

Anthropometric indicators in older adults from Florianópolis: a population-based study conducted in 2002 and 2010

Indicadores antropométricos em idosos de Florianópolis: estudo populacional em 2002 e em 2010

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Abstract – The objective of this study was to describe and compare specific anthropometric indicators in older adults from Florianópolis who participated in two population-based studies conducted in 2002 and 2010. A total of 865 older adults in 2002, and 1,657 older adults in 2010 were assessed for weight, height, body mass index (BMI), waist circumference (WC), and waist-to-height ratio (WHtR). Significant increases in body weight of 3.0 kg for men and 4.9 kg for women were identified from 2002 to 2010 ($P < 0.05$). The BMI also increased in both genders (+0.9 kg/m² for men and +1.6 kg/m² for women), while height increased only in women (+1.5 cm) ($P < 0.05$). No significant differences were observed for WC or WHtR. BMI classification revealed an increase in the prevalence of overweight/obesity in both genders ($P < 0.05$). However, when the subjects were classified based on WC and WHtR, no significant difference was observed between the two time points in either gender, highlighting the high percentage of older adults (> 70%) with inadequate WC and WHtR in 2002 as well as in 2010. The results suggest an increase in weight and BMI from 2002 to 2010 in older adults from Florianópolis. Furthermore, the prevalence of overweight/obesity characterized by BMI increased in women and men, whereas WC and WHtR remained unchanged between 2002 and 2010.

Key words: Aging; Anthropometry; Time.

Resumo – O objetivo do presente estudo foi descrever e comparar alguns indicadores antropométricos em idosos de Florianópolis em 2002 e em 2010, a partir de dois estudos populacionais. Para tanto, 865 idosos em 2002 e 1657 idosos em 2010, de ambos os sexos, foram avaliados quanto à massa corporal, estatura, índice de massa corporal (IMC), circunferência de cintura (CCint) e razão cintura estatura (RCEst). Acréscimos estatisticamente significantes de 3,0 e 4,9 kg no peso corporal foram identificados, respectivamente, para homens e mulheres, de 2002 para 2010 ($P < 0,05$). O IMC também aumentou em ambos os sexos (+0,9 kg/m² para homens e + 1,6 kg/m² para as mulheres), enquanto a estatura aumentou apenas para as mulheres (+1,5 cm) ($P < 0,05$). Para as variáveis CCint e RCEst não foram encontradas diferenças estatisticamente significantes. A partir da classificação do IMC, observou-se aumento da prevalência de sobrepeso/obesidade em ambos os sexos ($P < 0,05$). Entretanto, quando os sujeitos foram classificados a partir da CCint e da RCEst, nenhuma diferença estatisticamente significativa foi observada entre os dois períodos do estudo, em nenhum dos gêneros, enfatizando a alta prevalência de idosos (> 70%) com CC e RCEst inadequadas, tanto em 2002 quanto em 2010. Os resultados sugerem que idosos de Florianópolis apresentaram aumento da massa corporal e IMC de 2002 para 2010; o percentual de idosos com sobrepeso/obesidade, classificados a partir do IMC, aumentou para ambos os sexos; e os indicadores CCint e RCEst não sofreram alterações de 2002 para 2010.

Palavras-chave: Antropometria; Envelhecimento; Tempo.

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INTRODUCTION

Population aging is a phenomenon that has been observed worldwide over the last decades, mainly as a result of the demographic transition characterized by declining fertility rates in conjunction with a reduction in infant mortality. Furthermore, the burden of morbidity and mortality has shifted to the elderly population, with a predominance of morbidity¹.

In Brazil, a significant increase in the number of people aged 60 years or older was observed over the period from 2001 to 2011. In absolute terms, this number increased from 15.5 to 23.5 million persons (+3.1%)¹. Projections indicate that the elderly population will correspond to approximately 19% of the Brazilian population in 2050, whereas the young population tends to decrease².

This transition in the Brazilian population age composition is also closely related with Brazil's social and economic development³. In this regard, if, on the one hand, advances in urban sanitation measures, nutritional conditions and educational levels have improved the general living conditions of the population, on the other hand, these advances contributed to the adoption of an increasingly inadequate lifestyle, including changes in eating habits and physical activity levels^{4,5}. These lifestyle changes have favored the emergence of chronic noncommunicable diseases such as obesity, one of the major risk factors for the development of cardiovascular diseases⁶, which leads the list of causes of death among older adults⁷.

