ORIGINAL ARTICLE

Pressure pain threshold, lifestyle, muscle strength, and functional capacity in elderly women with sarcopenia

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ABSTRACT

Objective: The present study sought to assess the impact of this condition on muscle strength, functional capacity, lifestyle, and the pressure pain threshold. **Methods:** Elderly people considered healthy (n = 75) aged 60-75 years (66.8 ± 4.6 years) were studied in an observational and cross-sectional design. Those who registered pain above 4 on the Visual Analogue Scale (VAS) and used analgesic and/or anti-inflammatory medication were excluded from the study. Body composition and presence of sarcopenia were evaluated by bioelectric impedance. Two groups were formed: CO - control group (n = 51) and SARC - sarcopenic group (n = 24, muscle mass index less than 6.86 kg/m^2). **Results:** Functional capacity was determined by the 6-minute walk test (6MWT); handgrip strength and elbow flexion strength were both determined by dynamometry. Lifestyle was assessed by the FANTASTIC questionnaire. The pressure pain threshold was determined by algometry. Data were analyzed using the Student's t-test ($p < 0.05$). CO and SARC did not differ regarding age, body fat percentage, lifestyle, 6MWT, elbow flexion strength, or in algometry measurements at almost any point. However, statistically significant differences between groups were found regarding handgrip strength and algometry in the right insertion of the biceps. **Conclusion:** Elderly women with significant reduction of muscle mass do not present impairments in functionality or in the sensation of muscle and tendon pain, probably due to a pre-sarcopenic condition.

Keywords: Aging, Muscle Strength, Physical Fitness, Pain Threshold, Sarcopenia

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INTRODUCTION

The prevalence of elderly in the Brazilian population has increased significantly.[1] At this stage of life, as an integral process of a normal biological cycle, it is manifested by morphofunctional changes and declines in the functions of the various components that lead the individual to a continued, inevitable, and irreversible process of organic breakdown.[4] One example of a morphological alteration is sarcopenia, defined here as the loss of muscle mass and strength.[5,6] The prevalence of sarcopenia is approximately 9% in women aged between 65 and 75 years and 17.5% in men over the age of 75 years.[5] Its etiology is multifactorial, being a consequence and cause of physical inactivity, its main risk factor. Often accompanying sarcopenia are vascular alterations, mitochondrial abnormalities, hormonal changes, weight loss, the presence of pro-inflammatory cytokines, loss of motor end plates, peripheral neuropathies, and even cell apoptosis, changing the body composition and muscle quality, resulting in a decline in strength, physical independence, functionality, and an increased risk of falls.[5-9]

Pain is part of everyday life for most people and is closely related to quality of life. It is one of the most common complaints of older people during medical consultations. Individuals over 60 complain twice as often about pain than younger people, and this occurs more often among women.[2,10,11]

The pressure pain threshold (PPT) can be evaluated by means of algometry, which is characterized as a measurement of perceptual experience of a person's pain and that is used to monitor and diagnose the pain.[12.13] The high prevalence of pain in the elderly is associated with chronic disorders of musculoskeletal origin,[12] which may be related to sarcopenia itself. One example of this would be osteoarthritis among the elderly.[14.15] The way sarcopenia and pain tend to increase with aging,[16.17] it seems intuitive that the association is unavoidable.

OBJECTIVE

The present study aimed to assess the impact of sarcopenia on functional capacity, muscle strength, lifestyle, and pressure pain threshold in elderly females.

METHODS

An observational and cross-sectional study was conducted with 75 elderly women, randomly drawn from a population of approximately 1,000 elderly, all were participants in the social activities program for older people in the city of Embú-Guaçú, in São Paulo. After approval from the Research Ethics Committee of the Centro Universitário Adventista de São Paulo-UNASP (No. 1,063.539), all procedures were explained to the volunteers and those who agreed to participate signed an informed consent form. The examinations were performed at the UNASP.

People aged between 60 and 75 years old were included in the study, except those with psychiatric disorders, chronic diseases (such as fibromyalgia and rheumatoid arthritis), arthralgia with intensity of pain greater than or equal to 4 on the Visual Analogue Scale (VAS),[18] those who were doing physiotherapy, and those who had made use of an analgesic or anti-inflammatory medicine in the 12 hours prior to the assessment.

The volunteers were evaluated as to anthropometric data (weight and height), body composition, functional capacity, muscle strength, and life style.

