Epidemiology

Anthropometric indicators as predictors of dynapenia in postmenopausal women

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Abstract - Aim: Anthropometry represents an alternative to the evaluation of nutritional status and screening of events related to muscle fitness. Therefore, this study aimed to compare anthropometric indicators of postmenopausal women with and without dynapenia and to identify the predictive capacity of these indicators to screen the respective outcome in this population. **Methods:** Cross-sectional epidemiological study, conducted with postmenopausal women. Dynapenia was diagnosed by handgrip strength < 20 kgf. Arm (AC), abdominal (AbC), hip (HC) and calf circumferences (CC), triceps, biceps, subscapular, supraspinatus and thigh skinfolds were analyzed. Body Mass Index, Conicity Index (CI), Body Adiposity Index (BAI), Waist to Hip and Waist to Height Ratio (WHtR), Corrected Arm Muscle Area (CAMA) and Arm Muscle Circumference (AMC) were calculated. **Results:** A total of 273 women participated in the study. The BAI, WHtR, and CI did not present significant differences between the groups. For the other indicators, the dynapenic group obtained significantly lower values compared to the non-dynapenic. AC was the indicator with the highest sensitivity to screen for postmenopausal dynapenia (79.8%). While CAMA and AMC were the indicators with the best specificity (86.2%). However, CC showed the best balance between sensitivity (67.5%) and specificity (63.0%). **Conclusion:** The indicators AC, CAMA, and/or the AMC can be used together, or CC alone, to predict postmenopausal women with dynapenia. Therefore, these indicators can be used as important epidemiological tools to improve women's health surveillance actions.

Keywords: anthropometry, climacteric, epidemiology, muscle weakness.

Introduction

The ovarian structural and functional transformations that occur during climacteric, especially after menopause, provide endocrine modifications, which trigger changes in body composition[1,2]. These changes, in turn, may potentiate the development of adverse conditions, such as muscle weakness referred to in the literature as dynapenia[3,4,5].

Given this context, it is observed that the prevalence of dynapenia in postmenopausal women varies between 18.7[6] and 34.4%[7], which raises considerable health concerns, given that muscle weakness is an important factor for other outcomes that can lead to greater health problems, such as sarcopenia[8], frailty syndrome[9], falls, and fractures[10]. Moreover, this condition represents a higher risk of mortality, which makes it essential to monitor and assess muscle strength levels, especially throughout aging, for good health surveillance of women[11].

Among the most used measures in clinical practice for the diagnosis of dynapenia, handgrip strength measured by a hydraulic dynamometer stands out because it is easy to obtain and has a good correlation with overall muscle strength[12]. However, not all health care units and/or outpatient clinics have this instrument available, making it necessary to use simpler methods to predict muscle strength[13].

In this context, anthropometric indicators have been shown as accessible epidemiological tools, of effortless application and interpretation that supply information on important health indicators, such as muscle mass and adipose tissue disposition. Therefore, anthropometry presents itself as a feasible alternative to the assessment of nutritional status and screening of events related to muscle fitness[14-16].

In view of the above, this study aimed to compare anthropometric indicators of postmenopausal women with and without dynapenia and to identify the predictive capacity of these indicators to screen for this outcome in this population.

Research design and methods

Study Design, Local and Participants

This is a cross-sectional study, conducted with women 50 years of age or older, registered in the 11 coexistence groups for the elderly, linked to the Association of Friends, Coexistence Groups, and Open University with the Third Age (*AAGRUTI*), in Jequié-BA.

According to information provided by *AAGRUTI* management, 280 middle-aged and elderly women were participating in group activities at the time of collection. However, two (0.8%) were not found after three visits in different weeks to their respective group meetings. Thus, 278 women made up the population contingent[5].

For the present study, the following inclusion criteria were adopted: having a fixed residence in Jequié-BA and having stopped menstruating at least one year before the collection. Five women (1.80%) were excluded for not having the muscle strength values. Thus, 273 postmenopausal women participated in the study (Figure 1).

