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Anthropometry of Muscle Mass: The Relationship Between Risk and Nutritional Status and Functionality in the Elderly

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Abstract

Aging modifies the body composition and physiology of individuals, influencing the decrease in body mass and nutritional status. This study aims to analyze the association between anthropometric indicators of muscle mass assessment with nutritional risk and functional deficit in the elderly. This is a cross-sectional study, with community-dwelling elderly (≥ 60 years old) assisted in primary care centers in the city of Doutor Ricardo, RS. The analyzed variables were: sociodemographic data; lifestyle; chronic noncommunicable diseases; nutritional risk; nutritional status; muscle mass; skeletal muscle mass index; calf circumference; corrected arm muscle area; adductor pollicis muscle thickness; adductor muscle index; and functionality. For statistical analysis, $P < 0.05$ was used. Forty-four elderly people with a mean age of 71.27±8.57 years were evaluated, 68.2% of whom were female (N= 30). Men had higher mean muscle mass ($P < 0.001$) and skeletal muscle mass index ($P < 0.001$). Higher percentages of inadequate calf circumference and skeletal muscle mass index were associated with the risk of malnutrition and low weight ($P < 0.001$). The relationships found with the indicators for assessing muscle mass, skeletal muscle mass index and calf circumference with nutritional risk and inadequate nutritional status point to the relevance of using these indicators in clinical practice.

Keywords: Anthropometry. Nutritional Assessment. Physical and Functional Performance. Elderly. Muscle.

INTRODUCTION

In Brazil, population aging is growing rapidly[1]. This may be due to improvements in living conditions, access to food and healthcare services, thus, increasing life expectancy while reducing birth and fertility rates[2]. In 2018, the country had 9.2% of its population aged 65 or over, it is estimated that in 2060 this percentage will reach 25.5%[3].

As a result of population aging, there have been major transformations such as the nutritional transition process, which has resulted in a decrease in malnutrition and an increase in obesity, generating economic, social, and demographic changes that influence the health and food consumption profiles of the elderly population[4]. However, these changes in diet and lifestyle are factors that contribute to a significant increase in chronic noncommunicable diseases, such as diabetes, hypertension, obesity, cardiovascular disea-

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ses, and cancer, which are the main causes of death[5].

The changes that occur during the aging process can influence nutritional status, which may reduce daily energy intake[6]. Beyond interfering with weight and height, cell aging can cause several changes, such as biological, physiological, and biochemical changes[7].

There are several ways to perform anthropometry in the elderly and, thus, obtain muscle mass indicators. It is always worth noting that assessments should be performed with age-specific markers since height and muscle mass normally decrease, and the percentage of fat, in some cases, may increase[8]. There is still no gold standard nutritional assessment method. The measurement of nutritional risk in aging requires the joint analysis of the various existing methods, in order to obtain a global diagnosis and accurate analysis of the nutritional status of the elderly[9]. An instrument of important relevance is the Mini Nutritional Assessment (MAN®), which consists of a questionnaire with several dimensions that allows for identifying malnourished individuals or those at risk of developing malnutrition in order to provide early intervention[10].

The assessment of the nutritional status (NS) of the elderly makes it possible to intervene in their proper nutrition, avoiding or minimizing health problems that compromise their functional capacity[11]. Currently, the concept of health for the elderly is directly linked to their functional capacity to decide and carry out their daily activities with autonomy and independence, in addition to avoiding the frequent falls in this age group that can cause several complications[8].

The loss of muscle mass and muscle function is associated with an increase in mortality[12], risk of falls[13], and risk of dependence[14], considering that most have a decrease in the percentage of lean mass, which can make it difficult to move around and even perform simple everyday tasks. As a result of this limited mobility, the risk of falls is significantly increased in the elderly and may be associated with loss of muscle mass[15]. In the literature, it is observed that some studies evaluated the muscle mass of the elderly[16,17], the nutritional risk[18], and the functionality of the elderly[7,19].

