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RAPID COMMUNICATION

Anthropometric indicators as predictors of serum triglycerides and hypertriglyceridemia in older adults

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OBJECTIVES: To compare the relation between anthropometric indicators and serum triglycerides, and to identify the indicators most strongly associated with hypertriglyceridemia in older adults.

METHODS: A population-based, cross-sectional study conducted with 316 subjects ($\geq$60 years old) in 2011. The following were checked: triglycerides, body mass index, waist-to-hip ratio, waist-to-height ratio, conicity index, body adiposity index, triceps skinfold thickness, and waist and calf circumference.

RESULTS: Linear regression analyses showed that waist-to-hip ration ($R^2 = 0.065$) in women and body mass index ($R^2 = 0.123$) in men were the indicators that best correlated with triglyceride. Poisson's regression showed that body mass index, calf circumference, and triceps skinfold thickness were the only indicators associated with hypertriglyceridemia (triglycerides $\geq$150 mg/dl) among female subjects. For male subjects, with the exception of waist-to-hip ratio and the conicity index, all other indicators were associated with hypertriglyceridemia.

CONCLUSION: The anthropometric indicators that best explain the variability of triglyceride differ according to sex. Body mass index, calf circumference, and triceps skinfold thickness are the best anthropometric indicators for hypertriglyceridemia in older adults of both sexes.

KEYWORDS: Anthropometry; Health of the Elderly; Risk Factors; Dyslipidemia.

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INTRODUCTION

High serum triglycerides (hypertriglyceridemia) are recognized as a public health problem. Alone or accompanied by metabolic disorders, hypertriglyceridemia is a risk factor for cardiovascular disease[1]. Heredity[2], lifestyle, inadequate nutrition[3], sedentarism[4], and excess body fat[5,6] are factors associated with the lipid profile. Furthermore, excess body fat is one of the main factors associated with hypertriglyceridemia in adults and older adults[7,8].

In epidemiological studies that address hypertriglyceridemia, the presence of excess body fat is identified by anthropometric measures, including body mass index (BMI), waist circumference[6–8], and waist-to-height ratio[7]. However, some other methods, such as computed tomography and magnetic resonance imaging, can also be used to assess body composition. Anthropometric measurements are relatively easy to take and are low in cost compared with more accurate methods. In addition, they can be used in household surveys, clinical practices, and primary health care[9].

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Studies comparing the association between anthropometric indicators and serum triglyceride levels have focused on only a few measurements or indices[6–8]. Other anthropometric indicators in this association still need to be studied. Furthermore, most studies were carried out with adults, and their results are far from consistent[7,8]. Therefore, determining the best anthropometric indicator for hypertriglyceridemia based solely on these studies is not possible. This research issue has been the subject of only limited investigation[6] involving older adults.

The objectives of the present study are as follows: (i) to compare the relation of anthropometric indicators with serum triglycerides and (ii) to identify the indicators most associated with hypertriglyceridemia.

METHODS

The present investigation employed data from the population-based cross-sectional study entitled "*Nutritional status, risk behavior and health conditions of older adults in Lafaiete Coutinho – BA*" ("*Estado nutricional, comportamentos de risco e condições de saúde dos idosos de Lafaiete Coutinho – BA*"). Details about setting, population, and data collection have been previously published[10]. The study population comprised all urban residents of Lafaiete Coutinho, in the state of Bahia, Brazil, aged ≥ 60 years old (n = 355). Of the 355 subjects in the study population, 316 (89.0%) took part in the research; 17 refusals (4.8%) were registered, and 22 individuals (6.2%) were not located after three household visits (alternate days), and were, thus, considered to be lost from the study.

The study protocol was approved by the research ethics committee of the Universidade Estadual do Sudoeste da Bahia (n° 064/10).

Triglycerides and hypertriglyceridemia (dependent variables)

The previously validated[11] Accutrend® Plus (Roche Diagnostics, Germany) system verified the triglycerides after a 12-hour fast. Capillary blood samples were collected through a transcutaneous puncture of the medial side of the tip of the middle finger using a disposable hypodermic lancet. Hypercholesterolemia (triglycerides ≥ 150 mg/dl) was defined according to the guidelines in effect in Brazil[1].

