Artículo Original / Original Article

Sarcopenia in elderly hospitalized coronary patients

Sarcopenia en pacientes coronarios hospitalizados

RESUMEN

La sarcopenia se define como un síndrome caracterizado por una pérdida progresiva y generalizada de la masa muscular y la fuerza del esqueleto, con un riesgo de resultados adversos como la discapacidad, la reducción de la calidad de vida y de muerte. **Objetivo:** Investigar la prevalencia de sarcopenia y sus factores asociados en pacientes cardíacos. **Métodos:** Se realizó un estudio transversal en el hospital público del noreste de Brasil, en el que participaron pacientes mayores de 60 años con enfermedad coronaria. La sarcopenia fue determinada por la masa muscular (análisis de impedancia bioeléctrica y ecuación predictiva para determinar el índice de masa muscular esquelético), la fuerza muscular (medida por la fuerza de agarre) y el rendimiento físico (prueba de velocidad de conducción). Entre la asociación de variables se consideraron aspectos socioeconómicos, demográficos, clínicos, nutricionales y de estilo de vida. **Resultados:** Fueron evaluados 148 pacientes, con una edad promedio de $73,9 \pm 7,4$ años. Se observó una prevalencia de sarcopenia del 62,8%; incluyendo un 72% clasificado como severamente sarcopénico. Las variables asociadas a sarcopenia fueron sexo masculino ($p = 0,014$), edad > 80 años ($p = 0,005$) y desnutrida según IMC ($p < 0,001$), CB ($p = 0,006$) y CP ($p = 0,045$); las otras variables no fueron estadísticamente significativas. **Conclusión:** La prevalencia de sarcopenia fue mayor, se encontró en una asociación con el género, un aumento en la edad, y el estado nutricional desfavorable.

Palabras clave: Ancianos; Sarcopenia; Enfermedad cardiovascular; Desnutrición.

ABSTRACT

Sarcopenia is a syndrome characterized by the progressive and widespread loss of skeletal muscle mass and strength, with a risk of adverse outcomes such as disability, reduced quality of life and death. **Objective:** To investigate the prevalence of sarcopenia and its associated factors in cardiac patients. **Methods:** We performed a cross-sectional study in a public hospital in northeast Brazil, involving patients aged ≥ 60 years with coronary artery disease. Sarcopenia was determined by muscle mass (bioelectrical impedance analysis) and skeletal muscle mass index by a predictive equation, muscle strength

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(measured by grip strength) and physical performance (driving speed test). We tested relationships between sarcopenia and socioeconomic, demographic, clinical, nutritional and lifestyle variables. **Results:** We evaluated 148 patients, with an average age of 73.9 ± 7.4 years. We observed a prevalence of sarcopenia of 62.8%; of which 72% were classified as having severe sarcopenia. The variables associated with sarcopenia were male sex ($p = 0.014$), age > 80 years ($p = 0.005$), and being malnourished according to BMI ($p < 0.001$), arm circumference ($p = 0.006$) and calf circumference ($p = 0.045$); the other variables were not statistically significant. **Conclusion:** The prevalence of sarcopenia in our sample was high. We found that sarcopenia related to sex, age, and nutritional status. **Keywords:** Elderly; Sarcopenia; Cardiovascular disease; Malnutrition.

INTRODUCTION

Aging is characterized by a continuous process in which changes occur in the various physiological systems. Among these changes, we highlight morphological changes, mainly related to changes in body composition, reduced functional capacity and the consequent impact on the quality of life of older people¹.

Sarcopenia is a syndrome characterized by the progressive and widespread loss of skeletal muscle mass and strength, with a risk of adverse outcomes such as disability, reduced quality of life and death². Although not restricted to older people, it is more prevalent in old age and increases with age³.

