Is there is an association between mass and skeletal muscle strength in hospitalized elderly persons?

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Abstract

Introduction: The variables mass and skeletal muscle strength contribute to the diagnosis of sarcopenia. *Objective:* To evaluate the association between strength and skeletal muscle mass in hospitalized elderly persons. *Method:* A cross-sectional study was carried out in a private hospital in the city of Salvador in Bahia. The study included individuals ≥60 years during their first and fifth day of hospitalization and who were neither sedated nor had taken vasoactive drugs. Muscle mass was calculated using an anthropometric equation and force was measured through handgrip strength. Muscle weakness was identified as <20 kgf for women and <30 kgf for men, and reduced muscle mass was when the muscle mass index was ≤8.9 kg/m^2 for men and ≤6.37 kg/m^2 for women. The Pearson correlation was used to evaluate the relationship between mass and strength and the accuracy of using mass to predict strength. *Results:* In 110 patients included, there was a moderate correlation between mass and strength (R=0.691; p=0.001). However, the accuracy of using mass to predict muscle strength was low (accuracy=0.30; CI 95% = 0.19-0.41; p=0.001). The elderly patients with muscle weakness were older than those without muscle weakness, with no differences between the other variables. *Conclusion:* There is a linear relation between skeletal muscle mass and strength, but mass did not predict strength, which suggests that the two measures continue to perform independently.

Key words: Muscle Strength; Muscle Skeletal; Elderly and Hospital.

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INTRODUCTION

Skeletal muscle is extremely important for carrying out activities of day-to-day life. Among the main variables that make up muscle function are skeletal muscle mass, muscle strength and physical performance, all of which contribute to the diagnosis of sarcopenia.[1] The gradual and generalized reduction of this skeletal muscle strength and mass are associated with negative outcomes such as physical incapacity, poor quality of life and increased mortality.[2,3]

Muscle mass can be defined as the quantity or volume of skeletal muscle, whereas strength is related to muscle contraction capacity. Muscle strength can be obtained by evaluating grip strength, which is measured with a handheld dynamometer. This is an easy to use tool and serves as a substitute method for measuring overall muscle strength.[4] To assess the muscle mass of elderly persons, the use of anthropometric prediction equations is a more affordable alternative when compared with methods such as magnetic resonance imaging and computed tomography.[5,6]

Longitudinal studies have shown that reduction of muscle strength is more significant for predicting mortality over the years than the reduction of muscle volume.[7,8] This shows that there is probably no linear relationship between these variables, and that it is necessary to understand the association between mass and muscle strength. Thus, the present study aimed to evaluate the association between mass and skeletal muscle strength in hospitalized elderly persons.

METHOD

An analytical study was carried out at the Hospital da Cidade (the City Hospital), located in Salvador, Bahia, from August 2013 to January 2014. The inclusion criteria were individuals aged 60 or above; between their first and fifth days of hospitalization; with a previous history of functional independence for locomotion (walking without external aids); medical permission to ambulate and who did not use vasoactive, inotropic medication or sedatives. Exclusion criteria were a drop in oxygen saturation below 90% during assessment, an increase in heart rate of approximately 30% of the base rate (before starting the test), and those who presented dyspnea or discomfort while performing the tests. However, no patient was rejected due to these exclusion criteria. The selection of individuals for inclusion in the study was carried out by physiotherapists, by means of daily checking of medical records on an electronic system. The sample calculation was based on the main objective of the initial project, that is, to identify the frequency of sarcopenia in hospitalized elderly persons, having adopted an expected proportion of sarcopenia of 15% and a 7% margin of error.[9]

The primary variables were anthropometric measurements (body weight in kilograms, height in meters, skinfolds and limb circumference), cognitive status evaluated by the Mini Mental State Examination (MMSE), handgrip strength and the Charlson index. The assessors were the research physiotherapists themselves, who were previously trained with the assessment tools in order to minimize measurement bias.

The study was approved by the Research Ethics Committee of the Escola Bahiana de Medicina e Saúde Pública (Bahia School of Medicine and Public Health), under protocol number 336.469/13. All participants of the research signed a Free and Informed Consent Form.

