



Are maximum respiratory pressures predictors of sarcopenia in the elderly?

Rhaine Borges Santos Pedreira¹, Marcos Henrique Fernandes¹,
Thaís Alves Brito¹, Paloma Andrade Pinheiro¹, Raildo da Silva Coqueiro¹,
José Ailton Oliveira Carneiro¹

1. Universidade Estadual do Sudoeste da Bahia – UESB - Jequié (BA) Brasil.

Submitted: 23 August 2021.
Accepted: 20 December 2021.

Study carried out in the Núcleo de Estudos em Epidemiologia do Envelhecimento, Universidade Estadual do Sudoeste da Bahia – UESB – Jequié (BA) Brasil.

ABSTRACT

Objective: To compare maximum respiratory pressures and spirometric parameters among elderly individuals classified as having no sarcopenia, probable sarcopenia, and confirmed sarcopenia, and to test the ability of these variables to discriminate sarcopenia in a community-dwelling elderly population. **Methods:** This was a cross-sectional study involving 221 elderly (≥ 60 years of age) individuals of both sexes. Sarcopenia was diagnosed in accordance with the new consensus of the European Working Group on Sarcopenia in Older People. Maximum respiratory pressures and spirometry parameters were assessed. **Results:** The prevalences of probable sarcopenia and confirmed sarcopenia were 20.4% and 4.1%, respectively. Regardless of the sex, those with confirmed sarcopenia had significantly lower MEP than those with no sarcopenia and probable sarcopenia, whereas only males with confirmed sarcopenia presented with significantly lower MIP than did the other individuals. There was an inverse association of MIP and MEP with sarcopenia, indicating that the decrease by 1 cmH₂O in these parameters increases the chance of sarcopenia by 8% and 7%, respectively. Spirometric parameters were not associated with sarcopenia. Cutoff points for MIP and MEP, respectively, were ≤ 46 cmH₂O and ≤ 50 cmH₂O for elderly women, whereas they were ≤ 63 cmH₂O and ≤ 92 cmH₂O for elderly men, and both were identified as predictors of sarcopenia (area under the ROC curve > 0.70). **Conclusions:** Sarcopenia was associated with lower maximum respiratory pressures, but not with spirometric parameters. Maximum respiratory pressures can be used as markers of sarcopenia in a community-dwelling elderly population regardless of the sex.

Keywords: Aging; Sarcopenia; Maximal respiratory pressures; Spirometry.

INTRODUCTION

The current European Working Group on Sarcopenia in Older People (EWGSOP) consensus⁽¹⁾ defines sarcopenia as a muscle disease diagnosed when there is a decline in muscle strength and mass. Recent evidence indicates that sarcopenia can affect the respiratory muscles,⁽²⁾ compromising their strength and impacting lung volumes and capacities,^(1,3) which increases the risk of respiratory diseases.^(3,4)

Although some respiratory parameters have already been shown to predict sarcopenia, PEF seems to be the spirometric parameter most frequently associated with this disease.⁽⁵⁻⁷⁾ The decline in PEF with advancing age makes it useful for assessing the severity of sarcopenia in the respiratory muscles of longevous elderly individuals.⁽⁵⁾ In addition, elderly people with sarcopenia have lower respiratory muscle strength, which is associated with the decline in strength and mass of peripheral muscles and physical performance.⁽⁸⁾

The change proposed by the EWGSOP⁽¹⁾ to diagnose sarcopenia, in which the assessment of muscle strength

becomes a priority, has created a gap in the literature, justifying further studies that follow current guidelines. Thus, it will be possible to verify whether the proposed changes may affect the diagnosis and behavior of sarcopenia in relation to other health conditions.

We have started with the hypothesis that respiratory parameters can be predictors of sarcopenia in the elderly, and this appears to be the first study to evaluate the capacity of maximum respiratory pressures (MRPs) and spirometric parameters to discriminate sarcopenia within a community-dwelling elderly population, using as a diagnostic criterion the most recent proposal of the EWGSOP consensus.⁽¹⁾ Thus, research to investigate the relationship between sarcopenia and respiratory condition in the elderly can contribute to the health care of this population group, making it opportune to diagnose sarcopenia in the elderly undergoing respiratory tests.

This study aimed to compare MRPs and spirometric parameters in a sample of elderly people classified as having no sarcopenia, probable sarcopenia, and confirmed sarcopenia, and to test the ability of these variables

Correspondence to:

Rhaine Borges Santos Pedreira. Universidade Estadual do Sudoeste da Bahia, Núcleo de Estudos em Epidemiologia do Envelhecimento, Rua José Moreira Sobrinho, s/n, Jequiezinho, CEP 45205-490, Jequié, BA, Brasil.

Tel.: 55 73 3528-9600. E-mail: rhaineborges@gmail.com

Financial support: This study received financial support from the *Fundação de Amparo à Pesquisa do Estado da Bahia* (FAPESB, Foundation for the Support of Research in the State of Bahia; Grant no. BOL0603/2018).

to discriminate sarcopenia in a community-dwelling elderly population.

METHODS

This was a cross-sectional study, with data from the project designated "Nutritional status, risk behaviors, and health conditions of the elderly in Lafaiete Coutinho-BA", which was approved by the Research Ethics Committee of the State University of Southwest Bahia (Protocol no. 491.661).