Anthropometric indicators (independent variables)

The anthropometric data were obtained by three undergraduate students who received theoretical and practical training to standardize the anthropometric techniques used in the study. Weight and height were measured with the participant barefoot and wearing the least amount of clothing possible, according to the technique of Frisancho[12]. Waist (umbilical scar level), hip, and calf circumferences were measured with an inelastic anthropometric tape measure. Hip and calf circumferences were measured according to the technique of Callaway et al.[13]. Triceps skinfold thickness (TSF) was measured with a skinfold caliper (WCS, Brazil), according to Harrison et al.[14]. All anthropometric measurements, except for body mass, were taken in triplicate, and the average values were used in the analyses. The following anthropometric indicators were calculated: BMI [BMI = body mass (kg) / height^2 (m)], waist-to-hip ratio (WHR = waist circumference / hip circumference), waist-to-height ratio [WHtR = waist circumference (cm) / height (cm)], conicity index[15], and body adiposity index (BAI)[16].

Adjustment variables

Sociodemographic: age group (60–69, 70–79, or ≥80 years) and literacy (yes or no).

Lifestyle: alcohol intake (≥ once/week/ < once/week) and physical exercise (insufficiently active / active). The instrument used to assess the level of habitual physical exercise was the *International Physical Activity Questionnaire*, long version[17]: insufficiently active (fewer than 150 minutes per week of moderate to vigorous physical exercise) and active (150 or more minutes per week of moderate to vigorous physical exercise).

High blood glucose: Accutrend® Plus was used to dose 12-hour fasting plasma glucose, with procedures as described for triglycerides. High blood glucose (plasma glucose > 100 mg/dl) was defined according to Brazilian guidelines[18].

Statistical procedure

Distribution normality was checked using the Kolmogorov-Smirnov test. The frequencies, means (or medians), and standard deviations (or interquartile intervals) were calculated. Differences between sexes were compared using the chi-squared test (qualitative variables) and the Mann-Whitney U test or Student's *t*-test for independent variables (quantitative variables), Simple linear regression analysis was used to check the relation between anthropometric indicators and triglycerides. The association between anthropometric indicators (independent variables) and hypertriglyceridemia (dependent variable) was tested with the Poisson regression technique. Robust, adjusted models were calculated to estimate the prevalence ratio with their respective 95% confidence intervals (CI 95%).

In all analyses, the level of significance adopted was 5% ($\alpha = 0.05$). The data were tabulated and analyzed in SPSS® 21.0 (SPSS Inc., Chicago, IL).

RESULTS

The study population consisted of 173 women (54.7%) and 143 men (45.3%) aged between 60 and 105 (74.2 ± 9.8 years). The mean age was 74.9 ± 10.0 years for women and 73.4 ± 9.4 years for men. Other characteristics of the participants, according to sex, are shown in Table 1. Individuals who stated that they could read and write, consumed alcoholic beverages once per week or more often, and did not have high triglycerides were more commonly men. Women had higher triglycerides levels; anthropometric values were variable, except for calf circumference, which was higher in men, and WHR, which showed no significant difference between the sexes.

According linear regression analyses, only the conicity index was not positively correlated with triglycerides (both sexes). WHR (6.5%) was the indicator that most explained triglyceride variability in women, whereas waist circumference (5.9%), WHtR (5.6%), and BMI (5.4%) exhibited approximately the same levels of variance. Among the male subjects, triglyceride variability was best accounted for BMI (12.3%), whereas waist circumference (10.8%) and TSF (10.0%) expressed almost the same quantity of variance. The order of correlation of anthropometric indicators and triglycerides was WHR > waist circumference > WHtR > BMI > calf circumference > BAI > TSF, among the women. Among the men, the order was BMI > waist circumference > TSF > WHtR > calf circumference > BAI > WHR (Table 2).

Using the Poisson regression analysis (Table 3), we found that among the women, the only indicators associated with hypertriglyceridemia were BMI, calf circumference, and TSF. Among the men, with the exception of WHR and conicity index, all other indicators were associated with hypertriglyceridemia. BMI ($p < 0.001$), TSF ($p < 0.001$), and BAI ($p < 0.001$) showed the strongest associations. With each increment of 1 mm of TSF, there was a 2.5% increase in the probability of women having hypertriglyceridemia and a corresponding 9.6% increase in men. The increment of one unit of BMI (1 kg/m^2) resulted in increases of 3.2% and 12.4% in the probability of hypertriglyceridemia in female and male individuals, respectively (Table 3).

