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Prognostic value of a rapid sarcopenia measure in acutely ill older adults

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Abstract

Background: Current recommendations to assess sarcopenia requiring specialized equipment hinder its use as a prognostic tool in busy acute settings.

Aims: To investigate the prognostic value of a rapid sarcopenia measure in acutely ill older outpatients for 1-year adverse outcomes.

Methods: Prospective study with 665 acutely ill older adults (mean age 78.7±8.3 years; 63% women) in need of intensive management to avoid hospital admission. Sarcopenia was screened upon admission, defined as the presence of both low muscle strength and low muscle mass. Low muscle strength was determined by handgrip strength according to the cutoffs of the Foundation for the National Institutes of Health (<16 kg for women and <26 kg for men). Low muscle mass was assessed by calf circumference, a validated surrogate measure of skeletal muscle mass, using previously established thresholds (33 cm for women and 34 cm for men). Outcomes were time to hospitalization, new dependence in basic activities of daily living (ADL), worsening walking ability, and death. To investigate the association of sarcopenia and its components with outcomes we used hazard models, considering death as a competing risk, adjusted for sociodemographic factors, Charlson comorbidity index, cognitive impairment, depressive symptoms, and weight loss.

Results: On admission, 203 (31%) patients had sarcopenia. Comparing 1-year adverse outcomes between older adults with and without sarcopenia, respectively, cumulative incidences for

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hospitalization were 46% vs 32% (adjusted sub-hazard ratio [sHR]=1.53; 95% CI =1.16–2.04), for new ADL dependence, 47% vs 24% (adjusted sHR=1.78; 95% CI=1.31–2.42), for worsening walking ability, 28% vs 13% (adjusted sHR=1.93; 95% CI=1.28–2.90), and for death, 22% vs 10% (adjusted HR=1.69; 95% CI=1.05–2.73). Low muscle strength alone was associated with all outcomes, and low muscle mass was associated with all outcomes except mortality.

Conclusion: Sarcopenia was a strong predictor of 1-year adverse outcomes among acutely ill older outpatients. Combining handgrip strength with calf circumference may be a practical and efficient approach to screen for sarcopenia, and thereby identify high-risk older adults in busy clinical settings.

Keywords

grip strength; calf circumference; screening; acute care; prognosis; sarcopenia

1. Introduction

Sarcopenia, the age-related loss of muscle mass and function [1], is a geriatric syndrome that increases the risk of adverse outcomes in older adults, such as mortality, hospitalization, disability, and falls [2]. Although most studies assessing the prognostic role of sarcopenia were conducted in community-dwelling older adults, some studies suggest sarcopenia may be a useful prognostic marker among acutely ill older adults [3–5]. Moreover, since sarcopenia is potentially treatable and preventable, interventions such as nutrition and exercise programs could be recommended to sarcopenic individuals to reduce risk after an acute event. [6].

While a consensual operational definition of sarcopenia is lacking, largely used approaches are based on the association of low muscle mass and function, requiring specialized equipment to evaluate muscle mass, and specific tests to assess muscle strength and physical performance [1, 7–9]. Unfortunately, following the current recommendations to diagnose sarcopenia may be impractical for patients admitted to fast-paced healthcare services [9, 10]. In such busy settings, to use sarcopenia to assess risk, providers need a rapid tool that captures key elements, rather than a direct measure of muscle mass, strength, and function.

Straightforward methods using self-report questionnaires [11] or simple objective measures, often involving anthropometric parameters to estimate muscle mass [12–14], have been used to screen for sarcopenia and identify high-risk older adults in clinical practice. Among the anthropometric parameters, calf circumference has been validated against dual-energy X-ray absorptiometry (DXA) as a useful surrogate measure of skeletal muscle mass in different populations [15–18]. Since the ability of sarcopenia tools to detect risk in busy acute care settings remains unclear, we investigated the value of a quick and easy-to-administer sarcopenia screening, which combines grip strength with calf circumference, to predict 1-year adverse outcomes such as hospitalization, disability, and death in acutely ill older outpatients.

