



Original Research

Is lower limb muscle power by vertical jump a sensitive and specific measure for screening sarcopenia compared to handgrip strength and chair stand test?



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ARTICLE INFO

Keywords:
 Diagnosis
 Muscle mass
 Muscle strength
 Older adults

ABSTRACT

Background: Muscle power declines earlier and more sharply than strength with aging, yet it is not included in sarcopenia diagnosis, partly due to limitations in assessment methods.

Objective: To evaluate the sensitivity and specificity of vertical jump performance, measured via a mobile app, for sarcopenia screening and compare its accuracy with established strength tests.

Methods: This cross-sectional study included 214 older adults (mean age 70.6, range 60–88 year; 84.6% women) without mobility limitations. Sarcopenia was defined using the European Working Group on Sarcopenia in Older People (EWGSOP2) algorithm (low muscle strength and mass). Jump height was measured using an app, and power was estimated using a validated equation. Sensitivity, specificity, and area under the curve (AUC) were analyzed using Receiver Operating Characteristic (ROC) curves.

Results: Sarcopenia prevalence was 4.7%, and probable sarcopenia was 12.1%. Jump height showed 50% sensitivity, 92.5% specificity, and an AUC of 0.7349. Jump power demonstrated higher discriminative ability (90% sensitivity, 82.1% specificity, AUC 0.9146), comparable to handgrip strength (90% sensitivity, 93.6% specificity, AUC 0.8824). The FTCS test showed lower accuracy when based on time (88.9% sensitivity, 45.1% specificity, AUC 0.701), while power estimation improved performance to diagnosis (77.8% sensitivity, 80.9% specificity, AUC 0.8489).

Conclusion: Vertical jump power showed high sensitivity and specificity for sarcopenia screening, suggesting its potential as a sarcopenia tool. However, among the tests evaluated, the handgrip appears to be the most accurate and most effective, because it can be applied to older adults with restricted mobility in their lower limbs.

Introduction

Aging is a natural process characterized by the accumulation of physiological changes, including reductions in muscle quantity and quality,¹ strength loss,² and decline in physical capacities.³ When these impairments surpass a critical threshold, they lead to sarcopenia.⁴ The prevalence of sarcopenia has been reported to range from 0.2 to 86.5%,⁵ depending on age, ethnicity, and region, partly reflecting differences in

diagnostic criteria and cutoff points. Among the main consensuses, the updated guideline from the European Working Group on Sarcopenia in Older People (EWGSOP2) is widely used.⁴

Although EWGSOP2 is well established, it does not explicitly consider certain neuromuscular characteristics also affected by aging. The decline in muscle power, defined as the product of muscle force and contraction velocity,⁶ occurs earlier and more markedly than the loss of muscle strength or mass and is more strongly associated with functional

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<https://doi.org/10.1016/j.bjpt.2026.101579>

Received 22 March 2025; Received in revised form 2 November 2025; Accepted 7 December 2025

Available online 29 January 2026

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capacity.⁷ Thus, assessing muscle power may provide valuable information for sarcopenia screening.

Muscle power can be evaluated through several tools. One safe and feasible option in both clinical,^{8,9} and non-clinical settings¹⁰ is the vertical jump test, which provides relevant data on functional performance and aging. In adults aged ≥ 70 years, vertical jump power declines annually by -0.88 W/kg in women and -0.99 W/kg in men,¹¹ with about 41 % lower jump height in older versus young adults.¹² This decline is even more pronounced in individuals with sarcopenia.¹³

Vertical jump performance can be measured from accessible methods like the Sargent Jump Test to advanced laboratory equipment such as force platforms. Mobile applications have recently shown high reliability (ICC = 0.948, TEM = 1.15, CV = 10.096)¹⁴ for measuring jump height and power in diverse populations,¹⁵ potentially improving the feasibility of sarcopenia screening in older adults.