DISCUSSION

In the present study, waist to hip ratio and body mass index are the indicators that express the highest variability percentage of triglycerides among women and men, respectively. This result is consistent with a study conducted with 2179 Iranian individuals (15 to 74 years of age)[19].

Table 1 - Characteristics of participants

Variables	Total	Women	Men	p value
Age group (%)				
60–69 years	36.5	34.3	39.2	0.479
70–79 years	33.7	33.1	34.3	
≥ 80 years	29.8	32.6	26.6	
Literacy (%)				
Yes	33.2	27.7	39.9	0.031
No	66.8	72.3	60.1	
Alcohol intake (%)				
≥ once/week	8.6	3.5	14.8	0.001
< once/week	91.4	96.5	85.2	
Physical activity (%)				
Insufficiently active	47.7	47.3	48.2	0.967
Active	52.3	52.7	51.8	
Triglycerides (mg/dl)	136.0 ± 83.5	146.0 ± 79.0	126.0 ± 80.0	0.002
Hypertriglyceridemia (%)				
Yes	40.6	47.9	31.7	0.005
No	59.4	52.1	68.3	
High blood glucose (%)				
Yes	18.8	22.4	14.4	0.102
No	81.2	77.6	85.6	
BMI (kg/m2)	24.5 ± 4.7	25.3 ± 4.9	23.7 ± 4.1	0.003
WC (cm)	91.8 ± 18.2	94.3 ± 17.9	89.3 ± 18.2	< 0.001
CC (cm)	33.2 ± 3.6	32.6 ± 3.5	33.9 ± 3.7	0.002
WHR	0.97 ± 0.08	0.98 ± 0.08	0.97 ± 0.09	0.073
WHtR	0.59 ± 0.12	0.63 ± 0.13	0.55 ± 0.08	< 0.001
Conicity index	1.37 ± 0.14	1.42 ± 0.12	1.32 ± 0.12	< 0.001
TSF (mm)	14.8 ± 11.2	19.7 ± 10.7	10.4 ± 5.8	< 0.001
BAI	30.6 ± 9.56	35.0 ± 8.8	26.5 ± 4.7	< 0.001

BMI, body mass index; WC, waist circumference; CC, calf circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio; TSF, skinfold triceps; BAI, body adiposity index.
The values are expressed in median ± interquartile interval or percentage, except for BMI, which is expressed as mean ± standard deviation.

Table 2 - Linear regression analysis between anthropometric indicators and triglycerides

Variables	Women			Men		
	β	R^2	p value	β	R^2	p value
BMI	4.441	0.054	0.002	6.913	0.123	< 0.001
WC	1.833	0.059	0.001	1.768	0.108	< 0.001
CC	5.234	0.035	0.009	4.452	0.037	0.013
WHR	427.829	0.065	0.001	109.562	0.029	0.026
WHtR	254.299	0.056	0.001	258.576	0.081	< 0.001
Conicity index	133.232	0.016	0.058	57.884	0.012	0.102
TSF	1.727	0.021	0.036	5.122	0.100	< 0.001
BAI	2.300	0.022	0.033	3.982	0.032	0.021

BMI, body mass índex; WC, waist circumference; CC, calf circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio; TSF, skinfold triceps; BAI, body adiposity index.

Table 3 - Prevalence ratio for increasing anthropometric indicators according to hypertriglyceridemia

Variables	Women			Men		
	PR*	CI 95%	p-value	PR*	CI 95%	p-value
BMI	1.032	1.002–1.063	**0.037**	1.124	1.071–1.179	**< 0.001**
WC	1.013	0.999–1.026	0.064	1.024	1.010–1.037	**0.001**
CC	1.052	1.003–1.104	**0.038**	1.124	1.051–1.202	**0.001**
WHR	1.024	0.993–1.057	0.129	1.012	0.998–1.026	0.087
WHtR	1.015	0.997–1.033	0.107	1.037	1.015–1.059	**0.001**
CI	1.756	0.421–7.329	0.440	2.265	0.847–6.058	0.103
TSF	1.025	1.007–1.043	**0.006**	1.096	1.062–1.131	**< 0.001**
BAI	1.012	0.990–1.035	0.279	1.085	1.044–1.128	**< 0.001**

PR, prevalence ratio; CI95%, confidence interval 95%; BMI, body mass index; WC, waist circumference; CC, calf circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio; CI, conicity index; TSF, skinfold triceps; BAI, body adiposity index.
*Adjusted for age group, literacy, alcohol intake, physical activity and high blood glucose.