Mensuration

Skeletal muscle mass was obtained using the anthropometric equation of Lee, which had a high correlation with magnetic resonance imaging (MRI) scan[6] and dual-energy x-ray densitometry.[5]

The equation used for the elderly patients with BMI <30 kg/m^2 to estimate skeletal muscle mass was based on weight and height: [height (meters) x (0.244 x body mass) + (7.8 x height) + (6.6 x gender) – (0.098 x age) + (ethnicity – 3.3)].[6]

For the elderly patients with BMI≥30 kg/m^2, a specific anthropometric equation was used:[6] [height x (CAC^2 x 0.007444 + 0.00088 x CTG^2 + 0.00441 x CCC^2) + 2.4 x gender – 0.048 x age + ethnicity + 7.8]. Where: CAC= Corrected Arm Circumference; CTG= Corrected Thigh Girth; CCC= Corrected Calf Circumference.

The skinfold measurements (S) were taken by trained assessors on the arm, thigh and medial part of the calf; and the circumferences of the limbs (C_{limb}) were also measured in the medial part of the arm, thigh and calf within an accuracy of 1 mm, according to anthropometric standards.[10] The Lange adipometer (USA) was used to measure the thickness of skinfolds. Three measurements were taken and the average of these was utilized. In order to remove the fat component, the corrected value of the circumference was calculated ($C_{m=}$ $C_{limb} – \pi$ x S).[6]

Subsequently, the skeletal muscle mass was divided by height squared in order to obtain the skeletal muscle mass index. The criteria used to identify reduction in skeletal muscle mass was based on the values of body mass index ≤6.37 kg/m^2 for women and ≤8.90 kg/m^2 for men, which are equivalent to 20% of the lower percentile encountered by Alexandre et al.,[11] according to studies by Newman et al.[12] and Delmonico et al.[13]

Grip strength measurement was used in order to evaluate muscular strength. Individuals were seated on a chair with elbows positioned at 90° and applied maximum force on the manual Saehan dynamometer (Saehan Corporation, 973, Yangdeok-Dong, Masan 630-728, Korea), which is highly correlated with the Jamar dynamometer, considered to be gold standard.[14] This measurement was performed three times with an interval of one minute between each measurement, and the highest result was utilized. The reference values for gender and age in the identification of muscle weakness were values of less than 20 kgf for women and less than 30 kgf for men.[4]

Cognitive function was measured by means of the MMSE, the variation of which is 0 to 30 points and serves as a parameter for the characterization of the sample group.[15] The Charlson comorbidity index[16] was used for evaluation of the presence of comorbidities in the hospitalized elderly persons, since most of the individuals assessed were not in the intensive care unit, which prevented the measurement of other severity scores.

Statistical analysis

The data from the numeric variables was described in averages and standard deviations and the categorical variables were described in proportions, with the respective confidence interval. The correlation between muscle mass and strength was obtained by means of the Pearson correlation. The Kappa concordance index was used to assess the concordance between weakness and reduced muscle mass. In order to evaluate the predictive capacity of mass in relation to muscle strength, sensitivity, specificity and accuracy were measured using the ROC curve (Receiver Operator Characteristic). Regarding the comparison of patients with and without weakness, the Student's *t* test for independent samples was used. The analyses were carried out using SPSS version 14.0.

RESULTS

In the sample of 110 elderly patients, the average age was 71.0 (± 8.5) and the Charlson index was 5.4 (± 1.8), with a predominance of males (58.2%) and a clinical admission profile of 59.1%. Abdominal surgery (34.5%), heart problems (20.0%) and pneumonia (13.6%) were the most frequent reasons for admissions, and the average time for carrying out the measurements was 2.7 days (Table 1). Among the elderly patients studied, 30.9% presented reduced muscle mass and 36.4% had muscle weakness.

Table 1. Descriptive sample data of the 110 hospitalized elderly persons. Salvador, BA, 2013-2014.

Variables	Average/sd	n (%)
Age (years)	71.0(±8.5)	
BMI (kg/m^2)	25.4(±4.7)	
Low weight		3 (2.7)
Normal		51 (46.4)
Overweight/obese		56 (50.9)
Gender		
Masculine		64 (58.2)
Feminine		46 (41.8)
Hospitalization time (days)	2.7(±1.6)	
Admission profile		
Clinical		65 (59.1)
Surgical		45 (40.9)
Charlson Index	5.4(±1.8)	
MMSE	23.7(±5.0)	
Skeletal muscle mass (kg)	21.9(±5.4)	
Handgrip strength (kgf)	27.9(±9.4)	

BMI= body mass index; MMSE= mini mental state examination; sd= standard deviation.

There was a moderate correlation between skeletal muscle mass and strength (R=0.691; p=0.001), as demonstrated in figure 1. In the analysis of reduced muscle mass and muscle weakness, weak concordance was observed (K=0.45; p=0.001). In relation to the capacity of muscle mass predicting strength, poor accuracy was also observed (accuracy=0.31; IC 95%=0.19-0.41; p=0.001) (Figure 2).

