Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 10, Issue, 11, pp. 41857-41863, November, 2020
https://doi.org/10.37118/ijdr.20394.11.2020

RESEARCH ARTICLE OPEN ACCESS

SARCOPENIA AND ASSOCIATED FACTORS IN INSTITUTIONALIZED ELDERLY

Matheus Santos Gomes Jorge[1]*, Patrik Nepomuceno[2], Gabriela Silva Garcia[1], Marlene Doring[1], Marilene Rodrigues Portella[1], Ana Carolina Bertoletti De Marchi[1] and Lia Mara Wibelinger[1]

[1]Faculty of Physical Education and Physiotherapy, University of Passo Fundo, Passo Fundo, Rio Grande do Sul, Brazil
[2]Health Sciences Departament, University of Santa Cruz do Sul, Santa Cruz do Sul, Rio Grande do Sul, Brazil

ARTICLE INFO

Article History:
Received 20th August, 2020
Received in revised form
29th September, 2020
Accepted 18th October, 2020
Published online 24th November, 2020

Key Words:
Sarcopenia, Muscle Weakness, Longevity; Nutritional status, Homes for the Aged.

Corresponding author:
Matheus Santos Gomes Jorge

ABSTRACT

Introduction: Sarcopenia is a condition related to the human aging process, it is characterized by muscle mass, strength and/or function loss. It is associated to several factors, it presents high prevalence among the institutionalized elderly. **Objective**: To verify the prevalence of sarcopenia and associated factors in institutionalized elderly. **Materials and methods**: Cross-sectional population-based study that evaluated 479 institutionalized elderly regarding sarcopenia (European Working Group on Sarcopenia Older People criteria), socioeconomic variables, comorbidities, anthropometric variables, cognitive status (Mini Mental State Examination), nutritional status (Mini Nutritional Assessment), fragility (Fried Phenotype) and functional capacity (Katz Scale). For statistical analysis were used descriptive statistics, association tests and crude and adjusted analysis by the Poisson Regression with robust variance. The level of significance was 5%. **Results**: The sample consisted of 225 elderly, 79.33 ± 9.40 years old, 65.8% female. The prevalence of sarcopenia was 44.4% (95.0% severe sarcopenia). Associated factors to sarcopenia were longevity, low body mass index, decreased calf circumference and poor nutritional status ($p \leq 0.05$). **Conclusion**: Sarcopenia is highly prevalent in institutionalized elderly, especially severe type, and is associated with longevity, decreased calf circumference and poor nutritional status (thinness and malnutrition).

Citation: ***Matheus Santos Gomes Jorge, Patrik Nepomuceno, Gabriela Silva Garcia, Marlene Doring et al., 2020.*** "Sarcopenia and associated factors in institutionalized elderly", *International Journal of Development Research*, 10, (11), 41857-41863.

INTRODUCTION

Sarcopenia is an independent clinical condition recognized in 2016 by Tenth Revision of the International Classification of Disease (ICD-10-CM), code M62.84 (Cao & Morley, 2016). It is defined by muscle mass loss accompanied by muscle strength and/or function loss, sarcopenia potentially contributes to disability, frailty and mortality in elderly (Kim, Jang, & Lim, 2016). Several outcomes are associated with sarcopenia, such as advanced age (Schopf, Allendorf, Schwanke, & Gottlieb, 2017), decreased calf circumference (Pagotto, Santos, Malaquias, Bachion, & Silveira, 2018), presence of chronic diseases (Dovjak, 2016), cognitive decline (Chang, Hsu, Wu, Huang, & Han, 2016), malnutrition (Eglseer, Eminovic, & Lohrmann, 2016) or functional capacity impairment (Yoshimura, Wakabayashi, Bise, & Tanoue, 2018). Prevalence of sarcopenia may be 1 to 29% in community-dwelling elderly, 10% in hospitalized elderly and 14% to 33% in elderly living in long-term care facilities (A. J. Cruz-Jentoft *et al*., 2014). However, studies carried out with elderly in this latter context are relatively scarce, even if its prevalence is higher than the others (Zeng *et al*., 2018). Different nationalities have studied the prevalence of sarcopenia widely. However, different operational methods to identify it influence its real prevalence and relation with clinical outcomes. This way, international groups outlined consensual guidelines about concept, definition and diagnosis of sarcopenia by means of the musculoskeletal mass index (Kim *et al*., 2016), capable of estimating the appendicular musculoskeletal mass. One of the most used and validated tools is the Equation of Lee (Lee *et al*., 2000). In Brazil, until now, only one study has investigated the prevalence of sarcopenia in elderly living in long-term care facilities in city of Salvador, Bahia (Mesquita *et al*., 2017), materializing the scientific scarcity on the subject. Thus, the purpose was to verify the prevalence of sarcopenia and associated factors in institutionalized elderly.

