DOI: 10.1590/1809-2950/17533725022018

ORIGINAL RESEARCH

Alternative appendicular muscle mass cut-off points for verification of sarcopenia in older Brazilians: data from Rede Fibra – Belo Horizonte/Brazil

Pontos de corte alternativos para massa muscular apendicular para verificação da sarcopenia em idosos brasileiros: dados da Rede Fibra – Belo Horizonte/Brasil

Puntos de corte alternativos para la masa muscular apendicular para la certificación de la sarcopenia en ancianos brasileños: datos de Red Fibra – Belo Horizonte/Brasil

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ABSTRACT | Alternative cut-off points for the calculation of appendicular muscle mass (AMM) in older Brazilians were established to classify sarcopenia. Data from 562 older adults from Belo Horizonte who participated in the Fibra study (Fragilidade em Idosos Brasileiros [Fragility in Older Brazilians) were analyzed. Through Lee's equation, cut-off points for AMM were determined based on the 20th percentile of their distribution in the studied population. Then, the subjects were classified for sarcopenia according to the criteria of the European Consensus on Definition and Diagnosis of Sarcopenia in Older Adults, and its possible associations with functional capacity and comorbidities were evaluated. Most of the sample was composed by women (65.5%) with 74.1 years of age (±6.4) and 1.5 (±1.4) comorbidities on average. The cut-off points for AMM were <6.47kg/m^2 for women and <8.76kg/m^2 for men. The prevalence of sarcopenia was 14.9%, 13.5% of the population being partially dependent for basic activities of daily living (BADL), 30.6% for instrumental activities of daily living (IADL) and 66.7% for advanced activities of daily living (AADL). Sarcopenia was correlated with IADL only (r=0.081, p=0.05), and a negative correlation was found between sarcopenia and comorbidities (r=−0.103, p=0.014). Cut-off points specific to AAM for the population of older Brazilians were proposed, and no correlations between the variables of the study were found, except for IADL and comorbidities.

Keywords | Sarcopenia; Older Adults; Muscles; Reference Values.

RESUMO | Estabeleceram-se pontos de corte alternativos para o cálculo da massa muscular apendicular (MMA) em idosos brasileiros para classificar a sarcopenia. Foram analisados dados de 562 idosos participantes do estudo Fibra (Fragilidade em Idosos Brasileiros), no polo Belo Horizonte. Por meio da equação de Lee, determinaram-se pontos de corte para MMA baseado na percentil 20 de sua distribuição na população estudada. Em seguida, os sujeitos foram classificados para sarcopenia de acordo com os critérios do Consenso Europeu sobre Definição e Diagnóstico da Sarcopenia em Idosos, além de avaliadas as possíveis associações desta com a capacidade funcional e comorbidades. A maioria da amostra foi composta por mulheres (65,5%) com idade média de 74,1 (±6,4) e média de 1,5 (±1,4) comorbidades. Os pontos de corte para MMA foram <6.47kg/m^2 para mulheres e <8.76kg/m^2

Study presented at the International Conference on Frailty and Sarcopenia Research 2015 – Boston (MA), USA.

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para homens. A prevalência de sarcopenia foi de 14,9%, sendo 13,5% da população parcialmente dependente para atividades básicas de vida diária (ABVD), 30,6% para atividades instrumentais de vida diária (AIVD) e 66,7% para atividades avançadas de aida diária (AAVD). A sarcopenia se correlacionou apenas com AIVD (r=0,081, p= 0.05), e encontrou-se uma correlação negativa entre sarcopenia e comorbidades (r= −0,103, p=0,014). Foram propostos pontos de corte específicos para MMA para a população de idosos brasileiros e não foram encontradas correlações entre as variáveis do estudo, exceto para AIVD e comorbidades.

Descritores | Sarcopenia; Idosos; Músculos; Valores de Referência.

