



ORIGINAL ARTICLE

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Association between abdominal obesity and periodontal disease. Cross-sectional study.

Abstract: Introduction: The aim of the study is to determine the association between abdominal obesity and periodontal disease by means of multivariate analysis. Materials and method: A cross-sectional observational study was carried out. From March to April 2014, patients admitted to the Dental Sciences Building at Universidad Austral de Chile were subjected to a clinical periodontal examination. Periodontitis was defined by a probing pocket depth equal to or greater than 4mm in at least one site of the teeth in two different quadrants, along with active bleeding within 30 seconds after probing. Abdominal obesity was defined by waist-hip ratio with values equal to or greater than 0.90 for men and 0.88 for women. Oral hygiene was assessed by Simplified Oral Hygiene Index. Smoker status was determined after undergoing an interview. Results: The sample comprised 136 participants (51 males and 85 females), with a mean age of 40.6±15.1 years. Prevalence of periodontal disease was 49.2% and obesity was 50.7%. A 62.3% of the patients showed both, periodontal disease and obesity. A statistically significant association between abdominal obesity (Odds ratio (OR)=2.4, 95% confidence interval (CI): 1.1, 5.1), cigarette consumption (OR=4.0, 95% CI: 1.0, 16.5), poor oral hygiene (OR=2.8, 95% CI: 1.3, 5.9) and periodontal disease was established. Conclusion: There is a statically significant association between abdominal obesity and periodontal disease.

Keywords: *Abdominal obesity, periodontal disease, waist-hip ratio, adipose tissue, metabolism, epidemiology.*

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INTRODUCTION.

Obesity is defined by the World Health Organization (WHO) as the abnormal or excessive accumulation of adipose tissue that can be harmful to health¹. If this occurs around the waist, it is called abdominal obesity², which is strongly associated with complications such as diabetes mellitus, insulin resistance, cardiovascular disease or dyslipidemia^{3,4}.

In 2005, the International Diabetes Federation (IDF) proposed that a waist circumference greater than or equal to 94cm in men and greater than or equal to 80cm in women would be considered as abdominal obesity in a

European population⁵. However, this definition is very sensitive to anthropometric characteristics of the population, and it is, therefore, recommended to be defined locally^{2,4}. In Chile, according to the National Health Survey (2009–2010) which considers what the IDF proposes, 45.1% of men and 71.5% of women have abdominal obesity⁶.

In recent studies^{3,7}, it has been observed that the accumulation of adipose tissue in the hip acts as a protective factor. Therefore, it is proposed to measure abdominal obesity by dividing abdominal circumference by hip circumference (waist/hip ratio, WHR).

During the past few years, it has been described that the nutritional status has a negative effect on periodontal disease (PD)^{8,9}, specifying that abdominal obesity would act as a risk factor¹⁰. Due to the impact it generates on the metabolic and immune parameters, susceptibility of the host increases^{11,12} favoring progression and severity of the disease. Hence, it can be speculated that abdominal obesity would act as a risk factor for PD.

For these reasons, and due to the high prevalence of PD in Chile (92.1% between the ages of 35 and 44 years, and between 65 and 74 years old¹³), it is necessary to study if there is an association between abdominal obesity and PD. However, there are no studies available to investigate the effect of abdominal obesity among Chilean populations in electronic databases.

Therefore, the aim of this study is to determine the association between abdominal obesity and PD by means of multivariate analysis.

MATERIALS AND METHODS.

A cross-sectional observational study was conducted. The population was patients admitted to the building of the Dental Sciences Building of the Universidad Austral de Chile (UACH) in the city of Valdivia during March and April 2014, prior to approval by the Bioethics Committee of the Faculty of Medicine of the UACH.

Patients between 18 and 70 years old, with at least two teeth in the mouth, who accepted to participate in the study and sign the informed consent were included. Pregnant women and patients who underwent periodontal treatment during the last 6 months, undergoing current periodontal treatment, on antibiotic treatment for a week or more in the last 6 months, or on treatment with immunosuppressive agents, all conditions that alter the periodontal status, were excluded.

In the sample size, 10 events per variable of study were considered¹⁴: abdominal obesity, PD, oral hygiene, smoking, age and gender; obtaining a sample size of 60 patients per group (with and without PD).

