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Original/*Ancianos*

Anthropometric indicators of obesity as predictors of cardiovascular risk in the elderly

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Abstract

Background: **various anthropometric indicators can be used as predictors of cardiovascular risk in the elderly.**

Objective: **Evaluate the predictive capacity of anthropometric measurements in identifying cardiovascular risk in elderly patients at the Family Health Strategy of Viçosa-MG.**

Methodology: **this was a cross-sectional epidemiological study with 349 elderly persons. Cardiovascular risk was calculated using the ratio of triglyceride levels with HDL-cholesterol (TG/HDL-c) levels. The anthropometric variables measured were waist circumference, body mass index, waist-to-height ratio, and conicity index. A biochemical assessment of triglycerides and HDL-cholesterol was performed. The anthropometric measurements were also related to cardiovascular risk using Receiver Operating Characteristic (ROC) curves.**

Results: **the observed results suggest that all these anthropometric indexes can be used to predict cardiovascular risk in males. However, in females, only BMI showed predictive capacity. The cutoff points identified appeared very close to the cutoffs recommended and recognized in other studies, with the exception of waist circumference measured at the midpoint between the last rib and the iliac crest, which showed a considerable difference.**

Conclusion: **all anthropometric indices can be used to predict cardiovascular risk in males and females. Waist circumference at the midpoint between the last rib and the iliac crest was the best anthropometric measure to predict cardiovascular risk in males and smaller waist circumference and waist-height were the best anthropometric measures in females.**

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Key words: *Elderly. Cardiovascular risk. Anthropometry. Cutoff points.*

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LOS INDICADORES ANTROPOMÉTRICOS DE OBESIDAD COMO PREDICTORES DE RIESGO CARDIOVASCULAR EN LOS ANCIANOS

Resumen

Introducción: **diversos indicadores antropométricos se pueden utilizar como predictores de riesgo cardiovascular en los ancianos.**

Objetivo: **evaluar la capacidad predictiva de las medidas antropométricas en la identificación de riesgo cardiovascular en pacientes ancianos en la Estrategia Salud de la Familia de Viçosa-MG.**

Metodología: **se realizó un estudio epidemiológico transversal con 349 ancianos. El riesgo cardiovascular se calculó mediante la relación de los niveles de triglicéridos con niveles de HDL-colesterol (TG / HDL-c). Las variables antropométricas medidas fueron: circunferencia de la cintura, índice de masa corporal, relación cintura-altura e índice de conicidad. Se realizó una evaluación bioquímica de triglicéridos y HDL-colesterol. Las mediciones antropométricas también estaban relacionados con el riesgo cardiovascular utilizando la característica (ROC) Curvas Receiver Operating.**

Resultados: **los resultados observados indican que todos estos índices antropométricos se pueden usar para predecir el riesgo cardiovascular en los hombres. Sin embargo, en las mujeres, solo el IMC mostró capacidad predictiva. Los puntos de corte identificados aparecieron muy cerca de los puntos de corte recomendados y reconocidos en otros estudios, con la excepción de la circunferencia de la cintura, que se mide en el punto medio entre la última costilla y la cresta ilíaca, que mostró una diferencia considerable.**

Conclusión: **todos los índices antropométricos se pueden usar para predecir el riesgo cardiovascular en hombres y mujeres. La circunferencia de la cintura en el punto medio entre la última costilla y la cresta ilíaca era la mejor medida antropométrica para predecir el riesgo cardiovascular en los varones y la circunferencia de cintura más pequeña y cintura-altura fueron las mejores medidas antropométricas en las mujeres.**

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Palabras clave: *Ancianos. Riesgo cardiovascular. Antropometría. Puntos de corte.*

Introduction

A worldwide phenomenon, population aging is a major challenge for public health. The demographic transition can be understood as a major change in the age structure of the population pyramid, influenced by cultural, historical, and socioeconomic determinants. Concomitantly, we have passed through the epidemiological transition, characterized by a substantial increase in non-transmissible chronic diseases, over the years. Data from the Brazilian Institute of Geography and Statistics show that 75.5% of elderly Brazilians manifest some form of chronic illness[1,2].

Cardiovascular diseases are responsible as the major causes of mortality among the elderly, most notably coronary atherosclerosis. About 20-30% of elderly people over 70 show symptoms of such diseases, and more than 70% of these cases are detected as coronary atherosclerosis after autopsy is performed[3,4].