However, other authors have identified a correlation between triglyceride serum levels and different anthropometric indicators in adults and older adults: WHR and waist circumference[20], BMI and waist circumference[21,22], and BMI, waist circumference, and WHR[23] in individuals of both sexes, and WHR and waist circumference in women[24].

The results of the present study show that calf circumference in both sexes, and BMI among men were the indicators most strongly associated with hypertriglyceridemia. TSF was the second indicator most strongly associated with hypertriglyceridemia in both sexes, standing out as a good predictor for the identification of this dyslipidemia. These results are somewhat surprising because, in older adults, calf circumference and TSF are indicators of muscle mass and subcutaneous fat reserves, respectively[9]. No other study found that these indicators were associated with hypertriglyceridemia. However, in a 30-year-long study conducted with 1511 men and 691 women (40 to 64 years of age, baseline), TSF was found to be predictive of fatal coronary heart disease in women (RR = 1.63, 95% CI = 1.12 to 2.39)[25]. Another study[24], conducted with 388 women, identified a correlation between triglycerides and the sum of the following five skinfolds: biceps, abdomen, suprailiac, mid-point of the thigh, and mid-point of the calf.

Regarding BMI, a study by Wannamethee et al.[26] showed that the addition of one standard deviation to BMI increased the probability of hypertriglyceridemia in men by 77%. In the present study, with each addition of 1 kg/m^2 unit to BMI, there was a 12.4% increase in the probability of hypertriglyceridemia for men, and 3.2% for women. The results for men are comparable to Wannamethee et al.[26], because the standard deviation in our study was 4.1 kg/m^2, which means that one standard deviation increase should increase the probability by 51%.

The present study is limited in its cross-sectional delineation, which does not enable us to establish a cause-and-effect relation between anthropometric indicator alterations and serum concentrations of triglycerides and hypertriglyceridemia. However, this study validates and encourages the use of anthropometric indicators in clinical practice for health professionals who aim to prevent, maintain, or improve monitoring of lipid levels in older adults.

The use of anthropometric indicators for routine assessment of the health of older adults could contribute to baseline studies and the monitoring of more specific care, particularly with therapies that include guidelines for physical activity and nutrition. Although WHR and waist circumference are independent predictors for metabolic disorders[27], these indicators, similarly to TSF and calf circumference, do not consider height or changes in body weight. Therefore, we recommend the combined use of these indicators, together with BMI, to improve the predictive capacity of metabolic changes and cardiovascular complications.

CONCLUSION

The anthropometric indicators that best explain triglyceride variability differ according to sex, with waist-to-circumference being the best predictor for women and body mass index for men. Body mass index, calf circumference, and triceps skinfold thickness stand out as the best anthropometric indicators for hypertriglyceridemia in elderly people of both sexes.

RESUMO

OBJETIVOS: Comparar a relação entre indicadores antropométricos e triglicerídeos séricos e identificar os indicadores mais associados à hipertrigliceridemia em idosos.

MÉTODOS: Estudo transversal de base populacional realizado com 316 idosos (≥ 60 anos), em 2011. Foram verificados os triglicerídeos (sistema Accutrend® Plus), o índice de massa corporal, a razão cintura-quadril, a razão cintura-estatura, o índice de conicidade, o índice de adiposidade corporal, a dobra cutânea tricipital e as circunferências da cintura e da panturrilha.

RESULTADOS: As análises de regressão linear mostraram que a razão cintura-quadril (6,5%), nas mulheres e o índice de massa corporal (12,3%), nos homens, foram os indicadores que mais explicaram a variabilidade dos triglicerídeos. A regressão de Poisson mostrou que o índice de massa corporal, a circunferência da panturrilha e a dobra cutânea tricipital foram os indicadores associados a hipertrigliceridemia (triglicérides ≥ 150 mg/dl), no sexo feminino. Para os homens, à exceção da razão cintura-quadril e do índice de conicidade, os demais indicadores foram associados à hipertrigliceridemia.

CONCLUSÕES: Os indicadores antropométricos que melhor discriminam a variabilidade dos triglicerídeos diferem entre os sexos. **O** índice de massa corporal, a circunferência da panturrilha e a dobra cutânea tricipital se destacam como os melhores indicadores antropométricos para hipertrigliceridemia em idosos de ambos os sexos.

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