This study was conducted according to the Helsinki Declaration of the World Medical Association, being in accordance with the determination of Resolution No. 466/

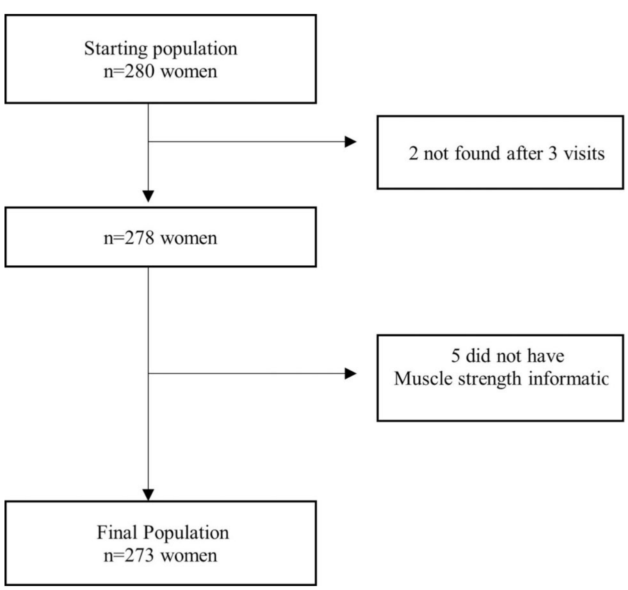

Figure 1 - Decision diagram in the selection process of the women participating in the study. Jequié-BA. Brazil, 2017.

2012 of the Brazilian National Health Council. Thus, it was approved by the Research Ethics Committee of the State University of the Southwest Bahia (UESB), under CAAE n° 67839516.6.000.0055.

Data collection

Data collection was conducted between July and September 2017, occurring in a single step, at the location where the socialization groups of *AAGRUTI* operate. There, interviews were conducted to identify sociodemographic information using a specific form, based on the one used by the Health, Well-Being and Aging Survey (*SABE*), conducted in seven Latin American and Caribbean countries[17]. Furthermore, on the same day, anthropometric measurements and the measurement of handgrip strength were performed.

Dynapenia

Dynapenia was diagnosed using the handgrip strength (HGS) values of the dominant upper limb, measured using a hydraulic dynamometer (Saehan Corporation SH5001®, Korea). Women who presented HGS < 20 kgf were considered dynapenic[18].

During the test, the participants remained comfortably seated, with the shoulder adducted, elbow flexed at 90°, and supported on the table. Moreover, they were instructed to keep the forearm in a neutral position, with the wrist varying from 0° to 30° of extension, and verbally encouraged to press the dynamometer handle as hard as possible[19]. Two attempts were made, with a one-minute interval between them, and the highest value in kilograms-force (kgf) was used for analysis.

Anthropometry

Body mass was measured using a portable digital scale (Zhongshan Camry Electronic, G-Tech Glass 6, China), with the volunteer wearing as little clothing as possible. Height was measured at the end of inspiration, using a fixed stadiometer, where the volunteer was instructed to remain barefoot, erect, with feet together and heels, buttocks, and shoulder girdle in contact with the wall, keeping her eyes fixed on a horizontal axis parallel to the ground, respecting the Frankfurt Line[20].

Arm circumference (AC) was measured at a midpoint between the lateral border of the acromion and the olecranon of the right arm ulna, while waist circumference (WC) was measured using the umbilical scar as a reference point. Furthermore, calf (CC) measurements were collected at the point of the greatest circumference of the direct leg and hip circumference (HC) measurements at the greatest proportion of the gluteal region[21]. The aforementioned measurements were performed using a 2 m inelastic flexible anthropometric tape with 1 mm precision (Sanny® brand).

