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Evaluation of functional parameters of the foot and ankle in elderly with sarcopenia

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SUMMARY

OBJECTIVE: With population aging, the prevalence of sarcopenia has increased. It is a pathology often neglected, with the potential to cause great damage if not diagnosed and treated. The objective of this study was to identify sarcopenic elderly people through the SARC-F score and palm grip test and to evaluate foot and ankle functionality parameters: gait speed, plantar sensitivity, and baropodometry.

METHODS: This is a descriptive and cross-sectional study. The sample consisted of 20 sarcopenic elderly diagnosed through the SARC-F score and the handgrip strength test, from which demographic data were obtained, and the three functional tests related to the foot and ankle were performed.

RESULTS: No individual was aware of the term sarcopenia. Regarding gait speed, 20 (100%) presented values compatible with sarcopenia (average of 0.52 m/s). Regarding plantar sensitivity, five (25%) of the patients showed changes in the exam with the detection of insensitivity. Regarding baropodometry, higher pressure values were observed in the right foot (average of 52.9±7.01%) compared to the left (average of 47.10±7.01%) and in the hindfoot (average of 55.85±16.21%) compared to the forefoot (mean 44.15±15.35%). When correlating the analyzed variables with the SARC-F scores, the only association that showed statistical significance ($p<0.05$) was the dynamometry on the right.

CONCLUSION: The SARC-F score and the handgrip strength test are easy to apply in the screening of sarcopenia, and the functional parameters of the foot and ankle were shown to be altered in the studied group.

KEYWORDS: Aging. Muscles. Muscle, skeletal. Sarcopenia.

INTRODUCTION

With population aging, the prevalence of sarcopenia has increased[1]. The European Working Group on Sarcopenia in the Elderly Population (EWGSOP2) recommends, for investigation, the application of the sarcopenia form (SARC-F)[2] questionnaire, for the detection of characteristic signs of sarcopenia. Once detected, the diagnosis can be confirmed by testing the handgrip strength using a calibrated dynamometer, which is a simple and inexpensive method[3].

It is known that sarcopenia is associated with changes in muscle architecture. As muscle size reduces with advancing age, muscle fibers become shorter and less feathered, which directly interferes with muscle function[4]. Aging is associated with the degeneration of the nervous system, which may affect plantar sensitivity, an important source of information for balance control, as it encodes changes in pressure under the foot, especially during gait[5].

The relationship between sarcopenia and functional parameters of the foot and ankle, such as gait speed, plantar sensitivity, and plantar pressure, has been little explored in the literature. It is questioned whether sarcopenia, through changes in muscle architecture and metabolic changes, affects the functionality parameters described above, a situation that, in a fragile group, can be very debilitating. The objective of this study was to evaluate the tracking of sarcopenia through the SARC-F score and the handgrip test and to evaluate foot and ankle functionality parameters in elderly individuals with sarcopenia.

This project was submitted to the ethics committee and approved under protocol 5.149.988. All participants signed an informed consent form.

This is a descriptive and cross-sectional study consisting of two stages. In the first, in a tertiary hospital, in 2 months (April and May of 2021), all 180 patients treated at an orthopedic outpatient clinic were included. After applying the exclusion criteria (i.e., age less than 60 years, use of walking devices, orthopedic, dermatologic, or neurologic diseases of the lower limbs, psychiatric disorders that interfered with participation, and diabetes mellitus), 39 were elected to participate in the study, to which the SARC-F[2] questionnaire was applied. Of these, 20 obtained a score suggestive of sarcopenia (SARC-F≥4), being included in the second stage of the study.

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The second stage was carried out in the human performance laboratory of a public university, where the 20 individuals were submitted to the handgrip strength test and functionality tests related to the foot and ankle.

Handgrip strength was assessed using a Jamar®[6] dynamometer. A value of less than 27 kg in males and a value of less than 16 kg in females in handgrip are objective indicators of sarcopenia[1]. The subjects remained seated in an office-type chair. The arm was kept suspended in the air with the hand positioned on the dynamometer, which was supported by the evaluator[6]. The same was repeated 3× on the right side and 3× on the left side, with an interval of 1 min between repetitions. The highest value obtained on each side was considered for registration. Figure 1 shows the position of the volunteer to assess the handgrip strength with a dynamometry instrument.

A socio-demographic questionnaire was applied to each participant containing the following variables: age, history of falls and previous fractures, and knowledge about sarcopenia.

The manual measurement of the 4 m gait speed was performed, being the gold standard test for such an evaluation in older adults[7]. According to the EWGSOP2[1], a velocity lower than or equal to 0.8 m/s is an indicator of sarcopenia. A well-defined path of 4 m was established, with the beginning and end marked on the ground. The time count started with the first movement of the participant's foot crossing the starting line and ended as soon as the foot crossed the final line[7].