The study was conducted specifically between April

and May of 2014. Periodontal clinical examination started with the approval of the informed consent, which was explained in writing and orally, by the patient. The groups of patients with and without PD were determined in accordance with the criteria of the American Academy of Periodontology. In consequence, probing depth was measured in millimeters from the gingival margin to the bottom of the furrow/periodontal sack¹⁵ using a North Carolina probe type (Hu-friedy Mfg. Co., IL, USA). Measurement was carried out by a researcher who was previously calibrated in a session of theoretical instruction and 4 clinical sessions evaluating 20 elderly patients. Data registration was assessed as suitable with a kappa index equal to or greater than 0.8 in measurements. These patients were not included in the study.

Periodontal examination was executed by evaluating each tooth at six sites (mesial, medial, distal lingual or palate-mesial, palate-medial and palate-distal), except for teeth with indication of exodontia, third molars and distal sites of second molars when the third molars were in the mouth. Results were coded as follows: patient without PD with less than 4 mm probing depth; and patient with PD with depth greater than or equal to 4 mm, together with the presence of active bleeding within 30 seconds after probing in at least one site in two different sextants.

Oral hygiene level was determined using the simplified oral hygiene index by Greene and Vermilion (OHI-S) with a plaque disclosing tablet and examining the vestibular faces of the first upper molars, upper central incisor right and lower left central incisor and the lingual surfaces of the lower first molars. Oral hygiene was valued as good (OHI-S between 0 and 1.25) and poor (OHI-S greater than 1.25). The cut-off value was determined based on the median value of the OHI-S of the patients evaluated.

In both groups, the presence of abdominal obesity was determined using WHR and an anthropometric tape measure (Lufkin W606PM, USA.). The researcher was calibrated in a session of theoretical instruction and 2

practical sessions, evaluating a total of 8 elderly patients. Data registration was considered as suitable when the kappa index in measurements was equal to or greater than 0.8. These patients were not included in the study.

Standing in an upright position, waist circumference was measured from the mid-point between the lower rib and the upper margin of the iliac crest². Hip circumference was measured as the largest circumference at the buttock level in a standing position. Two measurements were carried and the patient's WHR was determined by the average of both. Abdominal obesity was characterized by a proportion waist/hip ratio greater than 0.9 in men and 0.85 in women¹⁶.

By using a direct interview, cigarette consumption was evaluated to determine a smoker (5 or more cigarettes 24 hours before the test) or a non-smoker patient (less than 5 cigarettes 24 hours before the test)¹⁷. Also, systemic diseases were evaluated using an interview and were corroborated with their medical record.

Once the assessment was completed, patients were informed about the periodontal diagnosis detected and were referred to be treated in the same office according to their needs.

Data was encoded numerically and stored in Google Docs. Because of the risk of errors during the process and in order to avoid them, 5 subjects were added to each group; so the total number of the sample was not affected.

For the analysis of data, PD was determined as a dependent variable. The characteristics of the subjects and the variables were described using distribution of frequencies for categorical variables using χ^2 test; and the mean and standard deviation (SD) for continuous variables using student's t test. An analysis of statistical association was made between each variable characterized dichotomously and the presence/absence of PD using binary logistic regression with multivariate analysis and accepting a significance level of 5%. Data and result processing were performed using the statistical software SPSS version 11.5 for Windows (IBM, NY, USA).

RESULTS.

A total of 144 patients admitted to at the Dental Sciences building of the UACH from March to April 2014 were evaluated. From them, 8 were excluded due to antibiotic consumption for 7 days in the past 6 months (5.7%), current consumption of nifedipine (1.4%), older than 70 years old (2.8%) and presented abdominal hernia (1.4%). Therefore, 136 participants (51 men and 85 women) between 18 and 70 years old, with an average of 40.6 ± 15.1 years old ($p < 0.0001$) were included.

Prevalence of PD and obesity was 67 (49.2%) and 69 (50.7%) participants respectively (Table 2). From the total of patients with obesity, 24.2% were men ($p = 0.011$). The value for mean WHR for participants with PD was 0.89 ± 0.07 and without PD was 0.84 ± 0.08 ($p = 0.001$) (Table 1). Of all the patients, 43 (62.3%) presented PD and abdominal obesity ($p = 0.002$) (Table 2). This corresponds to 9% of those in the age range 18-30, 50% of those in the age range 31-40, 29% of those in the age range 41-50, 65% of those in the age range 51-60 and 36% were older than 61.