The skinfolds were measured on the right side of the body using an adipometer (Lange brand, Santa Cruz, California®), with 1 mm precision, properly calibrated. The biceps skinfold was measured vertically 1 cm above the midpoint between the lateral border of the acromion and the olecranon of the ulna on the anterior face of the arm; while the triceps skinfold was measured on the posterior side of the arm, exactly at the aforementioned midpoint, vertically. The suprailiac skinfold was measured diagonally, immediately above the iliac crest, and using as reference the anterior axillary line[20].

In addition to the aforementioned skinfolds, the measurements of the subscapular skinfold were collected diagonally two centimeters below the inferior angle of the scapula and the thigh skinfold, at a midpoint between the inguinal line and the upper border of the patella, in a vertical manner[20]. All anthropometric measurements were collected in triplicate by three trained physical education professionals and the mean values used in the analyses.

The following anthropometric indicators were also calculated: *Body Mass Index* [BMI= (body mass (kg) / height^2 (m))][22], *Conicity Index* [CI = waist circumference (m)/ 0.109$\sqrt{}$ (body mass / height (m))][23], *Body Adiposity Index* [BAI= (hip circumference (cm) / height (m) $\sqrt{}$ height (m)) - 18][24], *Waist-to-hip ratio* [WHR = waist circumference (cm) / hip circumference (cm)][25], *Waist-height Ratio* [WtHR = waist circumference (cm) / height (cm)][26]; *Corrected Arm Muscle Area* [CAMA = ((arm circumference (cm) - ((π/10) x TSF)))2 / 4 x π) - 6.5][27] and *Arm Muscle Circumference* [AMC = (arm circumference (cm)) - ((π/10) x TSF (mm))] [28].

Statistical analysis

For the descriptive analysis of the population characteristics, the absolute and relative frequencies, means, medians, standard deviations, and interquartile ranges were calculated. The comparison between the means or medians of the anthropometric indicators of women with and without dynapenia was performed using the Student's t-test or Mann Whitney's U test, according to the normality distribution of each variable, observed by the Kolmogorov Smirnov test.

The verification of the diagnostic performance of anthropometric indicators for dynapenia and the identification of the best cutoff points were performed using the parameters provided by the Receiver Operating Characteristic (ROC) curve: area under the ROC curve (AUC), sensitivity, and specificity. A 95% confidence interval ($p \leq 0.05$) was adopted for all analyses. Data were analyzed using the Statistical Package for Social Sciences (SPSS® 21.0, 2013, Inc, Chicago, IL) and MedCalc® (version 9.1.0.1, 2006).

Results

A total of 273 postmenopausal women participated in the study, with a prevalence of dynapenia of 45.8%. The mean age of the dynapenic group was 74.2 ± 8.2 years and of the non-dynapenic 67.9 ± 8.2 years ($p < 0.05$). Table 1 shows the comparative analysis of the anthropometric indicators. Regarding the BAI, WHtR, and CI variables, there was no statistically significant difference between the groups. In all the other variables, the dynapenic women had lower values ($p < 0.05$).

Figure 2 shows the areas under the ROC curve of the anthropometric indicators used as discriminators of dynapenia. It was observed that the five indicators studied presented the lower limit of the confidence interval of the AUC > 0.50.

The indicator that showed the highest sensitivity was the arm circumference (79.8%), with the best cut-off point being the value of 31.4 cm for the determination of dynapenia. While the corrected arm muscle area and arm muscle circumference were the indicators with the best

Table 1 - Comparison of handgrip strength and anthropometric indicators between dynapenic and non-dynapenic women. Jequié-BA, Brazil, 2017.

