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Anthropometric indicators of adiposity as predictors of systemic arterial hypertension in older people: a cross-sectional analysis

Indicadores antropométricos de adiposidade como preditores de hipertensão arterial sistêmica em pessoas idosas: uma análise transversal

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ABSTRACT

Objective

To analyze the association of anthropometric indicators of adiposity in older people, according to sex, with hypertension; to compare the scores of these variables between participants with and without hypertension; and to identify among them those with better predictive ability for screening the outcome.

Methods

Epidemiological, population-based, cross-sectional study conducted with 210 older people. The anthropometric indicators analyzed were: body mass index, waist circumference, abdominal circumference, body adiposity index, triceps skinfold, waist-to-hip ratio, waist-to-height ratio, and conicity index. Hypertension diagnosis was self-reported.

Results

The indicators of adiposity increased the probability of hypertension. Additionally, hypertensive older people of both sexes showed higher scores on adiposity indicators than non-hypertensive subjects ($p < 0.05$). For men, the most sensitive indicator for the outcome was conicity index (81.82%; cut-off point: 1.30) and the most specific was body mass index (69.77%; cut-off point: 25.05 kg/m^2). For women, the most sensitive indicator for the outcome was the body adiposity index (86.08%; cut-off point: 31.03%), and the most specific was the abdominal circumference (82.82%; cut-off point: 98.70 cm).

Conclusion

In both sexes, the indicators of adiposity were positively associated with hypertension; hypertensive participants showed higher values in the scores of the indicators. Additionally, the body adiposity index (women) and conicity index (men) demonstrated greater ability to screen for hypertension, while the abdominal circumference and body mass index demonstrated greater ability to screen for non-hypertensive women and men, respectively.

Keywords: Adipose tissue. Aging. Blood pressure. Epidemiology.

RESUMO

Objetivo

Analisar a associação de indicadores antropométricos de adiposidade com a hipertensão, em pessoas idosas, de acordo com o sexo; comparar os escores dessas variáveis entre os participantes com e sem hipertensão; e identificar os indicadores com melhor capacidade preditiva à triagem do desfecho.

Métodos

Estudo epidemiológico, populacional, transversal, realizado com 210 pessoas idosas. Os indicadores antropométricos analisados foram: índice de massa corporal, circunferência da cintura, circunferência abdominal, índice de adiposidade corporal, dobra cutânea tricipital, relação cintura/quadril, relação cintura/altura e índice de conicidade. O diagnóstico de hipertensão arterial foi autorreferido.

Resultados

Observou-se que os indicadores de adiposidade aumentaram a probabilidade à hipertensão. Além disso, as pessoas idosas hipertensas, de ambos os sexos, apresentaram maiores escores nos indicadores de adiposidade quando comparadas às não hipertensas ($p < 0,05$). Para os homens, o indicador mais sensível ao desfecho foi o índice de conicidade (81,82%; ponto de corte: 1,30) e o mais específico foi o índice de massa corporal (69,77%; ponto de corte: 25,05 kg/m^2). Nas mulheres, o indicador mais sensível ao desfecho foi o índice de adiposidade corporal (86,08%; ponto de corte: 31,03%) e o mais específico foi a circunferência abdominal (82,82%; ponto de corte: 98,70 cm).

Conclusão

Em ambos os sexos, os indicadores de adiposidade mostraram-se positivamente associados à hipertensão; os participantes hipertensos apresentaram valores mais elevados nos escores dos indicadores. Ademais, identificou-se para os sexos, feminino e masculino, que os indicadores com melhor capacidade de rastrear a hipertensão, foram, respectivamente, o índice de adiposidade corporal e índice de conicidade. Enquanto a circunferência abdominal e o índice de massa corporal mostraram maior capacidade de rastrear, respectivamente, as mulheres e os homens não hipertensos.

Palavras-chave: *Tecido adiposo. Envelhecimento. Pressão sanguínea. Epidemiologia.*

INTRODUCTION

Systemic Arterial Hypertension (SAH) is a chronic condition characterized by high and sustained blood pressure levels, one of the main risk factors for developing cardiovascular diseases, with a significant impact on the morbidity and mortality profile in different populations [1]. According to Lim et al. [2] in their epidemiological study, the global prevalence of SAH is forecast to increase from 26.40% in 2000 to 29.20% by 2025. Accordingly, low- and middle-income countries have a higher frequency of this outcome than high-income countries [3].

In Brazil, it is estimated that 26.30% of the population aged 18 years or older have SAH. Another alarming factor regarding the epidemiological panorama of SAH in the Brazilian population is that the prevalence of this morbidity tends to increase gradually with advancing age, assuming higher values in age groups between 55 and 64 years (49.40%) and 65 years or older (61.00%) [4].