Given the importance of this topic, this study was developed with the aim of analyzing the association between anthropometric indicators for assessing muscle mass with nutritional risk and functional deficit in the elderly.

METHODOLOGY

This is a cross-sectional study, with a group of elderly residents recruited in the Senior Citizens Group, which is a coexistence group, and in the Primary Healthcare Center (PHC) in the city of Doutor Ricardo, RS. To calculate the sample size, the *OpenEpi online*[20] program was used. The elderly population of the city of Dr. Ricardo, RS in 2010, was of 435 elderly individuals[21]. With a confidence level of 95%, the prevalence of below-average fat percentage among the elderly being 65%[22], a margin of error of 5.0 percentage points, and estimated loss of 10%, the total sample size calculated was 215 elderly individuals.

Data collection was carried out at the PHC of the aforementioned city from July to November 2019, using a convenience sample. As inclusion criteria, elderly people from the community aged 60 years and/or over, assisted in the primary healthcare network and participants in the Senior Citizens Group in the city of Doutor Ricardo, RS were considered. As exclusion criteria, the elderly individuals in the community with amputated limbs (circumstances that make it difficult to measure anthropometric measurements) or

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who were bedridden were excluded.

For data collection, the questionnaire developed for the study was used, comprised of the variables: identification data, socioeconomic data, health and lifestyle conditions, anthropometric assessment, body mass composition, and laboratory results.

The variables analyzed in this study were:

Sociodemographic variables: gender (female/male), age group (60 to 79 years old and ≥ 80 years old), ethnicity (Caucasian/Afro-descendant), minimum wage income (less than 1, 1 to 2, 2 to 3, or more than 3), marital status (married/widowed/divorced), occupation (retired/retired with paid work), type of housing (wood/masonry/mixed), place of residence (urban area/rural area), living arrangement (lives alone, lives with 1 person, 2 people, or ≥ 3 people) and education (illiterate, incomplete elementary school, complete primary education, complete secondary education).

Lifestyle: practice physical activity (no or yes), smoking (no, yes, or ex-smoker) and alcoholism (no, yes, or ex-alcoholic).

Chronic Noncommunicable Diseases (NCDs): the diagnosis of CNCDs was self-reported, where the elderly person reported the presence or absence of the following CNCDs: Diabetes Mellitus (DM), systemic arterial hypertension (SAH), dyslipidemia, cancer, asthma, chronic obstructive pulmonary disease (COPD), cerebrovascular accident (CVA), heart attack, cardiac arrhythmia, and heart failure.

Nutritional risk: to assess the nutritional risk of the elderly, the Mini Nutritional Assessment® (MNA®) questionnaire was used, which considers the following cutoff points: 24 to 30 points (adequate nutritional status); from 17 to 23.5 points (risk of malnutrition); and less than 17 points (malnourished)[23].

Nutritional status: assessed by measuring weight and height in order to calculate the Body Mass Index (BMI). For the collection of weight, a Balmak® brand digital scale with a maximum capacity of 200 kg and accuracy of 100 grams was used. The participants wore as little clothing as possible, with empty pockets, without accessories, preferably with light clothes, barefoot, and were instructed to position themselves in the center of the scale, to distribute the body weight between the feet[24]. For elderly people with difficulty maintaining an upright posture, weight was measured using the equation by Rabito *et al.*[25].

- Weight: 0.5759 x (upper arm circumference) + 0.5263 x (waist circumference) + 1.2452 x (calf circumference) – 4.8689 x gender [female = 2 and male = 1] – 32.9241

To measure height, a Welmy® vertical stadiometer was used, which measures up to 210 cm and has a 5 mm interval, with the elderly person barefoot or wearing thin socks, light clothing, no headgear that could alter the measurement, maintaining an anatomical position where the calf, buttocks, shoulders, and head, whenever possible, touch the vertical surface of the stadiometer. With their face facing forward in the Frankfurt Plane, the stadiometer was positioned over their head, applying pressure only to the hair[24]. In elderly people with difficulty maintaining an upright posture, height was measured using knee height, with the elderly person sitting down, ankle and knee flexed at a right angle[26] and placing the beginning of the anthropometric tape next to the heel of the right foot, extending it to the head of the fibula[27], and the value obtained was used to estimate height using Chumlea's, Roche's, and Steinbaugh's equations[26]:

- Female: Height = 84.88 - (0.24 x age) + (1.83 x knee height in cm)

- Male: Height = 64.19 - (0.04 x age) + (2.02 x knee height in cm)

Nutritional status was classified using the Body Mass Index (BMI) using the criteria established by Lipschitz[4] recommended by the Ministry of Health[28]: underweight (BMI < 22 kg/m²), eutrophic (BMI ≤ 22 kg/m² and < 27 kg/m²), and overweight (BMI ≥ 27 kg/m²).

The muscle mass evaluation indicators

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measured were:

Estimation of muscle mass: to calculate the estimate of muscle mass in kg, the predictive equation by Lee *et al.*[29] was used: MM = (0.244 x weight) + (7.8 x height) + (6.6 x sex) – (0.098 x age) + (ethnicity - 3.3), where the values 0 for females and 1 for males and -1.2 for Asians, 0 for Caucasians, and 1.1 for African descendants were assigned.

Skeletal Muscle Mass Index (SMMI): to calculate the SMMI, the MM equation was used and divided by the height squared, classified according to the cutoff point that considers the SMMI adequate when 6.37 kg/m^2 for women and 8.90 kg/m^2 for men[30].

Calf Circumference (CC): was measured using an inelastic Cescorf® tape measuring 2 meters in length and 1mm precision, following the protocol adopted by Barbosa-Silva *et al.*[31], with the individual standing, right calf exposed, legs relaxed and feet 20 cm apart. Values ≤ 33 cm for women and ≤ 34 cm for men were considered as the presence of low muscle mass[31].

Corrected Arm Muscle Area (CAMA): evaluates muscle tissue reserve by correcting the bone area using the equation:

Men: CAMA (cm^2) = $(AMA)^2/12.56 - 10$

Women: CAMA (cm^2) = $(AMA)^2/12.56 - 6.5$

For classification, the percentiles (P) were considered as the cutoff point according to the age group of the elderly individuals. Then, the obtained value was classified in CAMA as: > P15 eutrophy; between P5 to P15 mild/moderate depletion; and < P5 severe depletion[32].

Adductor Pollicis Muscle Thickness (APMT): to assess MM for APMT measurement, the procedure used by Bragagnolo *et al.*[33] was adopted, where the elderly participant remained seated, with their arm flexed at approximately 90° and with the forearm and hand relaxed resting on one knee. The measurement was performed with a Cescorf® clinical plicometer, which exerted a pressure of 10 g/mm^2 to clamp the muscle at the apex of an imaginary triangle formed by the index finger and the thumb of the hand. A single measurement was performed on the dominant hand. The cutoff point for malnutrition was < 13.4 mm for the right dominant hand and < 13.1 mm for the left dominant hand. The Adductor Pollicis Muscle Index (APMI) was calculated using the equation: APMI = measured APMT/height (m)[34].

Functionality: in this study, it was evaluated through self-reports of falls and difficulty in locomotion (help from someone to move, use of canes and/or walkers), respectively, in the last three months.

For statistical analyses, data were tabulated in a Microsoft Excel® version 16.0 spreadsheet. Analyses were performed using STATA Statistical software (StataCorp LP, College Station, TX, USA) version 12.0. Initially, a descriptive analysis was carried out, with distribution in absolute numbers, percentages, as well as measures of central tendency (mean) and variability (standard deviation). Continuous variables had their distributions investigated using the Kolmogorov Smirnov and Shapiro-Wilk tests to verify the normality of data distribution. To assess the association of categorical variables, Fisher's exact test was used. To assess the association between dichotomous categorical variables and the mean values of the measured anthropometric indicators (normal distribution), Student's t test was used. Results with $P < 0.05$ were considered significant.