The relation between triglycerides and HDL-cholesterol (TG/HDL-c) is used as an indicator of dyslipidemia due to its connection to increased cardiovascular risk. Recent analyses demonstrate that this ratio is a powerful predictor of the development of coronary heart disease, being directly correlated with plasma levels of type-B LDL-cholesterol. The use of the triglyceride to HDL-cholesterol ratio to assess cardiovascular risk has actually been widely used[5-9].

Obesity, especially the abdominal form, predisposes individuals to a number of cardiovascular risk factors such as dyslipidemia, hypertension, insulin resistance, and diabetes, and is associated with increased cardiovascular risk, represented by myocardial infarction, stroke, and premature death. In this scenario, it is essential to use anthropometric measures that assess excess body fat to predict cardiovascular risk in elderly persons[10,11].

This points out the relevance of studies that relate cardiovascular risk and anthropometric factors in the elderly population, taking into account the significance of the population group in question and the scarcity of related studies.

Objetive

Therefore this study aims to assess the predictive capacity of anthropometric measurements in identifying cardiovascular risk in elderly patients in the Family Health Strategy of Viçosa-MG.

Methodology

This paper integrates the largest extension project "Epidemiological study of functional capacity in elderly patients with metabolic syndrome". This is a cross-sectional epidemiological study with elderly patients, 60 years or older, of the Family Health Strategy (FHS) in the city of Viçosa-MG. Cardiovascular risk was calculated by the relation of triglyceride levels with HDL-cholesterol levels (TG/HDL-c)[12,13,14]. Metabolic syndrome affects significantly to the increase in morbidity and mortality cardiovascular[13,15,16].

The sample size calculation considerations included a 95% confidence level, a 65% prevalence of metabolic syndrome[17], and a 5% error tolerance. Thus, the sample size was 331, which was raised by 20% to cover possible losses, thus totaling 398 elderly to be studied. The final sample consisted of 402 elderly persons. After exclusion of the elderly who did not include the information in the database the final sample of 349 individuals.

Data collection was conducted in two meetings, at the FHS. In the first, an anthropometric assessment was performed and in the second, was held with the participant having fasted for 12 hours, for biochemical assessment, evaluating triglycerides and HDL-cholesterol.

The variable dependent was cardiovascular risk, calculated by the relation of triglyceride levels with HDL-cholesterol levels (TG/HDL-c), considering elderly persons with ratios over 3.5 to be at cardiovascular risk[14].

Waist circumference was measured at three points: at the midpoint between the iliac crest and the last rib, and at the minimal circumference point, with three repetitions at each point.

The weight was measured using a Kratos® brand digital electronic (modelo Linea - São Paulo-SP, Brasil). The height was determined using a Welmy® brand stadiometer portátil (Santa Barbara d'Oeste-SP, Brasil).

From height and weight, body mass index (BMI) was calculated as the ratio of weight in kilograms to height in meters squared (weight/height^2).

Waist-height ratio (WHtR) was determined by dividing waist circumference in centimeters by height in centimeters.

Conicity index was determined from the weight, height, and waist circumference measurements, using the mathematical equation proposed by Valdez[18].

$$\text{C index} = \frac{\text{Waist Circumference (m)}}{0.109 \times \sqrt{\dfrac{\text{Body Weight (kg)}}{\text{Height (m)}}}}$$

All variables were tested for normality using the Shapiro-Wilk test. The study used the Student's *t*-test to compare the means of the variables with a normal distribution between two independent groups, and the Mann-Whitney test for variables with nonparametric distribution. The significance level was 5%.

Anthropometric measurements were related to cardiovascular risk through Receiver Operating Characteristic (ROC) curves, frequently used to determine screening cutoff points. The total area under the ROC curve was determined using a confidence interval of

95%. Initially the cutoff point with a balance between sensitivity and specificity was obtained, and then the cutoff that presented a higher sensitivity, since the aim of the study was to identify anthropometric measures intended for screening for cardiovascular risk. The *Z*-test was used to verify differences between the areas under the curve[19].

The data were analyzed using the statistical software, Stata, version 9.1 (Stata Corp., College Station, United States).

The study fully met the standards for conducting research involving human subjects, Resolution 196/96 of the Brazilian National Health Council of 1996 and the Declaration of Helsinki. The research project was previously approved by the Ethics Committee on Human Research at the Federal University of Viçosa (No. 04/2013)[20,21].

Results

The sample included 402 elderly people, of which 349 granted the information necessary for evaluation of the proposed relationship. Cardiovascular risk, represented by the triglyceride/HDL-cholesterol ratio, showed a prevalence of 26.07%. In males, the prevalence was 32.41% and in females, the prevalence was 21.57%.