We had the support of the Municipal Health Department of Lafaiete Coutinho, a municipality in the state of Bahia, Brazil, which is 100% covered by the Brazilian Family Health Strategy, to locate the elderly (≥ 60 years of age) registered in the two Health Care Units in the urban area of the municipality. Thus, a census was carried out, and 331 individuals were identified in the initial screening. Of this total, 3 individuals refused to participate in the study and 10 were excluded because they were not located after three attempts. Therefore, 318 elderly people participated in the interviews. Participants whose information for the classification of sarcopenia was incomplete and those who did not undergo manometry and/or spirometry tests were excluded. The final sample of this study involved 221 elderly individuals (Figure 1).

Data collection took place in two occasions. Initially, a household interview was carried out using an instrument based on the Health, Well-being and Aging survey,⁽⁹⁾ the International Physical Activity Questionnaire adapted for the elderly population,⁽¹⁰⁾ and the Geriatric Depression Scale,⁽¹¹⁾ the latter two

validated for use in Brazil. Tests were also applied to assess functional performance in the first occasion. In the second moment, the elderly participants were invited to attend the Health Care Unit where they were registered, at a previously scheduled time, to perform anthropometric measurements, the handgrip strength test, and respiratory tests.

Sarcopenia (dependent variable)

Sarcopenia was diagnosed based on the algorithm recently proposed by the EWGSOP consensus.⁽⁴⁾ Initially, the elderly participants were classified as having no sarcopenia (adequate muscle strength, muscle mass, and physical performance); probable sarcopenia (insufficient muscle strength, but adequate muscle mass and physical performance); confirmed sarcopenia (insufficient muscle strength and muscle mass, but adequate physical performance); and confirmed severe sarcopenia (insufficient muscle strength, muscle mass, and physical performance). Then, the variable sarcopenia was retrieved, being considered for data analysis three categories: no sarcopenia, probable sarcopenia, and confirmed sarcopenia (including severe disease).

Muscle strength

Peripheral muscle strength was assessed through the handgrip strength test, using a hydraulic dynamometer (Saehan Corporation SH5001, Dangjin, South Korea).⁽¹²⁾

Insufficient muscle strength was defined according to sex and BMI.⁽¹³⁾ The BMI was classified into three categories⁽¹⁴⁾: BMI < 22 kg/m² (low weight); 22 kg/

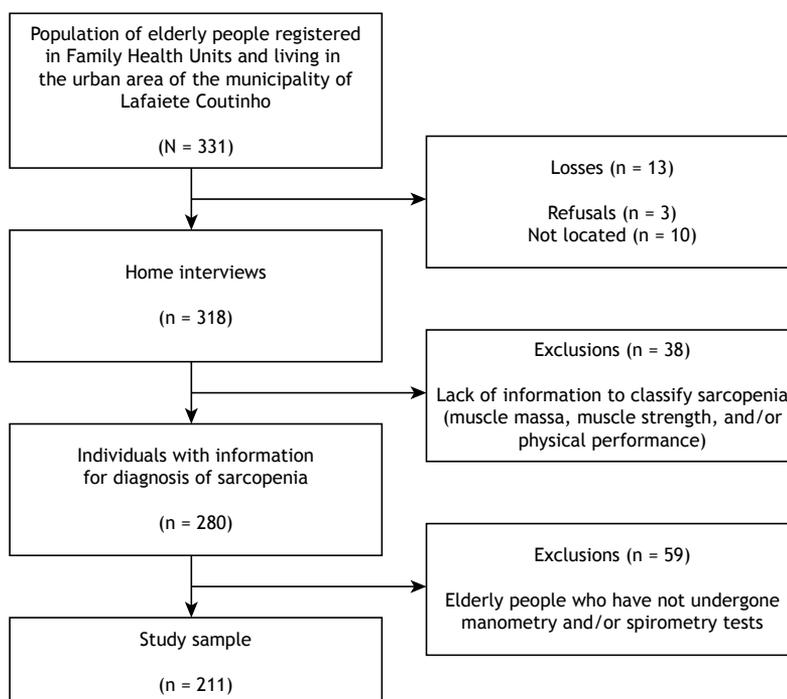


Figure 1. Flow chart of the participant selection process.

$m^2 \leq \text{BMI} \leq 27 \text{ kg/m}^2$ (adequate weight); and $\text{BMI} > 27 \text{ kg/m}^2$ (overweight). For each BMI category, the cutoff point for the handgrip strength test result was set at the 25th percentile. Thus, the participants were considered to have insufficient muscle strength when they presented values below the cutoff point related to their BMI category and sex. Those who during data collection were unable to perform the test due to physical limitations were classified as having insufficient muscle strength.

Muscle mass

The total muscle mass (TMM) was calculated using an equation proposed by Lee et al.⁽¹⁵⁾ and validated for use in the Brazilian elderly population by Rech et al.⁽¹⁶⁾:

$$\text{TMM (kg)} = (0.244 \times \text{BM}) + (7.8 \times h) - (0.098 \times A) + (6.6 \times S) + (E - 3.3)$$

where BA is the body mass (in kg), h is the height (in m), A is the age (in years), S is the sex, and E is the ethnicity.

The values 0 for women and 1 for men were adopted for the variable sex, and the self-referred ethnicity was categorized adopting 0 for White (White, mixed race [except Black], and indigenous), 1.2 for Asian, and 1.4 for African descent (Black and Black mixed with another race).