MATERIALS AND METHODS

A multicenter and cross-sectional study was conducted with 479 elderly living at 18 long-term care facilities in three cities located in Rio Grande do Sul State, South Brazil. This study was approved by Ethics and Research Committee of the University of Passo Fundo, unbder protocol 2.097.278, and it is in accordance with Declarations of Helsinki and Brazilian National Health Council. Participants signed the Free and Informed Consent Term with previous explanation and clarification of doubts. According to international literature, the prevalence of sarcopenia in institutionalized elderly may variate between 14% and 33% (A. J. Cruz-Jentoft *et al*., 2014). In order to establish the minimum sample value that is reliable, we considered the sample calculation against the mathematical formula “$n=[Z^2.p.(1–p)]/e^2$”. So, the sample size needed to respond the objective of this study should be 185 institutionalized elderly. We included in this study individuals aged 60 years or over, with physical capacity to carry out the proposed tests and who lived full-time in long-term institutions. We excluded individuals with physical or functional impossibility to perform proposed tests, individuals restricted to bed or wheelchair or who were in acute periods of chronic-degenerative or infect-contagious diseases. Therefore, we excluded 254 initially recruited elderly (116 did not perform 4-meter walk test; 75 did not perform 4-meter walk test and dynamometry manual test; 44 did not perform 4-meter walk test, dynamometry manual test and anthropometric measurements; 13 did not perform 4-meter walk test and anthropometric measurements; 06 did not perform dynamometry manual test), totalizing 53.02% loss.

We defined sarcopenia according to criteria of the European Working Group on Sarcopenia in Older People (EWGSOP): muscle mass loss accompanied by muscle strength or physical performance loss (Alfonso J. Cruz-Jentoft *et al*., 2010). Muscle mass was estimated by Equation of Lee (Lee *et al*., 2000). This formula has strong agreement with the gold standard, Dual Energy X-ray Absorptiometry (DEXA), and it is indicated as a good parameter to verify sarcopenia. Validated in the Brazilian population, it presents high correlation values (r=0.86 for men and r=0.90 for women) (Rech, Dellagrana, Marucci, & Petroski, 2012). We used as cutoff points the reference values for muscle mass loss of Brazilian elderly using the Equation of Lee: $<8,76kg/m^2$ for men e $<6,47kg/m^2$ for women (Viana *et al*., 2018). We evaluated the muscular strength by manual dynamometry, with a Kratos® dynamometer. Characteristics of this instrument were previously described in another study (Jorge *et al*., 2019). Evaluation procedure followed recommendations of the American Society of Hand Therapists: individual was seated in a chair with back support and without arm support, shoulder adducted, elbow flexed at 90º, forearm in neutral position and fist with 30º extension. Three attempts are made and arithmetic mean is calculated (MacDermid, Solomon, & Valdes, 2015). We used as cutoff points the EWGSOP reference values: 30 kg for men and 20 kg for women (Alfonso J. Cruz-Jentoft *et al*., 2010). We evaluated physical performance through 4-meter walk test. Elderly walk a total distance of six meters, but the initial and final meters, referring to period of acceleration and deceleration of gait process, are disregarded in the time counting (Perry, 2005). Then, gait speed is calculated considering result of distance traveled division by the time covered, registering in meters per second (m/s).

We adopted as cutoff points the EWGSOP reference value: <0.8 m/s for both genders (Alfonso J. Cruz-Jentoft *et al*., 2010). Considering this, the elderly were classified as having pre-sarcopenia (only muscle mass loss), sarcopenia (muscle mass loss accompanied by muscular strength or physical performance loss) or severe sarcopenia (muscle mass, muscular strength and physical performance loss) (Alfonso J. Cruz-Jentoft *et al*., 2010). The secondary outcomes analyzed were sociodemographic variables (age and gender), anthropometric variables (body weight, height, body mass index and calf circumference), comorbidities (chronic diseases and health issues), cognitive status, nutritional status, fragility and functional capacity. Sociodemographic variables and comorbidities were collected by elderly medical records. In the case of comorbidities, we considered the presence of some conditions identified in the literature as prevalent in Brazilian elderly (Costa Filho, Mambrini, Malta, Lima-Costa, & Peixoto, 2018; Malta *et al*., 2016). We measured anthropometric variables using a digital scale (body weight) and a tape measure (height). Through the results of these variables it was possible to calculate the body mass index (result of dividing the body weight value by the square height value). Calf circumference was measured by perimetry at local of greatest muscular volume with a measuring tape and recorded in centimeters. For elderly unable to measure body weight and height, these measures were estimated using the Equation of Chumlea, considering gender and measures of calf circumference, knee height, arm circumference and subscapular skinfold (body weight estimate), and gender, age and knee height (height estimation) (Chumlea, Roche, & Steinbaugh, 1985). All anthropometric measures followed protocols established by the International Society for the Advancement of Kinanthropometry (Stewart, Marfell-Jones, Olds, & Ridder, 2011).