These findings point to a serious public health problem, given that SAH is associated with lesions in vital organs, including the heart, kidneys, and brain, increasing the risk of heart failure, acute myocardial infarctions, chronic kidney disease, and stroke, particularly in older individuals [5].

In this context, health professionals who work in *Atenção Primária à Saúde* (APS, Primary Healthcare Assistance) services of the Brazilian *Sistema Único de Saúde* (SUS, Public Health System) have an important role in relation to the management of SAH, acting both in the prevention and diagnosis of the disease, as well as in its monitoring and control. The assistance provided by these professionals should focus on the patient and consider the context in which they are inserted. Thus, family members and caregivers must be involved in the care process, at an individual and collective level, for the implementation of SAH control strategies [6].

Given this, ambulatory or residential blood pressure monitoring has been demonstrated to be the most effective method of confirming a clinical diagnosis of SAH, complementing the evaluation conducted only by the doctor. With the use of automatic digital devices that employ the oscillometric technique, this hemodynamic parameter can be monitored and recorded throughout the vigil and during sleep [7]. Although sophisticated, these tests are expensive and highly complex, which makes their application in large population contingents unfeasible.

Because of this, epidemiological studies have investigated and shown the relationship between high adiposity and blood pressure levels [8-10]. In this context, only two studies were found in the literature on the predictive ability of anthropometry for screening older people more prone to hypertension [11,12].

In the studies, however, it is observed that the differences between anthropometric indicators of adiposity for participants with and without hypertension were not verified, indicating an important gap, since, in older people, body fat distribution and amount tend to differ for men and women, which is amplified by SAH. Additionally, despite the literature listing a variety of indicators, only the Body Mass Index (BMI), Waist Circumference (WC) [13], Waist-To-Height Ratio (WHtR) [14], and the Conicity Index (CIn) [15] were found to be accurate in relation to SAH by Diniz et al. [11] and Leal Neto et al. [12].

Accordingly, Abdominal Circumference (AC) [16], an important indicator of abdominal adiposity, and Triceps Skinfold (TSF) [17], a variable related to peripheral adiposity, are not included. Finally, Diniz et al. [11] did not examine the association between the indicators of adiposity and the outcome; they also did not consider important variables, including the Waist-To-Hip Ratio (WHR) (an indicator of abdominal adiposity) [13] and the body adiposity index [18] (an indicator of general adiposity).

This leads to the need for population health surveys that verify the potential of the anthropometric method to discriminate hypertension, and which are the best indicators for each sex, considering mainly the variables that have not yet been analyzed, because these results can support health surveillance actions in primary care, increasing the number of epidemiological tools that can be used at low cost, easily to apply and interpret to optimize the screening of the older people who are more likely to have SAH.

Considering the above, this study proposes to analyze the association of anthropometric indicators in older people, according to sex, with hypertension; to compare the scores of these variables between participants with and without hypertension; and identify among them those with better predictive ability for screening the outcome.

METHODS

This is an epidemiological, cross-sectional study, part of a population-based survey entitled *"Condições de saúde e estilo de vida de idosos residentes em município de pequeno porte"* [19] conducted out from February to April 2013 with older people registered with the *Estratégia Saúde da Família* (ESF) and living in the urban area of the municipality of Aiquara, in the state of Bahia (BA), Brazil.

For participation in the present study, the following inclusion criteria were adopted: age ≥ 60 years; not being institutionalized; having a fixed residence in the urban area and sleeping four days or more at home. Those excluded fit the following criteria: cognitive impairment, verified by the Mini Mental State Examination (< 13 points) [20]; neurological disease or hearing problems that compromised the understanding of the questions; or a bedridden condition.

At first, a census was conducted to identify all older adults living in Aiquara (BA), with assistance from community health agents working in the ESF unit, which covers 100.00% of the population of the municipality. There were 263 older individuals of both sexes living in the urban area [21]. Of these, nine refused to participate, 15 had previous neurological diseases or cognitive deficits, 4 were bedridden, 3 had hearing problems, and 22 did not perform anthropometric measurements. Thus, the evaluated population was composed of 210 older people.

As part of the effort to minimize potential biases in the information-gathering process, theoretical and practical workshops were conducted with the team responsible for the collection before the field visit to standardize the use of the instrument and the protocol adopted for anthropometric measurements. After training, a pilot study was conducted from December 2012 to January 2013 in a city neighboring Aiquara (BA) to determine the duration of the interview, possible doubts that may arise during completion, and the suitability of the interview instrument.