From the TMM, the muscle mass index (MMI) was estimated as proposed by Janssen et al.⁽¹⁷⁾:

$$\text{MMI} = \text{TMM}/\text{height}^2$$

Finally, the 20th percentile of the MMI was used as a cutoff point to classify the participants as having insufficient muscle mass, stratified by sex.

Physical performance

Physical performance was assessed using the 2.44-meter walk test. Insufficient physical performance was defined using the criterion adapted by Guralnik et al.,⁽¹⁸⁾ and, first, height was classified into two categories, according to sex, based on the median. Later, for each height category, the 75th percentile was used as the cutoff point for the time spent during the walk test. Thus, those elderly participants with values above the cutoff point for the time spent during the walk test and those who did not perform the test due to physical limitations were considered as having insufficient physical performance.

Independent variables

Respiratory muscle strength

The MRPs were evaluated following the guidelines of the American Thoracic Society⁽¹⁹⁾ and the Brazilian Thoracic Association,⁽²⁰⁾ using a digital manometer (MVD 300; Globalmed, Porto Alegre, Brazil).

For data analysis, the highest values of MIP and MEP were used among the maneuvers considered acceptable and reproducible. The maneuvers were considered acceptable when no leaks occurred and when they were sustained for at least two seconds. In order to be considered reproducible, among the three acceptable maneuvers, the two with the highest values should not differ more than 10% between them. Up to five maneuvers could be performed, respecting an interval of one minute between them. This amount was exceeded only if the highest MRP was recorded in the last maneuver performed, ending the test when a lower pressure was generated.

Spirometric parameters

Spirometric parameters were collected using the CareFusion Microlab spirometer apparatus (Micro Medical Ltd., Rochester, England) in accordance with the Brazilian Thoracic Association guidelines.⁽²⁰⁾ The following measurements were collected: FVC, $\text{FEV}_{1,}$ $\text{FEV}_{1}/\text{FVC}$ ratio, PEF, and $\text{FEF}_{25-75\%}$. In addition to these measurements, the predicted values for the Brazilian population were estimated, as described by Pereira et al.⁽²¹⁾ and calculated. For the statistical analysis, only the variables in percentage of the predicted values were considered.

Study population characteristics

The following variables were collected: sociodemographic variables (sex and age group); life habits (smoking and level of physical activity—using the long version of the International Physical Activity Questionnaire⁽¹⁰⁾ and classifying the participants as active or insufficiently active, respectively, those who practiced ≥ 150 min or < 150 min of moderate/vigorous physical activity per week⁽²²⁾; health condition (chronic diseases; hospitalization in the last 12 months; depressive symptoms [using the Geriatric Depression Scale]⁽¹¹⁾; falls in the last 12 months; and functional capacity—in which the basic activities of daily living (BADL) were evaluated by means of the Katz et al. scales⁽²³⁾ and the instrumental ADL (IADL) in accordance with Lawton & Brody.⁽²⁴⁾ The participants were classified as independent when they were able to perform activities without help and as dependent when they needed help in at least one of the activities. Functional capacity was classified in a hierarchical manner⁽²⁵⁾ into three categories: independent, dependent on IADL only, and dependent on BADL and IADL.

Statistical analysis

Absolute and relative frequencies, as well as medians and amplitudes, were calculated. The Kolmogorov-Smirnov test was applied to assess the normality of data distribution.

The association between sarcopenia and the categorical variables was performed by means of the chi-square test (linear-by-linear association). To compare MIP, MEP, and spirometric parameters among no sarcopenia, probable sarcopenia, and confirmed

sarcopenia subgroups, the one-way ANOVA test was used, followed by Tukey's post hoc test for variables with normal distribution, and the Kruskal-Wallis test followed by the Mann-Whitney U test for variables with no normal distribution. The Mann-Whitney U test was also used for comparative analysis between the sexes.

The association between the sarcopenia profile and respiratory parameters was evaluated using multinomial logistic regression analysis and expressed as ORs and 95% CIs. In this analysis, adjustments were made for the sex variable and the covariates that had a significant association with the diagnosis of sarcopenia.

The diagnostic power of sarcopenia determined by MRP and spirometric parameters and the identification of the best cutoff points, differentiated between men and women, were evaluated using the parameters provided by a ROC curve: AUC, sensitivity, and specificity.

Significance was set at 5% ($p \leq 0.05$). All statistical analyses were performed with the IBM SPSS Statistics

software package, version 21.0 (IBM Corporation, Armonk, NY, USA) and the MedCalc statistical package, version 9.1.0.1 (MedCalc, Mariakerke, Belgium).

RESULTS

The study population involved 221 elderly individuals, 54.3% being female, and 19.5% were ≥ 80 years of age. The characteristics of the sample according to the sarcopenia profile are presented in Table 1. The prevalence of probable sarcopenia was 20.4% and that of confirmed sarcopenia was 4.1%.

