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Original/*Ancianos*

Anthropometric differences related to genders and age in the elderly

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Abstract

Introduction: **anthropometry facilitates the evaluation of the risks associated with reduced lean body mass, as well as of excess adiposity. However, very little is known regarding the anthropometric standards among the elderly and the differences observed between the genders and among the various age groups**

Objective: **to compare indicators and indices anthropometrics of the elderly by gender and age group.**

Methods: **a cross-sectional study was undertaken using a representative probability sample, involving 621 elderly. We evaluated the weight, height, circumferences (waist, hip, calf and arm); body mass index, body adiposity index, waist-hip ratio and waist-stature ratio.**

Results: **women were found to have a higher mean body mass index, waist-stature ratio, body adiposity index and arm circumference ($p<0.001$), whereas men had higher values for weight, height and waist-hip ratio ($p<0.001$). The average arm and calf circumference, however, did not differ between the genders ($p>0.05$). Weight, and calf and arm circumferences were observed to be lower in the older age groups ($p<0.001$) and the same was true for the body mass index and height only in men ($p<0.05$). The waist circumference, waist-hip ratio, body adiposity index and waist-stature ratio did not differ among the age groups ($p>0.05$).**

Conclusion: **the total and peripheral body mass, for the men, in particular, was lower among the older subjects. Central adiposity did not differ among the age groups in both the genders.**

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DIFERENCIAS ANTROPOMÉTRICAS RELACIONADAS CON GÉNEROS Y EDAD EN LOS ANCIANOS

Resumen

Introducción: **la antropometría facilita la evaluación de los riesgos asociados con la masa corporal magra reducida, así como con el exceso de adiposidad. Sin embargo, se conoce muy poco acerca de las diferencias antropométricas observadas entre los géneros y entre los grupos de edad en los ancianos.**

Objetivo: **comparar indicadores e índices antropométricos de los ancianos por género y grupo de edad.**

Métodos: **estudio transversal, con una muestra de 621 ancianos. Se evaluó el peso, la talla, circunferencias (cintura, cadera, pantorrilla y brazo), índice de masa corporal, índice de adiposidad corporal, relación cintura-cadera y cintura-talla.**

Resultados: **se encontró que las mujeres tienen un promedio mayor de índice de masa corporal, relación cintura-talla, índice de adiposidad corporal y circunferencia del brazo ($p<0,001$); mientras que los hombres presentaron mayores valores para el peso, la talla y la relación cintura-cadera ($p<0,001$). Las circunferencias de brazo y pantorrilla, sin embargo, no fueron diferentes entre los géneros ($p>0,05$). Se observaron peso y circunferencias de pantorrilla y brazo menores en los grupos de mayor edad ($p<0,001$) y lo mismo sucedió para el índice de masa corporal y la talla solo en los hombres ($p<0,05$). La circunferencia de cintura, índice de adiposidad corporal, relación cintura-cadera y cintura-talla no fue diferente entre los grupos de edad ($p>0,05$).**

Conclusión: **la masa corporal total y periférica, para los hombres, en particular, fue menor entre los sujetos de mayor edad. La adiposidad central no fue diferente entre los grupos de edad en ambos géneros.**

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Palabras clave: *Envejecimiento. Antropometría. Pesos y medidas corporales. Circunferencia de la cintura. Adiposidad.*

Abbreviations

BAI: Body Adiposity Index
BMI: Body Mass Index
WHR: Waist-Hip Ratio
WSR: Waist-to-Stature Ratio

Introduction

The increase of the number of the elderly across the world, especially in the developing countries, has been rapid and expressive[1]. In Brazil, people 60 years old or above comprise 12.6% of the population[2] and in 2050 will be the fifth country in the world having the highest number of elderly people 80 years of age and above[1].

Corresponding to the demographic changes, there is an emergence of an unfavorable epidemiological and nutritional profile of the elderly population, with a prevalence of overweight persons and a high incidence of Non-communicable Chronic Diseases (NCD)[3]. Despite the availability of well-established scientific evidence regarding the effect of adiposity in NCD[3], define the physiological limits of body fat and the diagnosis of obesity continues to pose a challenge in the elderly[4].