We analyzed cognitive state through Mini Mental State Examination (MMSE), an instrument composed of 30 questions that test temporal and spacial orientation, attention, calculus resolution, memorization and remembrance of words, language and practice visuo-constructive (Folstein, Folstein, & McHugh, 1975). The cutoff scores are adjusted according to schooling, 13 points for illiterates, 18 points for elderly with 1 to 8 years of schooling and 26 points for elderly with 9 or more years of study (Bertolucci, Brucki, Campacci, & Juliano, 1994). We evaluated nutritional status through Mini Nutritional Assessment (MNA) reduced version, a scale composed of six questions that address reduced food intake, weight loss (last three months), mobility, psychological stress or acute disease (last three months), neuropsychological problems and body mass index. The items sum varies from 0 to 14 points, classifying elderly with malnutrition (0 to 7 points), at risk of malnutrition (8 to 11 points) or with normal nutritional status (12 to 14 points) (Rubenstein, Harker, Salvà, Guigoz, & Vellas, 2001). We measured fragility by means of the Fried Phenotype. We used four of the five criteria, unintentional weight loss (self-report), fatigue (issues 07 and 20 of “Depression Scale Center for Epidemiological Studies”, translated and adapted to the Brazilian culture), reduction manual grip strength (manual dynamometry, adjusted by gender and body mass index) and reduction gait speed (4-meter speed gait test, adjusted by gender and height). Elderly were classified as fragile (three or four positive criteria), pre-fragile (one or two positive criteria) or non-fragile (no positive criteria) (Fried *et al*., 2001). We did not evaluate physical activity due to context in which the elderly lived (long-term care facilities), because this variable is measured through the International Physical Activity Questionnaire (IPAQ) and this instrument involves diverse activities such as work, transportation, domestic activities, leisure, among others (Craig *et al*., 2003) that do not apply to a significant portion of this population. We evaluated functional capacity through Katz Scale, which is composed of six items (bathing, clothing, going to the bathroom, transference, sphincter control and feeding), where individual is classified as "independent" (one point) and "dependent which receives assistance" or "dependent" (no point) (Duarte, Andrade, & Lebrão, 2007; Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963). Final score considers the standardization proposed by Hartford Institute for Geriatric Nursing (HIGN) and classifies elderly with total independence (six points), moderate dependence (three, four or five points) and severe dependence (less than three points) (Wallace & Shelkey, 2007).

Statistical analysis: After data collection, it was performed statistical analysis through a software. Characteristics of the participants were analyzed through descriptive statistics and presented in mean and standard deviation (continuous variables) and counts and percentages (categorical variables). Participants characteristics with sarcopenia and without sarcopenia were compared according to t-test of independent samples (normal numerical variables), Mann-Whitney test (non-normal numerical variables) and Chi-Square test (categorical variables), considering as differences statistical values with $p \leq 0.05$. Associated factors were determined by use of Poisson regression with robust variance, with status of sarcopenia as outcome. Initially, we identified sarcopenia predictors by means of a gross analysis, considering as significant factors with $p \leq 0.200$ and, subsequently, included in an adjusted model to determine the best combination of sarcopenia predictors. Significance level adopted in final set was $p \leq 0.05$.

RESULTS

After the selection criteria, the final sample consisted of 225 institutionalized elderly (79.33±9.40 years, 65.8% female). Elderly patients with sarcopenia presented older age, lower anthropometric values (except for height and gait velocity, which did not show differences) and a higher prevalence of dysphagia, risk of malnutrition and malnutrition. The elderly without sarcopenia had a higher prevalence of depression (Table 1). According to the EWGSOP algorithm, 100 elderly (44.4%) were classified with sarcopenia, of which 95.0% presented severe sarcopenia and 5.0% sarcopenia. There were no cases of pre-sarcopenia (Figure 1). Overall, 219 elderly (97.3%) had a reduction in physical function, 213 (94.7%) of muscle strength and 100 (44.4%) of muscle mass. Participants had mean AMM of 7.56±1.75 kg/m², manual grip strength of 11.92±8.35 kg and gait speed of 0.27±0.20 m/s (Table 1). We analyzed the independent variables in the Poisson Regression model with robust variation in relation to sarcopenia in the institutionalized elderly. Initially, we identified eight variables (age, body mass index, calf circumference, depression, osteoporosis, dysphagia, nutritional status and frailty) as possible associations. After adjustments, remained as factors associated with the sarcopenia: longevity (PR: 1.989; $CI_{95\%}$: 1.437 – 2.753; p=0.000), thinness (PR: 2.379; $CI_{95\%}$: 1.743 – 3.247; p=0.000), decreased calf circumference (PR: 1.735; $CI_{95\%}$: 1.071 – 2.810; p=0.025) and malnutrition (PR: 1.686; $CI_{95\%}$: 1.145 – 2.482; p=0.008) (Table 2).

DISCUSSION

We found a high prevalence of sarcopenia in the institutionalized elderly (47.3% in women and 39.0% in men), with an alarming number of elderly patients with severe sarcopenia (95.0%) and no cases of pre-sarcopenia. Compared to studies conducted with elderly people in the community in many countries (which can permeate between 2.5% and 22.1%) (Diz, Queiroz, Tavares, & Pereira, 2015), including in Brazil (which can permeate between 14.4% and 17.0%) (Alexandre, Duarte, Ferreira Santos, Wong, & Lebrão, 2014; Diz *et al*., 2017), our values are high. In contrast, our results are similar to other international (Bravo-José *et al*., 2018; Buckinx *et al*., 2017; Kamo, Ishii, Suzuki, & Nishida, 2018; Landi *et al*., 2012; Lardiés-Sánchez *et al*., 2017; Salvà *et al*., 2016; Senior, Henwood, Beller, Mitchell, & Keogh, 2015; Yalcin *et al*., 2016; Zeng *et al*., 2018) and national (Mesquita *et al*., 2017) studies for the same purpose. This reinforces the evidence of the need for care in long-term institutes and standardized evaluative procedures to detect sarcopenia early, because it presents adverse outcomes such as morbidities and mortalities (Choi, 2016). Although one of the main challenges in studies that verify the prevalence of sarcopenia in the elderly is the evaluation and definitions of cut-off points, especially for the detection of muscle mass loss, we use methods validated and indicated for this purpose. Manual dynamometry and the 4-meter speed gait test are suggested by the EWGSOP (Alfonso J. Cruz-Jentoft *et al*., 2010) and widely used, including institutionalized elderly (Bravo-José *et al*., 2018; Buckinx *et al*., 2017; Henwood, Hassan, Swinton, Senior, & Keogh, 2017; Landi *et al*., 2012; Lardiés-Sánchez *et al*., 2017; Salvà *et al*., 2016; Senior *et al*., 2015; Yalcin *et al*., 2016; Zeng *et al*., 2018). The Equation of Lee *et al*. (Lee *et al*., 2000) is equivalent to DEXA to verify muscle mass and is validated for Brazilian elderly (Rech *et al*., 2012), including cut-off points for this population (Viana *et al*., 2018).

