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Number of teeth and its association with central obesity in older Southern Brazilians

R.J. De Marchi, F.N. Hugo, J.B. Hilgert and D.M. Padilha

Faculty of Dentistry, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Evidence suggests that older adults with extensive tooth loss may present dietetic restrictions and frequently choose softer and more processed foods, which consequently may lead to obesity. ***Objective:*** To evaluate whether there was an association between dental status and central obesity in community-dwelling elderly. ***Basic research design:*** A simple random sample of 471 community-dwelling Brazilian elderly ranging from 60 to 89 years old was evaluated in 2006. A questionnaire on socio-demographic, behaviour, general and oral health variables was applied. The number of natural teeth and the use of dental prostheses, following the World Health Organization (WHO) criteria, were assessed. ***Main outcome measures:*** The circumferences of the waist and the hip were measured in order to provide the waist circumference (WC) and the waist-hip ratio (WHR) measures. For both measures, participants were categorised as non-obese or obese according to the WHO-established cut-off points. ***Results:*** Participants with more than 8 teeth were less likely to have central obesity, as measured by WHR [OR=0.49 (0.32 to 0.87)], while participants with only 1-8 natural teeth were more likely to have central obesity when evaluated by WC [OR=3.28 (CI 1.43 to 7.52)]. ***Conclusions:*** Tooth loss was associated with central obesity, even when controlled for confounders, suggesting a relationship between oral health status and nutritional status in this sample of community-dwelling Brazilian elderly. Preserving natural teeth may have a positive impact on the nutritional status of older adults and on obesity-related morbidity.

Key words: *tooth loss, obesity, waist-hip ratio, waist circumference, Brazil*

Introduction

Developing countries are experiencing a dramatic increase in the proportion of older persons in their populations. It is estimated that Brazil will be the sixth country in terms of total population of older people by 2025 (Carvalho and Rodríguez-Wong, 2008). This represents a challenge to the health care system and creates a demand for research evaluating health and quality of life issues in order to establish public policies. In coming decades, health and social policy-makers will face tremendous challenges posed by the rapidly changing burden of chronic diseases in old age. In this context, tooth loss, dental caries and periodontal diseases can be observed as characteristic features of older adults' oral condition (Woods *et al*., 2009).

Previous evidence showed that persons with a compromised masticatory function resulting from tooth loss tend to consume more easy-to-chew food, avoiding fibrous, nutrient-rich food (Walls *et al*., 2000). Further, edentulous persons tend to consume less fruit and vegetables and more refined carbohydrates, sugar and fat (Hutton *et al*., 2002). It is hypothesised that the higher consumption of energy-dense food might represent an adaptation to the reduction of chewing capacity resulting from tooth loss (Sahyoun *et al*., 2003).

There are changes in body composition with ageing, particularly in fat and skeletal muscle mass. Body mass index (BMI) and hip circumference increase until the age of 60–65 years old and then decline, whereas waist circumference continues to increase until later old age (Teh *et al*., 1996). In particular, peripheral muscle mass and subcutaneous fat decreases with age, whereas visceral fat increases with age (Rice *et al*., 1989).

In this context, the US National Institutes of Health (NIH) and the International Diabetes Federation (IDF) included waist circumference (WC), a measure of central obesity, as part of the criteria for metabolic syndrome. Metabolic syndrome is based on the coexistence, in the same individual, of 3 or more of these 5 factors: high blood pressure, dysglycemia, low HDL-cholesterol, hypertriglyceridemia and central obesity as measured by WC (Grundy *et al*., 2004).

Previous evidence has shown an association between poor oral health status and obesity in the elderly, as assessed by BMI (Hilgert *et al*., 2009), which is a well-accepted measure for the evaluation of adiposity (Visscher *et al*., 2001). However, body fat is more likely to be deposited in the abdominal cavity with increasing age (Rice *et al*., 1989). The centralisation of body fat is considered a better predictor of the physiological disorders that accompany excess weight gain, such as cardiovascular disease, than total body fat measured by BMI (Shen *et al*., 2006) because the latter does not reflect regional fat distribution (Visscher *et al*., 2001).