Unlike previous definitions of sarcopenia that focus on measurements of small muscle mass only, the European Working Group on Sarcopenia in Older People (EWGSOP) proposed that the diagnosis of sarcopenia should include the reduction of muscle mass associated with reduced strength or functionality, justifying that muscular strength depends not only on muscle mass. Thus, previous definitions of sarcopenia that only adopt the evaluation of muscle mass would be insufficient and with a limited clinical value².

Several mechanisms may be involved in the development and progression of sarcopenia. One mechanism may relate to inherent changes in aging, such as the loss of units of motor neurons, decreased hormonal status (decline in serum levels of testosterone and growth hormone), physical inactivity, inadequate diet (low intake of protein, energy and vitamin D) and decreased insulin sensitivity. These changes lead to increased proteolysis, decreases in muscle protein synthesis and increased muscle fat infiltration. Furthermore, many diseases lead to prolonged rest and the use of numerous drugs, factors which may contribute to sarcopenia^{2,3}.

Few studies estimate the prevalence of sarcopenia using the new multidimensional criteria proposed by the EWGSOP^{2,3,4,5,6,7}, moreover, there are still scarce data about the magnitude of sarcopenia in some populations, like cardiac patients.

The association between sarcopenia and CVD risk is not well established. However, studies have shown that small muscle mass is associated with arterial stiffness, which is an independent predictor of cardiovascular disease (CVD). Sarcopenia may also affect the atherogenesis process due to the relative increase in secondary adipose tissue, muscle loss and replacement of myocytes by adipocytes^{8,9}. In addition, when sarcopenia and obesity co-occur, there is a synergy which may result in muscle loss and dysfunction related to a pathological accumulation of adipose tissue. This condition is defined as sarcopenic obesity¹⁰.

This study aimed to evaluate the prevalence of sarcopenia and its correlates in coronary patients. Second, we verified the performance of risk instruments and nutritional assessment in the diagnosis of sarcopenia.

METHODS

Design and study population

We conducted a cross-sectional study in a public referral hospital for cardiology in northeast Brazil from april to july 2015. We recruited patients of both sexes, aged ≥ 60 years, who were admitted to the coronary artery disease ward. Patients with physical and cognitive limitations, who were bedridden after cardiac surgery, with kidney disease on dialysis, who had edema and changes in the joints of the arms or legs that made it impossible to carry out the proposed tests were excluded.

To calculate the sample size, it was considered some internment of 250 seniors in the same period the year before the data collection. In a previous study of elderly hospitalized patients¹¹, a prevalence of sarcopenia of 27.5% was found. Thus, using a standard error of 5% we calculated a sample size of 138 individuals. To adjust for potential loss of information we inflated our calculation by 10%, for a total of 152 patients to be evaluated.

Data were collected after approval by the Ethics Committee for Research involving human subjects under protocol number 980360 - 03/25/2015.

Sarcopenia

Data were collected within 72 hours of admission to the ward by evaluators trained in the study protocol. Sarcopenia was identified, as proposed by EWGSOP², from the evaluation of the following components: muscle mass, muscle strength and physical performance. Severe sarcopenia was defined as having all three criteria: reduction of mass, muscle strength and lower physical performance. Pre-sarcopenia was coded when non-sarcopenic individuals showed unfavorable results in the evaluation of lean body mass, the condition before sarcopenia.

Muscle mass was assessed with the skeletal muscle mass index (SMMI) obtained by the equation: $SMMI = \text{skeletal muscle mass (SMM)} / \text{height}$. The SMM, on the other hand, was calculated according to Jansen et al.²⁰: $SMM (kg) = [(Height (cm)^2 / Resistance (ohm) \times 0.401) + (3.825 \times Sex (male= 1 and women= 0))] + (-0.071 \times Age \text{ in years})] + 5,102$. The resistance measurement used in the equation was obtained from bioelectrical impedance analysis (BIA), using the portable Biodynamics model 310, which applies an electrical current of 800 μA with a single frequency of 50 kHz, according to the methodology proposed by Kyle et al.¹². We used the cutoff point for SMMI from the National Health and Nutrition Examination Survey (NHANES III)¹³, which set a small muscle mass for the elderly as $SMMI < 6.76 \text{ kg} / m^2$ for women and $< 10.76 \text{ kg} / m^2$ for men².