Anthropometry is a noninvasive, inexpensive and widely used tool for assessing the weight change and body measurements associated with advancing age[5]. Several anthropometric indicators have been proposed to identify individuals with cardiovascular risk associated with abdominal obesity[6], in which waist circumference and waist-hip ratio have been the most studied and recommended, to this end[7]. However, in elderly, there are few studies about these indicators and others, including waist-stature ratio[8] and body adiposity index[9].

From some studies, it is evident that weight gain occurs, in the early stages of aging, with a significant increase in body fat[10]. After 65 years, observed a significant weight loss, with as much muscle mass as body fat being lost[11], depending on the ethnic and sociocultural patterns within the population[12]. We compared the indicators and anthropometric measurements of the elderly by gender and age groups in this study.

Methods

Design

This is a population-based, cross-sectional study, conducted utilizing a random sample of the elderly aged 60 years and above, living in Viçosa, Brazil.

Sample size

During the period of our study, the population of the elderly in the city was 7,980. For the sample size was used 95% confidence level, 50% estimated prevalence, 4% variability and 20% loss for the initial sample of 670 elderly, selected by the simple random sampling method. This loss was incurred due to refusal (3.6%), address not being located (1.2%), death (1.3%), removal (1.2%) and inability to directly measure the height (10.4%).

Procedures

A trained team interviewed the elderly in their own homes, under the supervision of the study investigators.

The interview included a semi-structured questionnaire. If the elderly encountered any difficulty in reporting the information requested, the help of the caregiver was sought.

In this study, the following variables were used age, gender, current smoking, alcohol intake, physical activity, weight, height and circumference of the waist, hip, arm and calf.

Anthropometrics measurements

Using the standard procedures[13] the following anthropometric measurements were obtained. Weight was measured on a digital, portable electronic scale, with a maximum capacity of 199.95 kg and accuracy of 50 g (model LC 200 pp, Marte Scales and Precision Instruments Ltd., Brazil). Height was measured using a portable stadiometer, with a maximum calibration of 2.13 m to the nearest 0.1 mm (brand Altura Exata, Brazil).

The circumferences were obtained using a flexible inelastic tape, with a maximum of 1.80 m with 0.1 mm of accuracy. Waist circumference was measured at the midpoint between the last rib and the iliac crest, during expiration, with the elderly in the standing position. Hip circumference was measured at the maximum posterior protusion of the buttocks, considered the largest circumference. The arm circumference was taken at the midpoint between the acromion and the olecranon, with the non-dominant arm being held at an angle of 90°. Calf circumference was measured at the bulk of the non-dominant leg, with the elderly sitting in a chair and holding the leg flexed at 90°.

We calculate Body Mass Index[13] (BMI), Waist-Hip Ratio[7] (WHR), Waist-to-Stature Ratio[8] (WSR) and the Body Adiposity Index (BAI)[9]. The BAI was calculated as (hip circumference (cm) ÷ height (m) 1.5) – 18. The BMI was classified based on the cutoff points proposed by Lipschitz (1994)[14], being underweight individuals with less than 22 kg/m^2 and overweight individuals with more than 27 kg/m^2.

Statistics analysis

Held doubled entered independently of then data analysis errors through the validate command in Epi

Info version 6.04 (CDC, Atlanta, GA). We used histograms and Shapiro-Wilk test to verify the normality. The variables in the study referred to the frequency and percentage or mean and standard deviation.

The association between the categorical variables was assessed using the chi-square test and, where applicable, and the chi-square test was used for the linear trend. We used Pearson coefficients to calculate the correlation between age and the anthropometric variables. Student's t test was performed for comparison of the means among the genders and ANOVA was used for comparison among the age groups, followed by the Bonferroni test.

We used STATA version 9.0 (STATA Corp., Texas, USA) and all analyses were performed considering $p<0.05$ as a significant level.

Ethics

The Ethics Committee on Human Research of the Federal University of Viçosa approved the study and interview of the participants occurred only after obtaining free and informed signed consent.