Table 2 shows that elderly men and women with confirmed sarcopenia had significantly lower MEP values than those with probable sarcopenia and no sarcopenia. Regarding MIP, only elderly males with confirmed sarcopenia had lower values in relation to those with probable sarcopenia and no sarcopenia ($p \leq 0.05$). In the no sarcopenia subgroup men had higher MIP and MEP values than women. In the probable

Table 1. Characteristics of the overall sample and according to sarcopenia profile subgroups.^a

Variable	Total (n = 221)	% of answers	No sarcopenia (n = 167)	Subgroup Probable sarcopenia (n = 45)	Confirmed sarcopenia (n = 9)	p
Sex		100				0,968
Female	120 (54.3)		91 (54.5)	25 (55.6)	4 (44.4)	
Male	101 (45.7)		76 (45.5)	20 (44.4)	5 (55.6)	
Age group, years		100				0.004
60-69	84 (38.0)		76 (45.5)	7 (15.6)	1 (11.2)	
70-79	94 (42.5)		61 (36.5)	29 (64.4)	4 (44.4)	
≥ 80	43 (19.5)		30 (18.0)	9 (20.0)	4 (44.4)	
Smoking		96.8				0.616
Never smoker	91 (42.5)		71 (43.6)	18 (41.9)	2 (25.0)	
Former smoker	101 (47.2)		75 (46.0)	22 (51.1)	4 (50.0)	
Current smoker	22 (10.3)		17 (10.4)	3 (7.0)	2 (25.0)	
Physical activity level		100				0.330
Active	157 (71.0)		122 (73.1)	30 (66.7)	5 (55.6)	
Insufficiently active	64 (29.0)		45 (26.9)	15 (33.3)	4 (44.4)	
Chronic diseases		94.6				0.049
None	26 (12.4)		21 (13.1)	2 (4.8)	3 (42.8)	
One	81 (38.8)		66 (41.3)	13 (31.0)	2 (28.6)	
Two or more	102 (48.8)		73 (45.6)	27 (64.2)	2 (28.6)	
Hospitalization in the last year		99.5				0.888
None	188 (85.5)		142 (85.5)	38 (84.4)	8 (88.9)	
One or more	32 (14.5)		24 (14.5)	7 (15.6)	1 (11.1)	
Depressive symptoms		99.5				0.566
No	187 (85.0)		143 (85.6)	36 (81.8)	8 (88.9)	
Yes	33 (15.0)		24 (14.4)	8 (18.2)	1 (11.1)	
Falls		98.2				0.035
No	176 (81.1)		139 (84.2)	31 (70.5)	6 (75.0)	
Yes	41 (18.9)		26 (15.8)	13 (29.5)	2 (25.0)	
Functional capacity		99.5				0.888
Independent	137 (62.3)		103 (62.0)	28 (62.2)	6 (66.7)	
Dependent for IADL	51 (23.2)		39 (23.5)	9 (20.0)	3 (33.3)	
Dependent for BADL and IADL	32 (14.5)		24 (14.5)	8 (17.8)	0 (0.0)	

IADL: instrumental activities of daily living; and BADL: basic activities of daily living. ^aValues expressed as n (%).

sarcopenia subgroup men also had higher MEP values than women ($p \leq 0.05$).

Table 3 shows that there were no significant differences between spirometric parameters in the sarcopenia profile subgroups or between the sexes ($p > 0.05$).

The adjusted analysis of the multinomial logistic regression model showed that MIP and MEP had an inversely proportional association with sarcopenia ($p \leq 0.05$), indicating that the increase of one unit ($1 \text{ cmH}_2\text{O}$) in MIP and MEP reduced the chance of the outcome in the elderly by 8% and 7%, respectively. There were no associations of spirometric parameters in the probable and confirmed sarcopenia subgroups (Table 4).

The no sarcopenia and probable sarcopenia subgroups, because they neither presented significant differences between the medians nor associations in the adjusted model, were grouped together as "no sarcopenia" for the analysis of the ROC curve. Regardless of the sex, the results of the areas under the ROC curve of MIP and MEP indicated values above 0.70, which can be considered as having good predictive power. The cutoff points established to screen elderly women and men with sarcopenia, respectively, were $\text{MIP} \leq 46 \text{ cmH}_2\text{O}$

and $\text{MEP} \leq 50 \text{ cmH}_2\text{O}$; and $\text{MIP} \leq 63 \text{ cmH}_2\text{O}$ and $\text{MEP} \leq 92 \text{ cmH}_2\text{O}$. It should be noted that MEP showed a better predictive power for sarcopenia, regardless of the sex, as well as better sensitivity and specificity (Figure 2).

DISCUSSION

This study showed that MEP was lower in the confirmed sarcopenia subgroup than in the probable and no sarcopenia subgroups regardless of the sex, whereas MIP was lower only for men with confirmed sarcopenia. In a comparison between the sexes, it was possible to observe that men in the no sarcopenia subgroup had higher MIP and MEP values when compared with women in the same subgroup and that men in the probable sarcopenia subgroup had higher MEP values when compared with women in the same subgroup.

Ohara et al.⁽⁶⁾ observed an association between sarcopenia and respiratory muscle strength and also identified that elderly individuals with sarcopenia had lower MIP and MEP values when compared with those without it. In addition, they noticed an association between the reduction in respiratory muscle strength and the decline in the components of sarcopenia. The

Table 2. Respiratory muscle strength according to sex and sarcopenia profile subgroups.^a

Respiratory muscle strength, cmH_2O	Women			p^*
	No sarcopenia (n = 91)	Probable sarcopenia (n = 25)	Confirmed sarcopenia (n = 4)	
MIP	58.0 (27.0) [†]	61.0 (26.0)	43.0 (10.0)	0.086
MEP	72.0 (31.0) ^{b,†}	71.0 (37.0) ^{b,†}	48.0 (3.0) ^c	0.033
Respiratory muscle strength, cmH_2O	Men			p^*
	No sarcopenia (n = 76)	Probable sarcopenia (n = 20)	Confirmed sarcopenia (n = 5)	
MIP	81.0 (47.0) ^{b,†}	65.5 (34.0) ^b	48.0 (23.0) ^c	0.050
MEP	111.0 (42.0) ^{b,†}	104.5 (64.0) ^{b,†}	71.0 (53.0) ^c	0.026

^aValues expressed as median (IQR). ^{b,c}Different letters indicate statistical difference ($p \leq 0.05$) between the subgroups (Mann-Whitney U test). *Kruskal-Wallis test: [†] $p \leq 0.05$ between sexes (Mann-Whitney U test).