Muscle strength, measured by hand grip, was obtained in triplicate using a Jamar dynamometer and a previously established technique¹⁴. Values $< 30 \text{ kg} / f$ and $< 20 \text{ kg} / f$ for men and women, respectively, were considered unfavorable per EWGSOP². For the assessment of physical performance the gait speed test was conducted in duplicate. This test involves walking a distance of 4 meters on a flat surface, with < 0.8 meters/second being considered slow speed¹⁵.

Sarcopenic obesity was diagnosed when the individual

had a waist circumference ≥ 88 cm for women and ≥ 102 cm for men, along with the diagnosis of sarcopenia¹⁶. Waist circumference was measured with a tape measure in duplicate at the midpoint between the last rib and the iliac crest; the reading performed at the end of the intervention¹⁷.

Socio-demographic, clinical, nutritional and lifestyle variables

Clinical and demographic data was collected from interviews with the patients or obtained from clinical records. We collected information on age, sex, race and education (years of study). The race/color was determined by the interviewer and classified as white, brown or black¹⁸. We considered whether participants had diabetes mellitus (DM), hypertension, or anemia. We assessed inflammatory status using C-Reactive Protein (CRP)¹⁹.

The variables used for the evaluation of the lifestyle were physical activity, evaluated according to the criteria of the American College of Sports Medicine²⁰, which classifies individuals as sedentary, intermediate and active, and smoking (smoker, non-smoker and former smoker).

The following anthropometric variables were assessed: body mass index (BMI), with established classification according to cutoff point for seniors proposed by Lipschitz [26], arm circumference (AC) and calf circumference (CC). For AC, we measured the left arm at the midpoint between the acromion of the scapula and the olecranon of the ulna. The midpoint was determined with the arm flexed at 90°, yet AC obtained with the arm relaxed. The results were compared with reference values provided by the National Health and Nutrition Examination Survey - NHANES III¹¹, and classified as proposed by Blackburn and Thornton²². For CC, the measurement was made at the highest volume of the calf and is considered reduced when CC < 31 cm². Nutritional risk was assessed using the Nutritional Risk Screening (NRS)²³; dietary risk was coded as a NRS score was greater than or equal to 3.

Statistical analysis

The tabulation and analysis of data were carried out with the help of SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). We performed a descriptive analysis of the variables by calculating the frequency distributions and measures of central tendency. Continuous variables were tested according to the standard distribution by the Kolmogorov-Smirnov test and in samples with normal distribution we used the average and standard deviation. The association among categorical variables was analyzed using the Pearson chi-square test. The significance level for all tests was less than 0.05. The performance of nutritional parameters (anthropometry and risk screening) as risk markers of sarcopenia was assessed using the Kappa index, sensitivity, specificity, and accuracy.

RESULTS

During the period of study, 219 elderly were admitted; 48 did not meet the eligibility criteria (2 had edema, 10 due to amputation of limbs, 14 to total bed rest, 11 were on dialysis and 11 were in the immediate postoperative period). In

addition, 1 person refused participation, 13 were discharged, and 9 had data inconsistencies. Thus, we concluded with a sample of 148 subjects, whose average age was 71.6 (± 7.6) years and the most common age group was 60-69 years (43.2%). There was homogeneous distribution between the sexes, the predominance of brown breed (46.6%) and low education (92.6%). About 80% of patients had been diagnosed with acute myocardial infarction or angina, and hypertension and DM prevalence were 90.5% and 45.9%, respectively (Table 1).

Table 1. Sociodemographic, clinical and behavioral characteristics of elderly coronary patients admitted to a cardiology hospital in Northeast Brazil (N= 148).