RESUMEN | Se establecieron puntos de corte alternativos para el cálculo de la masa muscular apendicular (MMA) en ancianos brasileños para clasificar la sarcopenia. Fueron analizados datos de 562 ancianos participantes del estudio Fibra (Debilidad en Ancianos Brasileños), en el polo Belo Horizonte. Por medio de la ecuación de Lee, se determinaron puntos de corte para MMA basado en la percentil 20 de su distribución en la población estudiada. Luego, los sujetos fueron clasificados para sarcopenia de acuerdo con los criterios del Consenso Europeo sobre Definición y Diagnóstico de la Sarcopenia en Ancianos, además de evaluadas las posibles asociaciones de esta con la capacidad funcional y comorbidades. La gran parte de la muestra fue compuesta por mujeres (el 65,5%) con edad media de 74,1 (±6,4) y promedio de 1,5 (±1,4) comorbidades. Los puntos de corte para MMA fueron <6.47kg/m^2 para mujeres y <8.76kg/m^2 para hombres. La prevalencia de sarcopenia fue del 14,9%, siendo el 13,5% de la población parcialmente dependiente para actividades básicas de vida diaria (ABVD), el 30,6% para actividades instrumentales de vida diaria (AIVD) y el 66,7% para actividades avanzadas de vida diaria (AAVD). La sarcopenia se correlacionó solamente con AIVD (r=0,081, p= 0.05), y se encontró una correlación negativa entre sarcopenia y comorbidades (r= −0,103, p=0,014). Fueron propuestos los puntos de corte específicos para MMA para la población de ancianos brasileños y no fueron encontradas correlaciones entre las variables del estudio, excepto para AIVD y comorbidades.

Palabras clave | Sarcopenia; Ancianos; Músculos; Valores de Referencia.

INTRODUCTION

Sarcopenia is an age-related condition that mostly affects the functional capacity of older adults, leading to a high incidence of adverse effects like falls, fractures, hospitalization and even death, increasing also the burden to the health system[1-3]. Irving Rosenberg was who first described this syndrome in 1989, characterizing it as a decline of muscle mass inherent to the aging process[4]. Since then, many researchers have become aware of it and new definitions and evaluation methods have been developed. There is still no valid and consistent classification for sarcopenia, but due to its multifactorial origin (molecular, biochemical, morphological, physiological, neural, nutritional, among others), it is a general agreement that not only muscle mass, but other variables contribute to the development of this syndrome[5-7].

In 2009, the International Working Group on Sarcopenia (IWGS) proposed its diagnosis based on low total body lean mass or reduced appendicular lean mass associated with poor physical function[5]. A year later, a clinical consensus[7] for the diagnosis of sarcopenia was established by the European Working Group on Sarcopenia in Older People (EWGSOP), according to which the loss of muscle mass – characterized by a loss of muscle mass two standard deviation below the reference population – should be associated with reduced muscle strength and/or decline of physical function. This same consensus suggests that muscle mass should be measured through imaging tests considered to be the gold standard, such as computed tomography, magnetic resonance or densitometry. However, when their use is not possible, more economic options with easier applicability are suggested, including indirect methods like body circumference calculation or estimating equations[7].

The heterogeneity in the classification and assessment techniques reflect the great variance of its prevalence in different populations. Cruz-Jentoft et al.[7] demonstrated a prevalence of 5% to 13% in older adults between 60-70 years old, possibly reaching 50% in those with 80 years of age or older. These pieces of data reinforce the need for population-specific studies so that it becomes possible to standardize the diagnosis of sarcopenia and, especially, define cut-off points for muscle mass measures[8].

Many studies have been conducted comparing different diagnostic criteria for sarcopenia and the relationship between its prevalence and adverse

outcomes. The results have shown low agreement, when the various methods are compared, and prevalence has been variable, according to the instrument and cut-off points used for evaluation of lean muscle mass[9-12].

Due to the lack of reference values for the older Brazilian population, the need to better classify and understand the specificities of sarcopenia, in addition to its clinical and functional outcomes for this population and the high cost of the imaging resources used to estimate muscle mass, the objective of this study was to suggest alternative cut-off points for the calculation of appendicular lean mass (ALM), using a predictive equation that can be easily employed in clinical practice for early detection of loss of lean body mass and diagnosis of sarcopenia, in addition to establishing possible correlations between this syndrome and functional capacity and comorbidities in Brazilian older adults.

METHODOLOGY

The Fibra study is an epidemiological, transversal, multidisciplinary and multicentric study approved by the Research Ethics Committee of Universidade Federal de Minas Gerais under number 187/07, which relied on data from a sample of approximately seven thousand older adults from all regions of Brazil. The study used a probabilistic sample of older adults from communities separated according to their density distribution, based on the Brazilian Demographic Census from 2000[13].

This work used a sub-sample of 601 older adults, men and women, who answered the Fibra questionnaire and completed the physical-functional tests (handgrip strength and gait speed in 4.6 m). Those who exhibited severe cognitive, motor, visual or auditory deficits, wheelchair users or bedridden and terminally ill individuals, were excluded from the study. A total of 562 older adults participated in the analysis, seeing as 39 of them had incomplete data related to physical measurements (weight or height), or because the group to which they belonged (indigenous) was not included in the equation used in this research for classifying muscle mass.