2. Materials and Methods

2.1. Design, setting, and participants

We conducted a prospective cohort study comprising acutely ill older adults in need of intensive management to avoid hospital admission. Patients were referred to an acute care day hospital from the emergency department, ambulatory services, home care, and primary health care unit of the University of Sao Paulo Medical School, which is the largest public medical center in Latin America, attending 1.5 million people (28% older adults) from the metropolitan region of Sao Paulo, Brazil. The day hospital operates 12 hours a day and offers short-term treatment (e.g., intravenous therapy, laboratory tests, imaging exams) for patients with acute disease and exacerbation of chronic illness in order to prevent full-time hospitalization. The primary reasons for referral include infectious diseases, acute anemia, uncontrolled hypertension, decompensated diabetes, symptomatic congestive heart failure, investigation or treatment of refractory pain, electrolyte disorders, and severe behavioral symptoms in dementia. Further details about the day hospital can be found in previous research [19].

All individuals aged 60 years and older consecutively admitted to the day hospital between May 2014 and April 2017 were screened for participation. We excluded patients requiring full-time hospitalization, severely impaired regarding cognitive or physical function (e.g., individuals with severe dementia defined as Mini-Mental State Examination ≤ 10 points [20] and those chronically bedridden), and unable to be assessed on admission because of severe pain, delirium, or anasarca (Figure 1). We also excluded patients presenting cachexia (as defined by the Society on Sarcopenia, Cachexia, and Wasting Disorders [21]). The final sample consisted of 665 participants (Figure 1).

The Research Ethics Committee of the University of Sao Paulo Medical School approved the study protocol. Signed informed consent was obtained from participants or, in the case of dementia, from their next of kin. A research team conducted the assessments, and the clinical staff had no access to the study information. All data were managed using Research Electronic Data-Capture (REDCap) software [22].

2.2. Baseline assessment

Participants underwent a comprehensive assessment on admission, including sociodemographic factors (age, sex, race, and household income), comorbidities, cognitive status, depressive symptoms, and nutritional evaluation. Overall disease burden was assessed by the Charlson comorbidity index computed from medical chart review and reported diagnoses [23]. Cognition was evaluated by the 10-point Cognitive Screener, a 2-min freely available instrument that has an education-corrected score with higher accuracy than the Mini-Mental State Examination to detect cognitive impairment [24]. Depressive symptoms were assessed by the 4-item Geriatric Depression Scale [25]. Unintentional weight loss estimated the risk of malnutrition [26, 27]. Weight was measured using a digital anthropometric scale (W-200A, Welmy®, Brazil) and compared with the reported weight of one year ago; those patients with weight loss >10 pounds (or 5% of body weight) were considered as having significant weight loss.

2.2.1 Assessment of sarcopenia—Sarcopenia was defined, according to the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project criteria, as the presence of both low muscle strength and low muscle mass [9]. For this study, we adapted the muscle mass FNIH component by replacing the DXA by calf circumference, a validated surrogate measure of muscle mass [15, 17, 28].

First, muscle strength was measured using a hand dynamometer (SAEHAN Hydraulic Hand Dynamometer; Model SH5001; South Korea) with the patient seated on a chair without armrest, the feet flat on the floor, and the elbow flexed at 90°. The best of three trials with the dominant hand was considered for analysis. We adopted the FNIH cutoff points to define low muscle strength: <16 kg for women and <26 kg for men [9]. Then, calf circumference was measured using a non-elastic plastic tape at the point of the greatest circumference on the non-dominant leg, avoiding compression of the subcutaneous tissue [29], with participants seated with the knee and ankle at a right angle and feet resting on the floor. We adopted the cutoffs of 33 cm for women and 34 cm for men to define low muscle mass, following previously established thresholds that validated calf circumference against DXA in older adults [16, 30].