The first stage of data collection consisted of a face-to-face interview conducted in the homes of the older adults by two master's degree students, one linked to the Graduate Program in Nursing and Health of *Universidade Estadual do Sudoeste da Bahia* (UESB) and the other to the Graduate Program in Biotechnology, Health, and Investigative Medicine, a professional with a Bachelor's degree in Biology, and three undergraduate students from UESB's Department of Health, who held scholarships of the Scientific Initiation Program. During this step, sociodemographic information, lifestyle information, and health information were collected. Following this moment, two undergraduate students and a Physical Education professional performed the anthropometric measurements, which comprised the second phase of the study.

The outcome analyzed was ascertained through self-reported prior diagnosis by the participants based on the following question: *"has a doctor ever told you that you have hypertension, i.e., that you have high blood pressure?"* Thus, according to the answer, this variable was categorized in a dichotomous way (hypertension: yes or no). Body mass was measured by a Plenna® portable digital scale with a maximum capacity of 180 kg. The participants remained standing, barefoot, with arms relaxed along the body, looking ahead, and wearing light clothing. The height (Ht) was measured with a portable stadiometer (WiSO®), where the evaluated were barefoot, in an upright position, with feet together, heels, buttocks, and shoulder girdle in contact with the wall, and eyes fixed on a horizontal axis parallel to the ground (Frankfurt Line) during inspiratory apnea [22]. Then, the Body Mass Index (BM/Ht^2) was calculated [13].

Body circumferences were measured using a flexible inelastic anthropometric tape (2 m), with 1 mm precision (Sanny®). The abdominal circumference was measured at the point of greatest protrusion between the last rib and the iliac crest [16] while the waist circumference was measured at the smaller perimeter between the two anatomical points mentioned previously, and hip circumference (HC) was measured at the region of the largest gluteal protuberance. The WHR was calculated by the following equation: WHR = WC/HC [13]. The TSF was measured using a Lange adipometer, Santa Cruz, California®, with 1mm precision, duly calibrated. This measurement was performed on the posterior side of the right arm, considering as a reference a midpoint between the lateral border of the acromion and the olecranon of the ulna [17].

To calculate the other anthropometric indicators analyzed, the following equations were used: conicity index [Cin = waist circumference (m)/0.109√ (body mass/height (m))] [15]; body index [BAI = (hip circumference (cm)/height (m)√ height (m)) - 18] [18]; waist-to-height ratio [WHtR = waist circumference (cm)/height (cm)] [14]. All anthropometric measurements were alternated in triplicate, and for the analyses, the mean values were considered.

In order to make the adjustments in the multivariate analyses, the following variables were listed: age (in years); marital status (with a partner or without a partner); schooling (with schooling or no schooling; never went to school and/or couldn't write one's name); skin color (white or non-white); income (≤1 minimum wage or >1 minimum wage; minimum wage in 2013: R$ 678,00); self-reported diagnosis of diabetes *Mellitus* (yes or no); self-perception of health (excellent/very good/good, fair or bad); use of alcohol and/or tobacco (yes or not); and level of physical activity verified using the International Physical Activity Questionnaire [23-25]. Participants who reported spending 150 minutes per week engaged in moderate to vigorous physical activity were considered insufficiently active [26].

The fifth International Physical Activity Questionnaire domain, which measures the time spent sitting or leaning on a regular weekday and a weekend day, was also considered to determine sedentary behavior (SB). The weighted mean of SB was calculated as follows: (5 x minutes/weekday + (2 x minutes/weekend day)/7) and the cut-off point adopted for high SB was based on the 75th percentile of the weighted mean, with a value of 342,85 minutes/day (5,71 hours/day) [27].

The descriptive analysis of the population's characteristics was conducted by calculating relative and absolute frequencies, means, medians, standard deviations and interquartile ranges, in addition to the response percentage for each analyzed variable (missing).

Based on the normality distribution of the data as observed by the Kolmogorov Smirnov test, the Student's *t*-test for independent samples or Mann-Whitney U-test were used to compare the body mass, height, and anthropometric indicators of adiposity among the groups with and without SAH. The association of the outcome with the sex of the participants was checked using Pearson's chi-square test.

The investigation of the association between the independent variables and the outcome was conducted by Poisson regression, with robust estimates, calculations of the Prevalence Ratios, and their respective Confidence Intervals (CIs) of 95.00%. For these analyses, the modeling was performed using the backward step method, where all adjustment variables, used to control possible confounding or effect modifications, were entered into the model and subsequently removed one at a time up to a critical level of 20,00% ($p \leq 20,00$).

Based on the parameters provided by the Receiver Operating Characteristic (ROC) curve, the screening power of the anthropometric indicators for SAH was verified, and the best cut-off points for discriminating the determined outcome. Thus, initially, the accuracy values of each indicator were analyzed by comparing the areas under the ROC curve [28]. Subsequently, the best cut-off points and their respective sensitivity and specificity values were identified by the Youden Index (sensitivity + specificity) - 1. In addition, positive predictive values and negative predictive values were calculated [29].