Lee et al.[15] equation was used to estimate AMM:

AMM = (0.244×body weight-kg) + (7.8×height-m) + (6.6×gender) – (0.098×age) + (race-3.3).

The value assigned to women was 0 and for men it was 1; 0 for whites or Hispanics; 1.4 for African-Americans; and –1.2 for Asians. This formula showed strong agreement with dual-energy X-ray densitometry (DEXA) and with the prevalence of sarcopenia. It has already been validated for use on the Brazilian population having DEXA as gold standard, with high correlation values (r=0.86 for men and r=0.90 for women)[16].

Sarcopenia was characterized as proposed by EWGSOP[7], based on grip strength evaluated using a *Jamar* manual dynamometer to measure muscle strength (positive for values <20kgf for women and <30kgf for men). Gait speed in a 4.6 meters course was used to verify muscle performance (positive, if <0.8m/s) and muscle mass was evaluated through Lee's equation, with cut-off points established based on the inferior 20th percentile, according to the distribution of the AMM values in the study population. The subjects were classified as pre-sarcopenic if they exhibited reduced muscle mass only, as sarcopenic if in addition to low muscle mass, they exhibited reduction of strength or muscle performance, and as severely sarcopenic if they exhibited all three of these variables[7].

Functional capacity was assessed through questionnaires on activities of daily living (ADL). The Katz scale was used to verify the basic activities of daily living (BADL)[17], the Lawton scale was used to classify the instrumental activities of daily living (IADL)[18], and a semi-structured questionnaire was used for the advanced activities of daily living (AADL). Comorbidities were assessed through the subjects' self-reports, the medical diagnosis of these pathologies in relation to the last year having been confirmed. They included: heart and pulmonary diseases, hypertension, diabetes mellitus, cancer, arthritis, depression, osteoporosis and stroke (CVA).

The descriptive statistical analyses were conducted through percentages for categorical variables and mean, and standard deviation (SD) for numeric variables. The normality of the data was verified through the Kolmogorov-Smirnov test, which showed normal distribution, justifying the use of nonparametric tests.

Spearman's correlation test was used to verify the correlations between sarcopenia and functional capacity and the number of comorbidities. All the analyses were conducted at α=0.05 significance level and 95% confidence interval, using the SPSS software version 16.0.

RESULTS

Of the 562 older adults, 65.5% were women with average age of 74.2 years old (±6.43), 13.5% were partially dependent for BADL and none were classified as dependent in that category. In relation to IADL, 30.6% were partially dependent and 6.6% were dependent for these activities, while 66.7% were partially dependent and 32.7% were dependent for AADL. Nine comorbidities had been diagnosed by a doctor in the last year, hypertension (55.1%) and arthritis (26.6%) having been the most prevalent (Table 1). The prevalence of sarcopenia for each functional profile is shown in Table 2. The subjects had 1.54 (±1.38) comorbidities and took 3.56 (±2.83) medicines/day on average. Pre-sarcopenic individuals encompassed 5.2% of the sample (low muscle mass only), 10.5% were classified as sarcopenic (low muscle mass associated with reduced strength or poor performance) and 4.4% were severely sarcopenic (reduction in the three variables: muscle mass, strength and performance).

Table 1. Clinical and demographic characteristics of the sample (n=562)

Variables	Means (±standard deviation) or percentages
Age	74.2 (±6.43)
Gender	
Male	194 (34.5%)
Female	368 (65.5%)
Non-sarcopenic	448 (79.7%)
Pre-sarcopenic	29 (5.2%)
Sarcopenic	59 (10.5%)
Severely sarcopenic	25 (4.5%)
Number of medications	3.54 (±2.83)
Number of comorbidities	1.54 (±1.38)
Comorbidities	
Hypertension	309 (55.1%)
Arthritis/rheumatism	150 (26.6%)
Diabetes	96 (17%)
Osteoporosis	92 (16.5%)
Heart diseases	70 (12.4%)
Depression	90 (15.9%)
Pulmonary diseases	38 (6.8%)
Stroke	20 (3.5%)
Cancer	11 (2.1%)

Table 2. Dependency profiles (activities of daily living) of the sample according to the diagnosis of sarcopenia (n=562)