Table 3. Spirometric parameters according to sex and sarcopenia profile subgroups.^a

Variable	Women			p
	No sarcopenia ^a (n = 85)	Probable sarcopenia ^a (n = 22)	Confirmed sarcopenia ^b (n = 3)	
FVC (% predicted)	69.0 (30.0)	63.5 (29.0)	47.0 (38.0)	0.404
FEV ₁ (% predicted)	72.0 (31.0)	61.5 (37.0)	50.0 (32.0)	0.398
FEV ₁ /FVC	80.3 (19.0)	81.1 (25.0)	75.7 (11.0)	0.664
PEF (% predicted)	41.0 (26.0)	40.0 (32.0)	32.0 (17.0)	0.249
FEF _{25-75%} (% predicted)	61.0 (53.0)	55.0 (71.0)	43.0 (26.0)	0.376
Variable	Men			p
	No sarcopenia ^a (n = 73)	Probable sarcopenia ^a (n = 18)	Confirmed sarcopenia ^b (n = 5)	
FVC (% predicted)	72.0 (22.0)	67.0 (20.0)	69.0 (38.0)	0.065
FEV ₁ (% predicted)	68.0 (22.0)	62.5 (22.0)	68.0 (49.0)	0.512
FEV ₁ /FVC	77.4 (18.0)	78.4 (18.0)	68.7 (38.0)	0.123
PEF (% predicted)	38.0 (27.0)	38.0 (21.0)	31.0 (26.0)	0.163
FEF _{25-75%} (% predicted)	62.0 (44.0)	51.5 (42.0)	38.0 (60.0)	0.118

^aValues expressed as median and interquartile range. ^bValues expressed as median and range (difference between lowest and highest values).