Results

The sample included 621 elderly persons, the majority of whom were female (53.3%) showing the highest mean age (71.54±8.4 vs 69.95±7:56; $p<0.01$) and a higher prevalence of overweight (59.9% vs 43.3%; $p<0.0001$), when compared with the men. The prevalence of underweight was higher in the males (18.2% vs 9%, $p<0.0001$).

Regarding lifestyle, more women reported engaging in physical activity (38.8% vs 25.5%; $p<0.05$), while found a higher percentage of men smokers (16.2% vs 6.1%; $p<0.001$) and consuming alcoholic beverages (46.5% vs 22.4%, $p<0.001$). The prevalence of the elderly who consumed alcohol, smoked and who practiced physical activity decreased with increase in age in both genders (data not shown in the Table).

Concerning the anthropometric parameters, we found that women had a higher BMI, WSR, BAI and arm circumference ($p<0.001$). In contrast, men revealed higher values for mean weight, height and WHR ($p<0.001$). The waist and calf measurements alone showed no difference between the genders ($p>0.05$) (Table I).

We found correlations inverse and significant, although weak, between age and weight, height, BMI, and waist, calf and arm circumferences for both genders. For WHR, WSR and BAI were not significantly correlated with age in both genders (Table II).

Weight and the arm and calf circumferences were lower in the older age groups in both genders ($p<0.001$) and BMI and height were lower only among older man ($p<0.05$). The waist circumference, WHR, BAI and WSR showed no difference among the age groups, in both genders ($p>0.05$) (Table III).

Regarding the 50th percentile, we found that compared to age groups 60-69 years, older subjects (≥80 years) had the lowest BMI in 3 units for men and 2 units for women. Moreover, the arm circumference was 3.7 cm lower in both genders and the calf circumference was lower 3.5 cm in the men and 1.7 cm in the women (Tables IV and V).

Discussion

In our study, the mostly was of the women, subjects in the age groups between 60 and 69 years of age, with

Table I
Mean and standard deviation (SD) of the anthropometrics variables by gender of elderly

Variables (n)	*Men*	*Women*
	Mean ± SD	*Mean ± SD*
Weight (Kg) (n=605)	70.6±0.87*	64.5±0.77
Height (cm) (n=551)	165.5±0.40*	152.4±0.35
BMI (Kg/m²) (n=551)	25.8±0.27	28.2±0.32*
Waist circumference (cm) (n=597)	95.9±0.73	95.60±0.71
WHR (n=594)	0.98±0.004*	0.94±0.003
WSR (n=543)	0.58±0.004	0.63±0.005*
BAI (%) (n=546)	27.9±0.22	36.4±0.39*
Calf circumference (cm) (n=611)	36.0±0.24	35.9±0.24
Arm circumference (cm) (n=617)	29.6±0.23	30.8±0.25**

BMI: body mass index; WHR: waist-hip ratio; WSR: waist-stature ratio; BAI: body adiposity index. Student`s t-test: *P value<0.0001; **P value<0.001.

Table II
Pearson coefficients (r) between age and anthropometrics variables by gender in elderly

Anthropometrics variables (n)	*Men*	*Women*
Peso (Kg) (n=605)	- 0.27*	- 0.25*
Height (cm) (n=551)	- 0.21*	- 0.12**
BMI (Kg/m²) (n=551)	- 0.22*	- 0.16*
Waist circumference (cm) (n=597)	- 0.17*	- 0.11**
WHR (n=594)	- 0.10	0.06
WSR (n=543)	- 0.10	- 0.04
BAI (%) (n=546)	0.00	- 0.04
Calf circumference (cm) (n=611)	- 0.34*	- 0.27*
Arm circumference (cm) (n=617)	- 0.40*	- 0.28*

BMI: body mass index; WHR: waist-hip ratio; WSR: waist-stature ratio; BAI: body adiposity index. Pearson's correlation. *P value<0.01; **P value<0.05.

high percentage of overweight, especially among the women, and a higher frequency of men with low weight[15]. These results were consistent with the findings of others studies which indicate that a worse lifestyle among the men, with lower prevalence of physical activity and a higher prevalence of smoking and consumption of alcoholic drinks[15,16].