In this study, we found as associated factors with sarcopenia in the institutionalized elderly the longevity, thinness, decreased calf circumference and the malnutrition. These complications can compromise the health of the individuals with sarcopenia, because they are, naturally, more predisposed to adverse events such as falls and fractures, functional dependence, greater use of hospital services, worse quality of life, mortality and, even, be conducted to institutionalization (Woo, 2017).
Sarcopenia can affect any age group, but its prevalence increases with age (Dodds, Roberts, Cooper, & Sayer, 2015). This is explained by the progressive decline of muscle mass from the age of 27, with a significant accentuation in the elderly with 80 years or more (Schopf *et al*., 2017). In this regard, we observed that longevity was demonstrated to be a factor associated with sarcopenia in the institutionalized elderly, corroborating with other studies (Bravo-José *et al*., 2018; Buckinx *et al*., 2017; Halil *et al*., 2014; Lardiés-Sánchez *et al*., 2017; Salvà *et al*., 2016). The use of anthropometric measures is recommended as an alternative to evaluate muscle mass and to pre-identify sarcopenia (Alfonso J. Cruz-Jentoft *et al*., 2010), due to the low cost and easy to obtain. One of the main measures is the calf circumference, essential in studies with this theme (Safer, Terekeci, Kaplan, Top, & Binay Safer, 2015), used even in institutionalized elderly (Halil *et al*., 2014). This measure showed good sensitivity and specificity with other specific tests to measure muscle mass, such as DEXA (Kawakami *et al*., 2015; Pagotto *et al*., 2018) and MMI (Kawakami *et al*., 2015), conferring cut-off points of 34 cm for

Table 1. Characteristics of institutionalized elderly in relation to sarcopenia

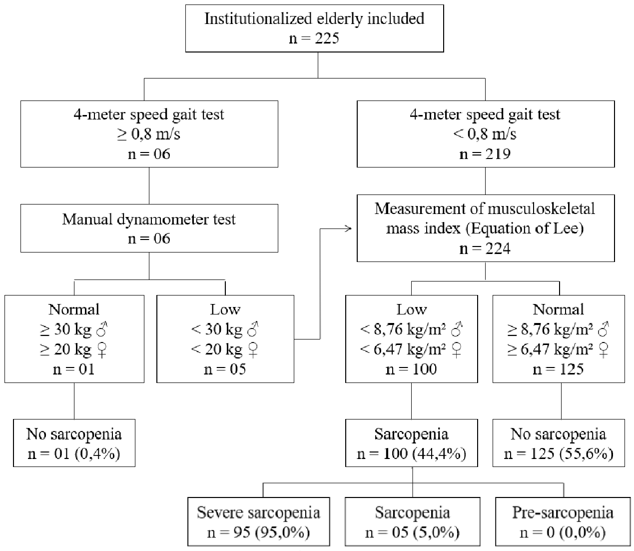
	Total (n=225)	No sarcopenia (n=125)	Sarcopenia (n=100)	p-valor
Sociodemographic variables				
Age (years)[a]	79.33±9.40	76.94±9.33	82.32±8.69	0.000*
Gender				0.260
Female	148 (65.8%)	78 (52.7%)	70 (47.3%)	
Male	77 (34.2%)	47 (61.0%)	30 (39.0%)	
Anthropometric variables				
Body Weight (kg)[a]	62.98±13.99	71.21±12.19	52.70±8.02	0.000*
Height (m)[a]	1.55±0.11	1.57±0.11	1.54±0.10	0.088
Body mass index (kg/m^2)[a]	25.85±4.79	28.88±3.98	22.06±2.44	0.000*
Calf circumference (cm)[a]	33.04±4.09	34.35±4.16	31.39±3.35	0.000*
AMM (kg/m²)[a]	7.56±1.75	8.52±1.38	6.36±1.39	0.000*
Handgrip strength (kg)[b]	11.92±8.35	12.90±8.32	10.70±8.27	0.049*
Gait speed (m/s)[b]	0.27±0.20	0.28±0.21	0.26±0.19	0.489
Comorbidities				
Cardiovascular disease	33 (14.7%)	20 (60.6%)	13 (39.4%)	0.574
Systemic arterial hypertension	125 (55.6%)	72 (57.6%)	53 (42.4%)	0.503
Stroke	35 (15.6%)	19 (54.3%)	16 (45.7%)	1.000
Diabetes mellitus	41 (18.2%)	24 (58.5%)	17 (41.5%)	0.730
Cancer	15 (6.7%)	10 (66.7%)	05 (33.3%)	0.430
Rheumatism	30 (13.3%)	16 (53.3%)	14 (46.7%)	0.845
Pulmonary disease	22 (9.8%)	14 (63.6%)	08 (36.4%)	0.502
Depression	83 (36.9%)	60 (72.3%)	23 (27.7%)	0.000*
Osteoporosis	26 (11.6%)	15 (57.7%)	11 (42.3%)	0.838
Dementia	81 (36.0%)	41 (50.6%)	40 (49.4%)	0.268
Parkinson's disease	20 (8.9%)	10 (50.0%)	10 (50.0%)	0.643
Falls in the last year	102 (46.2%)	55 (53.9%)	47 (46.1%)	0.684
Chronic pain	72 (32.7%)	44 (61.1%)	28 (38.9%)	0.195
Dysphagia	46 (20.5%)	17 (37.0%)	29 (63.0%)	0.007*
Polypharmacy	163 (74.1%)	93 (57.1%)	70 (42.9%)	0.642
Comprehensive Geriatric Assessment				
Cognitive state (MMSE)				0.891
Without cognitive decline	90 (40.0%)	51 (56.7%)	39 (43.3%)	
With cognitive decline	135 (60.0%)	74 (54.8%)	61 (45.2%)	
Nutritional status (MNA)[c]				0.003*
Normal nutritional status	85 (39.2%)	59 (69.4%)	26 (30.6%)	
Risk of malnutrition	104 (47.9%)	49 (47.1%)	55 (52.9%)	
Malnutrition	28 (12.9%)	12 (42.9%)	16 (57.1%)	
Fragility (Fried Phenotype)[c]				0.312
Non-frail or pre-frail	111 (56.6%)	67 (60.4%)	44 (39.6%)	
Frail	85 (43.4%)	45 (52.9%)	40 (47.1%)	
Functional capacity (Katz Index)[c]				0.279
Independence	59 (26.6%)	35 (59.3%)	24 (40.7%)	
Moderate dependence	96 (43.2%)	57 (59.4%)	39 (40.6%)	
Severe dependence	67 (30.2%)	32 (47.8%)	35 (52.2%)	