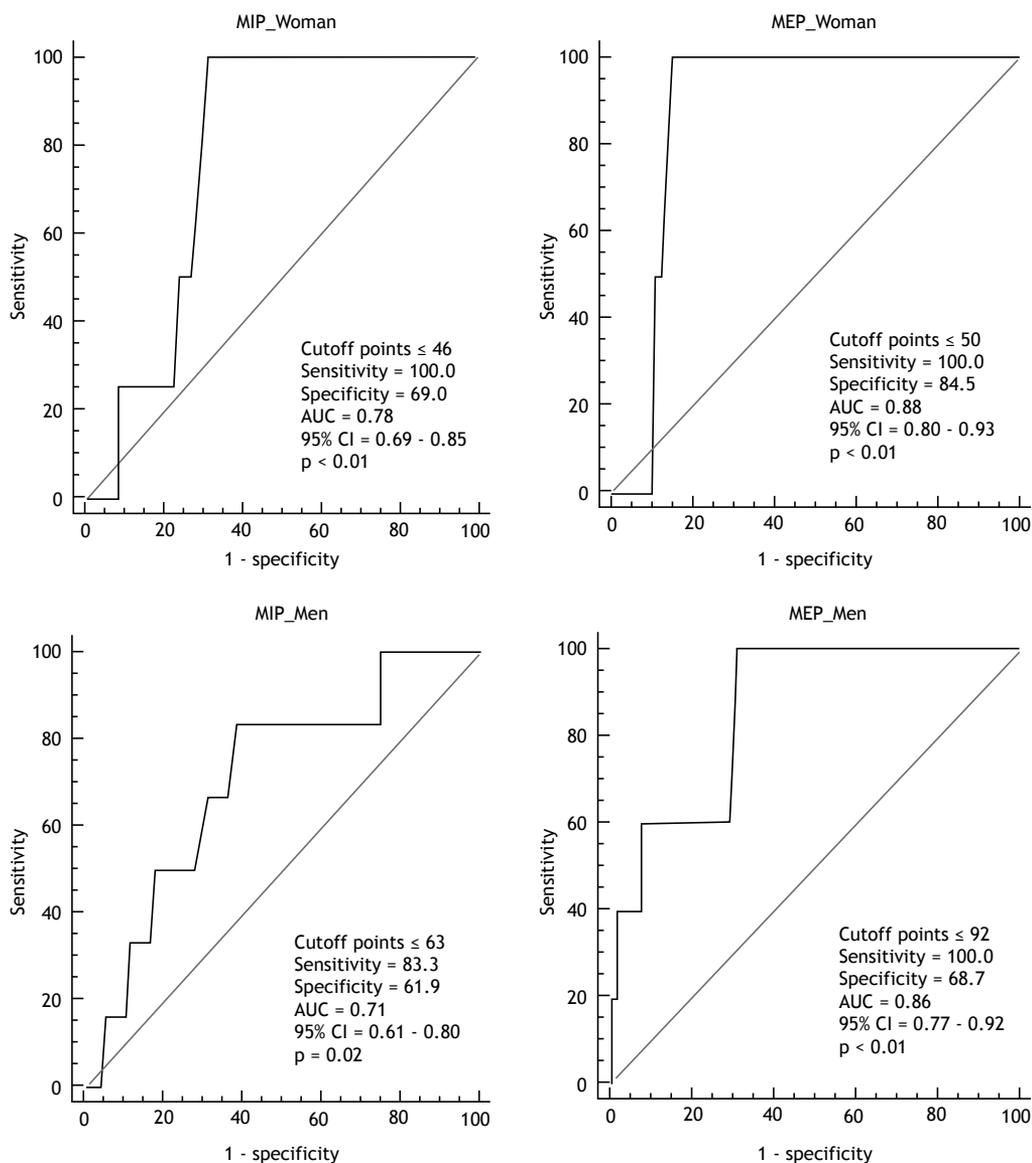


Figure 2. Cutoff points, sensitivity, specificity, and areas under the ROC curve for maximum respiratory pressures as discriminators of sarcopenia in elderly women and men.

physiological processes that accompany aging affect the muscle system of the elderly, so that weakness of the respiratory muscles is associated with the decline of peripheral muscles.⁽²⁶⁾

Diaphragmatic sarcopenia impacts on the performance of this muscle to produce strength, which affects inspiratory capacity and also the ability to perform expulsive maneuvers that are important for airway hygiene.⁽²⁷⁾ This finding was reaffirmed in a review study that discussed the mechanisms related to the aging of diaphragmatic muscle fibers.⁽⁴⁾ Thus, the findings of the present study corroborate the hypothesis described above. In addition, we highlight that aging is accompanied by accentuated thoracic kyphosis and increased rigidity of the rib cage, reducing elastic retraction capacity and lung compliance⁽²⁸⁾ and affecting respiratory muscle strength.^(29,30)

In this study, men with confirmed sarcopenia showed better MIP and MEP than did women with the disease, and men with probable sarcopenia showed better MEP than did women in the same category, as reported in a previous study.⁽³¹⁾ These findings can be explained by the differences that exist in the body composition of men and women: males tend to present greater muscle strength and mass.^(26,32)

The results also showed that an increase of 1 cmH₂O in both MIP and MEP was able to reduce the chance of sarcopenia in the elderly by 8% and 7%, respectively. This reduction was higher than that reported in other studies.⁽⁸⁾ These differences may be related to the profiles of populations related to social aspects and health conditions. Methodological differences in relation to the criteria used for the diagnosis of sarcopenia are also highlighted, since our study used the new

Table 4. Associations between probable and confirmed sarcopenia subgroups with maximum respiratory pressures and spirometric parameters.

Variable	Probable sarcopenia		Confirmed sarcopenia	
	Adjusted OR* (CI 95%)	p	Adjusted OR* (CI 95%)	p
MIP (cmH ₂ O)	1.00 (0.99-1.02)	0.403	0.92 (0.85-0.98)	0.018
MEP (cmH ₂ O)	1.00 (0.98-1.01)	0.882	0.93 (0.88-0.98)	0.011
FVC (% predicted)	0.99 (0.97-1.01)	0.522	0.68 (0.10-4.54)	0.691
FEV ₁ (% predicted)	0.99 (0.97-1.01)	0.571	0.98 (0.94-1.03)	0.483
FEV ₁ /FVC	1.01 (0.98-1.04)	0.548	1.00 (0.94-1.08)	0.870
PEF (% predicted)	0.99 (0.97-1.01)	0.653	0.93 (0.86-1.01)	0.093
FEF _{25-75%} (% predicted)	0.99 (0.98-1.00)	0.348	0.99 (0.95-1.02)	0.484

*Sex, age group, chronic diseases, and falls.

EWGSOP consensus,⁽¹⁾ whereas Ohara et al.⁽⁶⁾ based their study on previous recommendations. We add that Ohara et al.⁽⁶⁾ used an analog manometer, and we used a digital device. Such differences may have influenced the values observed.

Another important finding of this study was the identification of cutoff points to assist in the screening of sarcopenia from the values obtained in manometry. In our study, we noted that the cutoff points for MIP and MEP showed better sensitivity values for both sexes and better specificity for women in relation to those in the study by Ohara et al.⁽⁶⁾ Both studies had similar cutoff points for older women and suggested greater values for men, although the cutoff points for men were quite distinct between the two studies. These differences may also have occurred because of differences in the profile of elderly men samples, in addition to methodological differences between the two studies for the diagnosis of sarcopenia.^(1,33) Comparisons with other national studies were not possible, since there are still few investigations proposing such cutoff points for diagnosing sarcopenia in the community-dwelling elderly population in Brazil.

The analysis of sensitivity of cutoff points for MEP, for both sexes, and MIP, especially in women, demonstrated that these parameters are very efficient in truly diagnosing sarcopenia in the community-dwelling elderly population. Furthermore, we found that the cutoff point for MEP also showed high specificity for elderly women.

Considering the repercussions that sarcopenia can generate in the lives of the elderly, such as functional decline and vulnerability to respiratory diseases, it is important to identify respiratory parameters capable of predicting sarcopenia by means of cutoff points with adequate sensitivity and specificity. With this information, health professionals will find one more opportunity to screen for sarcopenia in the respiratory assessment of the elderly, and manometry may provide useful information to establish early interventions and reverse or minimize the adverse effects of the disease.