Poor oral hygiene was detected in 64 patients, of whom 64% presented PD ($p = 0.001$) with a mean value of 1.45 ± 0.53 (Table 1 and 2); and cigarette consumption was present in 13 participants being a 76.9% PD ($p = 0.36$); both associations were statistically significant (Table 2).

The prevalence of diseases was: diabetes mellitus (DM) ($n = 2$), hypertension (HTN) ($n = 7$), dyslipidemia ($n = 6$), arthritis ($n = 7$) and hypothyroidism ($n = 5$), without detecting statistical significance between PD and patients without PD ($p > 0.05$). This situation changes in those patients who simultaneously present at least two: DM, hypertension and dyslipidemia ($p = 0.017$) (Table 2).

The analysis of binary logistic regression established a statistically significant association between abdominal obesity [Odds ratio (OR)=2.4, 95% confidence interval (CI): 1.1, 5.1], cigarette consumption (OR=4.0, 95% CI: 1.0, 16.5), poor oral hygiene (OR=2.8, 95% CI: 1.3, 5.9) and PD (Table 3).

Table 1. Average value of years of age, waist diameter, hip diameter, waist/hip ratio (WHR), Simplified Oral Hygiene Index - (IHO- S) between the group of patients with and without periodontal disease (PD).

	With PD	Without PD	Total	p*- Value
Average age (years old) (Mean ± SDa)	45.9 ± 12.9	35.4±15.4	40.6 ±15.1	< 0.0001
Waist Diameter (cm.) (Mean ± SDa)	92.34 11.65	+ 86.18 14.36	+89.22 13.41	+0.006
Hip Diameter (cm.) (Mean ± SDa)	102.2 ± 8.16	100.6 ± 8.94	101.4 ± 8.57	0.282
WHR (Mean ± SDa)	0.89 ± 0.07	100.6 ± 8.94	0.87 ± 0.08	0.001
(OHI - S) (Mean ± SDa)	1.45 ± 0.53	1.072 ± 0.58	1.260 ± 0.59	0.0001

* Analyzed using t-test. a Standard deviation.

Table 2. Distribution of frequencies for gender, systemic diseases-high blood pressure (hypertension), diabetes mellitus (DM), dyslipidemia, arthritis, and hypothyroidism; abdominal obesity, gender, poor oral hygiene and smoking among the group of patients with and without periodontal disease (PD).

		With PD	Without PD	Total	p*- Value
Gender	Female	35	50	85	0.014
	Male	32	19	21	
Systemic disease	HTN	3	4	7	0.758
	DM	1	1	2	0.983
	Dyslipidemia	4	2	6	0.383
	Two or more (hypertension, diabetes or dyslipidemia).	8	1	9	0.017
	Arthritis	5	2	7	0.189
	Hypothyroidism	1	4	5	0.182
Abdominal obesity	43	26	69	0.002	
Poor Oral Hygiene	41	23	64	0.001	
Smokers	10	3	13	0.036	

*Analyzed using chi-square.

Table 3. Effect of the predictive variables on the development of periodontal disease obtained through the analysis of binary logistic regression.

	Regression coefficient (β)	ORa (95% CI(b)	p*- Value
Abdominal obesity	0.89	2.4 (1.1-5.1)	0.017
Cigarette consumption	1.40	4.07(1.0-16.5)	0.050
Poor Oral Hygiene	1.04	2.8 (1.3-5.9)	0.006
Constant	-1.09	0.33	0.001

*Analyzed using chi-square.

DISCUSSION.