The association between vertical jump parameters and functional tests supports its potential as a marker of age-related decline. Jump power and height correlate moderately with handgrip strength, gait speed, and the five-times chair stand test (FTCS), core measures within the sarcopenia concept.^{16,17} Therefore, this study aimed to assess the sensitivity and specificity of vertical jump performance, measured via a mobile app, for sarcopenia screening in older adults. We also compared its diagnostic accuracy with other EWGSOP2-recommended strength measures (handgrip strength and the FTCS test) as well as chair stand power.⁴ We hypothesized that app-based vertical jump assessment would demonstrate high sensitivity and specificity for identifying sarcopenia. To compare the accuracy between tests, our study is exploratory in nature, with no pre-established hypothesis.

Methods

Study characterization

This study has a cross-sectional design, with data collection conducted in a single session. The research was approved by the Ethics Committee of the Federal University of Ceará – UFC (CAAE: 74251523.3.0000.5054; protocol number: 6443326). This manuscript was written in accordance with the Standards for Reporting of Diagnostic Accuracy Studies (STARD).¹⁸

Participants

The inclusion criteria were age ≥ 60 years; both sexes; no injury, discomfort, or pain during the vertical jump movement. Exclusion factors included chronic obstructive pulmonary disease, cancer, acute myocardial infarction within the past six months, heart failure, renal or hepatic insufficiency, physical disability, or any condition that hindered the proper execution of functional performance tests.

The sample recruitment was conducted through social media, word-of-mouth invitations, and partnerships with facilities offering physical exercise programs for older adults. Sample size calculation was performed using the website <https://wnarifin.github.io/ssc/ssnsp.html>, based on expected values for sensitivity (85 %), specificity (90 %), precision (10 %), confidence interval (95 %), and sarcopenia prevalence (17 %).¹⁹ The sample size calculation determined a total of 289 participants to be evaluated.

Data collection procedure

Initially, individuals interested in participating were contacted either by phone or in person to assess their eligibility. On the evaluation day, participants were provided with a detailed explanation of the study, followed by the reading and signing of the informed consent form if they agreed to participate. Subsequently, health and demographic questionnaires, as well as physical activity assessments, were administered. Participants then underwent tests from the EWGSOP2 algorithm for

diagnosing sarcopenia,⁴ along with vertical jump performance evaluation.

Assessment of sociodemographic, anthropometric, and health characteristics

The health questionnaire collected sociodemographic data, including age, sex, per capita income, and race/ethnicity, as well as information on participants' health history. Anthropometric measurements included total body mass and height. Body mass index (BMI) was calculated as the ratio of body mass in kilograms to body height in meters squared (kg/m^2).

Assessment of physical activity levels

Physical activity levels were self-reported using the International Physical Activity Questionnaire (IPAQ) short version, validated for the Brazilian population.²⁰ However, after data collection with 32 participants, it became apparent that older adults faced difficulties understanding the instrument. Consequently, the Minnesota Leisure Time Activities Questionnaire,²¹ was employed. For each activity, participants indicated whether they engaged in it, and if so, the number of times per week, considering the past three months, as well as the average duration of each session.

For both questionnaires, total weekly physical activity duration was calculated. Additionally, using the Minnesota Questionnaire, activities were categorized into cardiorespiratory, muscle-strengthening, and multicomponent activities to determine the prevalence of older adults engaging in each category.

Diagnosis of sarcopenia using the EWGSOP2 algorithm

Following the EWGSOP2 algorithm, assessments began with evaluations of muscle strength through handgrip strength and the FTCS tests. The handgrip strength test was performed using a digital dynamometer (CAMRY EH101, Sensun Weighing Apparatus Group Ltd, Guangdong, China). Participants were evaluated in an upright position, holding the device according to established guidelines from prior studies.²² After one familiarization attempt, two trials were performed with a one-minute interval between them, and the highest value was used for analysis. The cut-off points for sarcopenia were <27 kg for men and <16 kg for women.⁴

For the FTCS, participants began seated in a chair. Upon the evaluator's command, they stood up without using their arms, fully straightened, and sat back down, repeating this sequence five times as quickly as possible.²³ The stopwatch was stopped at the end of the fifth repetition. After a familiarization attempt, two trials were performed with a one-minute rest interval, and the shortest time recorded was used for analysis.