Although tooth loss influences diet and nutrition (Walls *et al*., 2000), there are few studies evaluating if it is associated with central obesity (CO) using waist-hip ratio (WHR) and waist circumference (WC) as indicators in this age group. The hypothesis of this study was that there would be no association between dental status and CO as assessed with WHR and WC in community-dwelling older adults. Therefore, the objective of this study was to evaluate if the

Correspondence to: Dr R.J. De Marchi, Faculty of Dentistry, Universidade Federal do Rio Grande do Sul, Ramiro Barcelos Ave., 2492, Caminho do Meio, Porto Alegre, RS, Brazil 90035-003. Email: demarchirenato@yahoo.com.br

oral health status was associated with Central Obesity (CO) in Southern Brazilian community-dwelling older people.

Methods

The present report is based on the data collected from a larger study about oral health, nutritional status, diet and anthropometric measures of community-dwelling older adults from the city of Carlos Barbosa, Rio Grande do Sul, Brazil. The city had 20,519 inhabitants in the year 2000, from which, approximately 2,000 were 60 years old or over. The sample in this cross-sectional study was identified using a table of random numbers to select participants from the Social Assistance Department of the Municipality register of those aged 60 years or more. Participation was invited by telephone or letter in cases where telephone numbers were not available. Those who refused to participate were replaced using subsequent numbers in the random numbers table. Special transport was provided through the support of the Social Assistance Department of the Municipality.

Previous data from a study about body composition conducted by our group in the city of Carlos Barbosa in 2004 were used to calculate the sample size. The calculation was made using a bidirectional alpha of 0.05 and a beta of 0.20 with 480 participants being needed to identify differences in respect to the number of natural teeth between obese and non-obese participants.

This study was approved by the Ethics Committee in Research of the Faculty of Dentistry of the Federal University of Rio Grande do Sul and all participants signed an informed consent form. Only persons aged 60 years or more, living independently and generally healthy were invited to take part in the study. Generally healthy persons were defined as those whose physical, medical and mental status allowed them to take the transportation and to participate in a comprehensive oral health examination conducted in a clinical setting (Holm-Pedersen *et al*., 2005).

To check the representativeness of the study participants, socio-demographic data of the population of aged persons of the city was retrieved from the municipality records. There were no significant differences regarding age, gender, income and geographic location of residences between study participants and the overall population aged 60 years or more living in Carlos Barbosa (data not shown).

Data collection was carried out in dental surgeries provided by the municipality and comprised interviews, anthropometric measurements, nutrition and diet evaluation and oral examination. All participants answered a questionnaire containing social, demographic and behavioural information as well as self-assessed medical and oral health data. Interviews and examinations were carried out by a single researcher (RDM).

Participants completed an interviewer-administered structured questionnaire of 36 questions assessing a wide range of socio-demographic, behavioural, medical and dental information. These questions referred to age, monthly income (less than two, or two or more minimum wages – a minimum monthly wage at the time of data collection was equivalent to US$ 209), marital status and behaviour variables, such as tobacco consumption, besides medical history.

To determine waist and hip circumferences, a flexible measuring tape was placed around the abdomen and the hips, taking care not to compress the skin. The reading was made to the nearest centimetre. The circumferences were measured with the individuals wearing light clothes, at an orthostatic posture, with relaxed abdomens, arms by body, feet close together and at the end of the exhalation movement. For the estimation of WHR, the measure of the waist circumference was taken at the navel level, immediately above the iliac crest, and the hip circumference was measured on the maximum diameter of the buttocks (Dos Santos and Sichieri, 2005); while the point for measuring WC was the midpoint between the last rib and the iliac crest. The cut-off points used to classify WHR and WC were the ones recommended by the World Health Organization (WHO) (2000). The values of 0.85 for women and 1.00 for men were used for WHR, and 0.80m for women and 0.94m for men for WC.

Natural teeth were counted and registered and the use of prostheses checked accordingly to the WHO criteria (1997). The participants were categorised according to the use of prostheses: edentulous using either complete dentures or only one denture.