* ($p \leq 0.05$); [a] (t-test of independent samples); [b] (Mann-Whitney test); [c] (only valid values are counted); AMMA (appendicular musculoskeletal mass); MMSE (Mini Mental State Examination); MNA (Mini Nutritional Assessment); kg (kilogram); m (meter); kg/m^2 (kilogram per square meter); cm (centimeters); m/s (meters per second)

Table 2. Poisson regression model gross and adjusted associated factors with sarcopenia in the institutionalized elderly

	Gross analysis		Adjusted analysis	
Variables	PR ($CI_{95\%}$)	p-value	PR ($CI_{95\%}$)	p-value
60-79 years	1 (ref.)			
80 years or over	1.865 (1.240 – 2.806)	0.003*	1.989 (1.437 – 2.753)	0.000*
Male	1 (ref.)			
Female	1.109 (0.746 – 1.648)	0.610		
Body mass index >22 kg/m^2	1 (ref.)			
Body mass index ≤22 kg/m^2	3.162 (2.423 – 4.128)	0.000*	2.379 (1.743 – 3.247)	0.000*
CC normal (cm)	1 (ref.)			
CC decreased (cm)[a]	2.404 (1.445 – 3.998)	0.001*	1.735 (1.071 – 2.810)	0.025*
Cardiovascular disease	0.891 (0.529 – 1.498)	0.662		
Systemic arterial hypertension	1.119 (0.760 – 1.650)	0.568		
Stroke	1.228 (0.788 – 1.912)	0.364		
Diabetes mellitus	0.811 (0.477 – 1.378)	0.438		
Cancer	0.665 (0.253 – 1.746)	0.407		
Rheumatism	0.895 (0.505 – 1.584)	0.702		
Pulmonary disease	0.625 (0.267 – 1.461)	0.278		
Depression	0.485 (0.303 – 0.779)	0.003*		
Osteoporosis	1.422 (0.898 – 2.254)	0.134*		
Dementia	1.131 (0.773 – 1.656)	0.525		
Parkinson's disease	1.235 (0.756 – 2.019)	0.399		
Falls in the last 1 year	0.963 (0.665 – 1.392)	0.839		
Chronic pain	0.792 (0.519 – 1.208)	0.278		
Dysphagia	1.806 (1.285 – 2.540)	0.001*		
Polypharmacy	0.952 (0.625 – 1.449)	0.818		
Without cognitive decline	1 (ref.)			
With cognitive decline	1.209 (0.830 – 1.760)	0.323		
Normal nutritional status	1 (ref.)			
Deficient nutritional status[b]	2.042 (1.333 – 3.126)	0.001*	1.686 (1.145 – 2.482)	0.008*
No frail or pre-frail elderly	1 (ref.)			
Frail elderly	1.379 (0.958 – 1.987)	0.084*		
Functional independence	1 (ref.)			
Functional dependence[c]	1.243 (0.792 – 1.950)	0.344		

CC (Calf circumference); kg/m^2 (kilogram per square meter); cm (centimeters); PR (prevalence ratio); CI (confidence interval); [a](≤ 33 centimeters for women e ≤ 34 centimeters for men); [b](risk of malnutrition or malnutrition); [c](moderate or severe dependence); * (variables included in the gross and adjusted models)



n (absolute value); % (percentage); ♂ (male); ♀ (female); ≥ (greater or equal); < (smaller); m (meters); m/s (meters per second); kg (kilogram); kg/m² (kilogram per square meter)