Total muscle mass (TMM) was estimated using the following anthropometric equation²⁴:

$$\text{TMM} = (0.244 \times \text{body mass}) + (7.8 \times \text{body height}) - (0.098 \times \text{age}) + (6.6 \times \text{sex}) + (\text{ethnicity} - 3.3)$$

Where, for the variable sex, numerical values of 0 for women and 1 for men were used. For ethnicity, the following values were assigned: 0 for white, -1.2 for Asian, and 1.4 for African American. Muscle mass index (MMI) was subsequently calculated as: $\text{MMI} = \text{TMM} / \text{body height}^2$. Cut-off points for MMI were <8.9 kg/m^2 for men and <6.4 kg/m^2 for women.²⁵

Sarcopenia classification followed the criteria established by Cruz-Jentoft.⁴ Participants were classified as having probable sarcopenia if they had muscle strength (handgrip strength or chair stand test) or muscle mass below the cut-off points, and as having sarcopenia was defined as having both low muscle strength and low muscle mass.

Vertical jump assessment

The countermovement jump was performed on a flat surface with participants barefoot. The movement was recorded using mobile devices equipped with the My Jump app (My Jump Lab v.4.2.2; developed by Dr. Carlos Balsalobre, Madrid, Spain). iPhone devices, model 11 and model SE (Apple Inc., California, USA), were used, configured for slow-motion video recording at 1080p HD and 240 fps, following validation study protocol.¹⁴ Standardized instructions were provided for the jump. Participants began in a standing position, feet shoulder-width apart, and hands placed on their hips throughout the entire movement. They were instructed to jump as high as possible following a countermovement with an angular range of their choice, ensuring knee flexion did not exceed 90°. The same take-off and landing positions were to be maintained. Take-off involved plantar flexion of the ankles, and landing required the lower limbs to remain extended with the ankles in plantar flexion, so that the toes made first contact with the ground. Jumps were deemed invalid if participants: 1) did not land in the same location as the take-off; 2) removed at least one hand from their hips; 3) flexed their knees immediately before landing; 4) did not perform plantar flexion. Each participant completed eight jumps, with the first three serving as familiarization attempts. Five test jumps followed to obtain at least three valid jumps for analysis, with a 30 s rest between attempts. If additional attempts were necessary, up to two extra jumps were performed, capping the total at 10 jumps per participant. For participants demonstrating insecurity during the test, evaluators were positioned laterally to provide support if needed, without making direct contact or interfering with movement execution.

Jump height analysis was performed using the manual mode of the My Jump app. The frames corresponding to the start of the flight phase (when both feet were off the ground) and landing (when at least one foot made contact with the ground) were identified. After marking these frames, the app automatically calculated and provided the jump height values. The muscle power during the vertical jump was estimated by equation, incorporating the values of jump height and body mass²⁶:

$$\text{Power (W)} = (60.7) \times (\text{jump height}) + 45.3 \times (\text{body mass}) - 2055.$$

After applying the equation, the peak power was relativized by body mass (W/kg).

Power assessment in the FTCS test

Power was also assessed by the FTCS test, according to the equation developed and validated²⁷:

$$\text{Muscle power} = \text{body mass} \times 0.9 \times g \times [\text{body height} \times 0.5 - \text{chair height}] / \text{time test} \times 0.1.$$

The acceleration of gravity (g) was considered as 9.8 m/s².

Statistical analysis

Data are presented as mean \pm standard deviation for continuous data, and as absolute and relative values for categorical data. The characteristics of the sample and the performance results in the tests are presented in three categories (i.e., non-sarcopenia, probable sarcopenia, and sarcopenia). Data normality was analyzed by the Shapiro-Wilk test. To compare groups according to sarcopenia classification, the Chi-square test was used for categorical data and the Kruskal-Wallis test for continuous data. Sensitivity, specificity, positive predictive value

(PPV), and negative predictive value (NPV) were analyzed using the Receiver Operating Characteristic (ROC) curve and the area under the curve (AUC) with a 95 % confidence interval (CI), based on the binary classification of sarcopenia (sarcopenia and non-sarcopenia). Cutoff points were determined by applying the Youden Index²⁸ and accuracy by AUC, considering the following cutoff points: 0.5–0.6 fail, 0.6–0.7 poor, 0.7–0.8 fair, 0.8–0.9 good, 0.9–1.0 excellent.²⁹ The pairwise agreement analysis between tests was performed using Cohen's Kappa, and the overall agreement analysis among all tests was performed using Light's Kappa, with classification values as follows: 0–0.20 none, 0.21–0.39 minimal, 0.40–0.59 weak, 0.60–0.79 moderate, 0.80–0.90 strong, and >0.90 perfect.³⁰ The analyses were conducted using Jamovi 2.3 software (Jamovi Project, Sydney, Australia), with a significance level set at 0.05.