The distributions of the anthropometric variables by gender are shown in table I, with their medians and interquartile range (p25 and p75). The variables cardiovascular risk and all waist circumference taken at the midpoint between the last rib and the iliac crest, showed no differences between the sexes. While the variables BMI, waist-height ratio, the minimal waist circumference, the circumference measured at the umbilicus and conicity index did show such differences, with higher values for females.

The ROC curve analysis has been recommended in epidemiological studies, for determining cutoffs. ROC curves were constructed to assess the capacity of the different anthropometric measures in predicting the presence of cardiovascular risk. For this, the area under the curve (AUC) is an indicator of how well the anthropometric measurements can detect a positive result for the problem in question. The area under the curve ranges from 0 to 1, with 0.5 indicating no predictive power, and 1 indicating perfect predictive power. It is valid to point out that the larger the area of the curve, the more accurate and the greater diagnostic power that the test presents. The cutoff points also showed a balance between sensitivity and specificity[19].

Figure 1 identifies the areas under the ROC curve. It was observed that the minimum portion of the interval under the ROC curves is greater than 0.5 for all the anthropometric measurements in both sexes. This clearly shows that all the anthropometric measurements have the capacity to predict cardiovascular risk in males and females.

In males, it is observed that there were statistical differences between the areas under the ROC curve. Note that all the anthropometric variables displayed the power to predict cardiovascular risk, with the lowest confidence interval being greater than 0.50. The largest area was for the minimal waist circumference variable (0.75).

In females, as well, there were differences between the areas under the curves (p=0.01), and all the variables also appeared capable of predicting cardiovascular risk. The variables, minimal waist circumference and waist-height ratio, presented the largest areas under the curve (0.70).

In table II, cutoff points were suggested for the anthropometric indicators that proved valid for predicting cardiovascular risk, considering the best cutoff

Table I
Median, p25, and p75 for the variables, broken down by gender, in the elderly patients attended by the Family Health Strategy. Viçosa, Minas Gerais, Brazil, 2013. n=349

Variables	*Men (N = 108) Median (p25-p75)*	*Women (N = 113) Median (p25-p75)*	*P**
Age	71 (66-77)	72 (67-78)	0.14
TG/HDL	2.79 (1.54-4.45)	2.56 (1.73-3.52)	0.40
WC_1 (cm)	92.00 (84.0-100.0)	94.00 (86.16-102.00)	0.06
WC_2 (cm)	87.10 (80.5 -94.0)	82.90 (77.6- 91.00)	0.01
WC_3 (cm)	92.30 (84.2-99,30)	94.80 (87.00-102.8)	0.01
BMI (kg/m^2)	25.05(22.53-27.99)	27.51 (24.00-30.43)	<0.01
WHtR	0.56 (0.50-0.60)	0.62 (0.57-0.68)	<0.01
CI	1.31 (1.25-1.37)	1.35 (1.29-1.40)	<0.01

Legend: TG/HDL = ratio of triglycerides to HDL (cardiovascular risk); WC_1 = waist circumference at the midpoint between the last rib and the iliac crest; WC_2 = minimal waist circumference; WC_3 = umbilical waist circumference BMI = ody mass index; WHtR = waist-height ratio; CI = conicity index. *Mann-Whitney test.