Body composition was determined by bioimpedance, because it is very precise for this type of assessment, in addition being fast, safe, and free of radiation.[19] We used the appliance Biodynamics BIA 450, Bioimpedance analyzer - BIODYNAMICS®, with a gel electrode. Before carrying out the test, the volunteers had received the following recommendations: be well fed, but do not eat anything for 4 hours before the test; drink plenty of water during the day of the exam, especially 1 hour before him; do not drink alcoholic or caffeinated beverages for 48 hours before the test; and do not perform any strenuous physical activities in the last 24 hours. For the exam, the volunteers were instructed to empty the bladder and remove any metal objects. They were placed in a supine position, the electrodes were set after cleaning the contact points with cotton and alcohol 70ºGL. The volunteers rested for 10 minutes before the measurements.

The diagnosis of sarcopenia was based on skeletal muscle mass, calculated using the equation from Janssen et al.[19] from the data of bioelectrical impedance, through the following equation: skeletal muscle mass (SMM, kg) = $[(\text{height}^2 \div \text{bio-resistance} \times 0.401) + (\text{gender} \times 3.825) + (\text{age} \times -0.071)] + 5.102$, where: height (cm), bio-resistance (ohms), sex: men = 1 and women = 0, age in years. This equation was validated by comparing the results of muscle mass obtained through magnetic resonance imaging with those obtained by means of bioelectrical impedance.[19] The correlation coefficient (r) was of 0.93, with a coefficient of determination (r^2) of 0.86, and a standard error of 2.7 kg (9%). Then we calculated the Skeletal Mass index (SMI) by dividing the SMM by the square of height[20] (height in m^2). According to Janssen et al.[21] values equal to or greater than one standard deviation below the average indicate SMI normal. Values of SMI between one and two standard deviations below the mean characterize class I sarcopenia, and values of SMI below two standard deviations-of the mean characterize the class II sarcopenia.[21] Janssen et al.[21] had proposed that normal values be obtained from the same population. Therefore, women (n = 49) with ages between 18 and 40 years, with suitable body fat (%F) and body mass index (BMI) were evaluated as recommended.[21] The average values of SMI ± 1SD found were: women: SMI = 7.59 ± 0.73 kg/m^2. Hence, women with SMI < 6.86 kg/m^2 were classified as having class I sarcopenia and those with SMI < 6.13 kg/m^2 with class II sarcopenia. The women were then divided into 2 groups: a control group: CO (n = 51) and sarcopenic: SARC (n = 24, classes I and II).

Functional capacity was evaluated by means of the 6-minute walk test (6MWT), because it is safe, simple, and practical to apply, because it is an indicator of the ability to perform activities of daily living, and a predictor of morbidity and mortality.[22.23] The test was applied in a covered court. The volunteers were instructed to walk back and forth as many times as possible along a stretch marked out by cones. They were told that if they felt the need to slow down or even stop the test, they should do that. A starting point was defined and the test would begin at the command of the examiner, who would follow the participants closely at all times, who were divided into groups of ten people. All patients received verbal encouragement in accordance with the standards of the American Thoracic Society.[22] The distance travelled in 6 min was recorded by means of a Laser DLE-70 BOSCH Professional® tape measure.

Muscle strength was assessed through dynamometry. Handgrip strength was measured using a TKK 5401 dynamometer (Takei Instruments, Japan), graduated in kilograms (Bolingbrook, IL, USA). The dynamometer was positioned in the palm of the hand and the upper limb positioned beside the body, but not leaning against the trunk. Each subject was instructed to apply the maximum force possible for 4 seconds. There were 3 trials performed with each hand, with intervals of 60 seconds between retries. The highest value was considered for analysis.[24] The strength of flexion of the elbows was measured on a dynamometer for trunk and limbs (TKK 5002 - Takei Instruments, Japan). Each participant was positioned seated, with the feet supported on the device, and the elbows and knees at an angle of 90°. At a signal from the examiner, the volunteer applied the maximum force possible of flexion of the elbows for 4 seconds. There were 3 trials performed with each hand, with intervals of 60 seconds between retries. The highest value achieved was considered.[24]

The style of life was assessed using a translated version of the "FANTASTIC Life Style" questionnaire[25] validated in Portuguese; it is a generic instrument that considers the behavior of individuals within the past month, and whose results can be used to determine the association between lifestyle and health. The application of the questionnaire was performed individually in a private space prior to the physical assessment procedures.

