 and 27.9% of the obese patients were aged 50 to 59.

The clinical parameters of the patients who participated in our study are shown in the Table 4. Patients had an average PI of 1.21, an average BOP of 0.56, an average PD of 2.28 mm, and an average CAL of 2.48 mm. From 950 subjects, 131 were healthy in periodontal terms while 592 had gingivitis and 227 had periodontitis.

77.3% of the underweight subjects, 67.1% of the normal-weight subjects, 59.7% of the overweight subjects, and 53.2% of the obese subjects based on the BMI classification were diagnosed with gingivitis. While 36.3% of the obese subjects had periodontitis, 29.8% of the overweight subjects, 15.6% of the normal-weight subjects, and 4% of the underweight subjects had periodontitis. A statistically significant difference was found between the PI, BOP, PD and CAL values and BMI values of the patients (p<0.05). The average plaque index of the normal-weight group was significantly lower than that of the overweight and obese groups, and BOP and PD values of the normal-weight group were significantly lower than the obese group. Average CAL values of the overweight and obese groups were statistically higher than the average CAL values of the underweight and normal-weight groups (Table 5).

A statistically significant correlation was found between the waist circumference scores and periodontal health conditions of the patients (p<0.05). Based on the WC measurements, 64.5% and 19.8% of the normal patients had gingivitis and periodontitis, respectively while 57.7% and 32.3% of the obese patients had gingivitis and periodontitis, respectively. BOP (%), PD and CAL values of the normal-weight group were significantly lower than those of the obese group (p<0.05) (Table 6).

According to the DMFT scores, 59.9% of the subjects were below the average and 40.1% were above the average. The average DMTF value of the subjects was 6.31 and the values varied between 0 and 27. The subjects had approximately 1 decayed tooth, 3 filled teeth, 2 missing teeth and 26 teeth in their mouths, on average (Table 4).

Based on the BMI classification, DMTF scores of 77.3% of the underweight patients, 69.3% of the normal-weight patients, and 51.9% of the overweight patients were below 6.3 while the DMTF scores of 59.9% of the obese patients were above 6.3 (Table 7).

A statistically significant correlation was found between the waist circumference scores and DMTF scores of the patients ($p<0.05$). While 67.3% of the normal patients had a DMTF score below 6.3, 55.5% of the obese patients had a DMTF score above 6.3 (Table 8).

Table 1. Distribution of socio-demographic statuses of the participants

		N	%
Sex	Female	551	58
	Male	399	42
Educational Status	None	7	0.7
	Primary School	304	32
	High School	236	24.8
	University	403	42.4
Monthly Household Income	Less than 1000	96	10.1
	1000-2000	328	34.5
	2000-3000	246	25.9
	More than 3000	280	29.5
Marital Status	Single	367	38.6
	Married	583	61.4
Age	18-29 years	396	41.7
	30-39 years	228	24
	40-49 years	162	17.1
	50-59 years	129	13.6
	60 Years and Older	35	3.7
Systemic Diseases	Healthy	808	85.1
	Diabetes	17	1.8
	Goiter	27	2.8
	Hypertension	37	3.9
	KVH	28	2.9
	Asthma	14	1.5
	Other	8	0.8
	Hypertension + Diabetes/Goiter/KVH	11	1.2
Smoking	Non-smoker	679	71.5
	0-10 cigarettes	130	13.7
	10-20 cigarettes	127	13.4
	More than 20 cigarettes	14	1.5
Use of Medications	Non-smoker	817	86
	Takes Medications	133	14
Tooth Brushing Frequency	Never	11	1.2
	Once a day	498	52.4
	Twice a day	259	27.3
	Occasionally	182	19.2
Interproximal Care	No	896	94.3
	Yes	54	5.7
Application to a Dentist	Once in every 6 months	10	1.1
	Once a year	38	4
	When I have a complaint	902	94.9
Reason for Applying to the Clinic	Gingival Treatment	148	15.6
	Filling	260	27.4
	Toothache	139	14.6
	Overall Checkup	87	9.2
	Having a Tooth Out	177	18.6
	Joint Problem	30	3.2
	Having a Prosthesis	91	9.6
	Orthodontic Treatment	18	1.9

N:Number of individuals

Table 2. Height, weight, waist circumference and BMI values of the subjects and BMI values for the WHO classification of the patients who participated in the study