This study is linked to the study, Body Composition and its relationship with sociodemographic, clinical, lifestyle and food consumption in community-dwelling elderly, approved by the Ethics and Research Committee of the University of Caxias do Sul/RS under opinion number 4.521.886, which followed all the ethical precepts of Resolution 466/2012[35].

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RESULTS

Forty-four elderly people participated in this study, most were female, Caucasian, and had a mean age of 71.27±8.57 years. It was observed that 43.2% were aged between 60-79 years. Regarding income, the majority received a minimum wage, were retired, and had an incomplete primary education. The type of housing of the majority was masonry, located in an urban area, and who lived with one person. As for lifestyle, most were sedentary, non-smokers, and non-drinkers. Regarding the anthropometric indicators of muscle mass assessment, most of the elderly had adequate CC, CAMA classified as eutrophic, adequate SMMI and APMT classified as malnutrition.

Regarding nutritional status, 47.7% of the elderly were overweight and 77.3% had adequate neck circumference. Most of the elderly reported a diagnosis of CNCD, with the presence of three comorbidities being found in 25% of the elderly. Regarding mobility, 84.1% had falls (N=37) and 77.3% had difficulty walking (N=34).

Table 2 describes anthropometric indicators for assessing muscle mass according to sex and age group. Regarding gender, higher means of muscle mass (27.57 ± 3.26 versus 10.36 ± 3.93; P <0.001) and SMMI (9.81 ± 1.02 versus 7.49 ± 1.47, P <0.001) are observed in males. There were no significant differences in mean CC, CAMA, APMT and APMI between men and women (P ≥ 0.05). There were no significant differences in mean CC, CAMA, muscle mass, SMMI, APMT, and APMI between different age groups (P ≥ 0.05).

Table 3 presents the classification of anthropometric indicators for assessing muscle mass according to nutritional status. Higher percentages of inadequate CC (P <0.001) and inadequate SMMI (P <0.001) were associated with the risk of malnutrition according to MNA. Regarding nutritional status according to BMI, higher percentages of inadequate NS (100.0% versus 5.9% and 14.3%; P <0.001), inadequate SMMI (100.0% versus 11.8% and 0.0%; P <0.001) were observed in underweight individuals when compared to eutrophic or overweight individuals. There were no significant differences in percentages according to the CAMA classification, despite the prevalence of depletion being associated only with an underweight nutritional status and not with eutrophic and overweight (16.7% versus 0.0% versus 0.0%, P= 0.136). Moreover, malnutrition according to APMT is associated in a higher percentage with an underweight nutritional status, followed by eutrophy and overweight (83.3% versus 82.4% and 47.6%; P= 0.050).

Table 4 presents the classification of anthropometric indicators for assessing muscle mass according to the functionality of the elderly. No significant differences were observed regarding the anthropometric indicators for the assessment of muscle mass in relation to the functionality of the elderly, assessed through the presence of falls and difficulty walking (P ≥ 0.05).

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Tabela 1 – Sociodemographic and behavioral characteristics, indicators for assessing muscle mass, health, and the use of health services in the elderly. Doutor Ricardo, RS, 2021 (N=44).

Sociodemographic variables		
Sex		
Male	14	31.8
Female	30	68.2
Age Group		
60-79 years	35	79.6
≥ 80 years	09	20.4
Ethnicity		
Caucasian	43	97.7
African descent	01	2.3
Income (minimum wage[1])		
Less than 1	29	65.9
From 1 to 2	09	20.5
From 2 to 3	04	9.1
Three or more	02	4.6
Marital status		
Married	35	79.5
Widowed	08	18.2
Divorced	01	2.3
Occupation		
Retiree	30	68.2
Retired with paid work	14	31.8
Type of housing		
Wood	1	2.3
Masonry	29	65.9
Mixed	14	31.8
Place of domicile		
Urban area	27	61.4
Rural area	17	38.6
Home Arrangement		
Lives alone	4	9.1
One person	25	56.8
Two people	11	25.0
Three people or more	4	9.1
Education		
Illiterate	07	15.9
Incomplete primary education	30	68.2
Complete primary education	02	4.5
Complete high school	05	11.3