We additionally examined a second definition of sarcopenia proposed by the FNIH consortium, which requires the combination of low muscle mass, low muscle strength, and low physical performance (gait speed < 0.8 m/s) [31]. Gait speed was assessed with participants walking over a 4.5-meter course at their usual pace [32], considering the best time of two trials. For patients unable to perform the test on admission, we defined low physical performance as a “no” answer to the question “Can you walk two blocks or further without help? [33]”

2.3. Outcomes

The primary outcomes were time to hospitalization, experiencing new dependence in basic activities of daily living (ADL), worsening walking ability, and death. During the first year after admission at the day hospital, blinded investigators conducted monthly phone calls using standard forms to evaluate the occurrence of the four outcomes. Hospitalization was defined as staying more than 24 hours in a hospital for an unplanned medical condition; the exact date of hospital admission was registered. Functional status was evaluated every month, and a new dependence in ADL was defined if participants reported the need for help in a different ADL, among eating, transferring, dressing, toileting, and bathing, compared to baseline [34]. Individuals' ability to walk across the room was assessed every three months, and the performance was categorized into three levels: independent, need for help, and unable to walk. Worsening walking ability was determined for individuals reporting a worse level of performance in comparison to baseline. Since establishing the exact date of experiencing new dependence in ADL and worsening walking ability is challenging, we considered the incident date as the median time between the last two phone contacts in which the outcome happened. Participants' vital status was checked every month. In case of death, information about the exact date was obtained from the next of kin. Our follow-up approach included up to ten additional calls after the first monthly attempt if participants or their proxies could not be reached. We succeeded in contacting all participants using this

method, and those who did not develop the outcome by the end of 1-year follow-up were censored.

2.4. Statistical analyses

Baseline characteristics of participants according to sarcopenia status were compared using independent samples t-test for continuous variables and chi-square test for categorical variables. To investigate any additional value of combining slow gait speed to our original sarcopenia definition (the presence of both low muscle strength and low muscle mass), we compared the areas under the receiver operating characteristic curves of the two sarcopenia definitions (with and without low gait speed) in discriminating the outcomes using nonparametric methods [35].

We computed curves of cumulative incidence of the outcomes over 1-year follow-up according to sarcopenia at baseline, using Kaplan-Meier estimates for mortality and unadjusted competing risk models for the other outcomes. To examine the association of sarcopenia and its defining components with time to hospitalization, new ADL dependence and worsening walking ability, we used competing risk hazards models, considering death as a competing risk [36, 37]. To explore the association of sarcopenia and its defining components with time to death, we used Cox proportional hazards models. Three models were fitted for each outcome: (1) unadjusted; (2) adjusted by sociodemographic factors (age, sex, race, and household income); and (3) adjusted by sociodemographic factors and health measures (Charlson comorbidity index, cognitive impairment, depressive symptoms, and weight loss). Finally, we tested for interactions of sex and very old age (≥ 80 and <80 years) with sarcopenia for the four outcomes.

Schoenfeld residual analyses showed that the proportional assumptions of the survival models were met. We conducted all analyses using Stata (version 15, StataCorp, College Station, TX, USA). The alpha-level was set at 0.05.

3. Results

Baseline characteristics of the 665 participants are shown in Table 1. Sarcopenia was found in 203 (31%) patients on admission (Figure 1). Nearly half of the sample (44%) had low muscle strength, and more than half of the participants (57%) had low muscle mass. Sarcopenic individuals were older, had a higher frequency of cognitive impairment and unintentional weight loss than non-sarcopenic participants (Table 1).

We detected 428 (64%) participants with low gait speed at baseline. Among 48 (7%) patients who were unable to perform the gait speed test on admission, 41 reported needing help in walking two blocks, and we incorporated them into the low gait speed group. After the inclusion of low gait speed to our original definition, sarcopenia was identified in 158 (24%) older adults. Table 2 shows that both definitions of sarcopenia, with and without gait speed, presented similar discriminatory power in predicting the outcomes, which have led us to favor the simpler approach when investigating the association of sarcopenia with the outcomes.

During the 1-year follow-up period, 238 (36%) older patients were hospitalized, 205 (31%) developed new dependence in ADL, 117 (18%) worsened their ability to walk, and 90 (14%) died. Figure 2 illustrates the cumulative incidence of the four outcomes according to sarcopenia status at baseline, highlighting the increased rate of adverse outcomes associated with sarcopenia over the 1-year follow-up.

