Association between oral health status and central obesity among Brazilian independent-living elderly

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Abstract: The aim of this study was to investigate the association between oral health status and central obesity (CO) in Brazilian independent-living elderly. A cross-sectional study was carried out in a sample of 489 elderly, who were participants of the Study on Aging and Longevity, in Londrina, state of Parana. The number of natural teeth and use of prostheses were evaluated according to the World Health Organization criteria. The presence of CO was assessed using measures of waist circumference (WC) and waist-hip ratio (WHR). Information concerning sociodemographic profile and some systemic conditions was also collected. Data were analyzed using stepwise logistic regression, α=5%. According to WC and WHR measures, the prevalence of central obesity was 79.3% and 76.1%, respectively. CO according to WC was not associated with oral status. Considering the WHR measure, the following oral conditions were associated to CO: having fewer natural teeth (OR = 2.61; 95%CI = 1.17–5.80), being edentulous and wearing both upper and lower complete dentures (OR = 2.34; 95%CI = 1.11–4.93), and being edentulous wearing only the upper complete denture (OR = 2.64; 95%CI = 1.01–6.95). Traditional risk factors for CO such as gender, dyslipidemia, hypertension and diabetes were associated with both measures. A poor oral health due to extensive tooth loss, whether partial or complete, even if rehabilitated by removable prostheses, may be considered a good predictor of CO in Brazilian independent-living elderly.

Keywords: Oral Health; Tooth Loss; Obesity, Abdominal; Aged.

Introduction

The aging of the population represents a reality throughout the world[1]. It is estimated that Brazil will be the sixth country in total population of older people by 2025[2], reaching 64 million inhabitants in 2050, about 30% of its total population[3]. The economic impact of this process in health systems has been a reason for concern for health and social policy-makers. The challenge, in addition to providing adequate health assistance, is to implement public policies that will promote general health, by controlling risk factors that are common to noncommunicable diseases (NCDs), highly prevalent among the elderly population[4].

Obesity has a multi-factorial nature, and it can be modulated by an individual's eating habits[5]. It is associated to cardiovascular diseases, such

as arterial hypertension, dyslipidemia, and type-2 diabetes, thus contributing to an increased burden of NTCDs[6]. The World Health Organization (WHO) regards the metabolic syndrome (of which the main characteristic is the presence of abdominal obesity) as the greatest and most prevalent risk factor for cardiovascular diseases (CVDs)[7]. Mortality due to CVDs increases with age, and is the main cause of death in Brazil, as well as in other countries around the world, accounting for 30% of global deaths[8].

The association between oral health status and factors that increase the risk of developing cardiovascular diseases has been the aim of several investigations[9,10,11], which include variables related to eating patterns and nutritional status in their analyzes. It is known that the oral health status may interfere in people's food choices[12,13,14]. As an example, tooth loss may lead to chewing and swallowing problems, and therefore affect the early digestive process, nutrient intake, and appetite itself, leading to the adoption of a softer, more processed diet[12,13]. This diet is usually poor in nourishing terms, affecting the individual's general health, leading to increased levels of cholesterol, triglycerides, and obesity, and raising the risks of developing cardiovascular diseases[11,15,16,17,18].

The literature that addresses the relationship between the oral health status of independent elderly and the presence of obesity is conflicting. Some studies found an association between edentulous persons and low weight[12,18,19,20]. Others, however, report that dentate elderly with few teeth and those that were edentulous, even if rehabilitated with complete dentures, were more likely to be obese.[13,15,16,17] Few researchers took into consideration central tendency measurements to assess the presence of obesity[16,17], which are regarded as more appropriate to evaluate the risk of developing cardiovascular diseases[22]. The results of two large-scale international studies involving various countries showed that the measure of waist circumference (WC)[22] and waist-hip ratio (WHR)[23] were stronger predictors of cardiovascular diseases than the Body Mass Index (BMI).

Tooth loss and edentulism in Brazil affect about 94% of the individuals between 65 and 74 years of age[24]. These conditions have a negative impact on quality of life of the elderly from a social standpoint,

owing to a low self-esteem and self-image[25]. Also, they impair the quality of their dietary intake[13,14,26,27], and may increase the risk of developing various health-related problems.