Sociodemographic variables		
Alcoholism		
No	42	95.4
Yes	01	2.3
Former alcoholic	01	2.3
Calf circumference		
Inappropriate	10	22.7
Adequate	34	77.3
CAMA[2] classification		
Eutrophy	43	97.7
Depletion	01	2.3
SMMI[3] classification		
Inappropriate	08	18.2
Adequate	36	81.8
APMT[4] classification		
Malnutrition	29	65.9
Normal	15	34.1
Nutritional status		
Underweight	06	13.6
Eutrophic	17	38.6
Overweight	21	47.7
CNCD[5]		
No	4	9.1
Yes	40	90.9
Comorbidities[6]		
0	01	2.3
1	05	11.4
2	10	22.7
3	11	25.0
4	08	18.2
5 or more	09	20.5
Falls		
No	7	15.9
Yes	37	84.1
Difficulty in locomotion		
No	10	22.7
Yes	34	77.3

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...continuation table 1

Sociodemographic variables		
Physical activity		
No	27	61.4
Yes	17	38.6
Smoking		
No	32	72.7
Yes	04	9.1
Former smoker	08	18.2

[1]Value of the minimum wage in Rio Grande do Sul in 2019: R$ 998.00. [2] CAMA: Corrected Arm Muscular Area; [3]SMMI= Skeletal Muscle Mass Index; [4]APMT= Adductor pollicis muscle thickness. [5]CNCD: Chronic Noncommunicable Diseases (Diabetes Mellitus (DM), systemic arterial hypertension (SAH), dyslipidemia, cancer, asthma, chronic obstructive pulmonary disease (COPD), stroke, heart attack, cardiac arrhythmia, and heart failure.

Table 2 – Mean and standard deviation of anthropometric indicators for assessing muscle mass according to gender and age group in the elderly. Doutor Ricardo, RS, 2021. (N=44)

Anthropometric indicators for assessing muscle mass	Sex				Age Group		
	Total	Male	Famale		60-79 years	≥ 80 years	
	Mean (SD[1])	Mean (SD[1])	Mean (SD[1])	P-value[2]	Mean (SD[1])	Mean (SD[1])	P-value[2]
CC	36.10 (±3.69)	36.04 (±3.11)	36.13 (±3.97)	0.936	36.07 (±3.48)	36.22 (±1.55)	0.914
CAMA	64.38 (± 19.32)	62.29 (±17.05)	65.36 (±20.50)	0.623	65.76 (± 19.69)	59.03 (± 17.86)	0.358
MM (Kg)	21.29 (±5.70)	27.57 (±3.26)	10.36 (±3.93)	<0.001	21.70 (±5.84)	19.68 (±5.09)	0.349
SMMI	8.22 (±1.72)	9.81 (±1.02)	7.49 (±1.47)	<0.001	8.32 (±1.78)	7.88 (±1.52)	0.501
APMT	12.52 (± 2.25)	13.43 (± 2.55)	12.10 (± 2.00)	0.067	12.63 (±2.39)	12.11 (±1.64)	0.544
APMI	4.90 (±0.82)	4.78 (±0.87)	4.95 (±0.81)	0.528	4.89 (±0.84)	4.93 (±0.78)	0.888

[1]SD: Standard Deviation. [2]*Student's t test*. CAMA: Corrected Arm Muscular Area; CC: Calf Circumference; SMMI: Skeletal Muscle Mass Index; APMT: Adductor pollicis muscle thickness; APMI: Adductor pollicis muscle index. MM= Muscle Mass.