Figure 1. Study profile using the EWGSOP criteria

men and 33 cm for women, including the Brazilian population (Pagotto *et al*., 2018). For this reason, we adopted these values in our study and observed that the calf circumference was associated with sarcopenia, corroborating with other studies carried out in this context (Halil *et al*., 2014; Zeng *et al*., 2018). Poor nutritional status, such as low body mass index (thinness) or unfavorable nutritional risk (malnutrition or risk of malnutrition), is closely related to sarcopenia in the elderly (Eglseer *et al*., 2016). In our study, thinness was associated with sarcopenia in the institutionalized elderly, according to other studies (Bravo-José *et al*., 2018; Buckinx *et al*., 2017; Kamo *et al*., 2018; Landi *et al*., 2012; Lardiés-Sánchez *et al*., 2017; Mesquita *et al*., 2017; Senior *et al*., 2015). This can be explained, often, by the aging process itself, which causes changes in body composition, such as loss of muscle and adipose tissue (Hickson, 2006), circumstances that are aggravated in the context studied. The prevalence of malnutrition in institutionalized elderly is high, reaching 74.7% (Damo, Doring, Alves, & Portella, 2018). This factor was associated with sarcopenia in our sample, as well as previous research (Bahat *et al*., 2010; Halil *et al*., 2014; Yalcin *et al*., 2016; Zeng *et al*., 2018). This association can be explained by the fact that, in the Western World, the body weight gain is increasing until the 65 years and, from then on, the elderly may present unintentional weight loss (Eglseer *et al*., 2016). In addition, the high prevalence of sarcopenia and malnutrition in the elderly living in long-term care institution may have contributed to our finding.

Some limitations may be pointed in our study. We had a sample loss greater than 50% due to the physical impossibilities presented by the individuals, since institutionalized elderly people present worse health conditions, such as chronic diseases and other health problems that significantly impact the quality of life, especially in physical aspects, compared to their peers in the community (Delgado-Sanz *et al*., 2011). On the other hand, this placement may also explain the low prevalence of chronic diseases found in this context, since, possibly, the elderly included had better health conditions than the excluded. In addition, the non-associations of sarcopenia with sex, chronic diseases, cognitive status, fragility and functional capacity may be anchored in this finding, and further and specific investigations are necessary to categorically affirm these hypotheses However, our sample is representative, since the sample number was higher than other studies performed in this context (Bahat *et al*., 2010; Landi *et al*., 2012; Mesquita *et al*., 2017; Senior *et al*., 2015; Yalcin *et al*., 2016), and it remained above the minimum sample number to answer the objective of this research.

The prevalence of sarcopenia was high in comparison to the mean prevalence of sarcopenia in the Brazilian population (Diz *et al*., 2017). We believe that this value can be much higher, considering that the excluded participants could not be evaluated through the criteria proposed by the EWGSOP, evidencing limitations for a precise evaluation in this population. On the other hand, the association between sarcopenia and calf circumference and thinness, presented in this study, reinforces the suggestions that these easily accessible tools can be useful in monitoring the muscular mass of the institutionalized elderly. In summary, health professionals and managers, as well as the relatives of the institutionalized elderly, should be educated about the monitoring and treatment of sarcopenia in this context, aiming to implement integral and multidisciplinary actions in order to improve health conditions and quality of life these individuals.

Conclusion

Sarcopenia is highly prevalent in institutionalized elderly, especially the severe type, and is associated with longevity, decreased calf circumference and poor nutritional status (thinness and malnutrition).

Acknowledgements

The authors thank the Higher Education Personnel Improvement Coordination Program (CAPES/Brazil) from the scholarship and financial support for this research.

REFERENCES

Alexandre, T. da S., Duarte, Y. A. de O., Ferreira Santos, J. L., Wong, R., & Lebrão, M. L. 2014. Prevalence and associated factors of sarcopenia among elderly in Brazil: Findings from the SABE study. J Nutr Health Aging, 183, 284–290.

Bahat, G., Saka, B., Tufan, F., Akin, S., Sivrikaya, S., Yucel, N., … Karan, M. A. 2010. Prevalence of sarcopenia and its association with functional and nutritional status among male residents in a nursing home in Turkey. Aging Male, 133, 211–214.

Bertolucci, P. H. F., Brucki, S. M. D., Campacci, S. R., & Juliano, Y. 1994. O Mini-Exame do Estado Mental em uma população geral: impacto da escolaridade. Arq Neuro-Psiquiatria, 521, 01–07.

Bravo-José, P., Moreno, E., Espert, M., Romeu, M., Martínez, P., & Navarro, C. 2018. Prevalence of sarcopenia and associated factors in institutionalised older adult patients. Clin Nutr ESPEN, 27, 113–119.

Buckinx, F., Reginster, J. Y., Brunois, T., Lenaerts, C., Beaudart, C., Croisier, J. L., … Bruyère, O. 2017. Prevalence of sarcopenia in a population of nursing home residents according to their frailty status: results of the SENIOR cohort. J Musculoskelet Neuronal Interact, 173, 209–217.

Cao, L., & Morley, J. E. 2016. Sarcopenia Is Recognized as an Independent Condition by an International Classification of Disease, Tenth Revision, Clinical Modification ICD-10-CM Code. J Am Med Dir Assoc, 178, 675–677.

Chang, K.-V., Hsu, T.-H., Wu, W.-T., Huang, K.-C., & Han, D.-S. 2016. Association Between Sarcopenia and Cognitive Impairment: A Systematic Review and Meta-Analysis. J Am Med Dir Assoc, 1712, 1164.e7-1164.e15.