It is therefore important to monitor the health of older adults, including the evolution of nutritional status, so that public health measures for disease prevention and health promotion in this population can be implemented or restructured. In this respect, representative studies of the elderly population need to be conducted in different regions of the country in order to observe possible temporal changes in nutritional status, and to adopt measures that minimize or reverse the increase in morbidity and mortality due to cardiovascular diseases. The use of anthropometric measures seems to be an interesting option when the objective is to evaluate a large number of subjects, since these are simple and low cost methods that provide important obesity-related indicators⁸.

Therefore, the objective of the present study was to describe and compare specific anthropometric indicators in older adults from Florianópolis who participated in two population-based studies conducted in 2002 and 2010.

METHODOLOGICAL PROCEDURES

This study was a panel study composed of two home-based population surveys, conducted in the municipality of Florianópolis, Santa Catarina, Brazil, in 2002 and 2010. The samples consisted of older adults aged 60 years or older who lived in the municipality.

In 2002, the sample comprised 865 older adults (438 women and 427 men) who participated in a study entitled "Profile of older adults from the

municipality of Florianópolis⁹, which was approved by the Ethics Committee of the Federal University of Santa Catarina (Permit No. 051/2001). In that year, there were 28,816 older adults in Florianópolis, corresponding to 8.4% of the total population, distributed in 12 districts and 460 census tracts. All but 20 census tracts were investigated (barracks and military bases: 2; prison facilities: 2; nursing homes: 2; household sectors: 3, and tracts with less than 50 people: 11). The sample was defined in a probabilistic manner and stratified according to census tract and gender. One older adult at the beginning of each census tract and another in the middle were interviewed. A formula for sample size calculation was applied¹⁰, which indicated a minimum number of 788 older adults to be interviewed.

In 2009/2010, the sample comprised 1,657 older adults (1,059 women and 598 men) who participated in a comprehensive survey about the health conditions of older adults in Florianópolis, called EpiFloripa Idoso¹¹. The study was approved by the local Ethics Committee (352/2008) and was conducted between the second half of 2009 and the first half of 2010. The 60+ population of Florianópolis comprised 44,460 people in 2009, corresponding to 10.8% of the total population.

The sample size of the EpiFloripa Idoso study was calculated assuming a population of 44,460 older adults, a prevalence of leisure-time physical activity of 26%¹¹, a sampling error of 4%, a 95% confidence interval, and a design effect of 2.6. To this number, 20% was added for losses and refusals and 15% for association studies. Calculation indicated a minimum number of 1,604 older adults to be interviewed.

The sample was obtained by two-stage cluster sampling. In the first stage, 420 urban census tracts were stratified according to income deciles of the household head and eight tracts per decile were drawn (total of 80 census tracts). The sampling units of the second stage were the systematically selected households. The number of inhabited dwellings ranged from 61 to 725. To reduce the variability between the number of households in each census tract, some of them were grouped and others were split observing the corresponding income decile. The initial coefficient of variation thus changed from 52.7% (n = 80 tracts) to 35.2% (n = 83 tracts). It was estimated that 60 households should be visited per census tract to find 20 older adults. All older adults living in the selected households were considered eligible for the study. In 2009/2010, only the urban population was interviewed since it accounted for 96.2% of the population residing in the municipality of Florianópolis. Institutionalized older adults were excluded both in 2002 and in 2010. Subjects who could not be interviewed after four attempts (including night time and weekends) were defined as losses, and subjects who refused to answer the questionnaire by choice were considered refusals. No replacements were made.

Body weight (kg), height (cm) and waist circumference (WC, cm) were measured. These anthropometric measures were used for calculating the body mass index (BMI) and waist-to-height ratio (WHtR). All measurements were made at the older adult's residence by previously trained

interviewers with high school diplomas, who were available full time for the field study.

The BMI was classified according to criteria defined by the World Health Organization¹²: low weight: < 18 kg/m²; normal weight: 18.5 to 24.9 kg/m²; overweight: 25 to 29.9 kg/m², and obesity: > 30 kg/m². The low and normal weight categories and overweight and obese categories were grouped. Specifically, the low weight category was grouped because of the low prevalence in the sample studied (< 2%).