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Table 3 – Classification of anthropometric indicators for assessing muscle mass according to risk and nutritional status. Doutor Ricardo, RS, 2021. (N=44)

Anthropometric indicators for assessing muscle mass	Nutritional status according to the Mini Nutritional Assessment (MNA)			Nutritional status according to Body mass index (BMI)			
	Normal	Malnutritional risk		Underweight	Eutrophic	Overweight	
	N (%)	N (%)	P-value*	N (%)	N (%)		P-value*
Total	35 (79.5)	09 (20.5)		06 (13.6)	17 (38.6)	21 (47.7)	
CC			**<0.001**				**<0.001**
Inadequate	04 (11.4)	06 (66.7)		06 (100.0)	01 (5.9)	03 (14.3)	
Adequate	31 (88.6)	03 (33.3)		0 (0.0)	16 (94.1)	18 (85.7)	
CAMA rating			**0.205**				**0.136**
Eutrophic	35(100.0)	08 (88.9)		05 (83.3)	17 (100.0)	21 (100.0)	
Depletion	00 (0.0)	01 (11.1)		01 (16.7)	0 (0.0)	0 (0.0)	
SMMI classification			**<0.001**				**<0.001**
Inadequate	02 (5.7)	06 (66.7)		06 (100.0)	02 (11.8)	0 (0.0)	
Adequate	33 (94.3)	03 (33.3)		0 (0.0)	15 (88.2)	21 (100.0)	
APMT rating			**0.105**				**0.050**
Malnutrition	21 (60.0)	08 (88.9)		05 (83.3)	14 (82.4)	10 (47.6)	
Normal	14 (40.0)	01 (11.1)		01 (16.7)	03 (17.7)	11 (52.4)	

[1]Fisher's exact test. CAMA: Corrected Arm Muscular Area; CC: Calf Circumference; SMMI: Skeletal Muscle Mass Index; APMT: Adductor pollicis muscle thickness.

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Table 4 – Classification of anthropometric indicators for assessing muscle mass according to the functionality of the elderly. Doutor Ricardo/RS, 2021. (N=44)

	Functionality of the elderly individual					
	Presence of falls			Difficulty in locomotion		
	No	Yes		No	Yes	
Anthropometric indicators for assessing muscle mass	N (%)	N (%)	P-value*	N (%)	N (%)	P-value*
Total	07 (15,9)	37 (84,1)		10 (22,7)	34 (77,3)	
CC			**0,509**			**0,406**
Inadequate	02 (28,6)	08 (21,6)		03 (30,0)	07 (20,6)	
Adequate	05 (71,4)	29 (78,4)		07 (70,0)	27 (79,4)	
CAMA rating[1]			**0,841**			**0,773**
Eutrophic	07(100,0)	36 (97,3)		10 (100,0)	33 (97,1)	
Depletion	00 (0,0)	01 (2,7)		00 (0,0)	01 (2,9)	
SMMI classification[2]			**0,100**			**0,253**
Inadequate	03 (42,9)	05 (13,5)		03 (30,0)	05 (14,7)	
Adequate	04 (57,1)	32 (86,5)		07 (70,0)	29 (85,3)	
APMT classification[3]			**0,552**			**0,536**
Malnutrition	05 (71,4)	24 (64,9)		07 (70.0)	22 (64,7)	
Normal	02 (28,6)	13 (35,1)		03 (30,0)	12 (35,3)	

*Fisher's exact test; [1]CAMA: Corrected Arm Muscle Area; CC: Calf Circumference; [2]SMMI: Skeletal Muscle Mass Index; [3]APMT: Adductor pollicis muscle thickness.

DISCUSSION

Female participants (68.2%) and aged between 60 and 79 years prevailed in this study. These results are similar to the results found by Veloso *et al.*[19] and Oliveira *et al.*[15] in that the majorities in their study populations were female at 57.7% and 73%, respectively, and the predominant age group was 60 to 69-year olds at 56.8% in the study by Veloso *et al.*[8] The higher prevalence of female participation in the studies is justified by the fact that women take greater care of their health; therefore, the estimates point to that women live 5 to 7 years longer than men. This is due to greater access to healthcare services and the growth of medical technology, in addition to a better lifestyle in general[15]. The greater participation of younger elderly people may be associated with their greater mobility, independence, and functional capacity[19].