All analyses were conducted at a significance level of 5.00%. The following software was used to analyze the data: IBM®SPSS® (21.0, 2013, Inc, Chicago, IL) and MedCalc® (version 19.4.1, 2019).

This study was carried out in accordance with Resolution nº. 466/2012 of the *Conselho Nacional de Saúde do Brasil* and approved by the Research Ethics Committee of the UESB, under opinion nº. 171.464/2012 and CAAE: 10786212.30000.0055. All participants were informed about the objectives, procedures and voluntary character. Thus, after explanations about the study, they signed an informed consent form.

RESULTS

A total of 210 older people (58.60% of whom were women) with a mean age of 71.61 ± 7.34 years participated in the study. The mean ages of men and women were 72.26±8.10 and 71.07 ± 6.73 years, respectively. The self-reported prevalence of hypertension was 58.0% (men: 50.60%; women: 64.20%; $p = 0.048$).

According to the results, 61.20% of the participants had no formal education; 86.30% reported incomes equivalent to or below one minimum wage; 51.90% were not sufficiently active, and 17.60% were diagnosed with diabetes *Mellitus*. Other characteristics of the population can be seen in Table 1.

Table 1 – Descriptive analysis of the characteristics of the participants in the study. Aiquara (BA), Brazil, 2013.

Variables	% response	n	%
Sex	100.00		
Male		87	41.40
Female		123	58.60
Age Group	100.00		
60-79 years		87	41.40
70-79 years		88	41.90
≥80 years		35	16.70
Skin color/ Race	96.66		
White		31	15.30
Not White		172	84.70
Marital status	100.00		
With partner		115	54.80
Without partner		95	45.20
Education	98.09		
With schooling		80	38.80
Without schooling		126	61.20
Income*	93.80		
≤1 minimum wage		170	86.30
>1 minimum wage		27	13.70
Smoking	100.00		
No		190	90.50
Yes		20	9.50
Alcohol consumption	100.00		
No		164	78.10
Yes		46	21.90
Level of physical activity	100.00		
Sufficient		101	48.10
Insufficient		109	51.90
High sedentary behavior	100.00		
No		152	72,38
Yes		58	27,62
Diabetes *Mellitus*	100.00		
No		173	82.40
Yes		37	17.60

Note: *Dichotomized by the median (1 minimum wage in 2013 = R$ 678.00). n: number of participants.

The older adults with hypertension had, on average, a higher body mass (64.66 ± 13.53 kg) compared to those without hypertension (58.37 ± 13.33) ($p < 0.001$). However, their median heights in meters were statistically similar between groups (hypertensive: 1.54 (IQR: 0.13) m; non-hypertensive: 1.57 (IQR: 0.13) m).

Table 2 shows the comparisons between anthropometric indicators of adiposity of participants of both sexes, with and without hypertension. In hypertensive males, all the indicators of adiposity showed higher values in relation to non-hypertensive subjects ($p < 0.05$). Female hypertensive older adults presented higher BMI, WC, AC, BAI, WHtR, and CIn compared to non-hypertensives ($p < 0.05$).

Table 2 – Comparative analysis of anthropometric indicators of adiposity among older adults with and without Systemic Arterial Hypertension according to sex. Aiquara (BA), Brazil, 2013.

Variables	Men								*p*-value
	Non-Hypertensive (n = 43)				Hypertensive (n = 44)				
	M	SD	Mdn	IQR	M	SD	Mdn	IQR	
Body mass index (kg/m²)	23.52	3.68			25.74	3.01			0.003*
Waist circumference (cm)	87.35	10.37			95.74	8.72			<0.001*
Abdominal circumference (cm)			89.80	17.80			96.35	10.50	0.001**
Body adiposity index (%)	26.50	3.57			28.01	3.25			0.009*
Triceps skin fold (mm)	14.88	4.82			18.14	4.87			0.002*
Waist-to-hip ratio	0.95	0.06			0.98	0.05			0.001*
Waist-to-height ratio	0.53	0.06			0.58	0.05			<0.001*
Conicity index			1.29	0.08			1.36	0.09	<0.001**
Variables	**Women**								***p*-value**
	Non-Hypertensive (n = 44)				Hypertensive (n = 79)				
	M	SD	Mdn	IQR	M	SD	Mdn	IQR	
Body mass index (kg/m²)	23.97	4.68			27.79	5.42			<0.001*
Waist circumference (cm)	86.51	14.43			95.89	13.44			<0.001*
Abdominal circumference (cm)			91.33	13.10			100.00	12.71	<0.001**
Body adiposity index (%)	31.82	9.50			37.18	6.60			<0.001*
Triceps skin fold (mm)	26.61	8.90			26.27	8.73			0.834*
Waist-to-hip ratio			0.92	0.10			0.95	0.10	0.151**
Waist-to-height ratio	0.57	0.10			0.63	0.09			0.001*
Conicity index			1.33	0.14			1.38	0.13	0.013**

Note: *p-value obtained using student's t-test, **p-value obtained using the Mann-Whitney u-test. n: Number of participants; M: Mean; SD: Standard Deviation; Mdn: Median; IQR: interquartile range.