Results

The target sample size for the study was not achieved, as the study was prematurely terminated due to limitations in human and financial resources. A total of 214 participants were assessed, comprising 33 men and 181 women. Ages ranged from 60 to 93 years, with an average BMI classified as within the normal weight range. Most participants were white, with a higher prevalence of undergraduate and postgraduate education, and a per capita income equivalent to three or more minimum wages.

Most participants were non-smokers and did not consume alcohol, with an average sleep duration of five to six hours. The weekly physical activity level classified the sample as active. Regarding health history, the most common conditions were high cholesterol, high blood pressure, depression/anxiety, osteoarthritis/rheumatoid arthritis, osteoporosis, and diabetes (Table 1).

According to the EWGSOP2 algorithm, the prevalence of probable sarcopenia in the sample was 12.1 % and that of sarcopenia was 4.7 %. The groups, according to the sarcopenia classification, presented significant differences in the variables sex, age, total body mass, BMI, calf circumference, multicomponent exercise, and number of medications (Table 1).

Two participants were excluded from the jump analysis and one from the FTCS test because they were unable to complete the tests. The sensitivity and specificity analyses for vertical jump height and power are presented in Table 2. For jump height, the AUC values showed significant discriminatory power for sarcopenia screening. Jump power showed AUC with significant discriminatory power for sarcopenia. Jump power showed greater sensitivity than jump height (90 % vs. 50 %), as well as a higher AUC, as shown in Fig. 1. Considering the accuracy of the diagnostic test for sarcopenia by AUC, jump power was classified

as excellent, while jump height had fair accuracy.

The AUC of handgrip strength, as well as the time and power performance in the FTCS, showed significant discriminatory power (Table 2). The highest sensitivity and specificity values among the physical tests were found for the handgrip strength test. Among the time and power assessed in the FTCS test, power showed the highest sensitivity and specificity values, also with the highest AUC. Handgrip strength and power assessed in the FTCS test were considered good diagnostic tests for sarcopenia, considering the accuracy by AUC. The time in the chair-standing test was fair. In all tests, the NPV was higher than the PPV. The highest PPV was for handgrip strength, while the lowest was for the chair stand test.

The groups differed in handgrip strength, jump height and power,

Table 1- Sociodemographic, health, and physical activity characteristics of the total sample and stratified by sarcopenia classification.