According to the data obtained, there is a statistically significant association between PD and abdominal obesity ($p=0.002$). It is 2.4 times more likely to develop PD when presenting abdominal obesity defined by WHR. Similar results were obtained by Saito *et al.* when determining that low WHR values are associated with a low risk of PD¹⁸. Years later, they added that a greater probing depth would correlate with a higher WHR. Another study found that individually BMI, WHR and the area of visceral adipose tissue had a dose- effect relationship in terms of the number of sextants with PD¹⁹. Likewise, Chopra *et al.* determined that obese individuals were 1.2 times (95% CI: 1.02, 2.7) at increased risk of developing PD, in comparison with non-obese individuals²⁰. Palle *et al.* confirmed the existence of a strong association between PD and severe obesity, despite the fact that the latter was measured by BMI²¹, agreeing with Moura-Grec *et al.* who also added that the magnitude of this association is not yet clear, but the risk factors that exacerbate these diseases should be better clarified to elucidate the direction of this association²².

However, Kim *et al.* concluded that obesity only would be associated with PD if defined by waist circumference, but not when measured with BMI²⁰. This can be explained because the anatomic distribution of the different deposits of adipose tissue determines different levels of function, being central more metabolically active than peripheral^{2,23}.

The immune activity of adipose tissue may play an important role in PD²⁴ since obesity is characterized by maintaining a basal inflammatory state²⁵. This is because adipose tissue acts as a true endocrine gland which can secrete important metabolic hormones and cytokines that regulate the inflammatory status²⁵ which increases likelihood of developing an active inflammatory response by the host, by encouraging destruction of connective tissue and periodontal bone resorption^{26,27}. Among these cytokines is Tumor Necrosis Factor- α (TNF- α) that increases insulin-resistance, contributing to a genera-

lized hyperinflammatory state that affects periodontal tissues, especially in the presence of oral pathogens^{21,24}. It also highlights leptin hormone secretion, which has a fundamental role in the regulation of the feeling of satiety, but also acts as an anti-inflammatory hormone and promotes bone formation²⁴. Normally, circulating leptin levels have a direct correlation with the amount of adipose tissue, but this relationship is usually altered in obesity²⁴.

Notwithstanding, one study concluded that PD and abdominal obesity measured by WHR would not be associated⁹. It would be possible to explain this due to ethnic and anthropometric differences in the populations studied. Another study establishes that obesity would be related to tooth loss, oral hygiene, and low educational level, but not with PD²⁸. This difference may be due to the variation in the measurement of the variables, and data collection using a questionnaire which was administered to the participants (with the exception of PD) being exposed to memory bias. In addition, it is important to emphasize that obesity and common oral diseases (caries and PD) are closely linked to diet and behavior²⁹, and can manifest clinically as a result of one or the other.

A higher tendency to suffer from PD along with abdominal obesity was found between 50 and 60 years of age (65%), similar to the study of Lee & Park with an interval between 35 and 59 years old³⁰; and Han *et al.* with a range between 45 and 54 years old³¹. However, another study says there is a significant association in all ages²⁰. This could be explained by the type of analysis used.

The results also show the association between PD and abdominal obesity along with: poor oral hygiene and smoking, with a high level of significance ($p=0.001$ and $p=0.036$, respectively). Chopra *et al.*, Han *et al.* and Kim *et al.* adjusted the analysis to: monthly family income, alcoholism, physical activity, presence of active caries, number of decayed and lost teeth^{20,22,31}. This is despite the fact that they determined the presence of oral hygiene indirectly using a questionnaire to find about the habits of brushing, flossing and an interproximal tooth-

brush. Then, this procedure is subject to memory bias and it shows that the model of binary logistic regression used is consistent with the risk factors associated with PD, which were amply described in previous studies.

Regarding systemic diseases, the association with PD was determined only if the same patient records at least two: hypertension, diabetes and/or dyslipidemia. This is due to the fact that the number of participants included in the study and who presented systemic diseases in a unique way was considerably low and fair between the group of patients with and without periodontal disease, compared to those with two or more, decreasing the power of the effect. In recent years, the effect of hypertension, dyslipidemia³¹ and type 2 diabetes mellitus has been recognized as a risk factor for the PD, either individually or through the metabolic syndrome (MS). In fact, Han et al. stipulate that MS is strongly associated with PD (OR=1.7, 95% CI: 1.22, 2.37), proportionally increasing the number of components³¹. They also say that people with PD may have more severe chronic illnesses and are more likely to have MS compared with people without PD³¹.