Table 3 shows the association of independent variables with SAH in the older men and women, respectively, who live in the urban area of Aiquara (BA). It was found, among men, that an increase of one unit for BMI, WC, AC, BAI, and TSF, and one-tenth (0.1) for WHR, WHtR, and CIn, referred to a higher probability for the outcome analyzed. A similar result was found among women except for TSF and WHR.

Table 3 – Association between anthropometric indicators of adiposity and Systemic Arterial Hypertension in older men and women. Aiquara (BA), Brazil, 2013.

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Variables	Men		*p*-value
	Adjusted PR	95% CI	
Body mass index (kg/m²)[a]	1.09	1.03-1.15	0.003
Waist circumference (cm)[a]	1.04	1.02-1.06	<0.001
Abdominal circumference (cm)[b]	1.04	1.02-1.07	<0.001
Body adiposity index (%)[c]	1.08	1.02-1.14	0.010
Triceps skin fold (mm)[c]	1.05	1.02-1.09	0.002
Waist-to-hip ratio[a]	1.05	1.02-1.08	0.002

Table 3 – Association between anthropometric indicators of adiposity and Systemic Arterial Hypertension in older men and women. Aiquara (BA), Brazil, 2013.

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Variables	Men		*p*-value
	Adjusted PR	95% CI	
Waist-to-height ratio[c]	1.06	1.02-1.09	0.001
Conicity index[c]	1.02	1.01-1.03	<0.001
Variables	**Women**		***p*-value**
	Adjusted PR	95% CI	
Body mass index (kg/m^{2})[d]	1.05	1.02-1.07	<0.001
Waist circumference (cm)[e]	1.02	1.01-1.03	0.002
Abdominal circumference (cm)[e]	1.02	1.01-1.03	0.001
Body adiposity index (%)[f]	1.03	1.01-1.05	<0.001
Triceps skin fold (mm)[g]	1.01	0.97-1.04	0.402
Waist-to-hip ratio[h]	1.01	0.98-1.02	0.502
Waist-to-height ratio[i]	1.02	1.01-1.03	0.003
Conicity index[i]	1.02	1.01-1.03	0.002

Note: [a]adjusted for diabetes *Mellitus* and skin color/race; [b]adjusted for diabetes *Mellitus* and income; [c]adjusted for diabetes *Mellitus*; [d]adjusted for age and diabetes *Mellitus*; [e]adjusted for diabetes *Mellitus* and alcohol consumption; [f]adjusted for diabetes *Mellitus*, alcohol consumption, skin color/race, and age; [g]adjusted for diabetes *Mellitus*, alcohol consumption, and physical activity level; [h]adjusted for diabetes *Mellitus* and physical activity level; [i]adjusted for physical activity level, skin color/race, marital status, and alcohol consumption.

Figure 1 shows the areas under the ROC curve of the anthropometric indicators of adiposity used as discriminators of Systemic Arterial Hypertension in older adults of both sexes. The analyzed variables presented the lower limit of the confidence interval of the area under the ROC curve > 0.50. For males, the area under the ROC curve presented by CIn was significantly higher than the area under the ROC curve observed for WHtR ($p = 0.041$) and WHR ($p = 0.013$). In contrast, there was no significant difference between the accuracy of anthropometric indicators of adiposity for females ($p > 0.05$).