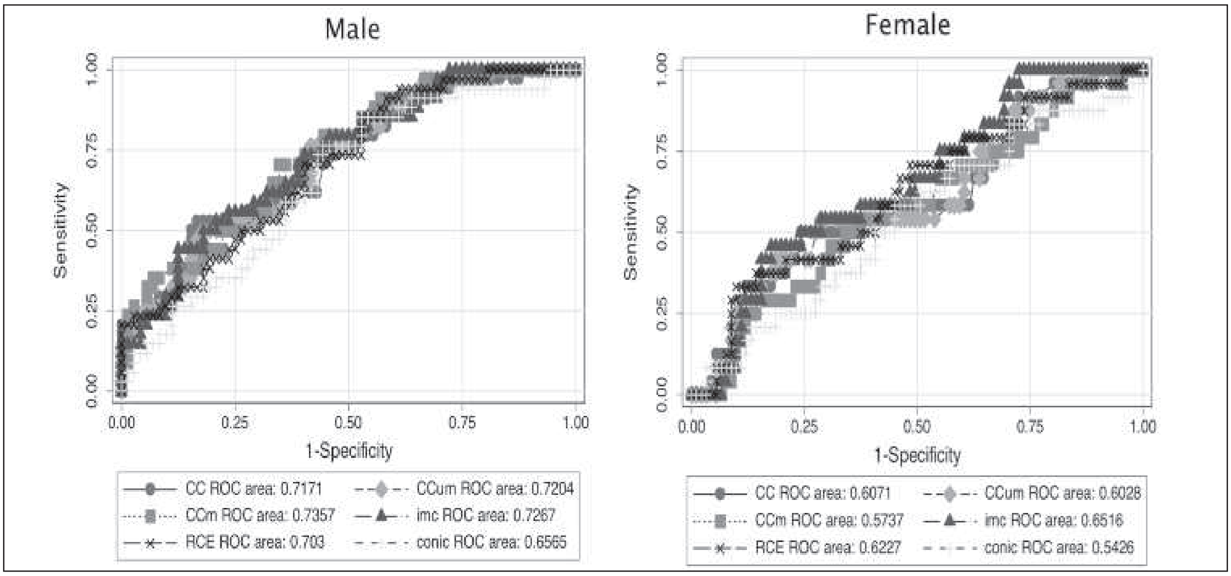

Fig. 1.—Areas under the ROC curves for the anthropometric variables in predicting cardiovascular risk, broken down by gender, in the elderly patients attended by the Family Health Strategy, Viçosa, Minas Gerais, Brazil, 2013. n = 349.
Legend: CC = waist circumference at the midpoint between the last rib and the iliac crest; CCm = minimal waist circumference; CCum = umbilical waist circumference; imc = body mass index; conic = conicity index

Table II
Cutoff points, sensitivity and specificity in balance, for the anthropometric indicator predictors of cardiovascular risk in elderly patients attended by the Family Health Strategy, Viçosa, Minas Gerais, Brazil, 2013. n = 349

Anthropometric variables	*Cutoff point*	*Sensitivity*	*Specificity*
WC_1 (cm)	>92.00	68.09%	61.22%
WC_2 (cm)	>88.00	70.21%	64.29%
WC_3 (cm)	>92.50	65.96%	60.20%
BMI (kg/m^2)	>24.73	72.34%	60.20%
WHtR	>0.57	68.09%	68.37%
CI	>1.31	65.96%	54.08%
WC_1 (cm)	>95.60	61.36	60.63
WC_2 (cm)	>84.00	72.73	60.00
WC_3 (cm)	>97.00	65.91	62.50
BMI (kg/m^2)	>27.80	61.36	59.38
WHtR	>0.63	70.45	60.00
CI	>1.35	61.36%	55.00%

Legend: WC_1 = waist circumference at the midpoint between the last rib and the iliac crest; WC_2 = minimal waist circumference; WC_3 = umbilical waist circumference; BMI = body mass index; WHtR = waist-height ratio; CI = conicity index.

point to be the one that showed better balance between sensitivity and specificity.

Table III shows the cutoff points with higher sensitivity for identifying individuals with cardiovascular risk, for treating anthropometric measures that are generally used for screening.

Discussion

No studies were found that used anthropometric indicators to predict cardiovascular risk exclusively in the elderly. It is clearly shown that the study reveals a simple, easily applied, low cost, and high validity proposal for predicting cardiovascular risk in the elderly, by seeking to elucidate the accuracy of anthropometric indicators regarding this risk.

For men, waist circumference at the midpoint between the last rib and the iliac crest showed the largest area (AUC=0.75), followed by BMI, umbilical waist circumference, and waist-height ratio (AUC=0.73), minimal waist circumference (AUC=0.72), and, finally, the conicity index (AUC=0.66). While for women, minimal waist circumference and waist-height ratio had the largest areas under the curve (AUC=0.70), followed by minimal waist circumference (AUC=0.68), umbilical waist circumference, and BMI (AUC=0.66), and subsequently by conicity index (AUC=0.65). Thus, waist circumference at the midpoint between the last rib and the iliac crest in males, and minimal waist circumference and waist-height ratio in females, had a higher predictive capacity to assess cardiovascular risk, when there is a balance between sensitivity and specificity. The cutoff point for waist circumference at the midpoint between the last rib and the iliac crest in males was 92 cm. In females, the cutoff point for minimal waist circumference was 84 cm, and 0.63 for waist-height ratio.