The assessment of plantar cutaneous sensitivity was performed using a Semmes-Weinstein monofilament (referring to 10 g). Sensitivity evaluation was performed in three plantar areas of each foot: hallux, plantar region of the first metatarsal head, and plantar region of the fifth metatarsal head, and repeated three times each[8].

Figure 1. Positioning of the volunteer to assess the handgrip strength with a dynamometry instrument.

The assessment of plantar pressure in the right and left foot was performed using an electronic baropodometry platform (Sensor Medica®, Guidonia Montecelio, Italy) connected to a computer (Dell All®, Texas, USA). For the baropodometrics, the participants were positioned barefoot in the orthostatic posture with bipedal support on the baropodometric platform. The platform was positioned 1 m from the wall, and the participants were instructed to keep their eyes fixed, taking as reference a fixed point on the wall at eye level, with arms relaxed along the body[9].

The quantitative variables were classified using measures of central tendency and for categorical variables, absolute and relative frequency. Data analysis was performed using Minitab version 19.1 and the Statistical Package for the Social Sciences, Inc. (SPSS) Chicago, USA, version 26.0. The significance level used was $p<0.05$. Spearman's ordinal correlation test was used to assess the correlations based on the distribution of variables.

RESULTS

Twenty individuals with a mean age of 75.6±5.9 years (ranging from 65 to 90 years) were evaluated, 95% of whom were female. A total of 100% mentioned a history of falls and 40% mentioned a history of fractures. A total of 100% of the sample reported unfamiliarity with the term sarcopenia.

Table 1 shows the descriptive analysis of the functional parameters.

Regarding gait speed, the maximum and minimum values obtained were, respectively, 0.76 and 0.2 m/s, with an average, in the sample, of 0.52 m/s and a standard deviation of 0.13. Regarding plantar sensitivity, five individuals (25%) presented alterations in the exam.

Regarding baropodometry, when evaluating the distribution of plantar pressure in the left and right feet, higher pressure values were observed in the right foot (mean of 52.9±7.01%) compared to the left (mean of 47.10±7.01%). When comparing the load distribution in the anteroposterior direction, greater pressures were observed in the hindfeet (mean of 55.85±16.21%) compared to the forefeet (mean of 44.15±15.35%).

When correlating the analyzed variables with the SARC-F scores through Spearman's correlation, the only association that showed statistical significance ($p<0.05$) was the right dynamometry, whose interpretation was that lower levels of grip strength in the right hand were associated with a higher level of SARC-F score. Table 2 exemplifies Spearman's correlation between SARC-F and the analyzed variables.

DISCUSSION

Malmstrom and Morley[10] suggested that a SARC-F score greater than or equal to 4 is a predictor of sarcopenia. In this study, of the 39 elderly people who met the inclusion criteria, 20 had a SARC-F score suggestive of sarcopenia, and of these 20, 100% had confirmation through the handgrip strength test. In an investigation carried out in Spain with 235 elderly women, Aibar-Almaz et al. found an association between sarcopenia and falls[11]. Lim et al. investigated the association between sarcopenia and falls in 147 elderly patients aged over 65 years from different hospitals in South Korea[12] with hip fractures. As a result, the authors found a significant correlation between sarcopenia and falls. Such findings are in line with the results obtained in the study in question, in which 100% of the elderly participants reported a history of falls and 40% reported a history of suffered fractures.

A study that evaluated handgrip strength in elderly people over 65 years of age in Turkey[13] in 2016, evaluating 406 individuals, found a mean strength of 25.7±8.7 kgf. In the study in question, the handgrip strength values were lower, as this was a more fragile group with a SARC-F score suggestive of sarcopenia. An average force (kgf) of 13.25±1.41 was found on the right, and when correlating the force values obtained in the dynamometry with the SARC-F score, lower levels of force were observed in higher scores of SARC-F. A systematic review analyzed the effects of resistance training on muscle strength in very elderly adults and found that participation in resistance training over 8–18 weeks with a frequency o 1–3 days per week can restore the strength that has been potentially lost over several years of inactivity[14].

It is believed that the deterioration in gait speed related to sarcopenia during aging is due to qualitative and quantitative changes in muscle structure and function[15]. A study carried out in Colombia[16] evaluated gait speed as a predictor of sarcopenia including 19,705 individuals. A higher prevalence of sarcopenia was found at older ages, a result consistent with the study in question, in which higher SARC-F scores were found in older age groups. A Brazilian study in 2016 evaluated the gait speed in hospitalized elderly people. In a total of 110 elderly people, the average speed value was 1.26±0.44 m/s, and, of these, 15

Table 1. Descriptive statistics of functional variables and handgrip strength test.