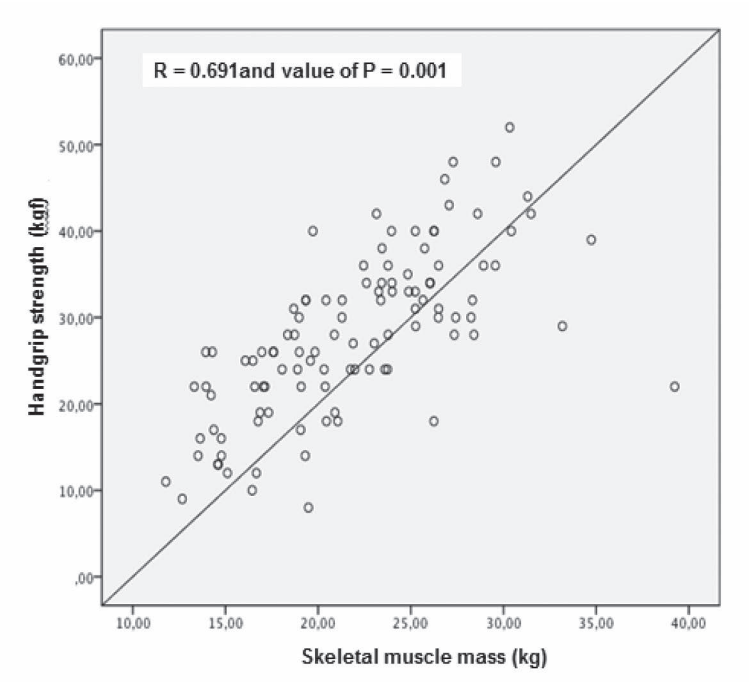

Figure 1. Correlation between appendicular skeletal muscle mass and muscle strength. Salvador, BA, 2013-2014.

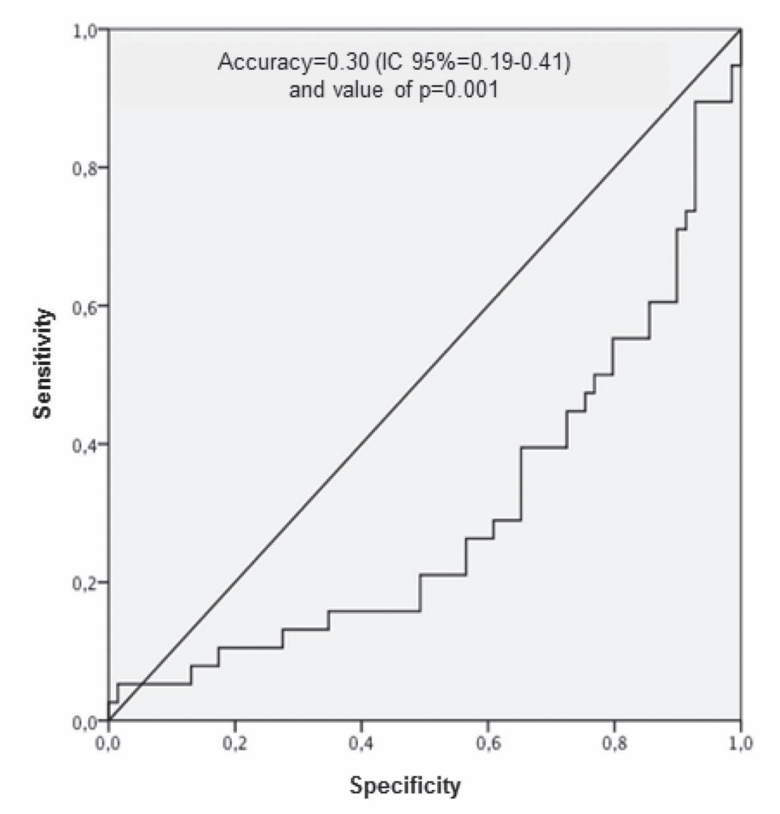

Figure 2. Accuracy of skeletal muscle mass for predicting muscle weakness. Salvador, BA, 2013-2014.

In the comparison between patients with and without muscle weakness, it was observed that the elderly patients with muscle weakness were older, with no significant difference in other variables (Table 2).

Table 2. Intergroup comparison of elderly patients with and without muscle weakness. Salvador, BA, 2013-2014.