Table III
Cutoff points with higher sensitivity and specificity of anthropometric indicators predicting cardiovascular risk, in elderly patients attended by the Family Health Strategy, Viçosa, Minas Gerais, Brazil, 2013. n = 349

Anthropometric variables	*Cutoff point*	*Sensitivity*	*Specificity*
WC_1 (cm)	>89.10	80.85%	46.94%
WC_2 (cm)	>86.00	80.85%	59.18%
WC_3 (cm)	>89.00	80.85%	47.96%
BMI (kg/m²)	>24.06	80.85%	55.10%
WHtR	>0.54	80.85%	48.98%
CI	>1.30	80.85%	50.00%
WC_1 (cm)	>88.50	81.82	37.50
WC_2 (cm)	>79.50	81.82	38.75
WC_3 (cm)	>89.60	81.82	37.5
BMI (kg/m²)	>25.45	81.82	44.38
WHrR	>0.60	84.09	45.63
CI	>1.31	84.09%	36.87%

Legend: WC_1 = waist circumference at the midpoint between the last rib and the iliac crest; WC_2 = minimal waist circumference; WC_3 = umbilical waist circumference; BMI = body mass index; WHtR = waist-height ratio; CI = conicity index.

When evaluating the cutoff points with a higher sensitivity, since the purpose is to use anthropometric measurements for cardiovascular risk screening, we observed that the cutoff point for waist circumference at the midpoint between the last rib and the iliac crest, for males, was 89.1 cm, and for females, the cutoff point for minimal circumference was 79.5 cm and the cutoff point for waist-height ratio was 0.60.

Almeida in a study with 270 adult and elderly women, employees of a public university in Feira de Santana (BA), found conicity index to be an indicator, with a cutoff point of 1.25, sensitivity of 71.2%, and specificity 64.0%, presenting better discriminatory power for coronary risk, having also identified cutoffs for waist circumference at 86 cm (sensitivity = 69.5% and specificity = 63.5%), and for waist-height ratio at 0.55 (sensitivity = 67.8% and specificity = 65.9%), with values very close to those found by this study[25].

Also, Haun with 968 adults and elderly in the city of Salvador (BA), identified the anthropometric indicators: conicity index, waist-hip ratio, waist-height ratio, waist circumference, and BMI, for predicting coronary risk, broken down by gender. The coronary risk used in the study by Haun was the algorithm proposed in the Framingham cohort study by Wilson[10,26].

The cutoff points in the present study were very close to the cutoff points proposed by Haun when we compared the anthropometric indicators BMI, waist-height ratio, conicity index, and waist circumfe-

Table IV
Cutoff points, sensitivity and specificity in balance, for the anthropometric indicator predictors of cardiovascular risk in elderly patients attended by the Family Health Strategy, Viçosa, Minas Gerais, Brazil, 2013. n = 349

Anthropometric variables	*Cutoff point*	*Sensitivity*	*Specificity*
WC_1 (cm)	>92.00	68.09%	61.22%
WC_2 (cm)	>88.00	70.21%	64.29%
WC_3 (cm)	>92.50	65.96%	60.20%
BMI (kg/m²)	>24.73	72.34%	60.20%
WHtR	>0.57	68.09%	68.37%
CI	>1.31	65.96%	54.08%
WC_1 (cm)	>95.60	61.36	60.63
WC_2 (cm)	>84.00	72.73	60.00
WC_3 (cm)	>97.00	65.91	62.50
BMI (kg/m²)	>27.80	61.36	59.38
WHtR	>0.63	70.45	60.00
CI	>1.35	61.36%	55.00%

Legend: WC_1 = waist circumference at the midpoint between the last rib and the iliac crest; WC_2 = minimal waist circumference; WC_3 = umbilical waist circumference; BMI = body mass index; WHtR = waist-height ratio; CI = conicity index.

Table V
Cutoff points, sensitivity, and specificity of anthropometric indicators predicting cardiovascular risk, in elderly patients attended by the Family Health Strategy, Viçosa, Minas Gerais, Brazil, 2013. n = 349

Anthropometric variables	*Cutoff point*	*Sensitivity*	*Specificity*
WC_1 (cm)	>89.10	80.85%	46.94%
WC_2 (cm)	>86.00	80.85%	59.18%
WC_3 (cm)	>89.00	80.85%	47.96%
BMI (kg/m²)	>24.06	80.85%	55.10%
WHtR	>0.54	80.85%	48.98%
CI	>1.30	80.85%	50.00%
WC_1 (cm)	>88.50	81.82	37.50
WC_2 (cm)	>79.50	81.82	38.75
WC_3 (cm)	>89.60	81.82	37.5
BMI (kg/m²)	>25.45	81.82	44.38
WHrR	>0.60	84.09	45.63
CI	>1.31	84.09%	36.87%