	N	Mean	Median	Min	Max	SS
Height (cm)	950	166.32	165	144	194	9.24
Weight (kg)	950	73.24	72	39	148	20.12
BMI	950	26.30	25.53	15.06	49.61	5.38
Waist Circumference	950	81.59	81	39	134	13.79
				N		%
BMI Classification		Underweight BMI <18.5 kg/m^2		44		4.6
		Normal weight BMI: 18.5-24.9 kg/m^2		410		43.2
		Normal weight BMI: 18.5-24.9 kg/m^2		295		31.1
		Obese-1 BMI: 30-34.9 kg/m^2		126		13.3
		Obese-2 BMI: 35-39.9 kg/m^2		54		5.7
		Obese-3 BMI>40 kg/m^2		21		2.2
		Obese-3 BMI>40 kg/m^2		950		100

BMI: Body mass index, N: Number of individuals, Min: Minimum, Max: Maximum, SS: Standard Deviation

Table 3. Distribution of neck and chest circumference values of the participants by their genders

			N	Mean	Median	Min	Max	SS
Neck Circumference	Normal	Female	306	25.26	25	21	27	1.42
		Male	248	30.75	31	25	33	1.91
		Total	554	27.72	27	21	33	3.19
	Obese	Female	245	29.70	29	28	39	1.80
		Male	151	36.24	35	34	87	4.63
		Total	396	32.19	31	28	87	4.50
	Total	Female	551	27.24	27	21	39	2.72
		Male	399	32.83	33	25	87	4.18
		Total	950	29.59	29	21	87	4.39
Chest Circumference	Normal	Female	316	80.17	80	65	88	4.54
		Male	264	86.81	87	0	95	8.52
		Total	580	83.19	83	0	95	7.42
	Obese	Female	235	98.78	97	89	129	8.32
		Male	135	102.51	101	96	131	6.47
		Total	370	100.14	99	89	131	7.89
	Total	Female	551	88.11	86	65	129	11.23
		Male	399	92.12	93	0	131	10.84
		Total	950	89.79	89	0	131	11.24

N: Number of individuals, Min: Minimum, Max: Maximum, SS: Standard Deviation

Table 4. Periodontal clinical parameters and DMFT index values of the participants

	N	Mean	Median	Min	Max	SS
Plaque Index	**950**	**1.21**	1	0	3	0.62
Bleeding During Probing (%)	**950**	**0.56**	0.54	0	1	0.33
Pocket Depth (mm)	**950**	**2.28**	2.12	0.83	5.79	0.61
Clinical Attachment Level (mm)	**950**	**2.48**	2.16	0	9.08	0.96
Number of Decayed Teeth	**950**	**0.71**	0	0	17	1.27
Number of Filled Teeth	**950**	**3.41**	2	0	19	3.50
Number of Missing Teeth	**950**	**2.19**	1	0	10	2.56
Number of Teeth in Mouth	**950**	**25.80**	27	18	28	2.57
DMFT Values	**950**	**6.31**	5	0	27	5.01

N: Number of individuals, Min: Minimum, Max: Maximum, SS: Standard Deviation

Table 5. Analysis results based on the differences between the BMI values and periodontal clinical parameters of the participants

		BMI						Kruskal Wallis-H	
		n	Mean	Median	Min	Max	SS	Mean Rank	H	p
PI	**Underweight**	**44**	1.10	1	0	3	0.62	422.91	13.750	0.003*
	Normal Weight	**410**	1.15	1	0	3	0.61	404.85		
	Overweight	**295**	1.27	1	0	3	0.61	501.31		
	Obese	**201**	1.31	1	0	3	0.63	511.65		
PD (mm)	**Underweight**	**44**	2.06	2.08	1.25	4	0.46	377.47	52.906	0.001*
	Normal Weight	**410**	2.15	2.08	0.83	5.33	0.52	414.05		
	Overweight	**295**	2.37	2.16	1.12	5.25	0.63	516.54		
	Obese	**201**	2.48	2.25	1.16	5.79	0.72	562.07		
BOP (%)	**Underweight**	**44**	0.54	0.58	0	1	0.36	464.10	16.102	0.001*
	Normal Weight	**410**	0.52	0.50	0	1	0.34	442.15		
	Overweight	**295**	0.57	0.54	0	1	0.33	482.94		
	Obese	**201**	0.63	0.63	0	1	0.33	535.10		
CAL (mm)	**Underweight**	**44**	2.08	2.08	1.25	4.83	0.54	350.52	73.029	0.001*
	Normal Weight	**410**	2.25	2.08	0.83	6.62	0.73	402.48		
	Overweight	**295**	2.67	2.25	0.00	9.08	1.07	536.21		
	Obese	**201**	2.75	2.33	1.41	8.41	1.12	562.70		