After adjustment for sociodemographic factors and health measures, older patients with sarcopenia had a higher risk of hospitalization, new ADL dependence, worsening walking ability, and death compared with individuals without sarcopenia (Table 3). Additionally, low muscle strength alone was associated with all outcomes, and low muscle mass was associated with all outcomes except mortality (Table 3). There was no significant interaction between sarcopenia and very-old age or sex for all outcomes (all interaction term *P*-values >0.10).

4. Discussion

The present study showed that a quick and easy-to-administer screening test for sarcopenia, which combines grip strength with calf circumference, was a strong predictor of 1-year adverse outcomes among acutely ill older outpatients. Our results indicated that sarcopenic older adults presented a higher risk of hospitalization, new ADL dependence, worsening walking ability, and death during the 1-year after experiencing an acute condition when compared to non-sarcopenic older individuals. These findings remained robust even after adjustment for multiple confounders, such as sociodemographic factors, comorbidities, depressive symptoms, cognitive impairment, and unintentional weight loss.

While the FNIH criteria is a powerful tool to screen sarcopenia, and thereby identify high-risk older patients [9, 10], we still need more straightforward approaches to assess the components of sarcopenia (muscle function and muscle mass) in settings with scant resources, high patient volume, and rapid turnover of care spaces [12, 13]. Grip strength and calf circumference, which require simple equipment, can quickly capture the elements of risk associated with sarcopenia in fast-paced healthcare services. We showed that these measures successfully assessed almost all participants (98%) in a realistic scenario of acute care. Our results indicated that grip strength and calf circumference were predictors of adverse outcomes in acutely ill older adults.

Although experts advised that age-related changes in fat deposits and loss of skin elasticity make the calf circumference measurement vulnerable to errors in older people [38], recent studies using DXA have shown the validity of this anthropometric measure as a surrogate marker of skeletal muscle mass in different older populations [12, 15, 17, 18, 39, 40].

Previous work has also indicated that calf circumference is a predictor of adverse outcomes (i.e., disability, mortality) in community-dwelling older adults [41–43]. In our research, calf circumference was associated with hospitalization, new dependence in ADL, and worsening walking ability in older patients presenting acute disease or exacerbation of chronic illness.

In our study comprising acutely ill older adults, low muscle strength was an independent risk factor for all studied adverse outcomes. Studies that assessed muscle strength defined by the

FNIH criteria showed similar results among community-dwelling older adults. McLean et al. demonstrated that low grip strength was associated with mortality and incident mobility disability [10]. Additionally, the revised European consensus on sarcopenia (EWGSOP2) highlights grip strength as a primary screener for sarcopenia because low muscle strength captures a key characteristic of the disease and works as a powerful predictor of unfavorable outcomes such as hospitalization, disability, poor quality of life and death [44]. Although most of the current sarcopenia definitions have incorporated elements of muscle strength and function [9], our findings suggested that gait speed did not add value to handgrip strength combined with calf circumference in predicting the risk of adverse outcomes, indicating that the simpler approach was efficient.

It is noteworthy that we identified a high prevalence of sarcopenia among acutely ill outpatients, even after excluding those with cachexia and severe impairment on admission. The frequency of low muscle strength and low muscle mass in our research was similar to previous studies involving hospitalized patients [3, 45–47], which means that there is considerable variability in community-dwelling people and that older adults admitted to acute clinical services represent the most vulnerable portion of this heterogeneous population [30, 48, 49]. Considering the escalating number of older individuals requiring acute care, our results reinforce the need for practical and efficient approaches to identify sarcopenia, and therefore high-risk individuals in acute healthcare settings [13, 50].