The chi-square test was used for the categorical variables, while the Student's t test was used for the continuous variables. The value for the rejection of the null hypothesis was established at $p<0.05$. The Fisher test was used when there were fewer than 5 cases in a given cell of a contingency table. To test the hypothesis of this study, all the variables showing an association with $p<0.25$, as well as the ones with clinic-epidemiologic relevance, according to the literature, were included in the multivariate model. Variables that did not contribute ($p>0.25$) to the model were eliminated and a new model was calculated. The new model was always compared to the previous one using the likelihood-ratio test (Hosmer and Lemeshow, 2000). The crude and adjusted odds ratios (OR) are expressed with their respective 95% confidence intervals (95% CI) (Tables 3 and 4). Associations between the oral health variables and WHR and WC were adjusted through multivariate logistic regression for medical, social-demographic and behaviour variables. The analyses were performed using the SPSS 12.0 (Illinois, USA).

Results

A total of 471 elderly were evaluated between March and December of 2006. Most subjects were women (58%). The subjects' age varied between 60 and 92 years old and the mean monthly income wage was R$593.00. Most participants were white and married; 46% were edentulous and 114 (24%) had more than 8 teeth. There were 312 (67%) who were classified as obese according to the WHR and 412 (87%) according to the WC. We were not able to measure the hips of 10 participants.

The variables significantly associated with central obesity as measured by WHR were: residential location, tobacco consumption, the presence of 2 or more chronic conditions, marital status, income and oral health status (Table 1).

The variables significantly associated with the WC were: residential location, tobacco consumption, the presence of two or more chronic conditions, marital status and oral health status (Table 2).

The variables independently associated with WHR and WC through multivariate logistic regression are shown in Tables 3 and 4, respectively. In relation to the WHR,

Table 1. Univariate analysis and p-value of characteristics of the sample in relation to central obesity as measured by waist-hip ratio (n=461)

Variables	*Category*	*Non-obese (n=149)*	*Obese (n=312)*	*p*
Age	In years (sd)	70.0 (6.6)	69.4 (6.9)	0.44[a]
Residence	Rural	78 (52%)	138 (44%)	0.10[b]
	Urban	71 (48%)	174 (56%)	
Gender	Female	8 (5%)	265 (85%)	**<0.01**[c]
	Male	141 (95%)	47 (15%)	
Current smoking	Yes	11 (7%)	10 (8%)	**0.04**[b]
	No	137 (93%)	300 (92%)	
Oral health status	Edentulous, using both dentures	44 (29%)	143 (46%)	
	Edentulous, using one denture	8 (5%)	19 (6%)	
	1 to 8 teeth	47 (31%)	90 (29%)	**0.02**[b]
	>8 teeth	50 (33%)	60 (19%)	
≥2 comorbidities	Yes	33 (22%)	152 (49%)	
	No	116 (78%)	160 (51%)	**<0.01**[b]
Income	<2 minimum wage	59 (39%)	155 (50%)	
	≥2 minimum wage	90 (61%)	157 (50%)	0.05[b]
Marital status	Married	132 (88%)	206 (66%)	
	Other	17 (12%)	105 (34%)	**<0.01**[b]

[a] t Test, [b] Chi-square Test, [c] Fisher Test

Table 2. Univariate analysis and p-value of characteristics of the sample in relation to central obesity as measured by waist circumference (n=471)

Variable	*Category*	*Non-obese (n=59)*	*Obese (n=412)*	*p*
Age	In years (sd)	69.0 (6.4)	69.7 (6.9)	0.50[a]
Residence	Rural	38 (64%)	184 (45%)	
	Urban	21 (36%)	227 (55%)	**<0.01**[b]
Gender	Female	5 (8%)	272 (66%)	**<0.01**[b]
	Male	54 (92%)	140 (34%)	
Current smoking	Yes	6 (10%)	16 (4%)	
	No	53 (90%)	393 (96%)	**0.03**[c]
Oral health status	Edentulous, using two dentures	27 (46%)	164 (40%)	
	Edentulous, using one denture	3 (5%)	24 (6%)	
	1 to 8 teeth	9 (15%)	130 (32%)	**0.02**[b]
	>8 teeth	20 (34%)	94 (23%)	
≥2 comorbidities	Yes	9 (15%)	179 (43%)	
	No	50 (85%)	233 (57%)	**0.01**[b]
Marital status	Married	53 (90%)	293 (71%)	
	Other	06 (10%)	118 (29%)	**<0.01**[c]

[a] t Test, [b] Chi-Square Test, [c] Fisher Test.

participants having more than 8 teeth were less likely to have CO (OR=0.49; 95% CI 0.32 to 0.87). Regarding the WC, participants having only 1-8 teeth were more likely to have CO (OR=3.28; 95% CI 1.43 to 7.52). There were no interactions between predictors in the WHR and WC final models.