Variables	Mean	SD	1° Q	Median	3° Q
Right handgrip strength (kgf)	13.250	1.410	12.00	14.000	14.000
Left handgrip strength (kgf)	11.550	2.144	10.000	12.000	13.500
Gait speed (m/s)	0.5290	0.1398	0.4400	0.5500	0.6500
Plantar sensitivity	0.767	0.53	0.287	0.69	1.045
Right full weight bearing (%)	52.9	7.01	46.5	56.50	1.022
Left full weight bearing (%)	47.10	7.01	43.50	47.50	53.50
Right hindfoot weight bearing (%)	28.35	9.63	25.00	30.00	34.00
Left hindfoot weight bearing (%)	27.50	6.58	24.00	25.50	32.25
Right forefoot weight bearing (%)	24.55	9.09	19.50	25.00	29.00
Left forefoot weight bearing (%)	19.60	6.26	16.00	20.50	24.00

SD: standard deviation.

Table 2. SARC-F and variables correlation.

Variable 1	Variable 2	Correlation	95%CI for ρ	p-value
SARC-F	Right handgrip strength (kgf)	-0.516	(-0.792 to 0.065)	**0.020**
SARC-F	Previous fractures	0.267	(-0.207 to 0.639)	0.256
SARC-F	Gait speed	-0.152	(-0.559 to 0.314)	0.522
SARC-F	Plantar sensitivity	0.095	(-0.364 to 0.517)	0.690
SARC-F	Left handgrip strength (kgf)	-0.067	(-0.495 to 0.388)	0.780
SARC-F	Age	-0.025	(-0.463 to 0.422)	0.916

Statistically significant value is indicated in bold.

patients had a gait speed lower than or equal to 0.8 m/s, suggestive of sarcopenia[17]. Comparing the different ages, a tendency toward a reduction in gait speed values was observed in the more advanced age groups, which is also compatible with the findings of the study in question.

A Brazilian study evaluated the differences in plantar sensitivity between 19 young adults and 19 elderly people[18]. The elderly showed greater loss of plantar sensitivity compared to adults. In this study, when evaluating 20 elderly people known to have sarcopenia and without pathologies that affect plantar sensitivity, five (25%) had impaired plantar sensitivity; however, no significant correlation was established between insensitivity and the SARC-F score. A study carried out in China evaluated the correlation between diabetic neuropathy and sarcopenia in type 2 diabetics[19]. A total of 1,104 patients were included, of which 204 had sarcopenia. There was a higher prevalence of neuropathy in sarcopenic than in non-sarcopenic patients.

Sousa et al.[20] studied the distribution of plantar pressure in two groups of women of different age groups: 50–65 years and 66–88 years. In both groups, greater plantar pressure was detected in the right foot, compared to the left, and greater in the hindfoot, compared to the forefoot. Such results are in line with the study in question, with the same finding. A study by Alvaro et al.[18] evaluated the differences in plantar pressure between 19 young adults and 19 elderly people. In agreement with the study in question, both groups had higher pressures in the hindfeet regions. However, comparing both groups of different age groups, the elderly had values of plantar pressure in the forefoot higher than young adults. The hypotheses that would justify this, according to the authors, could be the natural modification that occurs in the feet of the elderly, with a reduction in the medial plantar arch, or even the posture with a greater anterior inclination of the trunk that the elderly adopt during the orthostatic position. This hypothesis is in line with the study in question. When analyzing the positioning of the center of gravity in the anteroposterior direction of this group of sarcopenic elderly, it was found that in 90% of the sample, it was detected in a pre-fixed position.

A Japanese study evaluated the use of customized insoles as a factor for improving physical activity levels in individuals with sarcopenia. The sample was divided into two groups; half used the customized insoles for 6 months, compared to the other half who did not use it. It was seen that the use of the insole improved the pain reported during walking and improved the levels of physical activity when comparing both groups, despite not having improved the muscle quantity, that is, objectively, it did not interfere with the sarcopenia status[21].

Among the limitations of the study, the following stand out: sample defined by convenience; definition of sarcopenia based on the application of a score associated with a physical test, without a complementary exam that quantitatively evaluated muscle tissue; absence of a control group to compare the data obtained; and scarcity, in the literature, of studies that evaluated the same variables explored in this work. Among the strong points, considering the high prevalence of sarcopenia, this is, as far as the author is aware, the first study that describes the parameters of functionality in this specific group in a state of Brazil.

CONCLUSION

The prevalence of sarcopenia increases with population aging but is often neglected in clinical practice and, as seen in this work, unknown to the elderly population. The SARC-F score and the handgrip strength test were considered easy to apply in the screening of sarcopenia. When evaluating the functional parameters related to the foot and ankle, it has been noted: a reduced gait speed, sensitivity change in 25% of the sample, and, in relation to plantar pressure distribution, greater pressures in the right side and on hindfeet, highlighting the pre-fixed positioning of the center of gravity.

AUTHORS' CONTRIBUTIONS

EÁSJ: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **AMSVT:** Conceptualization, Data curation, Formal Analysis, Investigation, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft. **ATSS:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing.

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