Variable	n	%
Sex		
Male	76	51.4
Female	72	48.6
Age group (years)		
60-69	64	43.2
70-79	61	41.2
≥ 80	23	15.5
Race		
White	45	30.4
Brown	69	46.6
Black	34	23.0
Civil status		
Married/Stable	77	52.0
Single	27	18.2
Divorced	11	7.4
Widower/Widow	33	22.3
Schooling (years completed)		
≤ 9	137	92.6
> 9	11	7.4
Smoking		
Smoker	22	14.9
Non-smoker	104	70.3
Ex-smoker	22	14.9
Physical activity		
Active	07	4.7
Intermediate	28	18.9
Sedentary	113	68.7
Hypertension	134	90.5
Diabetes Mellitus	68	45.9
Clinical Diagnosis		
Acute myocardial infarction or angina	115	77.7
Others	33	22.3
CRP		
Average	42	31.3
Elevated	92	68.7
Anemia	70	47.3

CRP, C-Reactive Protein.

According to the nutritional screening, 34.9% of subjects had nutritional risk. The prevalence of malnutrition according to AC and CC were 25.7% and 25.0% respectively. The BMI average was $26.6 \pm 4.3 \text{ kg/m}^2$, with a high prevalence of overweight (39.2%). Higher prevalence of malnutrition according to AC was found in males ($p = 0.028$) and according to CC, in females ($p = 0.001$) (Table 2).

The prevalence of sarcopenia was 62.8%, and individuals were mostly classified as severely sarcopenic (72%). Evaluating the criteria for the definition of sarcopenia, 34.5% had reduced handgrip strength; 81.8% slow gait and 75.0% low skeletal muscle mass index. Among non-sarcopenic individuals, 29% had pre-sarcopenia, which was more prevalent in men ($p < 0.001$). The impairment of hand grip strength was similar in men and women, but low gait function was higher in females ($p = 0.027$) and reduced skeletal muscle mass was more prevalent in males (Table 3).

Among the variables analyzed, the presence of sarcopenia was associated with sex, being more prevalent among men ($p = 0.014$), among individuals with advanced age ($p = 0.005$), and malnourished, according to the anthropometric parameters assessed ($p < 0.05$). The other variables associated with sarcopenia are described in Table 4.

We found low performance of diagnostic parameters and nutritional risk screening as markers of sarcopenia: low

sensitivity, concordance and accuracy. Only high specificity was observed, varying from 72.7% to 94.5%, indicating the markers can be useful to determine the absence of sarcopenia, but not its presence (Table 5).

DISCUSSION

The aging of the population has aroused great interest as it is a phase of life in which health-related injuries usually occur with impairment of the autonomy of the elderly. It has been suggested that sarcopenia be regarded as a “geriatric syndrome,” a term for describing a complex, but common clinical situation observed in old age that does not fall into any category of disease (e.g. falls, weakness, delirium, and incontinence, among others)²⁴. The literature provides few studies evaluating sarcopenia in the hospital environment^{3,9}. Therefore, this research aimed to assess the prevalence of sarcopenia in hospitalized coronary heart disease patients using the criteria proposed by EWGSOP, which includes measures of muscle mass, strength and physical performance applied to clinical practice².

CVDs, including ischemic heart disease (the main reason for hospitalization of the study population), are the leading causes of death worldwide and have the greatest impact in low and middle-income countries. In Brazil, even with a reduction in mortality, CVD accounted for 31.2% of

Table 2. Nutritional and anthropometric classification of elderly coronary patients admitted to a cardiology hospital in Northeast Brazil (n= 148).