The pressure pain threshold (PPT) was evaluated by means of the J Tech (Salt Lake City, UT, USA) algometer. This is a hand-held device with a protruding rubber probe that is 1cm in diameter, which is able to electronically register the pressure applied on a surface. Its reliability has been previously demonstrated.[26,27]

The evaluator operated the algometer with his right hand while his left hand was placed over the muscle or tendinous insertion only to adjust and coordinate, thus avoiding small deviations. The pressure was applied perpendicularly to the point being stimulated, with pressure increasing at a constant of 1lb/sec on all points up to the level at which the participants said there was pain or discomfort. The reading was expressed in pounds (lb). During the assessment, the subject was instructed to say "stop" as soon as the feeling of pressure became unpleasant or painful. The application of pressure was stopped as soon as the volunteer indicated the onset of pain and the final amount of force applied was recorded. The application points were the muscle belly and insertions of the: brachial biceps, flexor carpi ulnaris, and flexor carpi radialis.

Data Analysis

The data were analyzed by means of the statistical package GraphPad Prism 6.0 for Windows (www.graphpad.com) and the results were expressed as means ± standard deviations. The distribution of the data was analyzed using the D'Agostino-Pearson test. The internal consistency of the FANTASTICO instrument for this sample of elderly women was established by the standardized Cronbach's Alpha. The comparisons between CO and SARC individuals were made using the *Student's t*-test and the significance level was set at 5% ($p < 0.05$).

RESULTS

There were 75 elderly women evaluated (66.8 ± 4.6 years old, 155.6 ± 1 cm in height, 70.2 ± 12.4 kg in weight, 29.1 ± 5.1 kg/m^2 of BMI, and 38.4 ± 6.4% of body fat. The results of skeletal muscle mass (SMM) and skeletal mass index (SMI) identified 24 women (28%) with SARC and 51 with CO. The overall results of the comparison between the groups evaluated are summarized below (Table 1).

The groups showed no statistical difference in age, physical capacity, muscle strength, lifestyle, or pressure pain threshold (Table 1). On the other hand, the CO women exhibited significantly higher values in relation to body weight, BMI, lean body mass, handgrip strength, and in one of the points analyzed by

Table 1. General characteristics of the control group and sarcopenia

VARIABLES	CONTROL GROUP	SARCOPENIA GROUP	*p*
N	51	24	-
Age (years)	66.4 ± 4.4	67.5 ± 5.3	NS
Height (cm)	155.8 ± 7.1	155.0 ± 7.4	NS
Weight (kg)	73.7 ± 11.9	62.8 ± 10.3	<0.001
BMI (Kg/m^2)	30.4 ± 4.8	26.2 ± 4.3	<0.001
Body fat (%)	37.6 ± 5.3	40.0 ± 8.1	NS
LM (kg)	45.7 ± 6.0	37.6 ± 7.7	<0.001
SMM (kg)	19.2 ± 3.0	15.0 ± 1.8	<0.001
SMI (Kg/m^2)	7.9 ± 0.9	6.2 ± 0.4	<0.001
Life Style (total score)	74.0 ± 10.9	74.8 ± 11.0	NS
Six-minute walk test (m)	481 ± 71	474 ± 64	NS
Elbows flexion strength (kgf)	47.6 ± 8.2	44.3 ± 5.9	NS
Hand Grip Strength (kgf)	18.6 ± 3.9	14.9 ± 4.3	<0.001
Algometry Brachial biceps			
Right insertion (lb)	12.0 ± 4.0	9.4 ± 4.2	0.011
Left insertion (lb)	11.2 ± 4.4	10.1 ± 4.2	NS
Right belly (lb)	11.6 ± 4.1	10.0 ± 3.1	NS
Left belly (lb)	11.1 ± 4.2	9.2 ± 3.0	NS
Flexor carpi ulnaris			
Right insertion (lb)	17.0 ± 5.3	16.0 ± 3.5	NS
Left insertion (lb)	15.7 ± 4.6	15.8 ± 2.9	NS
Right belly (lb)	14.1 ± 4.9	12.6 ± 2.5	NS
Left belly (lb)	12.9 ± 4.5	11.3 ± 3.3	NS
Flexor carpi radialis			
Right insertion (lb)	15.1 ± 4.9	13.3 ± 3.5	NS
Left insertion (lb)	14.5 ± 4.8	13.1 ± 2.8	NS
Right belly (lb)	12.1 ± 4.4	10.0 ± 3.0	NS
Left belly (lb)	12.2 ± 4.2	11.3 ± 3.1	NS

Legend: cm: Centimeters; m: Meters; m^2: Square Meters; kgf: Kg-force; lb: Pound; BMI: Body Mass Index; LM: Lean Mass; SMM: Skeletal Muscle Mass; SMI: Skeletal Mass Index.

algometry (right insertion of the brachial biceps). In addition, the internal consistency of the FANTASTIC instrument for this sample was good (Cronbach's Alpha = 0.77).