Variable	Total n = 214	Non- Sarcopenia n = 177	Probable- Sarcopenia n = 27	Sarcopenia n = 10
Sex, n = 214				
Women, n (%)	181 (84.6)	155 (72.4) [†]	17 (7.9)	9 (4.2)
Men, n (%)	33 (15.4)	22 (10.3) [†]	10 (4.7)	1 (0.5)
Age (years), n = 214				
	70.6 (6.9)	69.6 (6.4)*	74.0 (6.4)	78.9 (8.5)
Total body mass (kg), n = 214				
	64.1 (10.9)	64.5 (10.4) [‡]	66.1 (11.8) [‡]	50.6 (8.1)
BMI (kg/m²), n = 214				
	26.7 (4.1)	26.9 (4.0) [‡]	27.2 (3.6) [‡]	21.6 (2.6)
Height (m), n = 214				
	1.5 (0.1)	1.5 (0.0)	1.5 (0.1)	1.5 (0.1)
CC (cm), n = 214				
	33.7 (2.9)	33.8 (2.8) [‡]	34.3 (3.0) [‡]	30.2 (1.8)
Education level, n = 213				
Primary education, n (%)	53 (24.9)	43 (20.2)	7 (3.3)	3 (1.4)
Secondary education, n (%)	73 (34.3)	61 (28.6)	9 (4.2)	3 (1.4)
Undergraduate/graduate education, n (%)	87 (40.8)	72 (33.8)	11 (5.2)	4 (1.9)
Per capita income, n = 212				
<1 minimum wage, n (%)	25 (11.8)	23 (10.8)	2 (0.9)	0 (0.0)
1 to 2 minimum wages, n (%)	69 (32.5)	58 (27.4)	7 (3.3)	4 (1.9)
≥3 minimum wages, n (%)	118 (55.7)	95 (44.8)	17 (8.0)	6 (2.8)
Race/ethnicity, n = 214				
White, n (%)	94 (43.9)	72 (33.6)	17 (7.9)	5 (2.3)
Black, n (%)	15 (7.0)	14 (6.5)	1 (0.5)	0 (0.0)
Asian, n (%)	30 (14.0)	28 (13.1)	1 (0.5)	1 (0.5)
Indigenous, n (%)	4 (1.9)	3 (1.4)	0 (0.0)	1 (0.5)
Brown, n (%)	71 (33.2)	60 (28.0)	8 (3.7)	3 (1.4)
Smoking history, n = 212				
Smoker, n (%)	7 (3.3)	6 (2.8)	1 (0.5)	0 (0.0)
Non-smoker, n (%)	205 (96.7)	170 (80.2)	26 (12.3)	9 (4.2)
Alcohol consumption, n = 214				
No consumption, n (%)	134 (62.6)	112 (52.3)	16 (7.5)	6 (2.8)
<1 dose per week, n (%)	55 (25.7)	44 (20.6)	8 (3.7)	3 (1.4)
1 to 6 doses per week, n (%)	25 (11.7)	21 (9.8)	3 (1.4)	1 (0.5)
Sleep duration, n = 214				
<5 h per day, n (%)	22 (10.3)	19 (8.9)	2 (0.9)	1 (0.5)
5 to 6 h per day, n (%)	107 (50.0)	93 (43.5)	8 (3.7)	5 (2.3)
≥7 h per day, n (%)	85 (39.7)	65(30.4)	16(7.5)	4(1.9)
MVPA time (min), n = 214				
	535.2 (558.6)	571.5 (592.5)	356.8 (306.6)	374.5 (269.9)
MVPA categories, n = 182				
Cardiorespiratory, n (%)	147 (80.8)	121 (66.5)	20 (11.0)	6 (3.3)
Muscle-strengthening, n (%)	129 (70.9)	105 (57.7)	15 (8.2)	9 (4.9)
Multicomponent, n (%)	94 (51.6)	80 (44.0) [†]	7 (3.8)	7 (3.8) [†]

Table 1- (continued)

Variable	Total n = 214	Non- Sarcopenia n = 177	Probable- Sarcopenia n = 27	Sarcopenia n = 10
Health history, n = 214				
Cardiovascular diseases, n (%)	52 (24.3)	38 (17.8)	10 (4.7)	4 (1.9)
Hypertension, n (%)	111 (51.9)	89 (41.6)	17 (7.9)	5 (2.3)
Peripheral cardiovascular disease, n (%)	43 (20.1)	36 (16.8)	5 (2.3)	2 (0.9)
Osteoarthritis/rheumatoid arthritis, n (%)	81 (37.9)	67 (31.3)	10 (4.7)	4 (1.9)
Fibromyalgia, n (%)	16 (7.5)	15 (7.0)	1 (0.5)	0 (0.0)
Diabetes mellitus, n (%)	65 (30.4)	52 (24.3)	9 (4.2)	4 (1.9)
History of cancer, n (%)	20 (9.3)	17 (7.9)	2 (0.9)	1 (0.5)
History of injury, n (%)	54 (25.2)	41 (19.2)	9 (4.2)	4 (1.9)
Osteoporosis, n (%)	67 (31.3)	59 (27.6)	4 (1.9)	4 (1.9)
Thyroid disorders, n (%)	60 (28.0)	51 (23.8)	6 (2.8)	3 (1.4)
Cholesterol (above 200 mg/dl), n (%)	120 (56.1)	100 (46.7)	12 (5.6)	8 (3.7)
Depression/anxiety, n (%)	81 (37.9)	71 (33.2)	6 (2.8)	4 (1.9)
Other, n (%)	49 (22.9)	42 (19.6)	6 (2.8)	1 (0.5)
Medications, n = 214				
Number of medications	3.5 (2.3)	3.4 (2.2) [‡]	3.7(2.4)	5.3 (2.2)
Polypharmacy (≥5 medications), n (%)	56 (26.2)	44 (20.6)	7 (3.3)	5 (2.3)
Fall (last year), n = 214				
Yes, n (%)	135 (63.1)	114 (53.3)	16 (7.5)	5 (2.3)
No, n (%)	79 (36.9)	63 (29.4)	11 (5.1)	5 (2.3)