	Independent (n/%)					
	BADL		IADL		AADL	
Non-sarcopenic	389	80.2%	287	81.5%	3	100%
Pre-sarcopenic	28	5.4%	21	6%	0	0%
Sarcopenic	49	10.1%	37	10.5%	0	0%
Severely sarcopenic	21	4.3%	7	2%	0	0%
Total	485	100%	352	100%	3	100%
	Partially dependent (n/%)					
	BADL		IADL		AADL	
Non-sarcopenic	59	77.6%	134	77.9%	292	78.1%
Pre-sarcopenic	3	3.9%	8	4.7%	19	5.1%
Sarcopenic	10	13.2%	18	10.5%	44	11.8%
Severely sarcopenic	4	5.3%	12	7%	19	5.1%
Total	76	100%	172	100%	374	100%
	Dependent (n/%)					
	IADL		AADL			
Non-sarcopenic	27	73%	153	83.2%		
Pre-sarcopenic	0	0%	10	5.4%		
Sarcopenic	4	10.8%	15	8.2%		
Severely sarcopenic	6	16.2%	6	3.3%		
Total	37	100%	184	100%		

BADL: basic activities of daily living; IADL: instrumental activities of daily living; AADL: advanced activities of daily living

After the calculation of the estimate of appendicular lean mass (ALM) through Lee's equation, the cut-off points adjusted by (height)^2 were established based on the 20th percentile of the average result of the sample's distribution. The values were set as: <6.47kg/m^2 for women and <8.76kg/m^2 for men.

The magnitude of correlations between sarcopenia and ADL and the number of comorbidities were verified with Spearman's correlation test (Table 3). There were no significant correlations between sarcopenia and BADL (r=0.02 and p=0.56). A weak but relevant negative correlation was detected between sarcopenia and BADL (r=–0.08 and p=0.05). A weak and non-considerable correlation was found between sarcopenia and AADL (r=0.07 and p=0.08). Between sarcopenia and comorbidities, there was a significant negative correlation (r=–0.10 and p=0.01).

Table 3. Spearman's correlation coefficient between sarcopenia, activities of daily living and comorbidities (n=562)

	Correlation coefficient (r)	Sig. (2-*tailed*)
Sarcopenia × BADL	0.02	0.57
Sarcopenia × IADL	−0.08	0.05
Sarcopenia × AADL	0.07	0.08
Sarcopenia × Comorbidities	−0.10	0.01

BADL: basic activities of daily living; IADL: instrumental activities of daily living; AADL: advanced activities of daily living; significant correlation p=0.05 (2-tailed)

DISCUSSION

The main objective of this study was to determine cut-off points for AAM using an alternate method for older adults from communities in Belo Horizonte/Brazil, thus facilitating the screening of sarcopenia. Many studies have shown that the classification of sarcopenia is highly dependent on the method used to assess it, as well as on population specificity[7,8,10,11].

Our findings regarding the AAM values (<6.47kg/m² for women and <8.76kg/m² for men) are similar to those found by Alexandre et al.[19] (<6.37kg/m² for women and <8.90kg/m² for men), who used data from the Sabe study (Saúde, Bem-Estar e Envelhecimento)[20]. The Fibra and Sabe studies are large-scale Brazilian epidemiological studies, with samples derived from metropolitan regions of Brazil (Belo Horizonte and São Paulo). The Sabe study is an international consortium between seven countries of Latin America and the Caribbean, and gathered data about the living conditions of the older population (> 60 years old) and their access to health care. The Fibra study, on the other hand, is a national, multicenter study consisting of four main poles, which aims to characterize the profile of fragility of older Brazilians over the age of 65. Despite being studies with different goals and converging samples, the similar values found for AAM indicate that these are good options for application to the Brazilian population.

Our cut-off points differ from those proposed by EWGSOP[7], who determine the AAM for Caucasian subjects through DEXA, based on values which have as reference a young population with lower scores for men (<7.26kg/m²) and women (<5.5kg/m²). However, a Brazilian study[16] showed that the use of anthropometric equations to estimate muscle mass in older adults is an excellent alternative. In this research, the values of prevalence of sarcopenia based on DEXA, when compared to Lee's equation, did not differ (DXA=33%; Lee's equation=36.1%) and demonstrated high agreement (k=0.74; p<0,00), specificity (89%) and sensibility (86%). This same study also showed that the values of skeletal muscle mass, when estimated by any of these methods, showed no difference (p>0.05) and had good correlation for both men (r=0.90, p<0.00) and women (r=0.86; p>0.00).