Assessing the key elements of sarcopenia using grip strength and calf circumference can be a reasonable approach at (1) acute care settings, where time constraints hinder detailed evaluation of muscle mass and function; (2) hospital settings, where severely ill patients may not be able to perform the physical tests required for some sarcopenia definitions, and whose clinical conditions may distort results from muscle mass assessment with DXA or other techniques; and (3) limited resources settings, where the access to specialized equipment is not possible. The early identification of sarcopenia can help providers target interventions before major problems such as disability can occur [50]. For example, a multidimensional approach including nutritional program, physical therapy, exercise, social support enhancement, drug therapy review, treatment of depression, and home improvements to eliminate physical barriers may reduce the risks associated with sarcopenia and therefore the burden of health care utilization and the functional decline in sarcopenic patients following acute conditions [13, 50].

Our study has several strengths. First, we investigated sarcopenia in the real-world scenario of short-term acute care. Second, we were able to differentiate between sarcopenia and cachexia at baseline, and individuals with cachexia were excluded. Third, we analyzed multiple outcomes, encompassing a diversified spectrum of clinical domains important to older patients, and we used the competing risk analysis for non-death outcomes. Finally, we had no attrition during the 1-year follow-up. Nevertheless, the study has some limitations. First, despite the results favoring our simple approach, we did not perform direct comparisons with other rapid screening tests for sarcopenia. Second, we were unable to compare calf circumference with DXA, the measure recommended by FNIH. Lastly, while the context of acutely ill persons who seek medical attention but do not require inpatient

hospitalization is very common, our findings are based on a single medical center and therefore need to be confirmed in other populations and healthcare settings.

In conclusion, we showed that sarcopenia assessed by a quick, simple, and inexpensive screening, without the need for specialized equipment, was an independent predictor of 1-year adverse outcomes among acutely ill older outpatients. Future studies are needed to validate our proposal and to show its applicability in different environments.

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Figure 1.

Flowchart of study participants

Low muscle strength = grip strength < 16 kg for women and < 26 kg for men; low muscle mass = calf circumference < 33 cm for women and < 34 cm for men; sarcopenia defined as the presence of both low muscle strength and low muscle mass.

Figure 2.

Cumulative incidence of adverse outcomes according to sarcopenia: (A) Hospitalization; (B) New dependence in ADL; (C) Worsening walking ability; (D) Death (n=665).

The curves were computed from the Kaplan-Meier estimates for mortality, and from the Fine & Gray method that considered the competing risk of death for the other outcomes.

ADL = basic activities of daily living.

Table 1.

Baseline characteristics of the participants and comparisons according to sarcopenia

	Total (n = 665)	Nonsarcopenic (n = 462)	Sarcopenic (n = 203)	P-value
Sociodemographic measures				
Age, mean (SD)	78.7 (8.3)	77.3 (8.1)	82.0 (7.8)	< 0.001
Women, n (%)	421 (63.3)	303 (65.6)	118 (58.1)	0.07
Race, n (%)				0.45
White	403 (60.6)	280 (60.6)	123 (60.6)	
Black	70 (10.5)	51 (11.1)	19 (9.4)	
Mixed	159 (23.9)	112 (24.2)	47 (23.1)	
Asian	33 (5.0)	19 (4.1)	14 (6.9)	
Annual household income per capita, n (%)				0.10
< 4,000 USD	189 (28.4)	121 (26.2)	68 (33.5)	
4,000 – 8,000 USD	363 (54.6)	256 (55.4)	107 (52.7)	
> 8,000 USD	113 (17.0)	85 (18.4)	28 (13.8)	
Health measures				
Charlson comorbidity index, n (%)				0.10
0 points	110 (16.5)	84 (18.2)	26 (12.8)	
1 – 2 points	295 (44.4)	208 (45.0)	87 (42.9)	
3 points	260 (39.1)	170 (36.8)	90 (44.3)	
Number of depressive symptoms (GDS-4), n (%)				0.11
0 – 1	327 (49.2)	228 (49.3)	99 (48.8)	
2	223 (33.5)	146 (31.6)	77 (37.9)	
3 – 4	115 (17.3)	88 (19.1)	27 (13.3)	
Cognitive impairment (10-CS-Edu – 5 points), n (%)	198 (29.8)	113 (24.5)	85 (41.9)	< 0.001
Unintentional weight loss (> 10 pounds in last year), n (%)	229 (34.4)	140 (30.3)	89 (43.8)	0.001

Comparisons between sarcopenic and nonsarcopenic using independent samples t-test for age and chi-squared test for other variables.