Discussion

Our results demonstrated that a poor oral status, represented by the presence of only 1-8 natural teeth, increased the likelihood for central obesity (CO) as assessed by waist circumference (WC), while a better oral status, represented by the presence of more than 8 natural teeth, was protective for CO, as assessed with the waist-hip ratio (WHR). Therefore, the hypothesis that tooth loss was not associated with CO as measured by WHR and WC was rejected. This is one the first studies, at least to our knowledge, showing that tooth loss is associated with CO in a representative sample of community-dwelling older adults. These findings are relevant due to the association of abdominal fat with metabolic syndrome (Grundy *et al*., 2004), cardiovascular diseases and all-cause mortality (Visscher *et al*., 2001).

Table 3. Crude and adjusted odds ratio (OR) and 95% confidence intervals (CI) of the variables related to central obesity measured by waist-hip ratio

Variable		*n*	*Crude OR (95% CI)*	*p*	*Adjusted OR (95% CI)*	*p*
Residence	Rural	216	1.0 (ref)	0.10	1.0 (ref)	0.23
	Urban	245	1.38 (0.94 to 2.05)		1.37 (0.84 to 2.02)	
Income	£ minimum wage	214	1.0 (ref)	**0.04**	1.0 (ref)	
	> minimum wage	247	0.66 (0.45 to 0.99)		0.61 (0.41 to 0.99)	**0.03**
Current smoker	No	437	1.0 (ref)	0.05	1.0 (ref)	
	Yes	21	0.41 (0.17 to 1.00)		0.35 (0.13 to 0.93)	**0.04**
Oral health status	Edentulous, 2 dentures	187	1.0 (ref)	**<0.01**	1.0 (ref)	
	Edentulous, 1 denture	27	0.73 (0.30 to 1.78)		0.77 (0.30 to 2.02)	
	1 to 8 teeth	137	0.60 (0.36 to 0,96)		0.77 (0.4 to 1.14)	**<0.01**
	>8 teeth	110	0.37 (0.22 to 0.61)		0.49 (0.32 to 0.87)	
Marital status	Married	338	1.0 (ref)	**<0.01**	1.0 (ref)	
	Other	122	3.96 (2.27 to 6.91)		4.03 (2.24 to 7.28)	**<0.01**
Presence of comorbidities	<2 comorbidities	283	1.0 (ref)	**<0.01**	1.0 (ref)	**<0.01**
	≥2 comorbidities	188	3.34 (2.14 to 5.22)		3.03 (1.88 to 4.87)	

Table 4. Crude and adjusted odds ratio (OR) and 95% confidence intervals (CI) of the variables related to central obesity measured by waist circumference

Variable		*n*	*Crude OR and 95% CI*	*p*	*Adjusted OR and 95% CI*	*p*
Residence	Rural Area	222	1.0 (ref.)	**<0.01**	1.0 (ref.)	**<0.01**
	Urban Area	249	2.23 (1.27 to 3.94)		2.33 (1.25 to 4.22)	
Current smoking	Not	446	1.0 (ref.)	**0.04**	1.0 (ref.)	
	Yes	22	0.36 (0.13 to 0.96)		0.27 (0.09 to 0.83)	**0.02**
Oral health status	Edentulous using both dentures	191	1.0 (ref.)	0.06	1.0 (ref.)	
	Edentulous using one denture	27	1.31 (0.37 to 4.68)		1.62 (0.43 to 6.19)	
	1 to 8 teeth	139	2.38 (1.08 to 5.23)		3.28 (1.43 to 7.52)	**0.01**
	More than 8 teeth	114	0.77 (0.41 to 1.45)		0.80 (0.41 to 1.57)	
Marital status	Married	346	1.0 (ref.)	**<0.01**	1.0 (ref.)	
	Other	124	3.56 (1.49 to 8.50)		3.33 (1.36 to 8.15)	**<0.01**
Presence of comorbidities	<2 comorbidities	283	1.0 (ref.)	**<0.01**	1.0 (ref.)	**<0.01**
	≥2 comorbidities	188	4.27 (2.05 to 8.90)		4.11 (1.93 to 8.77)	

The association between poor oral health and diet has been previously acknowledged in the literature, where older adults with extensive tooth loss consumed a limited variety of food, ate less fruit and vegetables (Hutton *et al*., 2002) and also ate fattier food (Sahyoun *et al*., 2003). Previous evidence has also shown that tooth loss can impact on the nutritional status (Hilgert *et al*., 2009, Sahyoun *et al*., 2003). Lee *et al*. (2004), based on data from a longitudinal study of community-dwelling elderly in Great Britain, found that self-reported edentulism was a risk factor of a weight increase over 5% annually.