BMI: Body mass index, N: Number of individuals, Min: Minimum, Max: Maximum, SS: Standard Deviation
PI: Plaque index, PD: Probing depth, BP: Bleeding during probing, CAL: Clinical attachment level, *p<0.05

Table 6. Analysis results based on the differences between the WC values and periodontal clinical parameters of the participants

		Waist Circumference (WC) Score						Mann-Whitney U	
		n	Mean	Median	Min	Max	SS	Mean Rank	Z	p
PI	**Normal Weight**	640	1.20	1	0	3	0.63	468.34	1.196	0.232
	Obese	310	125	1	0	3	059	49028		
PD (mm)	**Normal Weight**	640	222	208	083	533	058	44642	4.699	**0.001***
	Obese	310	241	220	112	579	067	53554		
BP (%)	**Normal Weight**	640	054	050	0	1	034	45886	2.709	**0.007***
	Obese	310	060	058	0	1	033	50986		
CAL (mm)	**Normal Weight**	640	238	212	0	908	089	44246	5.337	**0.001***
	Obese	310	267	229	141	841	106	54370		

WC: Waist circumference, N: Number of individuals, Min: Minimum, Max: Maximum, SS: Standard Deviation
PI: Plaque index, PD: Probing depth, BP: Bleeding during probing, CAL: Clinical attachment level, *p<0.05

Table 7. Analysis results based on the differences between the BMI values and DMFT index values of the participants

		BMI										Chi-Square Analysis	
		Underweight		Normal Weight		Overweight		Obes		Total			
		n	%	n	%	n	%	n	%	n	%	Chi-Square	P
DMFT Score	Smaller than 6.3	34	773	284	693	153	519	98	488	569	599	38.830	0.001
	Greater than 6.3	10	227	126	307	142	481	103	512	381	401		
	Total	44	1000	410	1000	295	1000	201	1000	950	1000		

BMI: Body mass index, N: Number of individuals, Min: Minimum, Max: Maximum, SS: Standard Deviation
PI: Plaque index, PD: Pocket depth, BP: Bleeding during probing, CAL: Clinical attachment level, *p<0.05

Table 8. Analysis results based on the differences between the BMI values and DMFT index values of the participants

		Waist Circumference (WC) Score						Chi-Square Analysis	
		Normal Weight		Obes		Total			
		n	%	n	%	n	%	Chi-Square	P
DMFT Score	Smaller than 6.3	431	673	569	599	569	599	45.305	0.001
	Greater than 6.3	209	327	381	401	381	401		
	Total	640	1000	950	1000	950	1000		

WC: waist circumference, N: Number of individuals, Min: Minimum, Max: Maximum, SS: Standard Deviation, PI: Plaque index, PD: Probing depth, BP: Bleeding during probing, CAL: Clinical attachment level, *p<0.05

DISCUSSION

Defined as abnormal or excessive storage of fat in the body, obesity is a risk factor for the overall condition of health. Many studies about the effects of obesity on the overall condition of health revealed a correlation between obesity and chronic and inflammatory diseases. Based on these data, the fact that periodontal diseases are inflammatory in nature and classified as chronic diseases, studies were directed to the effort of finding a correlation between obesity and the periodontal disease. Particularly the recent data yielded from the studies on this matter suggest that the periodontal disease may be related to obesity (11,12).

The studies on this matter are epidemiologically oriented, and they investigate the relation between individuals with obesity and metabolic syndromes and the periodontal disease. Certain studies suggest such a relation but major differences between the studies in terms of the number of patients, age ranges or obesity measurement methods, or the methods for determining the presence of the periodontal disease draw attention (13,14). Unlike similar studies, the present study aimed to use a greater range of parameters to identify the presence of the periodontal disease. We planned to use waist circumference values in addition to BMI as well as clinical periodontal parameters and radiological examination to distinguish metabolically normal obese patients and study in a small fragment of the Turkish society the presence of a correlation between the periodontal disease and obesity based on the data derived from the study. In addition to this purpose, we aimed to find a threshold value by incorporating in our study the neck circumference values that have only recently been used for early diagnosis of obesity but lack a standard value for women and men, and the chest circumference values that have recently been suggested to be used for early diagnosis of obesity.