BMI, body mass index; CC, calf circumference; MVPA, Moderate to Vigorous Physical Activity; *Statistically different from the probable sarcopenia and sarcopenia groups ($p \leq 0.001$)

[‡] Statistically different from sarcopenia group ($p = 0.023$)

[†] Statistically different from probable sarcopenia group ($p < 0.05$).

and FTCS power, as shown in Table 3. Considering the cutoff points found for height and jumping power, described in Table 2, 20 (9.3 %) and 45 (21 %) of the older adults were classified with sarcopenia, respectively. In the handgrip test, it was observed that 21 (9.8 %) of the older adults presented values below the cutoff point. In the FTCS, the results showed that 120 (56.1 %) performed above the reference time, while 29 (13.6 %) exhibited lower power values. As shown in Table 4, the pairwise comparisons revealed no concordance between the diagnostic methods. Light's Kappa was 0.242 ($\alpha = 0.0397$; $p = 0.968$).

Of the 10 participants identified with sarcopenia according to the EWGSOP2 criteria, 5 had jump height values below the cutoff of 3.5 cm, while 9 had jump power values below the cutoff of 15.7 W/kg. Regarding strength tests, 8 participants had handgrip strength below the 15.7 kg cutoff, while 9 exceeded 9.3 s in the FTCS test, and 6 had power values below 1.4 W/kg.

Discussion

The aim of this study was to analyze the sensitivity and specificity of vertical jump performance, measured via an app, for sarcopenia screening in older adults. Contrary to our hypothesis, jump height showed low sensitivity but high specificity, making it a useful tool for identifying non-sarcopenic older adults. In contrast, jump power demonstrated both high sensitivity and specificity, proving to be a

Table 2
Characteristics of vertical jump height and power, handgrip strength and FTCS performance for screening of sarcopenia.

Variable	Sensitivity (95 %CI)	Specificity (95 %CI)	AUC (95 %CI)	PPV (%)	NPV (%)	p	Cut-off point
CMJ height	50.00 (23.66, 76.34)	92.57 (88.11, 95.45)	0.7349 (0.5822, 0.8876)	25.0	97.4	0.0122*	<3.5 cm
CMJ power	90.00 (59.58, 99.49)	82.18 (76.32, 86.84)	0.9146 (0.8488, 0.9804)	20.0	99.4	<0.0001*	<15.7 W/kg
Handgrip strength	90 (59.58, 99.49)	93.63 (89.40, 96.24)	0.8824 (0.7179, 1.000)	40.9	99.5	<0.0001*	<15.7 kg
FTCS time	88.89 (56.50, 99.43)	45.10 (38.42, 51.95)	0.701 (0.5484, 0.8535)	6.6	98.9	0.0414*	>9.3 s
FTCS power	77.78 (45.26, 96.05)	80.88 (74.94, 85.69)	0.8489 (0.7254, 0.9723)	15.2	98.8	0.0004*	<1.4 W/kg

AUC, area under the ROC curve; CMJ, countermovement jump; FTCS, Five-times chair stand; PPV, positive predictive value; NPV, negative predictive value. *Significant discriminatory power $p < 0,05$.