The aim of this study was to investigate the relationship between the oral health status and the presence of central obesity (CO) in Brazilian independent-living elderly.

Methodology

Study design

This cross-sectional, observational study is part of a larger thematic project: the EELO Project – Brazilian acronym for "Study on Aging and Longevity", which was carried out between February 2010 and November 2013 by an interdisciplinary team of the North University of Paraná (UNOPAR), in a partnership with the Departments of Health and of the Elderly in Londrina, a city in Southern Brazil. The EELO aimed to outline a regional epidemiological profile covering social-demographic and health related indicators for the elderly. Information about the project can be found at http://www2.unopar.br/sites/eelo/. The research was authorized by the Municipal Health Authorities of Londrina, and certified by the National Health Council. All participants provided written informed consents.

Population and sample

The sample of the EELO Project was obtained from a total of 43,610 elders registered in 38 Basic Health Units in the urban area of the city[28].

A minimum sample size of 396 was defined based on the formula proposed by Barbetta[29], considering a 95% confidence interval and a 5% sampling error. To extend the opportunity of performing health assessments to a greater number of individuals, the project coordinators increased the sample to 520 elderly.

A stratified random sampling method was used considering the municipality's five regions (15% were from the central, 27% from the northern, 23% from the southern, 19% from the eastern, and 16% from the western regions). Participants were randomly selected based on individual registries in the Family Health Program.

For the field work, small groups of participants were transported from their respective health units to the UNOPAR Research Center. Each evaluation was performed in three days of the same week, and complete data collection, which included structured interviews and a set of 48 different evaluations, was achieved within 18 months. As not all participants attended every session, the final sample consisted of 489 individuals who participated in both the oral and nutritional assessments.

The study included elderly ≥ 60 years old, of both genders, living independently and classified at level 3 or 4, as proposed by Spirduso[30], which means that they were able to perform basic activities of daily life.

Data collection

The sociodemographic information was obtained through interviews using a structured questionnaire that comprised the following variables: gender (male/female), age (60 to 64 years/ 65 to 74 years/ ≥ 75 years), living condition (lives with someone/ alone), schooling (≤ 4 years of education/ >4 years) and economic class (A1, A2, B1, B2, C1, C2, D and E), which were based on the Brazil Economic Classification criterion[31]. For statistical purposes, classes were grouped into the following categories: "upper" (A and B), "middle" (C) and "lower" (D and E).

Oral health assessment included the number of natural teeth and the use of prostheses for both arches, according to WHO criteria[32]. The number of natural teeth consisted of a discrete variable from 0 to 32. Individuals who did not have a single natural tooth in both arches were regarded as totally edentulous. Clinical examinations were performed at UNOPAR Dental Clinic by a single examiner. Based on their oral health status, the elderly were grouped into five categories as follows: edentulous wearing upper and lower complete dentures (2 CD); edentulous wearing only the upper complete denture (1 CD), dentate with 1 to 9 teeth, dentate with 10 to 19 teeth, and dentate with 20 or more teeth. The grouping by number of teeth and use of dentures has been reported in previous studies[19,20].

For the investigation of the lipid profile of the elderly (triglycerides, total cholesterol, HDL-c and LDL-c) and the presence of diabetes (blood levels of glycated hemoglobin – HbA1C > 6.5%), blood samples were collected by trained students of the UNOPAR Undergraduate Course of Pharmacy and sent to Cetel Laboratory in Londrina, for biochemical analysis. Based on the results, the elderly were classified into: presence or absence of dyslipidemia (according to the parameters described in the V Brazilian Guidelines on Dyslipidemia and Prevention of Atherosclerosis[21]), and diabetic or non-diabetic.

Arterial blood pressure was obtained with a semi-automatic apparatus (OMRON – HEM 705 CP), following specific procedures[33]. Individuals with systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg or on current use of antihypertensive medication were regarded as hypertensive. Smoking was assessed by self-reported information, and individuals were classified into smoker, former smoker, and non-smoker[34].

The dependent variables, for central obesity classification, were obtained by the anthropometric perimeter measures waist circumference (WC) and waist-hip ratio (WHR). Three consecutive measurements were taken by postgraduate students of the UNOPAR Course of Nutrition, and averaged.