In a study on a group of 450 subjects, authors reported that the prevalence of obesity increased with age, obesity is more prevalent among the married than the single, and obesity was inversely correlated with the educational status (15). In a study conducted on 3600 subjects, researchers studied the relation between socio-demographic variables and obesity, and found similar results (16). This is also supported by the results of the present study. Our study yielded a significant correlation between BMI and age, sex, monthly household income, marital status, and educational background. Reduced physical activity and basal metabolic rate with aging are common phenomena particularly among married women. Also, as the income levels and educational statuses of individuals lowers, consumption of vegetables also declines, and consumption of fat and carbohydrates increases. This affects individuals' predisposition to gaining weight. The results of the present study are in line with these data.

In a study conducted on 706 subjects, aged 30 to 65 using the BMI criteria of World Health Organization, it was found that 60% of the male patients and 65% of the female patients were obese and overweight. Considering the condition of periodontal diseases, 50.7% of men and 35.3% of women were diagnosed with periodontitis. In conclusion, while there was a significant correlation between BMI and periodontitis for female patients, no such correlation was observed for male patients (17). In a large-scale study, community periodontal index of treatment needs (CPITN) was used, and the patients were categorized in obese and non-obese groups based on their BMI. It was reported in the study that there was a significant correlation between the obese and overweight women and periodontal pocket depth values, and this correlation applied exclusively to the overweight individuals for men (18). While 79.5% of the underweight patients were female and 60.7% of

the normal-weight patients were female, 52.5% of the overweight patients were male in our study. 63.2% of the obese patients were female. Similarly, a statistically significant correlation was found between the genders and BMI and WC scores of the patients in the present study ($p<0.05$). It was also observed that periodontal clinical parameters of our patients diagnosed with obesity were significantly high.

A cross-sectional study on the third Health and Nutrition Research Questionnaire conducted on non-smoker adults in the United States revealed that aged adult individuals have 5% more odds rate for each 1 cm of WC in the case of periodontitis (19). On the other hand, Fotoushi et al. (2008) found a negative correlation between smoking and obesity. This result is similar to various studies (20). The close relation of obesity with systemic diseases is also known. This relation was revealed clearly for diabetes mellitus, hypertension and cardiovascular diseases (21). It is also known that smoking is a factor for many systemic diseases and it is thought that smoking causes loss of appetite and reduces the tendency to gain weight. While our study suggested a significant correlation between BMI and systemic diseases and medication use, it did not suggest any significant correlation between BMI and smoking, when the correlation between BMI and health variables (systemic diseases, use of medications, smoking) was considered. This may be explained by the fact that the smokers among the subjects were usually young adults and physically active.

An examination of the correlation between the waist circumference and socio-demographic factors revealed a significant correlation between WC and age, sex, educational background and marital status but no significant correlation between the monthly household income and the number of family members. It is known that waist circumference increases with age particularly for married women. This is affected by the educational and income status of individuals. This is supported by the results of our study. Lack of a significant correlation between the household income and WC is attributable to an insufficient level of income since Turkish families are usually large.

In a study that analyzes the general health conditions (systemic diseases, use of medications, smoking) and WC values, a significant correlation was found between WC and systemic diseases, use of medications and smoking. Smoking is very common in our society and an important risk factor for many diseases. Smokers are usually less inclined to gaining weight and have smaller waist circumference than non-smokers (22). The results of our study are in agreement with these opinions. Cunha-Cruz et al. (2006) showed in a cohort study that the frequency of brushing teeth is in a strong dose-dependent correlation with obesity for 1497 people (23). Kuis et al. (2013) had the same results for dental floss and interproximal brush (22). In our study, we found a significant correlation between brushing teeth and BMI values, but no significant correlation with interproximal care. This situation can be attributed to the fact that the individuals in the Turkish community are not adequately informed about the interproximal care and therefore the number of the individuals performing the interproximal care is smaller.

Oral hygiene habits can only be adopted by training at childhood. It is difficult to change brushing habits at older ages. This is usually in parallel with obesity. Training families about dietary habits may help to organize children's dietary habits and prevent them from gaining excessive weight.