10-CS-Edu = Education-corrected 10-point Cognitive Screener (0–10); GDS-4 = 4-item Geriatric Depression Scale.

Table 2.

Performance of two different definitions of sarcopenia on adverse outcomes discrimination (n=665)

Outcomes	Area under the ROC curve (95% confidence interval) *		P-value B–A comparison
	Sarcopenia Model A = Low muscle mass + weakness	Sarcopenia Model B = low muscle mass + weakness + slowness while walking	
Hospital admission	0.60 (0.55–0.64)	0.59 (0.55–0.64)	0.64
New dependence in ADL	0.66 (0.62–0.71)	0.66 (0.62–0.71)	0.73
Worsening walking ability	0.65 (0.60–0.71)	0.66 (0.60–0.71)	0.86
Mortality	0.68 (0.62–0.74)	0.67 (0.61–0.74)	0.49

* Values are adjusted for age and sex.

ROC = receiver operating characteristic; ADL = basic activities of daily living; low muscle mass = calf circumference < 33 cm for women and < 34 cm for men; weakness = grip strength < 16 kg for women and < 26 kg for men; slowness while walking = gait speed < 0.8 m/s at usual pace.

Table 3.

Association between sarcopenia and its components with 1-year adverse outcomes (n = 665)

	Sub-hazard ratio or hazard ratio (95% confidence interval)		
	Unadjusted	Model 1 = adjusted for sociodemographics	Model 2 = fully adjusted
Hospital admission			
Low muscle strength	1.48 (1.15–1.91)	1.42 (1.09–1.85)	1.37 (1.04–1.79)
Low muscle mass	1.38 (1.06–1.79)	1.39 (1.05–1.83)	1.39 (1.05–1.84)
Sarcopenia	1.60 (1.23–2.08)	1.60 (1.21–2.11)	1.53 (1.16–2.04)
New dependence in ADL			
Low muscle strength	2.28 (1.73–3.02)	1.95 (1.45–2.63)	1.83 (1.34–2.49)
Low muscle mass	1.69 (1.27–2.26)	1.44 (1.06–1.95)	1.37 (1.01–1.88)
Sarcopenia	2.31 (1.76–3.03)	1.92 (1.42–2.58)	1.78 (1.31–2.42)
Worsening ability to walk			
Low muscle strength	1.93 (1.34–2.79)	1.69 (1.14–2.51)	1.56 (1.03–2.36)
Low muscle mass	1.79 (1.21–2.64)	1.58 (1.06–2.37)	1.53 (1.02–2.29)
Sarcopenia	2.38 (1.66–3.41)	2.07 (1.39–3.08)	1.93 (1.28–2.90)
Mortality			
Low muscle strength	2.75 (1.78–4.25)	2.20 (1.39–3.50)	1.90 (1.18–3.06)
Low muscle mass	1.54 (0.99–2.38)	1.27 (0.80–2.04)	1.22 (0.74–1.99)
Sarcopenia	2.46 (1.63–3.72)	1.94 (1.23–3.05)	1.69 (1.05–2.73)

Estimates were calculated using Cox regression models for mortality (hazard ratio), and the Fine and Gray method (sub-hazard ratio), which considered death as a competing risk, for the other outcomes. The reference group was composed of participants classified as normal in each component of sarcopenia and as nonsarcopenic.

Model 1 = adjusted for sociodemographic factors, including age, sex, race, and income.

Model 2 = adjusted for age, sex, race, income, Charlson comorbidity index, depressive symptoms, cognitive impairment, and unintentional weight loss.

Low muscle strength = grip strength <16 kg for women and <26 kg for men; low muscle mass = calf circumference <33 cm for women and <34 cm for men; sarcopenia defined as the presence of both low muscle strength and low muscle mass.