DISCUSSION

The prevalence of sarcopenia in this sample was 32% greater than that found by other authors[28] (between 13% and 24%), including the Brazilian elderly (20%).[17] The values of handgrip strength of the SARC group were lower than the CO, a finding compatible with the diagnosis of sarcopenia. Despite this, the groups did not differ in relation to the results of the tests of elbow flexion force, 6MWT, perception of pain (except at the insertion of the right bicep), and life style. A plausible explanation for the subtle differences between groups may be the level of sarcopenia. It is possible that this sample of women with SARC were on the level of pre-sarcopenia.[29]

The similarity between the groups of elderly was evident when evaluating their life styles. Although the FANTASTIC[25] questionnaire has not been developed for the elderly, but instead for young people and adults, the analysis of the internal consistency of the instrument in this sample of elderly women showed a Cronbach alpha coefficient of 0.77, indicating acceptable reliability of data, on this multidimensional scale. This suggests that at least the samples offered consistent answers. Thus, in the impossibility of using specific instruments, one can suppose that the results have adequately estimated the life style of the elderly in this study. In this sense, the very good mean scores in both groups CO (74.0 ± 10.9) and SARC (74.8 ± 11.0) indicate that SARC is not associated with the worst habits of these people (Table 1) and that these habits may have attenuated the effects of sarcopenia.

The handgrip strength, in addition to being important in carrying out the tasks of daily life, is an important indicator of muscle strength in elderly indivíduals,[30.31] and a component in the diagnosis of sarcopenia and health.[30] Consistent with the condition of women in group A, the values were significantly lower than those of the CO group indicate that their reduced muscle mass significantly affected their muscular strength.[32] However, differences between groups with respect to the strength of elbow flexion have not been independently verified. Once more it is possible to suppose that the women in the group SARC are on the level of pre-sarcopenia, because taking the value of 16 kgf, suggested as a cut-off value for the diagnosis of sarcopenia in relation to the handgrip strength,[32] the values achieved by these SARC women (14.9 ± 4.3 kgf) were slightly less than the value reported by Dodds et al.[32] whereas the CO group showed 18.6 ± 3.9 kgf, slightly above the cut-off value.

In relation to the pressure pain threshold, in only one of the outcomes (right insert of the brachial biceps) was the value of the SARC group significantly lower than in the CO group. These results suggest some dissociation between the pressure pain threshold and sarcopenia. It seems that the ability to generate muscle strength does not affect pain perception. This proposition is corroborated by indications that the perception of pressure pain is related much more to neuroanatomical neurochemical and factors,[12,33,34] and less to the capacity to recruit the fibers and structural characteristics of muscles. Still, it is worth noting that the algometry has not assessed the overall the pressure pain threshold in the elderly, since only a few points in the upper limbs were considered in this study. This makes it impossible to conclude whether overall pain sensitivity is affected by sarcopenia.

From a clinical point of view, the results of this study are important in the sense that, even among elderly persons who present similar conditions of physical and functional capacity, the loss of lean mass may already be installed and generating small difficulties; for example, in performing simple daily activities that involve handgrip strength. This is why evaluating grip strength is advisable in the overall assessment of the elderly, because it is considered a predictor of overall strength and health, for being associated with morbidities, including risk of fractures and cognitive decline.[32] The results obtained from an evaluation of handgrip strength can be used to prepare strategies as the forwarding to performing specific activities for strengthening muscles, which may in turn reduce the limitations imposed by sarcopenia.

Muscle strengthening is known as a primary intervention for the prevention of and/or recovery from sarcopenia. However, other approaches should not be ignored, as improving life style: Exposure to sunlight, control of chronic diseases, controlled use of medications, proper food, and staying physically active. All these measures are effective for the prevention and treatment of sarcopenia during the aging process.[7,15,35,36]

Some limitations of this study need to be pointed out. The fact that the study was performed only with women limits the generalization of the findings. However, as the female gender has longer life expectancy and high prevalence of functional limitations,[35] the greater interest in this research is justified.

The transversal nature of the study does not allow cause and effect relationships to be established between the variables studied. On the other hand, the present study provides some evidence that handgrip strength is dissociated from sarcopenia. For this reason, other studies are needed that not only use other evaluation instruments, measures of body composition such as a computed tomography, as well as other tests: of vitamin D levels, ultrasound, magnetic resonance imaging, relationship of muscle mass and strength, and bone mass so that the conditions of aging can be increasingly understood.

CONCLUSION

The results of this study showed that in a group of 75 elderly women of the community, almost one third had sarcopenia. Still, those women classified with sarcopenia only differed from the control group in relation to the handgrip strength and in a single point of evaluation of their pressure pain threshold in the upper limbs.

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