Variable	n	%	Male (n= 76)		Female (n= 72)		p-value
			n	%	n	%	
Nutritional Screening*							0.227
At Risk	51	34.9	21	28.0	30	42.3	
No Risk	95	65.1	54	72.0	41	57.7	
Body Mass Index**							0.441
Underweight	22	14.9	12	15.8	10	13.9	
Normal weight	68	45.9	38	50.0	30	41.7	
Overweight	58	39.2	26	34.2	32	44.4	
Arm Circumference							0.028
Underweight	38	25.7	24	31.6	14	19.4	
Normal weight	96	64.9	49	64.5	47	65.3	
Overweight	14	9.5	3	3.9	11	15.3	
Calf Circumference							0.001
< 31 cm	37	25.0	10	13.2	27	37.5	
≥ 31 cm	111	75.0	66	86.8	45	62.5	
High waist circumference							<0.001
Yes	67	49.3	21	29.2	46	71.9	
No	69	50.7	51	70.8	18	28.1	

*NRS, 2002; **Lipschitz, 1994

Table 3. Prevalence and classification of sarcopenia; a predominance of sarcopenic obesity and changes to the criteria involved in the diagnosis of sarcopenia in the elderly coronary patients admitted to the cardiology hospital.

Variable	n	%	Male (n=76)		Female (n=72)		p-value
			n	%	n	%	
Sarcopenia							0.022
Yes	93	62.8	55	72.4	38	52.8	
No	55	37.5	21	27.6	34	47.2	
Pre-Sarcopenia*							<0.001
Yes	16	29.0	13	61.9	3	8.8	
No	39	71.0	8	38.1	31	91.2	
Classification of Sarcopenia**							0.142
Sarcopenia	26	27.9	19	34.5	7	18.4	
Severe Sarcopenia	67	72.0	36	65.5	31	81.6	
Sarcopenic Obesity							0.146
Yes	42	29.8	17	23.6	25	36.2	
No	99	70.2	55	76.4	44	63.8	
Grip Strength							0.136
Average	97	65.5	45	59.2	52	72.2	
Low	51	34.5	31	40.8	20	27.8	
Gait Speed							0.027
Average	24	18.2	18	25.3	6	9.7	
Low	108	81.8	53	74.6	56	90.3	
Skeletal Muscle Mass Index							<0.001
Low	111	75.0	69	90.8	42	58.3	
Average	37	25.0	7	9.2	30	41.7	

*Among non-sarcopenic individuals; **Among sarcopenic individuals.

deaths in 2010 and 27.4% of hospitalizations in people over 60 years of age. There is a paucity of literature investigating the occurrence of sarcopenia in these patients^{25,26}.

The prevalence of nutritional risk (34.9%) and malnutrition (varying from 14.9% to 25.7%, depending on anthropometric parameter) observed in this study was less than the national rate among hospitalized elderly Brazilians. The BRAINS survey (Brazilian Investigation of Nutritional Status in hospitalized patients)²⁷, a multicentric research study that included a sample of 10,234 seniors and used MAN (Mini Nutritional Assessment) as a tool for evaluation, reported a prevalence for risk of malnutrition of 69.2% and 38.4% for undernourishment.

Hospital malnutrition relates to higher incidence of complications and mortality, longer hospitalization, increased costs to the health service, delayed recovery, frequent hospital readmissions and reduced quality of life²⁷. Although this study involved a population homogeneous with respect to clinical condition, data on the nutritional status mirrors results for elderly patients hospitalized for various clinical diagnoses.

The high prevalence of sarcopenia observed in this study (62.8%) is a worrying finding considering the impact of this

condition on the quality of life of the elderly. Among the effects of sarcopenia include the reduction of mobility and functional capacity, increased fragility, increased risk of falls and fractures, as well as greater dependency, hospitalizations, and risk of death²⁸.