In this study, it is observed that 47.7% of the elderly were overweight, which corroborates the data found by Oliveira *et al.*[15], which showed a prevalence of 53.1% of overweight among the 65 evaluated elderly participants. With regards to the functionality of

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the elderly, in this study, 77.3% had difficulty walking. The same occurred in the study by Giakini *et al.*[36], carried out with 191 elderly people in the city of Passo Fundo, RS, in which 50.3% also had difficulty moving around. It was found that 84.1% of the elderly had suffered falls, which contrasts with a study[27] carried out with 48 elderly people in Belém, PA, where 45.8% of the elderly suffered falls in the last year and 58.3% of the participants were evaluated with low risk of falls according to the Tinnetti Index (significant result P <0.05). Falls occur more frequently in the elderly for intrinsic reasons, that is, physiological changes that are related to aging and diseases, or extrinsic factors that depend on social and environmental circumstances[37].

Another factor involved with the mobility and functionality of the elderly is muscle mass. With advancing age, elderly individuals tend to lose weight considerably, this is due to the decrease in muscle mass and lack of appetite, which corroborates the limited the strength and functionality of this population[38]. After the age of 30, there is a loss of muscle mass that can vary from 3 to 8% per decade and this increases to 10 to 20% per decade after the age of 50[39]. In the categorization of the total sample, it was verified that the evaluation indicators of muscle mass CC, AC, CAMA, SMMI, APMT were adequate in 77.3%, 52.3%, 97.7%, 81.8%, and 65.9%, respectively.

When associated with anthropometric indicators of muscle mass assessment in relation to sex and age group, in this study men had higher averages of muscle mass and SMMI. Ferreira *et al.*[38] also found higher means of muscle mass and SMMI among men. The association found between the inadequacy of CC and SMMI with the risk of malnutrition assessed by the MNA, and the low weight nutritional status assessed by the BMI, reflect the impact of low muscle mass on the nutritional profile of the elderly. The MNA is extremely important to assess and identify the nutritional risk and malnutrition of the elderly, providing greater practicality and speed in detection as it is based on a simple and complete questionnaire[15].

Among the elderly evaluated, 83.3% (n= 5) presented malnutrition classified by APMT associated with low weight, which was close to the level of statistical significance (P= 0.050). In turn, in the study by Margutti *et al.*[40] carried out with 113 elderly people in the city of Santa Maria, RS, reported a 50% association between malnutrition classified by APMT and low weight. APMT allows us to evaluate a flat muscle fixed between two bone structures and is the only muscle that it is possible to directly measure the thickness, assessing the muscle mass and pointing out a picture of malnutrition[41].

Among the evaluated population, no association was identified between muscle mass and the presence of falls and decreased functionality of the elderly, but it is known that the decrease in musculature can hinder movement and consequently cause falls and interfere with the functionality of the older population[42].

In this study, it should be noted that data collection was carried out by a single nutritionist, duly trained, which minimized the risks of bias. Despite this positive aspect, the limitations of this study are: (a) the sample size, which does not allow us to extrapolate the results to other populations; (b) the cross-sectional design that makes it impossible to verify the cause and effect; and (c) the sample is composed mostly of younger elderly people, which characterizes a more homogeneous profile.

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CONCLUSION

In this study, the indicators for assessing muscle mass, calf circumference, and skeletal muscle mass index, showed inadequacies associated with the risk of malnutrition, assessed by the MNA, and with the nutritional status of being underweight. This result highlights the relationship between these two factors. It should be noted that the presence of overweight found in the evaluated population may contribute to the increase in the chronic low-grade inflammatory process, known as inflammaging, which accelerates the loss of muscle mass.

Therefore, it is concluded that muscle mass assessment indicators are relevant for clinical practice, helping to detect not only low muscle mass, but also can be used to complement the assessment of nutritional status. Finally, new studies are suggested that associate the indicators of muscle mass assessment with other nutritional parameters, such as laboratory tests evaluating albumin, total protein and fractions, and longitudinal studies that aim to observe changes in muscle mass in relation to changes in nutritional status and food consumption.

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