Legend: WC_1 = waist circumference at the midpoint between the last rib and the iliac crest; WC_2 = minimal waist circumference; WC_3 = umbilical waist circumference; BMI = body mass index; WHtR = waist-height ratio; CI = conicity index.

rence in males. BMI corresponded to 24.06 and 24 kg/m^2, waist-height ratio to 0.54 and 0.52, and the conicity index to 1.30 and 1.25, waist circumference to 89.10 and 88.0, respectively, observing higher sensitivity in this study. The sensitivity and specificity in the study previously cited were, respectively, 67% and 53% for BMI, 68% and 64% for waist-height ratio, 74% and 75% for conicity index, and 65% and 67% for waist circumference. Conicity index was the anthropometric indicator that presented the greatest area under the curve in the study by Haun in contrast to the present study that showed waist circumference measured at the midpoint between the last rib and the iliac crest as a better indicator for predicting cardiovascular risk in males[10].

The study by Haun, in females, also identified conicity index, waist-height ratio, waist circumference, and BMI as measures with the power to predict cardiovascular risk, considering conicity index to be the indicator with greatest area under the curve. In this study, minimal waist circumference and waist-height ratio had greater area under the curve. The analyses from these studies showed, respectively, conicity index of 1.31 and 1.18, waist-height ratio of 0.60 and 0.53, midpoint waist circumference of 88.5 and 83 cm, and BMI of 25.45 and 26.0 kg/m2. The sensitivity and specificity were, respectively, 73% and 61% for conicity index, 67% and 58% for waist-height ratio, 64% and 62% for waist circumference, and 62% and 53% for BMI in the study by Haun[10].

There are three points where waist circumference can be measured. According to the National Cholesterol Education Program - NCEP (2001), it is recommended that waist circumference be measured at the midpoint between the last rib and the iliac crest, suggesting values greater than 88 cm for women and 102 cm for men for predicting the risk of atherosclerosis. With regard to males, higher sensitivity values, with a cutoff point of 89.10 cm or higher, are observed as predicting cardiovascular risk, being approximately 13 cm lower than the recommended value. In females, the value was 88.5 cm, very close to the one recommended. The measurement of minimal waist circumference is slightly different from the midpoint between the last rib and the iliac crest, suggesting a cutoff point of 86 cm or higher in males and 79.50 cm in females. Thus, it is important to review the cutoff proposed by the NCEP, especially for males, since the same recommended cutoff points are used for adults[27].

With regard to the International Diabetes Federation (2005), it is suggested that the measurement be performed at the umbilicus, with a cutoff point for males of 94 cm or greater, and 80 cm for females, to predict abdominal obesity. The cutoffs found in the study were 89 cm in males and 89.60 cm in females[28].

Body mass index (BMI) in this study identified a cutoff at 24.06 and 25.45 kg/m^2 or greater, respectively, for men and women, to predict cardiovascular risk. The WHO (1995) recommends a >25 kg/m^2 cutoff for overweight, and Lipchitz[29] recommends >27 kg/m^2. Interestingly, the cutoff points identified in the present study correspond to the approximate value proposed by the WHO[30].

Waist-height ratio has been appearing in studies as a predictive factor of chronic illness, but there are no recommended cutoff points for the elderly. A study conducted in Taiwan with 55,563 individuals found that waist-height ratio was a good predictor for cardiovascular risk factors, and even for the relationship between total cholesterol and HDL-cholesterol. In that study, the cutoff identified for predicting a cardiovascular risk factor varies between 0.48 and 0.50, close to the data found in this work, which is 0.54 for men and 0.60 for women[31-32].

Conicity index is an interesting indicator for providing information on the profile of body fat distribution. There are no recommended cutoff points for the elderly population. A study done by Pitanga and Lessa, with adults and elderly, found that the cutoff point for predicting coronary risk corresponds to 1.25 in males and 1.18 in females. In the present study, the value corresponds to 1.30 in males and 1.31 in females, the value proposed approximating the value for males in this study[33].

Conclusion

The results seen here suggest that all these anthropometric indexes can be used to predict cardiovascular risk in males and females. The cutoff points with higher sensitivity ought to be considered, since the anthropometric measurements are used for cardiovascular risk screening purposes. The study found that, for males, the cutoff point for waist circumference between the lowest rib and the iliac crest was 89.1 cm, and that, for females, the cutoff point for minimal waist circumference was 79.5 cm and 0.60 for waist-height ratio.

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