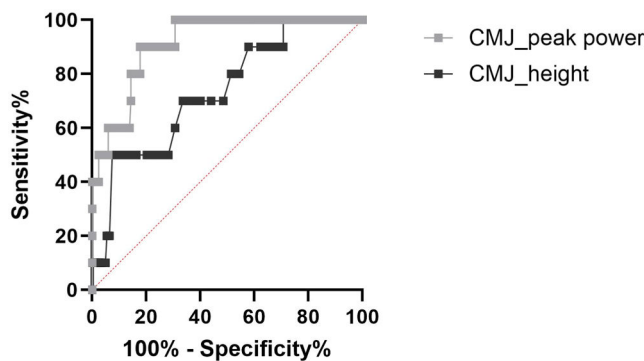


Fig. 1. ROC curve of jump height and power in the Counter Movement Jump (CMJ).

Table 3
Handgrip strength and FTCS performance characteristics, including time and power, of the total sample and stratified by sarcopenia classification.

Variable	Overall n = 214	Non-Sarcopenia n = 177	Probable-Sarcopenia n = 27	Sarcopenia n = 10
Handgrip strength, (n = 214), kg	22.4 (5.8)	23.3 (5.4)*	18.4 (5.2)	15.5 (5.7)
CMJ height, (n = 212), cm	8.0 (3.8)	8.5 (3.9)*	6.1 (2.3)	5.1 (2.6)
CMJ power, (n = 212), W/kg	20.1 (5.8)	20.8 (5.2)†	18.9 (5.6)†	10.1 (6.1)
FTCS time, (n = 213), s	9.8 (2.6)	9.4 (1.9)*	11.1 (3.3)	12.8 (6.6)
FTCS power, (n = 213), W/kg	2.0 (0.8)	2.0 (0.8)†	1.9 (0.8)†	1.2 (0.5)

CMJ, countermovement jump; FTCS, Five-times chair stand; *Statistically different from the probable sarcopenia and sarcopenia groups ($p < 0.001$).
† Statistically different from sarcopenia group ($p = 0.020$).

reliable measure for identifying both positive and negative cases of sarcopenia. However, the values obtained are comparable to those of the well-established handgrip strength test in the literature. Therefore, our results suggest the potential use of power measures in sarcopenia diagnosis, considering their applicability to a specific population, despite their lower accuracy compared to the handgrip strength test.

Currently, muscle power is not included in the concept of sarcopenia, despite its relationship with all components that characterize the condition,³¹ particularly its association with daily life activity performance.^{32,33} Researchers have highlighted the lack of studies exploring muscle power in the context of sarcopenia and proposed potential assessment methods.³³ In our study, vertical jump power normalized to body mass confirmed the accuracy and the high discriminative capacity

Table 4
Cohen's Kappa values for pairwise test comparisons.

Comparison (Pair)	Cohen's Kappa (κ)	p
CMJ power X CMJ height	0.345	<0.001
CMJ power X Handgrip	0.299	<0.001
CMJ power X FTCS time	0.096	0.066
CMJ power X FTCS power	0.590	<0.001
CMJ height X Handgrip	0.217	0.002
CMJ height X FTCS time	0.093	0.009
CMJ height X FTCS power	0.252	<0.001
Handgrip X FTCS time	0.088	0.017
Handgrip X FTCS power	0.232	<0.001
FTCS time X FTCS power	0.201	<0.001

CMJ, countermovement jump; FTCS, Five-times chair stand.

for screening sarcopenia, similarly to reported in previous study using a force platform.³⁴ In contrast, vertical jump height demonstrated fair discriminatory power for sarcopenia. Although both tests fundamentally require muscle power, the key differences in their assessment methods may account for this discrepancy. The observed difference between vertical jump height and jump power may be attributed to the inclusion of total body mass in jump power estimation, along with flight time.³⁵ In our study, participants with sarcopenia had lower total body mass compared to those with non-sarcopenia.