Variables	% respost	Non-Dynapenics	Dinapenics
HGS (kgf)^a	100.00	22.00 (4.00)	16.00 (4.00)*
Height (m)^a	93.70	1.53 (0.08)	1.50 (0.10)*
BM (kg)^a	96.00	66.60 (17.50)	57.50 (12.23)*
AC (cm)^b	96.80	30.98 (28.69)	28.69 (4.09)*
AbC (cm)^b	95.60	98.84 (10.77)	94.24 (11.48)*
HC (cm)^b	96.80	102. 26 (10.30)	97.50 (9.83)*
CC (cm)^b	96.00	35.42 (3.26)	33.46 (3.24)*
BMI (kg/m^2)^a	93.70	27.55 (6.58)	26.30 (6.10)*
WHR^b	96.40	0.92 (0.05)	0.90 (0.06)*
BAI (%)^a	96.40	35.30 (7.30)	35.36 (8.36)
WTHR^b	95.00	0.64 (0.07)	0.63 (0.08)
CI^b	91.70	1.37 (0.07)	1.38 (0.08)
AMC (cm)	95.30	23.46 (2.51)	22.13 (2.41)*
CAMA (cm^2)^a	95.30	36.74 (11.54)	32.56 (11.13)*
TSF (mm)^a	95.30	23.05 (8.34)	20.74 (9.85)*
BSF (mm)^b	95.30	17.86 (7.10)	16.02 (7.36)*
SSSF (mm)^b	95.30	25.84 (8.04)	22.74 (10.23)*
SISF (mm)^a	95.00	26.70 (9.90)	24.00 (12.01)*
MTS (mm)^b	93.80	29.31 (9.22)	26.38 (9.30)*

%: percentage; BM: body mass; kg: kilograms; m: meters; HGS: handgrip strength; kgf: kilogram-force; cm: centimeters; cm^2: centimeters squared; AC: arm circumference; AbC: abdominal circumference; HC: hip circumference; CC: calf circumference; WC: waist circumference; BMI: body mass index; kg/m^2: kilogram per square meter; WHR: waist-to-hip ratio; BAI: body adiposity index; WHtR: waist-to-height ratio; CI: conicity index; AMC: arm muscle circumference; CAMA: corrected arm muscle area; BSF: biceps skinfold; MTS: medial thigh skinfold; TSF: triceps skinfold; SISF: supra-iliac skinfold; SSSF: subscapular skinfold; ^{a}median and interquartile range; ^{b}mean and standard deviation *difference between the dynapenic and non-dynapenic group ($p < 0.05$).