There were no significant differences in spirometric parameters among the subgroups analyzed, nor was any association of spirometric parameters with the probable and confirmed sarcopenia subgroups. These results differ from those of Ohara et al.,⁽⁷⁾ in

which worse pulmonary function (FVC, FEV₁, and FEF_{25-75%}) and worse muscle strength were evidenced in the elderly with sarcopenia than in those with no sarcopenia. In this study, spirometric parameters were presented as percentages of predicted values, whereas Ohara et al.⁽⁷⁾ used the actual values (in L or L/s). The equations for calculating predicted values consider patient characteristics, such as sex, age, weight, and height, which are not considered in the analysis of actual values. These aspects can justify the different results found. In this sense, considering the divergences between the results and the small number of studies available in the literature that corroborate this discussion, it is suggested that more studies be carried out to investigate these aspects.

One limitation of the present study was the use of equations that consider anthropometric measurements to estimate muscle mass. Despite the choice of validated and useful equations to help diagnose sarcopenia in population-based studies, more complex imaging studies might produce more accurate measurements. Furthermore, we pointed out that the number of individuals in each group, according to the classification of sarcopenia,⁽¹⁾ may have influenced the results obtained.

Despite the limitations, this seems to be the first study to propose MIP and MEP cutoff points for the diagnosis of sarcopenia in a community-dwelling elderly population, considering the new EWGSOP consensus.⁽¹⁾ The use of the cutoff points presented in this study, either in clinical practice or as reference measures for other studies, may contribute to a more detailed investigation of the health condition of the elderly.

AUTHOR CONTRIBUTIONS

R BSP: literature search, data collection, study design, data analysis, manuscript preparation, critical review of the manuscript, and approval of the final version. MHF, TAB, PAP, and RSC: data collection, critical review of the manuscript, and approval of the final version. JAO: data collection, study design, data analysis, critical review of the manuscript, and approval of the final version.

CONFLICT OF INTEREST

None declared.