Throughout their adulthood, most men and women reveal a weight gain resulting mainly from an increase in body fat[17]. However, after 65 years of age there has been a progressive reduction in the height and body reserves, particularly of the subcutaneous fat and lean body mass[18-20].

The changes in the body composition, because of advancing age are heterogeneous and results of the reduction in the body water content, bone mass, muscle mass and or adipose tissue[10,11]. The quality and intensity of these changes vary according to the physical activity level, dietary pattern, smoking status[21], polypharmacy[22] as well as ethnicity[10,11].

In our sample, only the men showed a significant reduction in height, unlike other studies in which men and women[18,23] or just women[15] showed a significant decline in height with advancing age. Such differences between the studies may be attributed to the ethnic and socioeconomic differences[24], the living conditions during childhood[25], the postural changes resulting from degenerative changes in the intervertebral discs and a reduction in the lumbar movement[26].

Women had higher BMI values, and among the age groups a significant reduction of the same was observed only in men. The literature is quite confusing when considering the changes in the BMI among the elderly men and women with increasing age, with the results showing a decline only in the women[18] or both genders[15] and sometimes even no reading[23]. Variation in design and ethnic can also be factors contributing to these differences.

The relationship between BMI and mortality in the elderly is different from that found in adults and is defined as "obesity paradox". Lower mortality rates by all causes and cardiovascular disease has been found to decrease in subjects with BMI between 25 and 35 Kg/m² [27,28]. The BMI values identified in the extreme percentiles of this study show values close to these bands, especially in the 60-69 year age group. Although the BMI is a good predictor of change in the lean body mass and, more strongly, in the fat mass, in the elderly, its use and interpretation have limitations. Stability or small decreases in the weight BMI observed with increasing age may be masked. In general, occurred reduction of muscle mass and changes in the type and redistribution of body fat, with increased visceral fat, inter- and intramuscular fat and reducing subcutaneous fat[19,29]. This highlights the fact that the assessment of the elderly only by weight and BMI is inadequate and that it is necessary to examine the specific indicators or anthropometric indices that will be more accurate for the correct evaluation of the elderly.

For indicators or anthropometric indices of adiposity, we did not find differences in BAI, waist circumference, WSR and WHR among the age groups. In addition, no differences were observed in the waist circumference between the genders. Increased central adiposity has been identified as a predictor of morbidity[27], mortality[27,30] and disability in the elderly[31]. However, the absence of cut-off points for waist circumference, WHR and WHR limits estimate the risk of morbidity and mortality. For total body adiposity, the ability of BAI to predict any risk associated with excess body fat, especially among the senior citizens, is doubtful[32].

In this study, we found lower values for arm and calf circumference in the older age groups, in both genders. Other studies have also reported a reduction in these values with increasing age[15,33]. Calf circumference ≥ 31 cm has been associated with greater muscle strength, better physical performance, lower fragility index and better functional status in the elderly[34]. We think that the reduction in body weight with advancing age in elderly has been because of the loss of peripheral body tissue, specially of lean mass and subcutaneous fat, since we did not observed changes in indicators or anthropometric indices of central adiposity. Thus, this reflects that BMI is better predictor of lean loss than fat mass in elderly.

There are some limitations in this study. The anthropometric differences and percentile distributions for the elderly did not consider distinguishing variables that directly affect changes in the body composition over a period of time with alterations in factors such as education, income, level of physical activity, morbidity, and functional and cognitive disabilities. In addition, it is a cross-sectional study and should therefore be interpreted cautiously as the differences

Table III
Mean and standard deviation (SD) of the anthropometrics variables by gender and age groups of elderly