	With weakness (n=40)	Without weakness (n=70)	p
Age	75.2(±9.8)	68.7(±6.7)	0.002
Charlson	5.9(±1.9)	5.1(±1.7)	0.638
MMSE	21.4(±5.3)	25.2(±4.2)	0.058
BMI	24.2(±4.9)	26.1(±4.4)	0.528
HTDC (days)	3.0(±1.5)	2.5(±1.7)	0.088

MMSE= mini mental state examination; BMI= body mass index; HTDC: hospitalization time during collection.

DISCUSSION

In the present study, there was a moderate correlation between strength and skeletal muscle mass, corroborating other studies,[17,18] despite the low correlation between reduced muscle mass and muscle weakness. This study also identified poor accuracy of muscle mass in predicting muscle weakness, which demonstrates the need for independent measurement of the two variables, even when the patient has normal muscle mass. This occurs because, despite muscle mass being considered the fundamental variable for the diagnosis of sarcopenia, some elderly persons may have dynapenia, which is a reduction of muscle strength and is not associated with reduced mass.

Orsatti et al.[19] also found a direct relationship between muscle mass and strength in people aged over 40. In this study, muscle strength was evaluated in the muscle groups of limbs by means of the one repetition maximum test (1RM) and not by handgrip strength as in the present study. Despite non-assessment of overall muscle strength, grip strength reflects peripheral muscle strength, which justifies its use in daily practice to identify muscle weakness.[3] Clark & Manini[20] reported that loss of muscle strength related to age has a weak association with loss of muscular cross-sectional area. The present study did not evaluate the reduction of mass and strength over time, given that it is a cross-sectional study. However, it was concluded that mass alone is not a good predictor of strength due to the low accuracy obtained.

Studies evaluating these variables over periods of years have demonstrated that muscular weakness has greater influence than muscle mass reduction on negative outcomes such as mortality.[7,8] Cawthon et al.[21] reported that muscle weakness (RR=1.52; CI 95%=1.3-1.78), reduced muscle density (RR=1.47; CI 95%=1.24-1.73) and low gait speed (RR=1.70; CI 95%=1.45-1.98) increased the risk of hospitalization during five years of monitoring, which was not observed in relation to muscular mass. Therefore, it is suggested that the focus of interventions should be primarily on the variables of strength and physical performance, rather than muscle mass alone.

Over time, it has been observed that the decline in strength occurs in a more accentuated manner than the reduction of skeletal muscle mass due to factors associated with muscle quality being related to this condition.[22-25] Muscle power generation is influenced by several morphological factors, which are related to tension per unit of mass, great activation capacity of the neuromuscular system, deterioration of contractile fibers, increase in the percentage of muscle infiltration by fat tissue, and decreased tendon stiffness, in addition to the reduction of muscle mass itself.[22,23,25] These factors may explain, in part, the low accuracy of mass in predicting strength shown in the study.

In the present study, greater muscle weakness was also observed in older individuals, as in previous studies.[25] The causal factor may be related to the reduced voluntary activation of contractile tissue which is observed in individuals over the years and with advanced age.[20] Other information in the present study that agrees with previous studies was reduced cognitive function in elderly individuals with muscle weakness, compared to those with no weakness.[2,3]

With regard to the two variables studied and their impact on activities of daily living, studies show that it is more important to monitor strength in the elderly rather than muscle mass, due to its significant association with physical performance.[23,26] In this context, the manual dynamometer is a useful tool for identifying patients with muscular weakness, as it presents a correlation with overall muscular strength, as well as a correlation with mortality.[2,3,27] It is important to note that strength deficit is not the only determinant of worsening physical performance, as there are other systems involved.[22]

The study has some limitations such as the fact that it is a cross-sectional study, therefore making it impossible to associate the evaluation of these variables over time. Another limitation was the use of a less accurate tool for quantification of muscle mass, since the instruments considered to be gold standard are expensive. However, the anthropometric equation correlates well with high accuracy instruments in addition to having a lower cost and greater operational ease. Another limitation was that the anthropometric equation used for patients with a BMI ≥ 30 kg/m^2 is less accurate for estimating muscle mass. This was used on 12 of the total patient sample.

CONCLUSION

Despite the linear relationship between muscle mass and strength in the sample of hospitalized elderly persons evaluated, there was no correlation between reduced muscle mass and muscle weakness, and mass presented low accuracy for predicting strength. This data reinforces the need for the evaluation of mass and strength to be carried out independently in the diagnosis of sarcopenia. Further studies are required to identify the temporal relationship between mass and muscle strength in the elderly during periods of hospitalization.

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