Although jump performance is strongly associated with physical function and sarcopenia,^{36,37} it is also influenced by intrapersonal factors (e.g., body composition, age, and sex) and biomechanical variables such as kinematic factors (acceleration, countermovement depth) and kinetic parameters (peak power).^{38,39} In this context, a review study on instruments used to assess muscle strength and power reported that one limitation of the countermovement jump is that it is primarily applicable to independent individuals with good mobility.³³ Given its limited use in older adults with restricted lower-limb mobility, our findings highlight the accuracy of the handgrip strength test compared to power assessed by jump. Recommended by the EWGSOP, handgrip strength is widely recognized as an essential biomarker of aging.⁴⁰ In primary care, all studies in a review used handgrip strength.⁴¹ Moreover, handgrip strength outperformed the FTCS test in sensitivity, specificity, and AUC, corroborating previous findings.⁴²

In contrast, power estimated from the chair stand test demonstrated good diagnostic accuracy, surpassing the time-based chair stand measure recommended in the consensus. The estimation equation validated by Alcazar et al.,²⁷ is considered a practical tool for assessing muscle power. While not without limitations, it closely mirrors daily activities and has reference values established in a European cohort.⁴³ Additionally, sit-to-stand muscle power has shown a stronger association with physical function and sarcopenia than the traditional sit-to-stand time.²⁷ Our findings reinforce the use of power estimated from the chair stand test to gain deeper insights into the physical condition of older adults.

It is essential to consider the specific characteristics of the tests

compared in the present study. The two tests that we investigated for estimating power are dynamic, multi-joint, focused on the lower limbs, and require both strength and velocity, reflecting more functional tasks. An additional consideration is the potential collinearity. Measures such as jump power and FTCS power include muscle mass in their calculations, which may introduce collinearity and consequently limit the extent to which these assessments provide independent diagnostic information. In contrast, the handgrip test is isometric, single-joint, and focused on the upper limbs, providing greater stability and involving less complex movement patterns. Previous studies have shown poor agreement between the handgrip test and the FTCS test.^{44,45}

This study highlights concerns regarding the interchangeable use of diagnostic tests, as suggested by current consensus guidelines, given that each test appears to possess distinct discriminatory power. Furthermore, the NPVs observed across all tests indicate that the established cutoff points are clinically relevant for ruling out sarcopenia. However, their application should be approached with caution considering the disease's low prevalence, which increases the likelihood of false positives.

Our study is not without limitations. The estimated sample size was not reached, and the sample consisted of a highly specific population in good health, which limits the generalizability of the results. Most participants were women with higher education, high socioeconomic status, and of white ethnicity. This socioeconomic and lifestyle profile may have contributed to the limited prevalence of sarcopenia observed. The literature indicates that factors associated with sarcopenia include advanced age, low BMI, inability to perform daily activities, sleep duration, physical inactivity, diabetes, osteopenia/osteoarthritis,⁴⁶ as well as comorbidities, polypharmacy, and low education level.⁴⁷ Thus, our results should be interpreted with caution regarding external validity, given the inability to establish sex-stratified cutoff points for sarcopenia, as only one man was diagnosed. Our findings are limited to community-dwelling older adults capable of performing a vertical jump and do not apply to institutionalized, vulnerable, or frail older adults. On the other hand, a strength of our study was the use of an app to assess vertical jump, which proved to be highly portable and practical. Additionally, no adverse events occurred during the vertical jump tests, supporting previous studies that demonstrated the feasibility and acceptability of this assessment among older adults.⁴⁸

Conclusions

Based on our findings, we recommend the handgrip strength test as a more accurate and widely applicable tool for sarcopenia diagnosis. However, we also demonstrated that vertical jump power and estimated power from the sit-to-stand test are both sensitive and specific measures for sarcopenia screening. Therefore, we propose lower-limb power tests as promising alternatives that warrant further validation, highlighting the potential inclusion of lower-limb power assessment as a relevant measure for this population. While handgrip strength may be more suitable for large-scale evaluations, lower-limb power may be considered when feasible, given the weak association between upper- and lower-limb muscle strength in sarcopenia diagnosis. Future research should further investigate the role of muscle power in sarcopenia assessment and diagnosis.

Declaration of Competing Interest

None to declare.

Acknowledgements

The authors would like to thank the collaborators involved in the data collection of the study: Mateus Souza Pereira, João Mário Alencar Lopes, Ana Carolina Cunha Coelho, Amanda Silva Saldanha, Sara Marques Moura. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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