It is reported in the meta-analysis of 19 independent studies conducted by systematic analysis that there is a strong correlation between obesity and the periodontal disease (24). In a case-control study examining the correlation between the metabolic syndrome and chronic periodontitis, a total of 208 individuals-56 healthy and 152 with metabolic syndrome - were included. It was reported in the study that there was a correlation independent of other risk factors between the periodontal disease and the individuals with the metabolic syndrome (25). In addition to those studies, 396 non-smokers, non-diabetic individuals aged 30 to 59 participated in a small-scale study in 2010, and followed up for approximately 4 years. It was found in the study that obesity had a low and insignificant correlation with the periodontal disease. Researchers attributed this outcome to the fact that it was a small-scale study (26). A positive correlation was found between the BMI values and the clinical parameters of the periodontal disease in our study. A positive correlation was also found between WC values and the clinical parameters of the periodontal disease, except for the plaque index. The fact that although this index that shows the distribution of the microbial dental plaque, which is the primary factor in the periodontal disease, has a similar distribution for both patient groups, such parameters as BOP, PD and CAL, which are the determinants of the periodontal disease, are significantly higher in obese patients than they are in the non-obese group suggests that obesity may play an active role in the progression of the periodontal disease.

Kushiyama et al. (2009) analyzed the correlation between the metabolic syndrome and the periodontal disease in a study conducted on 1070 Japanese adults. They assessed the community periodontal index (CPI) and the components of the metabolic syndrome in for the diagnosis of the periodontal disease. They reported that there was a correlation between the periodontal disease and the metabolic syndrome (27). The results of our study showed a statistically significant correlation between the BMI values of the patients and their periodontal health. When gingivitis, the mildest form of periodontal diseases, is considered, gingivitis was found in 77.3% of the underweight patients, 67.1% of the normal-weight patients, 59.7% of the overweight patients, and 53.2% of the obese patients. When the periodontitis conditions of the subjects were examined, it was found that 4.5% of

the underweight patients, 15.6% of the normal-weight patients, 29.8% of the overweight patients, and 36.3% of the obese patients had periodontitis. The correlation between the patients' WC scores and the periodontal disease was also found to be statistical. While gingivitis, the mildest form of periodontal diseases, was inversely correlated with the WC scores, periodontitis was found to be correlated with the WC scores. We can attribute this, again, to the prevalence of gingivitis in the society and our classification of gingivitis patients based on the severity of the disease.

When the correlation of BMI and WC with the DMFT values was analyzed, neither of the values was found to be significantly correlated with DMFT. Kim et al. (2011) compared DMFT in normal and obese groups, and found a significant correlation between WC and BMI (28). Sarlati et al. (2008) also found similar results (29). The results of our study are in agreement with the literature.

It is stated in some studies that BMI and WC do not coherently reflect obesity (28). We believed that in this study, all findings that we identified for WC would be coherent with the results that we found with regard to BMI. We attribute the contradictory results between BMI and WC to the fact that parameter sub-groups are not large enough and that a definite WC threshold is not available for the Turkish society.

For the patients that participated in our study, the threshold value for the neck circumference was 33.5 cm for men and 27.5 cm for women, and the threshold value for the chest circumference was 99.5 cm for men and 88.5 cm for women. In a 2008 study published in Turkey, Erkan et al. (2009) used the neck circumference to identify abdominal obesity. 1912 male and female subjects aged 43 to 67 participated in the study. They found the neck circumference values in the range of 33.2 to 40.2 for all patients. They reported that neck circumference was a useful measurement to identify morbid obesity (30).

Neck circumference and chest circumference have started to be used in studies for early diagnosis of obesity. Nevertheless, since there is not a standard threshold value determined by World Health Organization yet, our study does not include such a threshold. However, further studies that may be conducted on this matter in Turkey may use the threshold values yielded by our study.

CONCLUSION

Both periodontal disease and obesity cause an inflammatory condition in the body. Two diseases may occur at the same time, or they may occur sequentially, creating a second disease by exacerbation or exacerbation of one disease. In the light of the information provided herein, it is seen that there is a significant correlation between the periodontal disease and obesity. We should consider this positive correlation within the boundaries of a cross-sectional study. Cross-sectional studies show association rather than causality. The diseases may be concurrent or occur in sequence by making a secondary disease because of the progression or exacerbation of a disease. Intensive studies are carried out all over the world regarding the relationship between obesity and periodontal disease. We believe that controlled studies with long-term follow ups, which will be conducted with multiple factors eliminated and where the correlation between the two diseases is plainly revealed are necessary to achieve decisive results.

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