The cut-off values suggested by the Brazilian Guidelines for Obesity¹³ were used for the classification of WC. According to these criteria, a circumference ≤ 90 cm for men and ≤ 80 cm for women is considered adequate. The classification of Pitanga and Lessa¹⁴ was adopted for WHtR, which defines a ratio ≤ 0.52 for men and ≤ 0.53 for women as adequate, demonstrating that WC cannot be greater than half the height.

All participants received detailed information about the study procedures and signed the informed consent form.

For statistical analysis of continuous variables, the Kolmogorov-Smirnov test was first applied to evaluate the normality of the data. Once confirmed, descriptive statistics was used and the results are expressed as the mean and standard deviation. Levene's test was used to determine the homogeneity of variances and, if this assumption was confirmed, the Student *t*-test for independent samples was applied to compare the anthropometric variables in 2002 and 2010. Categorical variables are reported as relative and absolute frequency and the chi-squared test was used for comparison of proportions. All analyses were performed using the SPSS 17.0 program, adopting a *P* value < 0.05.

RESULTS

Table 1 shows the percentage of men and women who participated in the study in 2002 and 2010 according to age group.

Table 1. Percentage of men and women according to age group in 2002 and 2010 (Florianópolis-SC, Brazil).

Age group	% Men		% Women	
	2002 (n = 427)	2010 (n = 598)	2002 (n = 438)	2010 (n = 1059)
60 – 69 years	45.2	53.3	46.6	49.5
70 – 79 years	39.3	34.1	34.7	36.9
≥ 80 years	15.5	12.5	18.7	13.6

There was a predominance of women and subjects in the 60-69 years age group in 2002 and 2010.

The anthropometric indicators of men and women in 2002 and 2010 are shown as continuous variables in Table 2.

In men, body weight (+3 kg) and BMI (+0.9 kg/m²) increased significantly from 2002 to 2010. In women, in addition to body weight (+4.9 kg) and BMI (+1.6 kg/m²), there was a significant increase in height (+1.5 cm).

No significant differences were observed for WC or WHtR.

Table 3 shows the percentage of men and women classified according to BMI, WC and WHtR in 2002 and 2010.

Table 2. Anthropometric indicators of older adults from Florianópolis in 2002 and 2010.

	Men		P	Women		P
	2002	2010		2002	2010	
Body weight (kg)	71.9 ± 13.8	74.9 ± 14.2	<0.01	62.2 ± 13.0	67.1 ± 13.8	<0.01
Height (cm)	165.8 ± 7.8	166.7 ± 7.4	0.05	151.9 ± 7.3	153.4 ± 7.1	<0.01
BMI (kg/m ²)	26.0 ± 4.0	26.9 ± 4.2	<0.01	26.9 ± 5.0	28.5 ± 5.5	<0.01
WC (cm)	96.7 ± 12.3	96.2 ± 12.1	0.06	91.7 ± 12.2	92.2 ± 13.4	0.50
WHtR	0.58 ± 0.1	0.58 ± 0.1	0.17	0.61 ± 0.08	0.60 ± 0.09	0.71

Values are the mean ± standard deviation. BMI: body mass index; WC: waist circumference; WHtR: waist-to-height ratio.

Table 3. Classification of anthropometric indicators in male and female older adults (Florianópolis, 2002 and 2010).

BMI	Men (%)		Women (%)	
	Acceptable weight	Excess weight	Acceptable weight	Excess weight
2002	39.8	60.2	38.4	61.6
2010	31.9*	68.1*	24.8*	75.6*
WC	Acceptable	Above acceptable	Acceptable	Above acceptable
2002	25.1	74.9	14.2	85.8
2010	27.8	72.2	14.4	85.6
WHtR	Acceptable	Above acceptable	Acceptable	Above acceptable
2002	15.0	85.0	16.5	83.5
2010	18.3	81.7	18.6	81.4

BMI: body mass index; WC: waist circumference; WHtR: waist-to-height ratio. * $P < 0.05$ (chi-squared test).

Among men, the percentage of older adults classified as excess weight based on BMI was higher in 2010 ($P < 0.05$). No significant difference between the two years of study was observed when the subjects were classified according to WC or WHtR. Similar to the findings obtained for men, the percentage of women classified as excess weight based on BMI was higher in 2010 ($P < 0.05$). Classification according to WC and WHtR showed no significant difference between 2002 and 2010. However, it should be noted that the percentage of male and female older adults with WC (> 70% men and > 80% women) and WHtR (> 80%) above acceptable levels was high both in 2002 and in 2010.