Although the majority of the studies cited here have not established cause-and-effect, results from Sahyoun *et al*. (2003), Lee *et al*. (2004) and our group (Hilgert *et al*., 2009) do suggest that extensive tooth loss is associated with weight changes leading to obesity in the elderly. It could be hypothesised that the association between dental status and CO found in this study is mediated by dietary changes related to a decreased chewing ability resulting from extensive tooth loss. It is likely that some participants with fewer natural teeth may actually avoid fibrous, nutrient-rich food (Walls *et al*., 2000), and may have been consuming foods with high caloric density as a coping strategy for a compromised masticatory function (Sahyoun *et al*., 2003).

The relationship between oral health and nutritional status is complex (Hutton *et al*., 2002). One may argue, for instance, that reverse causality may explain these findings. Obese people are more likely to have a diet rich in sugar, which in turn might explain the poor oral health. However, this is unlikely to be the case for this population of older adults who have mostly been presented with extensive dental extractions at young age, as a result of preceding styles of practice in dentistry (Woods *et al*., 2009), especially in rural areas of Brazil such as Carlos Barbosa City.

Nevertheless, the association between tooth loss and obesity allow for a range of interpretations, in the sense that not only can a poor oral health status impact on diet, but also that diet has a large influence on oral health and therefore these factors can form a cyclical and detrimental effect, especially for older persons who present tooth loss as a result of the cumulative effect of dental diseases throughout life (Woods *et al*., 2009). Such complexities have also been accredited for the associations between tooth loss and edentulism with mortality by vascular diseases and by all-cause mortality (Jansson *et al*., 2002). Hypotheses explaining such associations also include dietary changes

and body composition changes resulting from tooth loss, which could lead to vascular diseases (Hung *et al*., 2003).

In this study, there were 312 (67%) participants classified as obese according to the WHR, while regarding the WC, 412 (87%) individuals were classified as obese. This variation may be related to differences in the measurements and with changes in body composition associated with aging. In particular, visceral fat increases with age and is responsible for a larger waist circumference (Teh *et al*., 1996). Conversely, the WHC depends not only on waist circumference but also on the relative muscle and subcutaneous fat which take part in the hip circumference (Shen *et al*., 2006).

Participants living in the urban area presented higher odds for CO. This result can be attributed to the fact that they probably engage in less physical activity than those living in rural areas, where the practice of agriculture is highly prevalent amongst older persons. In addition, there could be differences related to diet between urban and rural older adults, given the fact that most families in rural areas traditionally produce most of their own food through subsistence farming.

An important limitation of the present study is that diseases were self-assessed. The confirmation of these diagnoses by a physician would result in more reliable information about the chronic conditions and, consequently, to a more precise adjustment of the confounding factors. Another relevant factor that was not assessed was physical activity, which is a variable known to be associated with obesity (Vardavas *et al*., 2009). Moreover, the cross-sectional characteristic of this study does not allow the evaluation of cause-and-effect relationships, thus limiting our conclusions.

This study's findings may suggest a need for interdisciplinary actions integrating oral health and nutrition programs aiming to improve and promote health and quality of life during aging. Oral health and nutrition educators could assume leadership roles in promoting this content in their respective curricula. Thus, partnerships among dieticians, dentists, and other health professionals might be identified, developed, strengthened, and expanded to encourage integrated, comprehensive practice.

Health policies with the objective of preserving natural teeth during aging may have a positive impact in the nutritional status and on the reduction of morbidity related to obesity. Longitudinal studies are necessary to evaluate the relation between incident tooth loss and central obesity and also to evaluate if oral prosthetic rehabilitation in cases of extensive tooth loss represents an advantage in terms of maintaining an adequate body composition during aging.

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