Choi, K. M. 2016. Sarcopenia and sarcopenic obesity. Korean J Intern Med., 316, 1054–1060.

Chumlea, W. C., Roche, A. F. R., & Steinbaugh, M. L. 1985. Estimating stature from knee height for persons 60 to 90 years of age. J Am Geriatr Soc, 332, 116–120.

Costa Filho, A. M., Mambrini, J. V. de M., Malta, D. C., Lima-Costa, M. F., & Peixoto, S. V. 2018. Contribution of chronic diseases to the prevalence of disability in basic and instrumental activities of daily living in elderly Brazilians: the National Health Survey 2013. Cad Saude Publica, 341, 1–12.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., … Oja, P. 2003. International Physical Activity Questionnaire: 12-Country Reliability and Validity. Med Sci Sports Exerc, 358, 1381–1395.

Cruz-Jentoft, A. J., Landi, F., Schneider, S. M., Zuniga, C., Arai, H., Boirie, Y., … Cederholm, T. 2014. Prevalence of and interventions for sarcopenia in ageing adults: a systematic review. Report of the International Sarcopenia Initiative EWGSOP and IWGS. Age Ageing, 436, 748–759.

Cruz-Jentoft, Alfonso J., Baeyens, J. P., Bauer, J. M., Boirie, Y., Cederholm, T., Landi, F., … Zamboni, M. 2010. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing, 394, 412–423.

Damo, C. C., Doring, M., Alves, A. L. S., & Portella, M. R. 2018. Risk of malnutrition and associated factors in institutionalized elderly persons. Rev Bras Geriatr Gerontol, 216, 735–742.

Delgado-Sanz, M. C., Prieto-Flores, M.-E., Forjaz, M. J., Ayala, A., Rojo-Perez, F., Fernandez-Mayoralas, G., & Martinez-Martin, P. 2011. Influence of chronic health problems in dimensions of EQ-5D: study of institutionalized and non-institutionalized elderly. Clin Geriatr Med, 856, 555–568.

Diz, J. B. M., Leopoldino, A. A. O., Moreira, B. de S., Henschke, N., Dias, R. C., Pereira, L. S. M., & Oliveira, V. C. 2017. Prevalence of sarcopenia in older Brazilians: A systematic review and meta-analysis. Geriatr Gerontol Internat, 171, 5–16.

Diz, J. B. M., Queiroz, B. Z. de, Tavares, L. B., & Pereira, L. S. M. 2015. Prevalência de sarcopenia em idosos: resultados de estudos transversais amplos em diferentes países. Rev Bras Geriatr Gerontol, 183, 665–678.

Dodds, R. M., Roberts, H. C., Cooper, C., & Sayer, A. A. 2015. The Epidemiology of Sarcopenia. J Clin Densitom, 184, 461–466.

Dovjak, P. 2016. Sarcopenia in cases of chronic and acute illness. Z Gerontol Geriatr, 492, 100–106.

Duarte, Y. A. de O., Andrade, C. L. de, & Lebrão, M. L. 2007. Katz Index on elderly functionality evaluation. Rev Esc Enferm USP, 412, 317–325.

Eglseer, D., Eminovic, S., & Lohrmann, C. 2016. Association Between Sarcopenia and Nutritional Status in Older Adults: A Systematic Literature Review. J Gerontol Nurs, 427, 33–41.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. 1975. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res, 123, 189–198.

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., … Cardiovascular Health Study Collaborative Research Group. 2001. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci, 563, M146-56.

Halil, M., Ulger, Z., Varlı, M., Döventaş, A., Oztürk, G. B., Kuyumcu, M. E., … Arıoğul, S. 2014. Sarcopenia assessment project in the nursing homes in Turkey. Eur J Clin Nutr, 686, 690–694.

Henwood, T., Hassan, B., Swinton, P., Senior, H., & Keogh, J. 2017. Consequences of sarcopenia among nursing home residents at long-term follow-up. Geriatric Nursing, 385, 406–411.

Hickson, M. 2006. Malnutrition and ageing. Postgrad Med J, 82963, 2–8.

Jorge, M. S. G., Ribeiro, D. dos S., Garbin, K., Moreira, I., Rodigheri, P. V., Lima, W. G. de, … Libero, G. A. 2019. Values of handgrip strength in a population of different age groups. EF Deportes, 23249, 56–69.

Kamo, T., Ishii, H., Suzuki, K., & Nishida, Y. 2018. Prevalence of sarcopenia and its association with activities of daily living among japanese nursing home residents. Geriatric Nursing, 395, 528–533.

Katz, S., Ford, A. B., Moskowitz, R. W., Jackson, B. A., & Jaffe, M. W. 1963. Studies of Illness in the Aged. The Index of ADL: a standardized measure of biological and psychosocial function. JAMA, 18512, 914–919.

Kawakami, R., Murakami, H., Sanada, K., Tanaka, N., Sawada, S. S., Tabata, I., … Miyachi, M. 2015. Calf circumference as a surrogate marker of muscle mass for diagnosing sarcopenia in Japanese men and women. Geriatr Gerontol Internat, 158, 969–976.

Kim, K. M., Jang, H. C., & Lim, S. 2016. Differences among skeletal muscle mass indices derived from height-, weight-, and body mass index-adjusted models in assessing sarcopenia. Korean J Intern Med, 314, 643–650.