Data on the magnitude of sarcopenia vary in the literature and depend on the characteristics of the sample (where individuals were sampled from, the ethnic composition of the population and underlying pathologies and the method selected for its definition. Chavez-Moreno et al.⁹, in a study conducted in Mexico, used the predictive equation for obtaining the appendicular skeletal muscle mass, grip strength and a functionality index for the performance of essential daily living activities to classify sarcopenia and found a prevalence of 27.5% of sarcopenia in hospitalized elderly patients, regardless of reason for hospitalization. In a recent study by Gariballa and Alessa²⁹, which aimed to study sarcopenia in elderly hospitalized patients revealed a prevalence of 10%. However, authors only evaluated muscle mass and handgrip strength, and not physical performance as suggested by EWGSOP criteria.

Table 4. Associations between sarcopenia and sociodemographic, clinical, behavioral and nutritional status of elderly coronary patients admitted to a cardiology hospital.

		With sarcopenia		Without sarcopenia		p-value
		n	%	n	%	
Sex	Male	55	72.4	21	27.6	0.014*
	Female	38	52.8	34	47.2	
Age group (years)	60-69	32	50.0	32	50.0	0.005*
	70-79	41	67.2	20	32.8	
	≥ 80	20	87.0	3	10.0	
Race	White	30	66.7	15	33.3	0.517
	Brown	40	58.0	29	42.0	
	Black	23	67.6	11	32.4	
Civil Status	Partner	50	64.9	27	35.1	0.582
	No Partner	43	60.6	28	39.4	
Schooling (total years)	≤ 9	88	64.2	49	35.8	0.330
	> 9	5	45.5	6	54.5	
Smoking	Smoker	14	63.6	8	36.4	0.561
	Non-smoker	63	60.6	41	39.4	
	Ex-smoker	16	72.7	6	27.3	
Physical Activity	Active	3	42.9	4	57.1	0.533
	Intermediate	18	64.3	10	35.7	
	Sedentary	72	63.7	41	36.3	
Hypertension	Yes	84	62.7	50	37.3	0.906
	No	9	64.3	5	35.7	
Diabetes Mellitus	Yes	42	61.8	26	38.2	0.803
	No	51	63.8	29	36.3	
CRP	Normal	25	59.5	17	40.5	0.697
	Elevated	58	63.0	34	37.0	
Anemia	Yes	51	68.0	24	32.0	0.177
	No	40	57.1	30	42.9	
Nutritional Screening	At Risk	36	70.6	15	29.4	0.165
	No Risk	56	58.9	39	41.1	
BMI	Underweight	19	86.4	3	13.6	< 0.001*
	Normal weight	52	76.5	16	23.5	
	Overweight	22	37.9	36	62.1	
AC	Underweight	32	84.2	6	15.8	0.006*
	Normal weight	54	56.3	42	43.8	
	Overweight	22	37.9	7	50.0	
CC	< 31 cm	28	75.7	9	24.3	0.045*
	≥ 31 cm	655	58.6	46	41.4	

*w < 0.05; Hypertension, systemic hypertension; CRP, C-reactive protein; BMI, body mass index; AC, arm circumference; CC, calf circumference.

Table 5. Sensitivity, specificity, consistency and accuracy of the assessment parameters and nutritional risk in diagnosing sarcopenia compared to the skeletal muscle index.

	BMI	AC	CC	NRS
Sensitivity (%)	20.4	34.4	30.1	38.7
Specificity (%)	94.5	89.1	83.6	72.7
Kappa (%)	12.0	20.0	11.0	10.0
Accuracy(%)	48.0	54.7	50.0	51.4

BMI, Body Mass Index; CB, Arm Circumference; CP, Calf Circumference; NRS, Nutritional Risk Screening

A study conducted by Patel et al.⁴, applied the EWGSOP criteria and found a prevalence of 7.8% sarcopenia in a sample of 1,787 elderly community residents in the UK, whose fat-free mass was assessed using anthropometry. However, in a small subsample of 103 men, in which lean body weight was determined by Dual Energy X-ray Absorptiometry (DEXA) a prevalence of 6.8% was found. Another study considered only skeletal muscle mass assessed by BIA and DEXA and found a prevalence of sarcopenia of 70.7% in men and 41.9% in women³⁰.