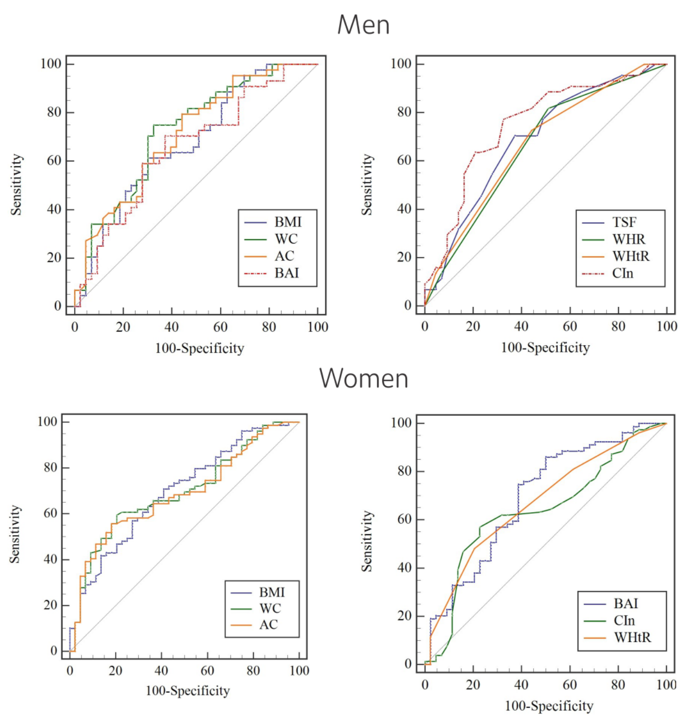

Figure 1 – Receiver Operating Characteristic curves of anthropometric indicators of adiposity used as predictors of Systemic Arterial Hypertension in older men and women. Aiquara (BA), Brazil, 2013.

Note: AC: Abdominal Circumference; BAI: Body Adiposity Index; BMI: Body Mass Index; CIn: Conicity Index; TSF: Triceps Skin Fold; WC: Waist Circumference; WHR: Waist-To-Hip Ratio; WHtR: Waist-To-Height Ratio.

Among men, the indicators that showed greater sensitivity were CIn (81.82%) and WHR (81.82%), with, respectively, the best cut-off points for predicting the outcome being the following values: 1.30 and 0.90 cm. On the other hand, BMI was the most specific indicator (69.77%), followed by WC (67.44%). For these indicators, the best cut-off points for screening men without hypertension were 25.05 kg/m^2 and 91.90 cm, respectively (Table 3).

For females, the adiposity and body mass indices were the most sensitive indicators of adiposity (BAI: 86.08%; BMI: 70.89%). Therefore, the values of 31.03% for BAI and 24.89 kg/m^2 for BMI were the best cut-off points for screening hypertensive women. Regarding specificity, AC (81.82%), followed by WC (79.55%) and WHtR (79.55%), were the anthropometric variables that showed the highest ability to discriminate the women without the outcome. Thus, the best cut-off points identified for these indicators of adiposity were as follows: AC: 98.70 cm; WC: 94.60 cm; WHtR: 0.60 (Table 4).

Table 4 – Receiver Operating Characteristic curve parameters of anthropometric indicators of adiposity used as predictors of Systemic Arterial Hypertension in older men and women. Aiquara (BA), Brazil, 2013.

Variables	Men					
	Cut-off point	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	AUC (95% CI)
BMI (kg/m^2)	25.05	61.36 (45.50-75.60)	69.77 (53.90-82.80)	65.50 (55.50-77.50)	63.80 (53.70-72.90)	0.68 (0.57-0.77)
WC (cm)	91.90	75.00 (59.70-86.80)	67.44 (51.50-80.90)	70.02 (59.70-78.90)	72.50 (60.30-82.10)	0.72 (0.62-0.81)
AC (cm)	90.30	79.55 (64.70-90.20)	55.81 (39.90-70.90)	64.80 (56.00-72.70)	72.70 (58.40-83.50)	0.71 (0.60-0.80)
BAI (%)	26.56	70.45 (54.80-83.20)	62.79 (46.70-77.00)	66.0 (55.70-74,90)	67.50 (55.50-77.60)	0.66 (0.55-0.75)
TSF (mm)	16.00	70.45 (54.80-83.20)	62.79 (46.70-77.00)	66.00 (55.70-74.90)	67.50 (55.50-77.60)	0.69 (0.58-0.78)
WHR	0.90	81.82 (67.30-91.80)	48.84 (33.30-64.50)	62.10 (54.20-69.30)	72.40 (56.70-84.10)	0.66 (0.55-0.74)
WHtR	0.50	72.73 (57.20-85.00)	55.81 (39.90-70.90)	62.70 (53.50-71.20)	66.70 (53.50-77.60)	0.67 (0.56-0.74)
CIn	1.30	81.82 (67.30-91.80)	55.81 (39.90-70.90)	70.80 (60.50-79.40)	74.40 (61.80-83.90)	0.75 (0.65-0.84)
Variables	Women					
	Cut-off point	Sensitivity (95%CI)	Specificity (95%CI)	PPV (95%CI)	NPV (95%CI)	AUC (95%CI)
BMI (kg/m^2)	24.89	70.89 (59.60-80.60)	59.09 (43.20-73.70)	75.70 (68.00-82.00)	53.10 (42.50-63.30)	0.68 (0.61-0.77)
WC (cm)	94.60	59.49 (47.90-70,40)	79.55 (64.70-90.20)	83.90 (73.90.90.60)	52.20 (44.60-59.80)	0.69 (0.61-0.77)
AC (cm)	98.70	55.70 (44.10-66.90)	81.82 (67.30-91.80)	(84.60) (74.00-91.40)	50.70 (43.60-57.70)	0.68 (0.60-0.77)
BAI (%)	31.03	86.08 (76.50-92.80)	50.00 (34.60-65.40)	75.30 (68.40-81.20)	57.10 (45.00-68.50)	0.69 (0.60-0.77)
WHtR	0.60	48.10 (45,30-68,10)	79.55 (62.20-88.50)	80.90 (69.30-88.80)	46.10 (39.70-52.50)	0.67 (0.58-0.75)
CIn	1.37	56.96 (45.30-68.10)	77.27 (62.20-88,50)	81.80 (71.6.88.90)	50.00 (42.60-57.40)	0.64 (0.55-0.72)