Variables	*Men*			*Women*		
	n	*Mean*	*SD*	*n*	*Mean*	*SD*
Weight (Kg)						
60-69	149	73.3[a,b]	15.6	159	67.4[a,b]	14.3
70-79	103	68.5[a]	12.8	108	62.7[a]	12.6
≥80	30	64.2[b]	12.6	56	60.0[b]	13.3
Height (cm)						
60-69	148	166.5[a]	6.6	155	152. 9	5.5
70-79	99	164.4[a]	6.5	89	152.0	6.5
≥80	27	164.1	6.7	32	151.0	5.7
Body mass index (Kg/m^2)						
60-69	148	26.40[a]	4.72	156	28.74	5.59
70-79	99	25.35	4.08	89	27.50	5.04
≥80	27	23.89[a]	3.94	32	27.20	5.80
Waist circumference (cm)						
60-69	151	96.7	13.2	156	96.6	13.0
70-79	102	95.3	10.9	108	95.0	12.2
≥80	29	91.6	12.0	51	93.8	12.2
Waist-hip ratio						
60-69	149	0.98	0.07	156	0.94	0.06
70-79	102	0.98	0.07	107	0.95	0.06
≥80	29	0.96	0.08	51	0.94	0.07
Waist-stature ratio						
60-69	148	0.58	0.07	152	0.63	0.8
70-79	98	0.58	0.06	88	0.63	0.8
≥80	25	0.56	0.07	32	0.63	0.08
Body adiposity index (%)						
60-69	147	27.8	3.6	154	36.6	6,4
70-79	99	28.1	3.9	88	35.8	6.1
≥80	26	27.6	3.3	32	37.1	7.7
Calf circumference (cm)						
60-69	151	36.8[a,c]	3.8	157	36.8[a,b]	4.6
70-79	103	35.4[a,b]	3.9	110	35.0[a]	3.8
≥80	32	32.9[b,c]	4.5	58	34.4[b]	3.8
Arm Circumference (cm)						
60-69	151	30.8[a,c]	3.7	159	31.8[a,b]	4.2
70-79	104	28.9[a,b]	3.5	111	30.2[a]	4.7
≥80	32	26.7[b,c]	4.1	60	29.0[b]	4.6

ANOVA with Bonferroni post-hoc test**.** Same superscript letters in the same column indicate significant differences between age groups, P value < 0.05.

Table IV
Percentiles (p) of indicators and indices anthropometrics of the elderly by gender and age group of elderly men

Variables	*n*	*p5*	*p10*	*p25*	*p50*	*p75*	*p90*	*p95*
Body mass index (Kg/m²)								
60-69	148	19.8	20.5	23.7	26.0	28.5	33.0	35.6
70-79	99	19.2	20.0	22.9	25.3	27.9	29.9	31.2
≥80	27	17.4	18.2	21.1	23.0	27.7	28.9	29.5
Waist circumference (cm)								
60-69	151	75.6	80.1	89.0	95.8	103.0	114.7	123.1
70-79	102	79.3	80.0	88.0	95.6	102.0	107.3	112.0
≥80	29	68.0	72.3	84.1	93.7	102.6	103.6	109.1
Waist-hip ratio								
60-69	149	0.87	0.88	0.93	0.98	1.03	1.08	1.10
70-79	102	0.87	0.89	0.94	0.98	1.02	1.08	1.10
≥80	29	0.82	0.85	0.89	0.97	1.03	1.05	1.07
Waist-stature ratio								
60-69	148	0.47	0.49	0.54	0.58	0.62	0.68	0.72
70-79	98	0.47	0.49	0.54	0.59	0.62	0.65	0.68
≥80	25	0.40	0.48	0.52	0.57	0.60	0.64	0.65
Body adiposity index (%)								
60-69	147	22.8	23.6	25.5	27.0	29.2	32.3	35.7
70-79	99	23.1	24.0	25.5	27.7	29.7	32.4	33.4
≥80	26	21.1	23.4	26.7	27.6	29.5	31.8	33.6
Arm circumference (cm)								
60-69	151	25.5	26.4	28.2	30.6	32.6	35.9	37.5
70-79	104	23.0	24.3	26.7	29.1	30.7	33.0	35.0
≥80	32	20.5	21.2	23.7	26.9	29.4	32.0	33.6
Calf circumference (cm)								
60-69	151	31.0	32.2	34.4	36.5	39.4	41.3	43.4
70-79	103	29.2	30.7	33.1	35.6	37.7	40.0	43.5
≥80	32	26.4	27.0	30.4	33.0	36.1	37.7	38.4

did not correspond to changes monitored over a period of time, although these findings are consistent with those reported in prospective longitudinal studies. However, these limitations do not invalidate the findings of this study, as they may contribute to data on the nutritional status of the elderly and its change with further aging.