WC and WHR were assessed according to internationally pre-established parameters[25]. Men with a WC ≥ 94 cm and women with a WC ≥ 80 cm were regarded as having central obesity[35]. WHR was determined by the following equation: [WHR= WC/hip circumference (cm)], which reflects the distribution of central fat. Men with a ratio >1 and women >0.85 were considered as having central obesity[36].

Statistical analysis

Relative and absolute frequencies were obtained by descriptive analysis. A univariate analysis and crude odds ratio (95%CI) were employed to assess associations between central obesity (through WC and WHR) and the independent variables. Statistically significant values from the univariate analysis were used in the stepwise logistic regression model (forward likelihood ratio), and adjusted odds ratios (95%CI) were obtained.

To analyze the independent variables, two tests were applied: the omnibus *chi*-square test of model coefficients, to verify if the set of variables improves

the prediction of the log odds and the Nagelkerke R^2 to investigate which variables could explain a low sum of variance. Hosmer and Lemeshow goodness-of-fit was used to assess if the observed values were close to expected. The accuracy of the prediction model was tested to check the ability to accurately classify people into one of the two categories of CO, for both anthropometric measures. For the stepwise regression analysis, the probability for variable entry or removal of the model were set to 0.05[37]. Statistical significance was set at 5% and all analyses were performed with SPSS version 20 (IBM SPSS®, Armonk, NY, USA).

Results

Among the 489 elders who participated in this study, there was a predominance of females (66.5%), of the age group 65 to 74 years (54.2%), of low level of schooling (80.4%), and of middle social class (63.8%). Based on their oral conditions, 10.8% were edentulous with 1 complete denture, 36.8% were edentulous with 2 complete dentures, 24.5% were dentate with 1 to 9 teeth, 15.1% had 10 to 20 teeth and 12.7% had 20 or more teeth. The prevalence of CO was 79.3% and 76.1%, based on WC and WHR, respectively.

Four steps were necessary in the first model (WC) with accuracy of 79.2%. In the second model (WHR), five steps were found with accuracy of 80.9%. The independent variables that were significantly associated with the presence of CO, according to WC and WHR, are shown in Tables 1 and 2, respectively.

Considering WC as the indicator (Table 1), after adjustment by stepwise logistic regression, the following variables remained associated to increased odds of having CO: female gender (OR = 5.20; 95%CI: 3.13–8.64), presence of dyslipidemia (OR = 2.01; 95%CI: 1.19–3.37), presence of hypertension (OR = 2.49; 95%CI: 1.48–4.17), and presence of diabetes (OR = 4.09; 95%CI: 1.97–8.48). Está muito espremido e faltaram os espaços. Having 10 to 19 natural teeth (OR = 2.03; 95%CI: 0.81–5.16), 1 to 9 natural teeth (OR = 2.33; 95%CI: 0.98–5.55) and being edentulous wering two complete dentures (OR =1.46; 95%CI: 0.65–3.30) did not remain associated to CO after the adjusted analysis.

According to WHR (Table 2), the following variables remained associated to increased odds of CO: female gender (OR = 6.71; 95%CI: 4.04 –11.18), presence of

dyslipidemia (OR = 2.12; 95%CI: 1.27–3.51); presence of hypertension (OR = 1.90; 95%CI: 1.15–3.13); and presence of diabetes (OR = 4.37; 95%CI: 2.22–8.61). Also, the following oral characteristics retained the association after model adjustment: edentulous wearing only upper complete dentures (OR = 2.64; 95%CI: 1.01–6.95); edentulous wearing upper and lower complete dentures (OR = 2.34; 95%CI: 1.11–4.93); and dentate with 1 to 9 natural teeth (OR = 2.61; 95%CI: 1.17–5.80).

Discussion

Hypertension, diabetes, and the presence of dyslipidemia are factors commonly associated with obesity, and are risk factors for the development of cardiovascular diseases[21]. The present investigation showed that partial and complete tooth loss are associated to CO even after adjusting for these traditional risk markers. Statistical associations were found between poor oral health status and CO only when WHR was used as the anthropometric measure of fat distribution.