Note: AC: Abdominal Circumference; AUC: Area Under the Roc Curve; BAI: Body Adiposity Index; BMI: Body Mass Index; CI: Confidence Interval; CIn: Conicity Index; NPP: Negative Predictive Value; PPV: Positive Predictive Value; TSF: Triceps Skin Fold; WC: Waist Circumference; WHR: Waist-To-Hip Ratio; WHtR: Waist-To-Height Ratio.

DISCUSSION

In this study, anthropometric indicators of adiposity increased the probability of SAH; hypertensive participants had higher scores for these variables than non-hypertensive participants.

Moreover, it was found that CIn was the most sensitive indicator for SAH in men, while BMI was the most specific indicator. In women, the most sensitive indicator was BAI, while the most specific was AC. Such findings demonstrate the potential of anthropometric indicators as possible epidemiological tools, which can help health professionals screen patients who need more sophisticated tests to confirm the diagnosis of SAH.

Similarly, Leal Neto et al. [12] observed in a population-based study conducted with 316 older people from Lafaiete Coutinho (BA), Brazil, that the BAI was associated with SAH in older women (PR: 1.010; 95% CI: 1.002-1.018). According to the authors, this indicator proved to be a possible predictor of the outcome (AUC: 0.68; 95%CI: 0.60-0.75) in this sex, with high sensitivity (75.90%) from a cut-off point of 31.80%. Another study conducted with 310 older adults enrolled in the *Estratégia Saúde da Família of Ibicuí-BA*, Brazil, found that CIn was a predictor of SAH in older men, with an AUC of 0.58 (95%CI: 0.58-0.68), a sensitivity of 57.40%, and a cut-off point of 1.29 [11].

Despite the studies conducted in Lafaiete Coutinho (BA) [12] and Ibicuí (BA) both in Brazil [11], that have shown cut-off points similar to those observed in Aiquara (BA), Brazil, for the BAI in older women and the CIn in the older men, there are some disparities in the sensitivity and the AUC of these anthropometric indicators, which proved to be higher in the present study compared to the findings of other studies. Among the possible explanations for these differences, it is possible to highlight the methodological aspects adopted, considering that Leal Neto et al. [12] and Diniz et al. [11] defined SAH from the identification of high blood pressure (systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg). In the health survey conducted in Aiquara (BA), Brazil, the dependent variable was the previous diagnosis of the outcome, self-reported by the older adults.

This study was unable to compare its results with those of other studies because only Diniz et al. [11] and Leal Neto et al. [12] used a method capable of verifying the accuracy of adiposity indicators for the screening of arterial hypertension as part of their studies, which were carried out with a similar objective to ours. Besides the methodological differences highlighted, the differences in the characteristics of the participants in each study, in terms of their living and health conditions, may also have contributed to the variance in the results.

Though sensitivity is an important measure of epidemiology, especially in disease screening, in large population groups, to identify those with the morbidity under investigation, there may be falsely positive cases. That is, people who present a positive diagnosis might not really be sick, which can have psychological implications for the patient, who will also have to undergo more sophisticated and expensive tests (some invasive) to confirm the diagnosis. Thus, in addition to tests that show high sensitivity, more specific tests can be used to complement screening since they will rarely result in a positive result in the absence of the disease [29,30]. Therefore, the results of this study point to the possibility of using an anthropometric indicator that showed higher specificity (women: AC = 81.82%; men: BMI = 69.77%), along with the more sensitive ones (women: BAI = 86.08%; men: Cin = 81.82%), according to sex, for more effective screening for SAH in the older people.

Although we are aware of other useful tools for screening SAH, such as auscultatory and oscillometric sphygmomanometers commonly used in clinical practice, we believe that anthropometric indicators of adiposity are an important measure to help screen older hypertensive people, complementing the clinical evaluation of these patients. We believe that using these indicators to screen for SAH can minimize the adverse effects of neurohumoral, environmental, and behavioral components that may influence the results obtained from casual blood pressure measurements or spot checks in the office [6,7].