We observed that 72.0% of sarcopenic participants had severe sarcopenia (unfavorable condition for the three diagnostic criteria: mass, strength, and function) and among non-sarcopenic participants, 29.0% had pre-sarcopenia (reduced muscle mass only). These data are different than previous findings of other authors. In a study conducted in a German hospital using the same criteria adopted in this research, Smoliner et al.³ identified that 25.3% of patients had sarcopenia, among which 18.7% had severe sarcopenia. In another study evaluating elderly persons seen in a geriatric outpatient clinic of a university hospital in northeast Brazil, the prevalence of sarcopenia was 18% and among these sarcopenic individuals, 66.7% had severe sarcopenia⁵.

The high percentage of severe sarcopenia may be attributed to the fact that the sample involved hospitalized cardiac patients. The cross-sectional design of this study does not infer cause and effect. However, as recent evidence has indicated, sarcopenia can be an independent predictor of cardiovascular disease. Sarcopenia is associated with arterial stiffness, the relative increase in fat tissue and replacement myocyte by adipocytes⁷. Thus, it is possible that these cardiac patients are often more at risk than patients without sarcopenia. Moreover, our study was conducted in a public hospital and the individuals had a high percentage of low educational level (92.6% with less than nine years of schooling), it can be assumed that participants were low-income. This may compromise access to a healthy diet from a qualitative and quantitative point of view.

A significant percentage of patients had sarcopenic obesity (29.8%). Its classification has a topic of controversy in the literature and there is still no consensus for such an

assessment. Therefore, it is difficult to carry out a comparative analysis with previously published data. Atkin et al.⁸ report that together, sarcopenia and obesity may increase the magnitude of effects on metabolic diseases, cardiovascular diseases and mortality rates as compared with obesity or sarcopenia alone.

Among the procedures adopted for diagnosis of sarcopenia, slow gait speed (which predicts functionality) showed the worst result (81.8% slow gait speed). A wide variety of tests are available for the assessment of physical performance. However, gait speed is considered a secure and reliable indicator for the screening of functional capacity, which can be used in clinical and research environments capable of reflecting the risk of adverse outcomes related to the health of the elderly^{2,14}.

Hand grip, which has been widely used and considered one of the validated techniques to measure muscle strength, was the criterion least related to sarcopenia (34.5%) in this research. A weak hand grip is a clinical marker of reduced mobility which has been associated with mortality in patients with advanced age and can be a reliable substitute for more sophisticated measures of muscle strength in the upper limbs, which also correlates with leg force². In a 24-year longitudinal study, Gale et al.³¹ observed that hand grip was a predictor of long-term mortality from cardiovascular disease and cancer in men.

The higher prevalence of sarcopenia in males corroborates evidence that has demonstrated a more pronounced decrease in muscle mass and strength in men compared to women. Janssen et al.³² reported a prevalence of sarcopenia 31% among elderly females and 64% among males. Men tend to have more muscle loss due to the decline of growth hormone, growth factor related to insulin (IGF-1) and testosterone; also, they have worse adaptation to muscle loss than women³³.

The increased prevalence of sarcopenia *pari passu* with the progression of age observed in this study has been reported in previously published data^{5,33}. It is known that age is a determining factor for the occurrence of sarcopenia. In addition, there is an increase in prevalence with each decade of life, as shown by Leite et al.³³, who reported a prevalence between 13% and 24% for ages 65-70 years and over 50% for those over 80.

Although we did not observe an association between sarcopenia and race in this investigation some have found higher muscle mass values for persons of African descent group compared to Caucasians and Asians³⁴. Delmonico et al.³⁵ reported the prevalence of sarcopenia among white men and women was 25.2% and 31.4%, respectively, and for blacks, 11.8% and 6.8%, respectively. The lower prevalence of sarcopenia in persons of African descent has been attributed to different amounts of lean mass and a greater amount of skeletal muscle. Mainly due to genetic factors, this group has higher testosterone compared to whites and thus may be more protected from tissue reduction that accompanies aging³⁶.