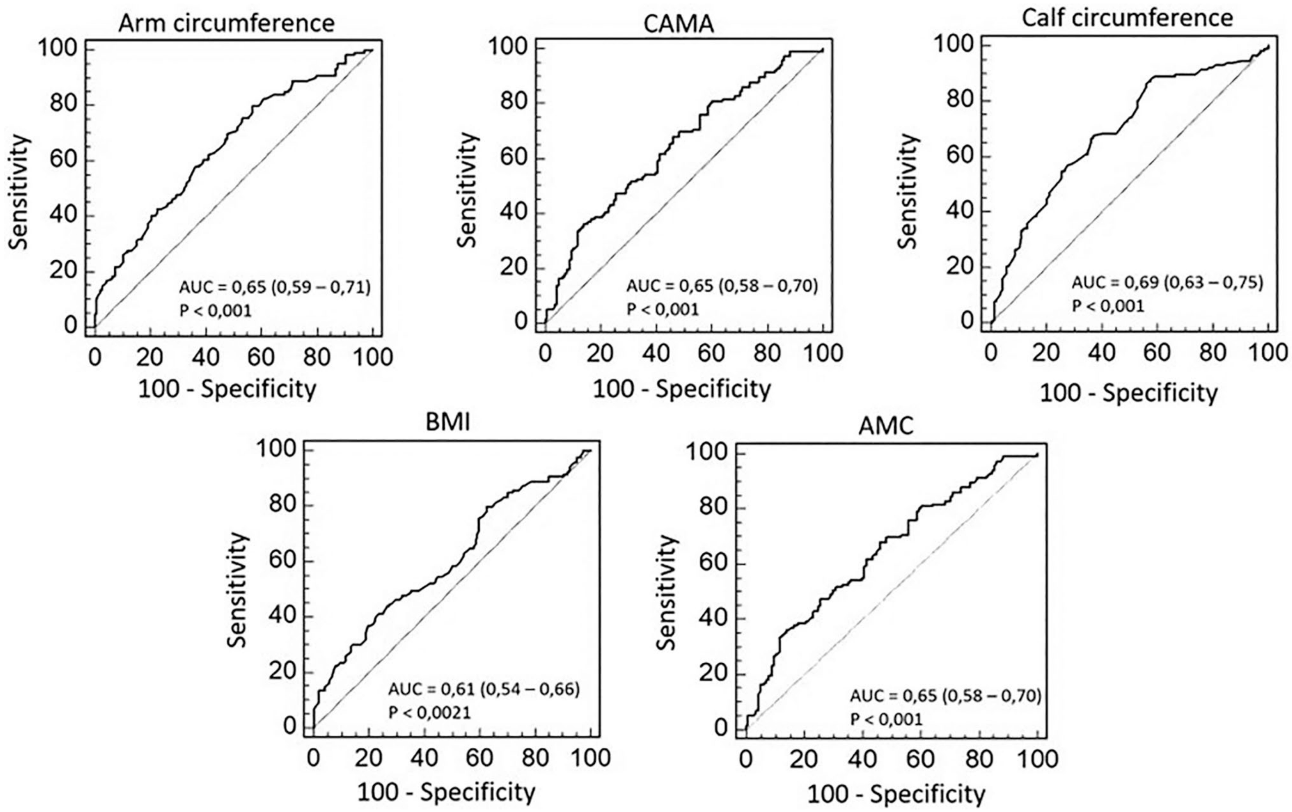

Figure 2 - ROC curves of anthropometric indicators as discriminators of dynapenia in middle-aged and elderly women. Jequié-BA, Brazil, 2017. CAMA: corrected arm muscle area; BMI: body mass index; AMC: arm muscle circumference; AUC: area under curve.

predictive ability to identify women without dynapenia, with a specificity of 86.2% (best cut-off points: CAMA: 29.0 cm^2; AMC: 21.1 cm). However, calf circumference was the indicator of muscle mass that showed the best balance between the parameters of sensitivity (67.5%) and specificity (63.0%), with a cut-off point of 34.4 cm (Table 2).

Discussion

This study proposed to compare anthropometric indicators of postmenopausal women with and without dynapenia and to identify the predictive ability of these indicators to triage the respective outcome in this population. Among our results, it was found that women with dynapenia had lower values for most indicators of obesity and muscle mass when compared to non-dynapenic women ($p < 0.05$).

Among the indicators of obesity analyzed, was observed a significant difference in the values of body mass index, which refers to the amount of body mass in relation to the individual's height. In the population studied, the higher BMI, possibly the greater the disposition of body fat. Despite this, was verified that both the dynapenic and non-dynapenic women presented a nutritional risk condition since they had a BMI > 25 kg/m^2, which, according to the World Health Organization[22], indicates an overweight condition. This fact was confirmed when was analyzed the

Table 2 - ROC curve parameters of anthropometric indicators of muscle mass used as discriminators of dynapenia in middle-aged and elderly women. Jequié-BA, Brazil, 2017.

Variables	Cut-off point	Sensitivity (CI 95%)	Specificity (CI 95%)
AC (cm)	31.4	79.8 (71.5-86.6)	43.2 (35.0-51.6)
CC (cm)	34.4	67.5 (58.2-75.9)	63.0 (54.6-70.8)
AMC (cm)	21.1	36.2 (27.5-45.6)	86.2 (79.5-91.4)
BMI (kg/m^2)	24.8	40.3 (31.4-49.7)	77.6 (69.9-84.0)
CAMA (cm^2)	29.0	36.2 (27.5-45.6)	86.2 (79.5-91.4)

CI: confidence interval; AC: arm circumference; CC: calf circumference; CAMA: corrected arm muscle area; AMC: arm muscle circumference; BMI: body mass index; cm: centimeters; cm^2: centimeters squared; kg/m^2: kilogram per square meter.

body adiposity index, which was high (> 35%)[24] both among the dynapenic and non-dynapenic women.