The maintenance of a functional natural dentition, defined as having more than 20 natural teeth, plays an important role in maintaining a satisfactory nutritional status[13]. Compared to having a functional dentition, having few natural teeth increased the odds of central obesity by 2.61 times, taking the WHR as reference. Still according to WHR, the odds of CO increased with the presence of edentulism and upper and lower dentures (2.34 times), and with edentulism and only upper denture (2.64 times).

Our results showing that edentulous individuals rehabilitated by total removable prostheses have an unsatisfactory nutritional status considering the diagnosis of abdominal obesity corroborate the findings of other authors[12,15,16,18]. Despite distinct methodologies, those studies showed associations between edentulism and the presence of obesity. Hilbert et al.[15] and Tôrres et al.[18], who used BMI measures for obesity definition, reported that totally edentulous individuals wearing only the upper denture had greater chances of suffering from obesity. Likewise in the present investigation, edentulous individuals rehabilitated only with a complete upper denture had greater chances of having central obesity than those totally rehabilitated, with WHR as a

Table 1. Stepwise logistic regression between the independent variables and the presence of central obesity (CO), as established by the measure of waist circumference (WC) in the elderly (n = 489).

Variable	Without CO	With CO	Crude OR	p	Adjusted OR	p
	n (%)	n (%)	95% (CI)		95% (CI)	
Gender						
Male	67 (66.3)	97 (25.0)	1.0 (ref.)	-	1.0 (ref.)	-
Female	34 (33.7)	291 (75.0)	5.91 (3.68–9.48)	< 0.001	5.20 (3.13–8.64)	< 0.001
Age in years						
60 to 64	19 (18.8)	105 (27.1)	1.0 (ref.)	-	1.0 (ref.)	-
65 to 74	55 (54.5)	210 (54.1)	0.69 (0.39–1.22)	0.205	0.68 (0.34–1.37)	0.280
74 and +	27 (26.7)	73 (18.8)	0.48 (0.25-0.94)	0.033	0,48 (0.21–1.11)	0.087
Living condition						
With someone	77 (76.2)	241 (62.1)	1.0 (ref.)	-	1.0 (ref.)	-
Alone	24 (23.8)	147 (37.9)	1.95 (1.18–3.23)	0.009	1.42 (0.78–2.59)	0.254
Schooling in years						
> 4	13 (12.9)	83 (21.4)	1.0 (ref.)	-	-	-
≤ 4	88 (87.1)	305 (78.6)	6.38 (0.28–1.02)	0.058	-	-
Economic class						
Upper	17 (16.8)	66 (17.0)	1.0 (ref.)	-	-	-
Middle	62 (61.4)	250 (64.4)	1.03 (0.56–1.89)	0.902	-	-
Lower	22 (21.8)	72 (18.6)	0.84 (0.41–1.72)	0.640	-	-
Dyslipidemia						
No	53 (52.5)	103 (26.5)	1.0 (ref.)	-	1.0 (ref.)	-
Yes	48 (47.5)	285 (73.5)	3.05 (1.94–4.79)	< 0.001	2.01 (1.19–3.37)	0.009
Smoking						
Never	53 (51.5)	244 (62.9)	1.0 (ref.)	-	1.0 (ref.)	-
Former smoker	36 (35.6)	119 (30.7)	0.69 (0.43–1.12)	0.142	1.37 (0.47–2.51)	0.314
Current smoker	13 (12.9)	25 (6.4)	0.40 (0.19–0.84)	0.016	0.58 (0.25–1.37)	0.219
Hypertension						
No	58 (57.4)	117 (30.2)	1.0 (ref.)	-	1.0 (ref.)	-
Yes	43 (42.6)	271 (69.8)	3.16 (2.01–4.97)	< 0.001	2.49 (1.48–4.17)	0.001
Diabetes						
No	90 (89.1)	248 (63.9)	1.0 (ref.)	-	1.0 (ref.)	-
Yes	11 (10.9)	140 (36.1)	4.63 (2.39-4.97)	< 0.001	4.09 (1.97–8.48)	< 0.001
Oral status						
20 or + teeth	20 (19.8)	42 (10.8)	1.0 (ref.)	-	1.0 (ref.)	-
10 to 19 teeth	13 (12.9)	61 (15.7)	2.34 (1.05–5.19)	0.036	2.03 (0.81–5.16)	0.132
1 to 9 teeth	18 (17.8)	102 (26.3)	2.86 (1.38–5.90)	0.004	2.33 (0.98–5.55)	0.056
Edentulous with 2 CD	35 (34.7)	145 (37.4)	2.04 (1.07–3.87)	0.029	1.46 (0.65–3.30)	0.354
Edentulous with 1 CD	15 (14.9)	38 (9.8)	1.39 (0.62–3.11)	0.429	1.38 (0.51–3.75)	0.530