It should also be noted that the anthropometric evaluation of the patient can be performed by all trained health professionals who have the expertise to collect the necessary measurements for this purpose and perform simple mathematical procedures to obtain the results of anthropometric indicators. Considering the indicators that are more sensitive to SAH, for the CIn (older men) calculation, the values of height and waist circumference are required, while for the BAI (older women) calculation, only two pieces of information are required: height and hip circumference. Among the more specific indicators, the BMI (older men) is determined by examining the distribution of body mass in relation to height, and the AC (older women) is determined by measuring the circumference of the central region of the trunk. Thus, the results of this study may contribute to better health care for older adults without requiring expensive expenditures from the health care system, allowing for the evaluation of a greater number of patients, as well as early intervention before the diagnosis of the investigated disease.

Discrepancies in the values of anthropometric indicators of adiposity among older adults with and without hypertension were observed in this study. The strong relationship between high adiposity and high blood pressure will likely explain the predictive ability of these variables to identify older adults with this morbidity [31-33]. Although they are multiple, interdependent, and not fully elucidated, some pathophysiological mechanisms of obesity on SAH have been pointed out in the literature because the adipose tissue is evidenced as an important organ [32]. Thus, the excessive accumulation of fat in adipocytes generates a greater production and circulation of pro-inflammatory cytokines that lead to endothelial dysfunction, mainly by increasing oxidative stress and lower availability of nitric oxide, which is an important hypotensive [31].

The inflammatory process resulting from obesity can also trigger insulin resistance, as well as greater leptin release, increasing the activity of the sympathetic nervous system and the renin-angiotensin-aldosterone system, which, in turn, alter the renal hemodynamic function and increase renal sodium reabsorption and extracellular volume expansion, resulting in increased cardiac output and greater arterial stiffness. These factors, together, increase the blood pressure in the arteries and lead to the development of SAH [31,33,34].

Another relevant finding in Aiquara (BA), Brazil, was the high prevalence of SAH, which was higher among women than men. This finding may be explained by some specific changes that occur during female aging, particularly after menopause. Among other factors, there is a decrease in estrogen production, a hormone that modulates a woman's metabolism. In this way, its deficit results in a higher calorie intake and a decrease in basal metabolic rate, resulting in the accumulation of fat in the adipose tissue and an increased probability of cardiovascular disease [35,36].

In addition, a finding that deserves attention among the results of the present study is the profile of the evaluated population, especially regarding their socioeconomic characteristics since most of the interviewees were non-white and had low levels of education and income. This profile, identified among older adults enrolled in the ESF and assisted in the context of the primary healthcare assistance in a poorly developed municipality in northeastern Brazil, reinforces the importance of debating the inequalities in access and use of health services and indicates the need to monitor this population's health [37].

This study has limitations, such as not investigating the participants' eating patterns. In addition, the self-reported diagnosis for the studied outcome stands out. Although the Mini Mental State Examination was used as an exclusion criterion for older adults with cognitive impairment to reduce the impact of memory bias, SAH is a morbidity that often manifests silently and does not generate severe symptoms, which does not motivate older adults to seek medical care. Furthermore, some individuals may not have been diagnosed because they do not frequently seek medical care for routine examinations.

Guidelines indicate the use of repeated measurements for the diagnosis of Arterial Hypertension, as proposed in Ambulatory Blood Pressure Monitoring or Residential Blood Pressure Measurement [5,7]. Despite the above, we consider that the self-report of the referred outcome is a useful measure for screening Arterial Hypertension in epidemiological studies, in which more sophisticated methods would not be feasible. We also highlight that a single casual measurement of Blood Pressure with tools like auscultatory or oscillometric sphygmomanometers would also not be sufficient to diagnose Arterial Hypertension, as the measurement act can also generate adverse effects for the patient, related to neurohumoral, environmental, and behavioral components that may influence the results obtained. Finally, both methods have limitations, and therefore, the use of the self-reported variable does not make this epidemiological study unfeasible.

A strong point of the study is the census perspective, which allowed the evaluation of the older population of a small municipality in northeastern Brazil that has low socioeconomic indicators and needs low-cost alternatives to assist in screening for SAH. Thus, we believe that our findings can serve as subsidies for health surveillance and guide health actions in primary care, not only in Aiquara (BA), Brazil, but also in other municipalities that have a similar context, by demonstrating the potential of anthropometry, as well as the indicators that best discriminate the SAH according to the sex of the older adults.

CONCLUSION

In both sexes, the indicators of adiposity were positively associated with hypertension; hypertensive participants showed higher values in the scores of the indicators. Additionally, the body adiposity index (women) and conicity index (men) demonstrated greater ability to screen for hypertension, while the abdominal circumference and body mass index demonstrated greater ability to screen for non-hypertensive women and men, respectively.

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