Analysis of BMI classification into the four categories (low weight, normal weight, overweight, and obesity) showed that, in 2002, most women were normal weight and overweight, whereas in 2010 most women were overweight and obese (Table 4). The same was not observed for men.

Similar results were obtained for women and men when the data from 2002 and 2010 were compared separately according to age group (60 to 69, 70 to 79, and ≥ 80 years).

Table 4. Classification of body mass index in female older adults (Florianópolis, 2002 and 2010).

BMI classification	2002	2010
Low weight ($< 18 \text{ kg/m}^2$)	1.8	1.2
Normal weight ($18 - 24.99 \text{ kg/m}^2$)	37.4	24.7
Overweight ($25 - 29.99 \text{ kg/m}^2$)	38.1	40.6
Obesity ($\geq 30 \text{ kg/m}^2$)	22.6	33.5

BMI: body mass index.

DISCUSSION

The main finding of the present study was the increase in body weight and BMI in male and female older adults from Florianópolis between 2002 and 2010. Female height, and the percentage of male and female older adults classified as excess weight based on BMI also increased. The alarming fact is that all anthropometric indicators used classified the majority of older adults as excess weight or above acceptable levels for health, both in 2002 and in 2010. This situation was further aggravated in 2010 when BMI was used for this classification.

Despite the scarcity of national and international studies evaluating the long-term evolution of nutritional status, particularly in older adults, some comparisons can be made. Data from a national survey, the Telephone-Based Surveillance of Risk and Protective Factors for Chronic Diseases (Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico - VIGITEL), indicate an increase in the prevalence of excess weight from 2006¹⁵ to 2010⁴ among Brazilian adults in general, and among adults from Florianópolis in particular (40.4 vs. 46.3%). Among people aged 65 years or older, this prevalence increased from 53.1 to 58.4% in Brazil. In 2011, the results showed a small increase among adults from Florianópolis (48.2%) and a slight reduction among those aged 65 years or older (55.7%)⁵.

Similar results for men, but different results for women, have been reported in another study¹⁶ which evaluated birth cohort effects on the nutritional status of older adults aged 71 to 81 years, who participated in the 1997 and 2008 Bambuí (Minas Gerais, Brazil) cohort study of aging. The proportion of overweight, BMI and WC of older adults born in 1916-1926 (old cohort) was compared to those of older adults born in 1927-1937 (recent cohort). Increases in BMI, proportion of overweight and WC were observed in men of the recent cohort, whereas a reduction in WC was seen among women. These results demonstrated a cohort effect on the worsening of anthropometric measures among men, but not among women. The authors of the study believe that these differences over time are associated with cultural, behavioral and environmental changes. Furthermore, they suggested that the differences between genders are related to the fact that women are more likely to seek health services¹⁷ and are more susceptible

to changes in dietary and physical activity habits. Similar to the findings of the Bambuí cohort study, Eiben et al.¹⁸ observed an increase in body weight, BMI and WC, as well as in the prevalence of overweight/obesity, among 70-year-old Swedish men and women born in 1930 when compared to those born in 1901, although the impact of time was greater for men.

In the present study no differences between genders, as generally reported in other studies^{16,18}, were observed. This finding is probably related to cultural differences between countries and/or regions of Brazil. In Florianópolis, concerns regarding health, esthetics, physical activity, and diet might be independent of gender. However, such speculation deserves further investigation.

Inadequate dietary habits and insufficient physical activity seem to explain the changes observed over time (2002 vs. 2010), irrespective of gender. This hypothesis is supported by another study¹⁹ which, using VIGITEL data, identified worsening of diet quality in the Brazilian population over the period from 2007 to 2009. Furthermore, the proportion of leisure-time physically active older adults in Florianópolis was 29.7% in 2009/2010¹¹, a low rate but slightly higher than that observed in 2002 (25.7%)⁹.

However, when data from Florianópolis were analyzed, comparison of the VIGITEL results obtained in 2006¹⁵ and 2010⁴ indicate improvement in the dietary habits of adults (≥ 18 years). The prevalence of fruit and vegetable consumption 5 days a week or more increased slightly from 35.7 to 39.3%, whereas the consumption of red meat with excess fat decreased from 33.3 to 31.7%. With respect to the prevalence of sufficient leisure-time physical activity among adults from Florianópolis, an increase was observed from 10.5% in 2006 to 16.3% in 2010. Therefore, despite a slight increase in physical activity levels and improvement in dietary habits, the results of the present study indicate that these changes are still insufficient to affect anthropometric indicators in such a way as to reduce overweight/obesity in the population studied. However, the VIGITEL survey does not provide data on physical activity and dietary habits specifically for older adults from Florianópolis, which therefore deserve further investigation.