CD: complete removable denture; Constant model: estimate = -0.81; SE = 0.26; χ^2_{Wald} = 9.78; p = 0.002.

Table 2. Stepwise logistic regression between the independent variables and the presence of central obesity (CO), as established by waist-hip ratio(WHR) in the elderly (n= 489).

Variable	Without CO n (%)	With CO n (%)	Crude OR 95% (CI)	p	Adjusted OR 95% (CI)	p
Gender						
Male	81 (69.2)	83 (22.3)	1.0 (ref.)		1.0 (ref.)	
Female	36 (30.8)	289 (77.7)	7.83 (4.93–12.42)	< 0.001	6.71 (4.04–11.18)	< 0.001
Age in years						
60 to 64	23 (19.7)	101 (27.1)	1.0 (ref.)			
65 to 74	68 (58.1)	197 (53.0)	0.66 (0.38–1.12)	0.124	-	
74 and +	26 (22.2)	74 (19.9)	0.64 (0.34–1.22)	0.182	-	
Living condition						
With someone	88 (75.2)	230 (61.8)	1.0 (ref.)		1.0 (ref.)	
Alone	29 (24.8)	142 (38.2)	1.87 (1.17–2.99)	0.009	1.01 (0.62–1.92)	0.754
Schooling in years						
> 4	20 (17.1)	76 (20.4)	1.0 (ref.)			
≤ 4	97 (82.9)	296 (79.6)	1,24 (0.72–2.14)	0.429	-	
Economic class						
Upper	25 (21.4)	58 (15.6)	1.0 (ref.)			
Middle	70 (59.8)	242 (65.1)	1.49 (0.86–2.55)	0.147	-	
Lower	22 (18.8)	72 (19.4)	1.41 (0.72–2.75)	0.314	-	
Dyslipidemia						
No	60 (51.3)	96 (25.8)	1.0 (ref.)		1.0 (ref.)	
Yes	57 (48.7)	276 (74.2)	3.02 (1.96–4.65)	<0.001	2.12 (1.27–3.51)	0.004
Smoking						
Never	59 (50.4)	237 (63.7)	1.0 (ref.)		1.0 (ref.)	
Former smoker	44 (37.6)	111 (29.8)	0.63 (0.40–0.98)	0.043	1.09 (0.61–1.97)	0.762
Current smoker	14 (12.0)	24 (6.5)	0.43 (0.21–0.85)	0.020	0.64 (0.27–1.52)	0.318
Hypertension						
No	61 (52.1)	114 (30.6)	1.0 (ref.)		1.0 (ref.)	
Yes	56 (47.9)	258 (69.4)	2.46 (1.61–3.77)	< 0.001	1.90 (1.15–3.13)	0.012
Diabetes						
No	103 (88.0)	235 (63.2)	1.0 (ref.)	< 0.001	1.0 (ref.)	< 0.001
Yes	14 (12.0)	137 (36.8)	4.29 (2.36–7.78)		4.37 (2.22–8.61)	
Oral status						
20 or + teeth	26 (22.2)	36 (9.7)	1.0 (ref.)		1.0 (ref.)	
10 to 20 teeth	23 (19.7)	51 (13.7)	1.66 (0.82–3.35)	0.155	1.18 (0.52–2.68)	0.691
1 to 9 teeth	22 (18.8)	98 (26.3)	3.37 (1.71–6.66)	<0.001	2.61 (1.17–5.80)	0.018
Edentulous with 2 CD	34 (29.1)	146 (39.2)	3.29 (1.76–6.16)	< 0.001	2.34(1.11–4.93)	0.025
Edentulous with 1 CD	12 (10.3)	41 (11.0)	2.56 (1.13–5.78)	0.028	2.64 (1.01–6.95)	0.049