The main strengths of this study are the use of a representative sample of elderly whose anthropometric measurements were objectively obtained by highly trained evaluators. Despite the large and growing number of elderly people in the world, there is a lack of studies of this nature. Thus, our results may help build an anthropometric standard for the elderly population.

In future, longitudinal research in this study is needed to explore and thereby comprehend the anthropometric changes according to the age and sex of the elderly. In addition, these studies should use a large sample size of individuals aged ≥ 80 years.

Conclusion

In conclusion, the prevalence of overweight subjects was higher in both the sexes, but low weight was more prevalent in older men. Except for the calf perimeter and waist circumference, the other measures and anthropometric indices differed between the sexes, with

Table V
Percentiles (p) of indicators and indices anthropometrics of the elderly by gender and age group of elderly women

Variables	*n*	*p5*	*p10*	*p25*	*p50*	*p75*	*p90*	*p95*
Body mass index (Kg/m²)								
60-69	156	20.9	22.4	24.7	28.0	32.1	36.0	38.2
70-79	89	19.6	21.8	24.4	27.4	30.0	33.9	36.1
≥80	32	21.1	21.8	23.5	26.0	29.7	34.6	38.4
Waist circumference (cm)								
60-69	156	80.4	82.0	86.8	96.2	104.4	112.4	117.1
70-79	108	70.2	81.1	88.3	95.2	103.4	109.5	114.2
≥80	51	79.0	80.0	84.5	89.8	102.0	108.3	114.5
Waist-hip circumference								
60-69	156	0.84	0.86	0.90	0.93	0.98	1.01	1.04
70-79	107	0.82	0.87	0.91	0.94	0.99	1.03	1.05
≥80	51	0.83	0.86	0.89	0.94	0.98	1.02	1.06
Waist-stature ratio								
60-69	152	0.52	0.53	0.57	0.62	0.69	0.73	0.76
70-79	88	0.48	0.53	0.58	0.63	0.68	0.73	0.79
≥80	32	0.52	0.54	0.58	0.61	0.67	0.71	0.78
Body adiposity index (%)								
60-69	154	28.2	29.3	31.9	35.7	40.0	44.4	47.8
70-79	88	27.6	29.2	32.0	35.0	38.6	44.0	46.1
≥80	32	27.0	30.9	31.5	35.2	39.8	51.1	52.6
Arm circumference (cm)								
60-69	159	25.7	26.2	28.5	31.9	34.8	37.5	39.3
70-79	111	22.0	24.5	27.2	30.2	33.0	36.2	38.3
≥80	60	22.6	23.5	25.6	28.2	32.1	35.4	37.8
Calf circumference (cm)								
60-69	157	30.7	31.9	33.5	36.0	39.3	42.5	47.6
70-79	110	28.8	30.3	33.0	35.0	37.9	39.9	40.6
≥80	58	28.0	30.0	31.8	34.3	36.5	38.7	39.7

older women showing higher BMI values, WSR, BAI, and arm perimeter, while men showed higher values of weight, height, and WHR.

The worst anthropometric profile was observed in older men (≥80 years), with lower values of BMI, calf circumference, and arm perimeter, which makes them comparatively more vulnerable to morbidity risks that are associated with low birth weight and higher mortality. In contrast, the adiposity indices BAI, WSR, WHR, and WC did not differ between the age groups of both the sexes, including BMI in older women.

Further studies are warranted to assist in the establishment of the physiological limits regarding the changes in body composition and to investigate the validity of the indices and the anthropometric indicators in predicting disability, morbidity and mortality in this population group.

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