This study found 14.9% of sarcopenic older people, corroborating the findings of another Brazilian study[19] that used the EWGSOP as a method for diagnosis of sarcopenia and the same equation for prediction of AAM. However, a recent systematic review showed prevalence ranging between 1% and 29% in the population of older adults from communities. Interestingly, all the studies also used EWGSOP's classification, but the differences between the populations and the methods used to access muscle mass (DEXA, bioimpedance, forearm circumference and cutaneous folds) resulted in heterogeneous prevalence[8].

Bjlsma et al.[9] compared seven different diagnostic criteria based on muscle mass and handgrip strength and found an extensive prevalence of sarcopenia without agreement between them, only one of the 654 subjects having been classified as sarcopenic by the seven methods applied. These findings suggest an urgent need to establish cut-off points that are population-specific, which is the case of our study, which used an equation that was highly correlated to a gold standard for evaluating muscle mass[14,15], to determine alternative cut-off points for AAM through an alternative low-cost method that is easily applicable in clinical practice.

Sarcopenia is usually correlated to various adverse outcomes, including the loss of functional capacity for ADL[21,22-24]. In this study, no significant correlations were found between sarcopenia and BADL or AADL, just a significant negative correlation with IADL (r=−0.08; p=0.05), indicating that the more sarcopenic they are, the more dependent the subjects probably are in relation to these activities.

It is well established in the literature that there is a hierarchy in the loss of functional capacity in older adults: it usually starts at the level of more complex activities, which are related to the subject's interactions with the environment and society (AADL and IADL) and in a later stage, there is a decline in self-care and basic survival activities (BADL)[25-27]. In our study, this hierarchy of loss is perceived through the lower

prevalence of dependency in BADL, which increases for IADL and AADL, respectively. The absence of correlation between sarcopenia and disabilities for ADL, however, can be explained by the characteristics of our sample of older adults from communities.

It is interesting to note that the loss of strength, evaluated through handgrip strength, was present in 53.9% of the sample of sarcopenic older adults, and this measure being suggestive of global loss of strength, we can infer that this would be the initial trigger for the disabilities caused by the decay of muscle mass. Manini and Clark[28] conducted a systematic review and calculated the relative risk (RR) of developing a poor physical performance, functional limitations or physical disability in older adults with dynapenia (reduced muscle strength) and sarcopenia (low muscle mass), and found a RR corresponding to 2.20 (95% CI: 1.5-3.1) for low muscle strength, while for reduced muscle mass, this risk was 1.37 (95% CI: 0.87-2.0). It is important to note that only a small portion of the subjects in our sample was considered sarcopenic and that they could have been at the beginning of the disability process, in which losses are generally underestimated or hardly detected, especially through self-report instruments.

Sarcopenia was negatively correlated with the number of comorbidities in our study, differently from findings of other studies in which this syndrome was associated with chronic conditions. Li et al.[29] showed correlation between low muscle mass and the presence of two or more comorbidities with physical performance, while Newman et al.[30] showed that older men with three or more comorbidities, of 11 comorbidities which were jointly analyzed, exhibited increased chances of developing sarcopenia. However, when these conditions were individually analyzed, only cancer was associated with the syndrome. Similar results were found in another study that demonstrated, in a univariate analysis, that there was no correlation between sarcopenia and several comorbidities, a significance which remained positive only for chronic kidney disease after adjustments for gender and age[31].

In the results of this study, the older adults had on average 1.54 (±1.38) comorbidities, which is very low when compared to the correlations seen in the studies mentioned. Our sample was composed of older adults from communities, which are usually more active and healthy, not yet affected by a large number of comorbidities that may lead to weakness, loss of muscle mass or physical performance.

A limitation of our study is that the cut-off point was not found using a gold-standard instrument, however, the results are in line with another research conducted in Brazil[19], showing that these may be reliable values for our population. Another relevant point is that the equation used is an important tool and perhaps the only one that can be applied in public health at the expense of high-cost instruments such as magnetic resonance or computed tomography, which also expose the subject to radiation. Another strong point of the study is the large and representative sample of the population, which reinforces its findings.

In this way, with the cut-off points found in this study, it is feasible that, with simple evaluations, health professionals, including physical therapists, in their daily clinical routine, are able to identify sarcopenia in the initial stages of functional loss, and develop prevention measures to ensure its advance and the functionality and quality of life of older people for longer.

AKNOWLEDGEMENTS

To Fundação de Amparo à Pesquisa de Minas Gerais (Fapemig), to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and to Hospital das Clínicas/UFMG.

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