Similarly, was verified differences in the waist-to-hip ratio and abdominal circumference variables, which are anthropometric indicators of central obesity. Although the non-dynapenic group showed superiority in these indicators ($p < 0.05$), both groups had values ≥ 88.00 cm for AbC ≥ 0.85 for WHR, which shows elevated risk for cardiometabolic diseases[22,25]. This is because the excessive accumulation of adipose tissue in the central region generates important inflammatory processes, leading to the onset of chronic diseases, such as diabetes mellitus, hypertension, and dyslipidemias[29].

This adverse profile observed from anthropometric indicators of adiposity among the evaluated women is probably a consequence of changes that occur in metabolism during female aging since estrogens have important modulating functions within the energy balance. Therefore, the conditions of deficiencies of this hormone, after menopause, may cause increased caloric intake and decreases in basal metabolism, which implies the excessive accumulation of fat[30,31].

With regard to the muscle mass indicators, it was observed that the group of dynapenic women had lower values in the arm and calf circumference, in addition to lower corrected arm muscle area and arm muscle circumference, when compared to the non-dynapenic group ($p < 0.05$). This finding corroborates the literature, where AC, CC, CAMA and AMC indicators are established as predictors of risk for frailty syndrome[15], sarcopenia[32,] and functional capacity[16], verified in this study by the ROC curve.

The difference in the values of AC, CC, CAMA, and AMC between the dynapenic and non-dynapenic groups and the possible use of these variables as predictors of dynapenia is due, considerably, to the fact that the dynapenic women presented at an older age when compared to the non-dynapenic ones ($p < 0.05$). This reports the possibility that, due to the ageing effects, the dynapenic women may have presented greater muscle atrophy, which results from structural alterations inherent to the aging process, such as decreases in the quantities and sizes of muscle fibers, generated by imbalances between protein synthesis and degradation[33].

Although there is no consensus in the literature on the amount of muscle mass lost during aging, a quantitative review[33], considering the results of 11 epidemiological studies and identified that in women, after menopause, the average value of skeletal muscle loss is 0.3% per year. However, with advancing age these declines become increasingly severe. Thus, they can reach 0.7% at age 75[33], resulting in estimated total losses of up to 40.0% among longevous[8].

This study highlights as a limitation its cross-sectional design, which does not allow establishing a causal relationship between changes in anthropometric indicators of muscle mass and dynapenia. However, it presents a strong point of evidence that points to the possible use of anthropometric indicators as a possible epidemiological tool of low cost and accessible to the surveillance of women's health, especially in the context of primary health care, for early diagnosis of dynapenia, thus contributing to obtaining better subsidies for actions of prevention, recovery, and health promotion of postmenopausal women.

Conclusion

We observed that the dynapenic women presented lower values in the indicators of muscle mass and obesity. Furthermore, our results showed that there is a possibility to concomitantly use AC and CAMA, and/or AMC for better screening of dynapenia in postmenopausal women in clinical practice. However, it is stressed that if it is impossible to use AC together with CAMA or AMC to predict the dynapenia, calf circumference may be a strategy, as it showed the best balance between sensitivity and specificity parameters.

Acknowledgments

We thank the *Associação de Amigos, Grupos de Convivência e Universidade Aberta com a Terceira Idade* (AAGRUTI), the women participating in the study, as well as the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (*CAPES*) for the master's scholarship of Lucas dos Santos.

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Manuscript received on January 28, 2022
Manuscript accepted on March 28, 2022