Within the limitations of the study is the difficulty to operationally define abdominal obesity due to the fact that there is no consensus in the cut-off points to define it. Other investigations have preferentially used WHR, waist circumference and BMI, either together or separately^{8,10,19,22,27,32}. On the one hand, WHR has been questioned due to the fact that the adipose tissue that builds up in the hips is variable. Therefore, if waist and hip obesity increase simultaneously, the reason will be kept constant without any increase in the absolute risk, which can lead to error. However, when compared with BMI, it has been shown that it allows detecting the presence of adipose tissue clinically relevant to recognize that intra-abdominal is metabolically more active than peripheral^{2,22}; eliminates inconsistency in the detection of fat or muscle^{2,8}; and has greater association to the risk of cardiovascular disease and myocardial infarction, and may even be applied to most of the ethnic groups³¹.

Regarding periodontal studies, Saito *et al.* pointed out that a high WHR significantly increases the risk of PD¹⁸. Han *et al.* determined that the area of visceral fat is a more appropriate indicator of obesity in relation to periodontitis³¹. However, Kim *et al.* pointed out that BMI and PD would not be associated²². This statement is contrasted two years later by Palle *et al.* when using multivariate logistic regression analysis²¹ to determine the association between WHR, BMI and PD. Therefore, there is no consensus to define obesity to be studied as a possible risk factor for PD. However, studies agree that it is essential to consider anthropometric and ethnic variations of the population to investigate^{2,4}.

To consider abdominal obesity as a risk factor for PD would force to change the approach for treating obese patients. They would not only require attention for their systemic condition, but also to ensure control and maintenance of their periodontal health since their oral health will be more affected than in non-obese patients and require a multidisciplinary team supported by the current family care system. The incorporation of this practice benefits both the individual at the functional, psychological or socio-economic level and public health, considering that reversing the damage usually associated with tooth loss with dentures or implants require a greater investment compared with periodontal treatment. Consequently, its incorporation as a public health policy is feasible.

It is vital to work with promotional and preventive measures to change the patient's behavior and generate an impact both oral and general. In fact, a study that demonstrates an association between oral health and awareness of systemic health reported the strong relationship between lack of flossing and being overweight³².

Finally, it is concluded that there is a statistically significant association between abdominal obesity and PD in the Chilean population. However, longitudinal studies are needed to establish the directionality of this association, in addition to studies which explain pathophysiological mechanisms of this association.

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Asociación de la obesidad abdominal y enfermedad periodontal. Estudio de corte transversal.

Resumen: Introducción: El objetivo es determinar la asociación de la obesidad abdominal y la enfermedad periodontal por medio de un análisis multivariado. Material y métodos: Se realizó un estudio observacional de corte transversal en donde se evaluaron pacientes ingresados al Edificio de las Ciencias Odontológicas de la Universidad Austral de Chile en los meses de marzo y abril del año 2014. Fueron sometidos a un examen clínico – periodontal. La periodontitis se determinó con una profundidad al sondaje igual o superior a 4 mm. en al menos un sitio del diente en dos cuadrantes diferentes con sangrado activo hasta 30 segundos luego del sondaje; y la obesidad abdominal mediante el Índice cintura/cadera con valores igual o mayores a 0.9 en hombres y 0.88 en mujeres. Se evaluó la higiene oral mediante el Índice de Higiene

Oral Simplificado; y la condición de fumador mediante un interrogatorio. Resultados: Se incluyeron 136 participantes (51 hombres y 85 mujeres) con una edad media de 40.6 años \pm 15.1 DE. La prevalencia de periodontitis fue 49.2% y de obesidad 50.7%. Un 62.3% presentó periodontitis y obesidad abdominal. Se estableció una asociación estadísticamente significativa entre obesidad abdominal (Odds ratio = 2.4, 95% Intervalo de confianza: 1.1, 5.1], consumo de tabaco (Odds ratio = 4.0, 95% Intervalo de confianza: 1.0, 16.5), higiene oral pobre (Odds ratio = 2.8, 95% Intervalo de confianza: 1.3, 5.9) y enfermedad periodontal. Conclusión: Existe una asociación estadísticamente significativa entre la obesidad abdominal y la enfermedad periodontal.

Palabras clave: *Obesidad abdominal, enfermedad periodontal, índice cintura/cadera, tejido adiposo, metabolismo, epidemiología.*

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