REFERENCES

- Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis [published correction appears in *Age Ageing*. 2019 Jul 1;48(4):601]. *Age Ageing*. 2019;48(1):16-31. <https://doi.org/10.1093/ageing/afz046>
- Kinugasa Y, Yamamoto K. The challenge of frailty and sarcopenia in heart failure with preserved ejection fraction. *Heart*. 2017;103(3):184-189. <https://doi.org/10.1136/heartjnl-2016-309995>
- Bahat G, Tufan A, Ozkaya H, Tufan F, Akpinar TS, Akin S, et al. Relation between hand grip strength, respiratory muscle strength and spirometric measures in male nursing home residents. *Aging Male*. 2014;17(3):136-140. <https://doi.org/10.3109/13685538.2014.936001>
- Elliott JE, Greising SM, Mantilla CB, Sieck GC. Functional impact of sarcopenia in respiratory muscles. *Respir Physiol Neurobiol*. 2016;226:137-146. <https://doi.org/10.1016/j.resp.2015.10.001>
- Kera T, Kawai H, Hirano H, Kojima M, Fujiwara Y, Ihara K, et al. Relationships among peak expiratory flow rate, body composition, physical function, and sarcopenia in community-dwelling older adults. *Aging Clin Exp Res*. 2018;30(4):331-340. <https://doi.org/10.1007/s40520-017-0777-9>
- Kera T, Kawai H, Hirano H, Kojima M, Watanabe Y, Motokawa K, et al. Definition of Respiratory Sarcopenia With Peak Expiratory Flow Rate. *J Am Med Dir Assoc*. 2019;20(8):1021-1025. <https://doi.org/10.1016/j.jamda.2018.12.013>
- Ohara DG, Pegorari MS, Santos NLO, Silva CFR, Oliveira MSR, Matos AP, Jamami M. Cross-sectional study on the association between pulmonary function and sarcopenia in Brazilian community-dwelling elderly from the Amazon region. *J Nutr Health Aging*. 2020;24(2):181-187. <https://doi.org/10.1007/s12603-019-1290-y>
- Ohara DG, Pegorari MS, Oliveira Dos Santos NL, de Fátima Ribeiro Silva C, Oliveira MSR, Matos AP, et al. Cross-Sectional Study on the Association between Pulmonary Function and Sarcopenia in Brazilian Community-Dwelling Elderly from the Amazon Region. *J Nutr Health Aging*. 2020;24(2):181-187. <https://doi.org/10.1007/s12603-019-1290-y>
- Albala C, Lebrão ML, León Díaz EM, Ham-Chande R, Hennis AJ, Palloni A, et al. The Health, Well-Being, and Aging ("SABE") survey: methodology applied and profile of the study population [Article in Spanish]. *Rev Panam Salud Publica*. 2005;17(5-6):307-322. <https://doi.org/10.1590/S1020-49892005000500003>
- Benedetti TRB, Antunes PC, Rodriguez-Añez CR, Mazo GZ, Petroski EL. Reprodutibilidade e validade do Questionário Internacional de Atividade Física (IPAQ) em homens idosos. *Rev Bras Med Esporte*. 2007;13(1):11-16. <https://doi.org/10.1590/S1517-86922007000100004>
- Almeida OP, Almeida SA. Reliability of the Brazilian version of the ++abbreviated form of Geriatric Depression Scale (GDS) short form [Article in Portuguese]. *Arq Neuropsiquiatr*. 1999;57(2B):421-426. <https://doi.org/10.1590/S0004-282X1999000300013>
- Figueiredo IM, Sampaio RF, Mancini MC, Silva FCM, Souza MAP. Teste de força de preensão utilizando o dinamômetro Jamar. *Acta Fisiatrica*. 2007;14(2):104-110. <https://doi.org/10.5935/0104-7795.20070002>
- Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56(3):M146-M156. <https://doi.org/10.1093/gerona/56.3.M146>
- American Academy of Family Physicians. American Dietetic Association. National Council On The Aging. Nutrition Screening Initiative. Nutrition screening and intervention resources for healthcare professionals working with older adults. Washington DC: American Dietetic Association; 2002.
- Lee RC, Wang Z, Heo M, Ross R, Janssen I, Heymsfield SB. Total-body skeletal muscle mass: development and cross-validation of anthropometric prediction models [published correction appears in *Am J Clin Nutr* 2001 May;73(5):995]. *Am J Clin Nutr*. 2000;72(3):796-803. <https://doi.org/10.1093/ajcn/72.3.796>
- Rech CR, Dellagrana RA, Marucci MFN, Petroski EL. Validade de equações antropométricas para estimar a massa muscular em idosos. *Rev Bras Cineantropom Desemp Hum*. 2012;14(1):23-31. <https://doi.org/10.5007/1980-0037.2012v14n1p23>
- Janssen I, Baumgartner RN, Ross R, Rosenberg IH, Roubenoff R. Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. *Am J Epidemiol*. 2004;159(4):413-421. <https://doi.org/10.1093/aje/kwh058>
- Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*. 1994;49(2):M85-M94. <https://doi.org/10.1093/geronj/49.2.M85>
- American Thoracic Society/European Respiratory Society. ATS/ERS Statement on respiratory muscle testing. *Am J Respir Crit Care Med*. 2002;166(4):518-624. <https://doi.org/10.1164/rccm.166.4.518>
- Sociedade Brasileira de Pneumologia e Tisiologia (SBPT). Diretrizes para testes de função pulmonar. *J Bras Pneumol*. 2002;28(Suppl 3):S1-S238.
- Pereira CAC, Sato T, Rodrigues SC. Novos valores de referência para espirometria forçada em brasileiros adultos de raça branca. *J Bras Pneumol*. 2007;33(4):397-406. <https://doi.org/10.1590/S1806-37132007000400008>
- World Health Organization (WHO) [homepage on the Internet]. Geneva: WHO; c2010 [cited 2021 Aug 1]. Global Recommendations on Physical Activity for Health. Available from: https://www.who.int/dietphysicalactivity/factsheet_recommendations/en/
- KATZ S, FORD AB, MOSKOWITZ RW, JACKSON BA, JAFFE MW. STUDIES OF ILLNESS IN THE AGED. THE INDEX OF ADL: A STANDARDIZED MEASURE OF BIOLOGICAL AND PSYCHOSOCIAL FUNCTION. *JAMA*. 1963;185:914-919. <https://doi.org/10.1001/jama.1963.03060120024016>
- Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist*. 1969;9(3):179-186. https://doi.org/10.1093/geront/9.3_Part_1.179
- Hoeymans N, Feskens EJ, van den Bos GA, Kromhout D. Measuring functional status: cross-sectional and longitudinal associations between performance and self-report (Zutphen Elderly Study 1990-1993). *J Clin Epidemiol*. 1996;49(10):1103-1110. [https://doi.org/10.1016/0895-4356\(96\)00210-7](https://doi.org/10.1016/0895-4356(96)00210-7)
- Shin HI, Kim DK, Seo KM, Kang SH, Lee SY, Son S. Relation Between Respiratory Muscle Strength and Skeletal Muscle Mass and Hand Grip Strength in the Healthy Elderly. *Ann Rehabil Med*. 2017;41(4):686-692. <https://doi.org/10.5535/arm.2017.41.4.686>
- Greising SM, Mantilla CB, Medina-Martínez JS, Stowe JM, Sieck GC. Functional impact of diaphragm muscle sarcopenia in both male and female mice. *Am J Physiol Lung Cell Mol Physiol*. 2015;309(1):L46-L52. <https://doi.org/10.1152/ajplung.00064.2015>
- Cruz C, Cruz L, Reis R, Inácio F, Veríssimo M. Doença alérgica respiratória no idoso. *Rev Port Imunoalergol*. 2018;26(3):189-205.
- Diz JBM, Queiroz BZ, Tavares LB, Pereira LSM. Prevalence of sarcopenia among the elderly: findings from broad cross-sectional studies in a range of countries *Rev Bras Geriatr Gerontol*. 2015;18(3):665-678. <https://doi.org/10.1590/1809-9823.2015.14139>
- Rosa RS, Bianchi PD, Hansen D, Monschau BT. Alterations of the physiological pulmonary function due to aging on the functionality of elder people [Article in Portuguese]. *Fisioter Brasil*. 2014;15(1):16-21. <https://doi.org/10.33233/fb.v15i1.307>
- Simões RP, Auad MA, Dionísio J, Mazzonetto M. Influência da idade e do sexo na força muscular respiratória. *Fisioter Pesq*. 2007;14(1):36-41. <https://doi.org/10.1590/fpusp.v14i1.75507>
- Falsarella GR, Gasparotto LPR, Coimbra IB, Coimbra AMV. Envelhecimento e os fenótipos da composição corporal. *Rev Kairos*. 2014;17(2):57-77. <https://doi.org/10.1590/S1809-98232014000100019>
- Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing*. 2010;39(4):412-423. <https://doi.org/10.1093/ageing/afq034>