Despite not having been identified to be associated with sarcopenia in the current study, one of the primary causes of this condition is the lack of physical activity. Kortebein et al.³⁷, demonstrated that the effect of 10 days of rest in healthy elderly individuals resulted in a loss of 3% in fat-free mass and 15% muscle strength. Physical exercise, especially resistance training, has been indicated as the most effective strategy to prevent and reverse sarcopenia, with benefits for strength and muscle mass³⁸.

The metabolic effects of sarcopenia include lower resting energy expenditure, reduced fat oxidation, increased insulin resistance, and higher predisposition to DM, dyslipidemia and hypertension^{3,4}. However, in this study, no association with sarcopenia was found with these conditions.

The literature suggests that inflammation may also relate to sarcopenia. Cesari et al.³⁹, showed that CRP and Interleukin-6 were inversely associated with fat-free mass. In this study, no association was observed between the prevalence of sarcopenia and inflammation, possibly because all individuals were hospitalized due to a coronary event. We measured CRP, which is a non-specific marker of inflammation and can be altered by many clinical situations. Thus, it is likely that in this circumstance, its alteration was more associated with other causes besides sarcopenia. This relationship should be further investigated in healthy subjects.

Malnutrition, assessed by anthropometric parameters (BMI, AC, and CC), was significantly associated with sarcopenia. Smoliner et al.³, on the other hand, observed that 53% of patients identified as malnourished or at nutritional risk were not considered sarcopenic. Although malnourished individuals are more likely to develop the condition of sarcopenia, given that the causative factors of both are similar and sometimes interrelated, it is important to emphasize that sarcopenia is a condition that involves other aspects in addition to mass muscle like strength and functionality.

Sarcopenia is still poorly assessed in clinical practice; equipment to measure sarcopenia is often unavailable and the test is difficult for elderly patients. Thus, the performance of easily obtained anthropometric parameters (BMI, CB and CC) and a nutritional risk score (NRS) as a marker of sarcopenia were tested, however, it was verified that these variables presented low sensitivity, agreement and accuracy. This finding reinforces the multidimensionality of sarcopenia, showing that diagnostic markers or nutritional risk measurements alone are not sufficient to predict the breadth of this condition, which includes functionality, muscle mass and strength. Therefore, anthropometry is limited and should not be used alone in the nutritional assessment of the elderly.

Some limitations must be considered when interpreting the data presented. The cross-sectional design of this study is a restriction in the analysis of causal relations between exposure variables and sarcopenia. Additionally, participants in the study were obtained from a reference hospital for cardiology. Therefore, the extrapolation of findings for

other older individuals should be carried out with caution. Another limitation was that diet, which is critical to muscle preservation, was not assessed. However, since we conducted a hospital-based study, dietary intake may vary compared to eating habits of other populations of older individuals. In addition, as the study was conducted with an elderly population, it must be mentioned that memory difficulties may make an accurate dietary accounting difficult.

The prevalence of sarcopenia was high in our sample, with higher rates in males, elderly patients with advanced age and underweight--o. Anthropometric parameters and nutritional risk screening were not useful markers for identification of sarcopenia. Considering the lack of research on the problem of sarcopenia in cardiac patients and the significant prevalence in these patients, this study contributes to building greater awareness among health professionals regarding the importance of evaluating, monitoring and preventing this condition to establish strategies to treat these patients and offer them better-living conditions. Moreover, it is important that other studies be developed in different populations so that a consensus can be reached on the characteristics of individuals with higher risk for sarcopenia. Also, prospective studies would be useful for elucidating the role of sarcopenia as a marker of cardiovascular risk.

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