With respect to the assessment of nutritional status, it is important to remember that imaging techniques such as magnetic resonance imaging, computed tomography and dual-energy X-ray absorptiometry²⁰ are alternatives that provide more accurate estimates of body fat accumulation. However, their application to a large number of subjects and clinical diagnoses is limited by the high cost of the devices and methodological sophistication⁸. In this respect, anthropometry is a good strategy to evaluate excess body fat, especially in population studies. Different indicators have been proposed to determine the association between excess weight and cardiovascular risk factors⁸.

Although BMI is a good indicator of generalized fat, which can be easily interpreted by experts and lay persons and is widely used in epidemiological studies, it does not permit the evaluation of body fat distribution and may overestimate the prevalence of obesity²¹. It therefore cannot be ruled

out that the increase in BMI from 2002 to 2010 observed in the present study may reflect an increase in other components of body composition, such as bone or muscle mass, and not necessarily an increase in fat mass, but this speculation also needs to be confirmed. Furthermore, the BMI is less associated with high coronary risk²², and there is no global consensus about the best acceptable BMI cut-off for health in the elderly population²³.

According to the literature, indicators of central or abdominal obesity, such as WC, are more associated with high coronary risk²⁴ and mortality risk²⁵ than overall obesity indicators, irrespective of age and gender. Coutinho et al.²⁵ suggested that the classification of overweight and obesity based on BMI does not necessarily indicate a higher mortality risk in the absence of abdominal obesity. This demonstrates the importance of the use of BMI in conjunction with other indicators of abdominal obesity, such as WC, when the objective is to monitor the health of older adults or of individuals in general. This is probably related to the fact that excessive accumulation of abdominal fat is associated with different metabolic disorders, such as glucose intolerance, hyperinsulinemia, diabetes, hypertension, and altered plasma concentrations of lipids and lipoproteins, generally found in conjunction with coronary diseases²⁶.

Another indicator that is gaining importance in epidemiological studies is WHtR. Studies have shown that this indicator is strongly associated with different cardiovascular risk factors^{8,13,27}. Haun et al.⁸ indicated WHtR to be a better predictor of high coronary risk than WC.

In the present study, the only indicator of obesity that increased from 2002 to 2010 was BMI, suggesting an increase in generalized obesity over time, but not necessarily an increase in coronary risk, especially when the “obesity paradox” is considered. According to this theory, overweight/obesity (diagnosed based on BMI) is a protective factor for some chronic diseases, including cardiovascular diseases, and physical inactivity or low cardiorespiratory fitness is a more important risk factor than obesity²⁸.

The literature also pointed out the importance of calf and arm circumference (indicators of muscle mass/sarcopenia) measurement in older adults. Tsai et al.²⁹ showed that calf circumference is more effective in predicting mortality risk in older adults than BMI. The results of that study indicated that low calf and arm circumference values are more associated with mortality risk than low BMI values in subjects aged 65 to 74 years. Additionally, a high BMI was not a good predictor of mortality risk.

One limitation of the present study is the use of cross-sectional studies instead of cohorts that follow up the same individuals. Nevertheless, it should be highlighted that a population-based sample was studied during the two collection periods (2002 and 2010), which was representative of the elderly population of Florianópolis. We therefore believe that the study provides evidence of changes in the anthropometric patterns analyzed over time (8 years). Additional strengths of the study include the high response rate of the subjects selected to participate in the two data collections, and the strict standardization of the measurement methods used in 2002 and 2010.

CONCLUSIONS

In summary, the results of the present study showed an increase in body weight and BMI from 2002 to 2010 among female and male older adults from Florianópolis. The percentage of older adults with overweight/obesity, classified based on BMI, increased among women and men. No alterations in WC or WHtR were observed between 2002 and 2010. These findings indicate the need for new disease prevention and health promotion measures or programs that specifically encourage the adoption of a healthy lifestyle (diet and physical activity) by older adults from Florianópolis. Furthermore, it is important that already existing measures and programs are revised and restructured, to account for the relationship between the increased prevalence of obesity and the occurrence of other diseases, such as hypertension and diabetes³⁰.

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