Landi, F., Liperoti, R., Fusco, D., Mastropaolo, S., Quattrociocchi, D., Proia, A., … Onder, G. 2012. Prevalence and Risk Factors of Sarcopenia Among Nursing Home Older Residents. J Gerontol A Biol Sci Med Sci, 67A1, 48–55.

Lardiés-Sánchez, B., Sanz-París, A., Pérez-Nogueras, J., Serrano-Oliver, A., Torres-Anoro, M. E., & Cruz-Jentoft, A. J. 2017. Influence of nutritional status in the diagnosis of sarcopenia in nursing home residents. Nutrition, 41, 51–57.

Lee, R. C., Wang, Z., Heo, M., Ross, R., Janssen, I., & Heymsfield, S. B. 2000. Total-body skeletal muscle mass: development and cross-validation of anthropometric prediction models. Am J Clin Nutr, 723, 796–803.

MacDermid, J., Solomon, G., & Valdes, K. 2015. Clinical Assessment Recommendations. J. MacDermid, G. Solomon, & K. Valdes, Eds. 3rd ed.. Mount Laurel: American Society of Hand Therapists.

Malta, D. C., Bernal, R. T. I., de Souza, M. de F. M., Szwarcwald, C. L., Lima, M. G., & Barros, M. B. de A. 2016. Social inequalities in the prevalence of self-reported chronic non-communicable diseases in Brazil: national health survey 2013. Int J Equity Health, 151, 153.

Mesquita, A. F., Silva, E. C. da, Eickemberg, M., Roriz, A. K. C., Barreto-Medeiros, J. M., & Ramos, L. B. 2017. Factors associated with sarcopenia in institutionalized elderly. Nutr Hosp, 342, 345.

Pagotto, V., Santos, K. F. dos, Malaquias, S. G., Bachion, M. M., & Silveira, E. A. 2018. Calf circumference: clinical validation for evaluation of muscle mass in the elderly. Rev Bras Enferm, 712, 322–328.

Perry, J. 2005. Análise da Marcha. São Paulo: Manole.

Rech, C. R., Dellagrana, R. A., Marucci, M. D. F. N., & Petroski, E. L. 2012. Validity of anthropometric equations for the estimation of muscle mass in the elderly. Braz J Kinanthropom Human Performance, 141, 23–31.

Rubenstein, L. Z., Harker, J. O., Salvà, A., Guigoz, Y., & Vellas, B. 2001. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment MNA-SF. J Gerontol A Biol Sci Med Sci, 566, M366-72.

Safer, U., Terekeci, H. M., Kaplan, M., Top, C., & Binay Safer, V. 2015. Calf circumference for diagnosis of sarcopenia. Geriatr Gerontol Internat, 158, 1103–1103.

Salvà, A., Serra-Rexach, J. A., Artaza, I., Formiga, F., Rojano i Luque, X., Cuesta, F., … Cruz-Jentoft, A. J. 2016. La prevalencia de sarcopenia en residencias de España: comparación de los resultados del estudio multicéntrico ELLI con otras poblaciones. Rev Esp Geriatr Gerontol, 515, 260–264.

Schopf, P. P., Allendorf, D. B., Schwanke, C. H. A., & Gottlieb, M. G. V. 2017. Idade, sexo, raça/etnia são fatores intrínsecos associados à perda de massa muscular: uma revisão sistemática. Rev Bras Cienc Mov, 252, 195–204.

Senior, H. E., Henwood, T. R., Beller, E. M., Mitchell, G. K., & Keogh, J. W. L. 2015. Prevalence and risk factors of sarcopenia among adults living in nursing homes. Maturitas, 824, 418–423.

Stewart, A., Marfell-Jones, M., Olds, T., & Ridder, H. De. 2011. International standards for anthropometric assessment 3rd ed.. Lower Hutt, New Zealand: International Society for the Advancement of Kinanthropometry.

Viana, J. U., Dias, J. M. D., Pereira, L. S. M., Silva, S. L. A. da, Hoelzle, L. F., & Dias, R. C. 2018. Alternative appendicular muscle mass cut-off points for verification of sarcopenia in older Brazilians: data from Rede Fibra – Belo Horizonte/Brazil. Fisiot Pesq, 252, 166–172.

Wallace, M., & Shelkey, M. 2007. Katz Index of Independence in Activities of Daily Living ADL. Urol Nurs, 271, 93–94.

Woo, J. 2017. Sarcopenia. Clin Geriatr Med, 333, 305–314.

Yalcin, A., Aras, S., Atmis, V., Cengiz, O. K., Varli, M., Cinar, E., & Atli, T. 2016. Sarcopenia prevalence and factors associated with sarcopenia in older people living in a nursing home in Ankara Turkey. Geriatr Gerontol Internat, 168, 903–910.

Yoshimura, Y., Wakabayashi, H., Bise, T., & Tanoue, M. 2018. Prevalence of sarcopenia and its association with activities of daily living and dysphagia in convalescent rehabilitation ward inpatients. Clin Nutr, 376, 2022–2028.

Zeng, Y., Hu, X., Xie, L., Han, Z., Zuo, Y., & Yang, M. 2018. The Prevalence of Sarcopenia in Chinese Elderly Nursing Home Residents: A Comparison of 4 Diagnostic Criteria. J Am Med Dir Assoc, 198, 690–695.