CD: complete removable denture; Constant model: estimate = -1.69; SE = 0.38; χ^2_{Wald} = 19.47; p < 0.001.

parameter. These results bring to light quality of life issues regarding total removable prosthetic rehabilitation with respect to nutritional aspects, as denture use is associated with decreased masticatory efficiency[12]. Although dental prostheses can help with aesthetic issues and restore function to a certain degree, a study has shown that impairment of normal oral neurosensory perceptions and masticatory force is irreversible[38].

The effects of poor oral health status of elderly persons resulting from extensive tooth loss and a poor diet, have been documented in the literature. They range from interference in appetite[14] and digestive process - by affecting chewing and swallowing[12,27] - to the selection of foods with a low fiber content, and the preference for a nutritiously poor soft diet[12,13,19]. Elderly with fewer teeth or those who were edentulous reported that they avoid hard-to-chew foods, such as apples and raw vegetables, more often than elderly with more teeth, thus substantially decreasing the general intake of fiber-rich foods[14,26]. In the present study, despite the fact that quality and quantity of the diet was not the focus of investigation, it may be assumed that changes in the dietary pattern of the older persons with an impaired oral situation explain the association found between oral health status and central obesity.

The relationship between oral health and nutritional condition is a complex one. For example, it is difficult to affirm whether tooth loss predicts CO or vice versa. In line with global food recommendations for the prevention of obesity and other diet-related chronic diseases, a diet rich in fruit, vegetables and grain, and restricted in free sugars and fat, will also benefit many aspects of oral health. As such, a healthy diet can prevent caries[39],which, along with periodontal problems, is the cause of tooth loss in many cases[40]. Therefore, a reverse causality could be implicated in our findings, since people who have a poor diet tend to be overweight and obese, and in turn, have an unsatisfactory oral health status. Nevertheless, this unlikely is the case in this study, because the extensive tooth loss found is probably the result of cumulative effect of dental diseases that occurred throughout the life of these individuals. As with adults of lower social classes that depend on

public dental care, socially disadvantaged Brazilian elderly have been unassisted for long periods of time, and in many instances the only dental care available to them was for pain relief or emergency care, which often involves mutilating approaches such as dental extractions[4,24].

In Brazil, despite the fact that the current oral health policy has created the Specialized Dental Care Centers and prosthesis laboratories, the common delays in care provision are often discouraging for the population that depends on such care. This is highly concerning because, as our study showed, a high proportion of individuals with CO have poor oral health and urgently need dental care. Because CO is a risk factor for a number of general health conditions[23], the findings of the present study highlight that in order to obtain a better quality of life for this population, it is indispensable that oral health care receive the proper attention, and duly financial support to promote an adequate rehabilitation for these individuals. Health promotion strategies should incorporate the need to retain a natural and functional dentition into old age to avoid diet restriction[13].

This study has some limitations, especially considering the cross-sectional design; therefore, causality cannot be inferred. In this case, the application of the Poisson regression with a robust adjustment of variance could have been considered to avoid possible overestimation of the odds ratios obtained using logistic regression. The analyses did not account for confounding variables, although the purpose of the study was to explore the prediction of the model.

Also, the prostheses' conditions used by the participants were not evaluated and some might had been inadequate due to long time without clinical maintenance, leading to lack of adaptation and tooth wear; this may have influenced the association of this variable with the dependent variables. Moreover, another possible limitation was the sample selection method, which involved only elderly who were enrolled in the Basic Health Units. Thus, the results should not be generalized to other elderly populations, given the particularly low socioeconomic level of this sample. Further research is needed to confirm these findings in diverse elderly populations.

Conclusions

Extensive tooth loss, whether partial or complete, even if rehabilitated by the use of removable prostheses may be considered potential predictors of central obesity in Brazilian independent-living elderly. Public health policies aimed at preserving natural teeth, as well as providing adequate oral health rehabilitation for the elderly may positively impact oral health, as well as overall health at the population level.

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