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Original Article

Accurate diagnosis of sarcopenia without using a body composition analyzer in a convalescent rehabilitation ward

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ABSTRACT

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Objective: The Asian Working Group for Sarcopenia 2019 recommends diagnosing sarcopenia without using a body composition analyzer and initiating treatment early. The present study aimed to investigate the accuracy of diagnosing sarcopenia without a body composition analyzer in a convalescent rehabilitation ward.

Methods: Eighty-five patients admitted to a convalescent rehabilitation ward were included, and sarcopenia diagnoses were performed with and without a body composition analyzer. To assess the accuracy of diagnosing sarcopenia without using a body composition analyzer, sensitivity, specificity, positive predictive value, and negative predictive value were calculated relative to sarcopenia diagnoses made using a body composition analyzer.

Results: The sensitivity of the technique for diagnosing sarcopenia was 0.94, specificity was 0.77, positive predictive value was 0.86, and negative predictive value was 0.90.

Conclusion: The accuracy of diagnosing sarcopenia without using a body composition analyzer was high. However, this technique may miss sarcopenia cases in patients with increased calf circumference due to adipose tissue and/or edema.

Key words: sarcopenia, AWGS2019, convalescent rehabilitation ward, diagnosis

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Introduction

Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength, and is accompanied by physical impairment, poor quality of life, and risk of death [1, 2]. Sarcopenia is classified as primary when aging is recognized as the causative factor and secondary when factors other than, or in addition to, aging are involved (e.g., disease-, physical inactivity-, or malnutrition-related factors). The prevalence of sarcopenia in community-dwelling older adults in Japan is reportedly about 8.0% [3–6]. In contrast, it is around 6–7 times more prevalent in patients admitted to convalescent rehabilitation wards than in community-dwelling older adults. Furthermore, sarcopenia in patients on convalescent rehabilitation wards was associated with dysphagia and impaired recovery of activities of daily living, leading to a lower rate of home discharge [7–9].

The measurement of skeletal muscle mass using bioelectrical impedance analysis or dual-energy X-ray absorptiometry is required for the diagnosis of

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sarcopenia. However, as the measurement devices are very expensive, they tend to be available only in medical and research facilities with specialized equipment (e.g., university hospitals or medical/research facilities managing outpatients with locomotive syndrome or frailty), which may be a barrier to extending sarcopenia diagnosis and treatment to convalescent rehabilitation wards. According to the latest criteria of the Asian Working Group for Sarcopenia 2019 (AWGS2019), sarcopenia can be diagnosed even in medical facilities without a body composition analyzer: patients can be screened based on clinical variables such as calf circumference (CC), and deterioration of muscle strength (grip strength) or physical function (5-time chair stand test) [10]. If sarcopenia can be diagnosed appropriately without a body composition analyzer, early detection and treatment will be possible even in convalescent rehabilitation wards not equipped with expensive measuring devices, which could improve the prognosis and outcome of inpatients.

The method for diagnosing sarcopenia without a body composition analyzer recommended by the AWGS2019 has already been reported to provide high diagnostic accuracy in outpatients with locomotive syndrome and frailty [11]. However, its performance in patients admitted to a convalescent rehabilitation ward who are elderly and have various comorbidities is unclear. The present study aimed to investigate the accuracy of diagnosing sarcopenia without a body composition analyzer among inpatients in a convalescent rehabilitation ward.

Methods

1. Participants

This cross-sectional study included patients aged over 20 years who were admitted to a 46-bed convalescent rehabilitation ward from October 2020 to February 2021. The ward is in a community-based rehabilitation hospital in Kyoto, Japan, a city with a population of approximately 1.46 million (approximately 28% aged over 65 years). All patients were transferred from an acute care hospital to the rehabilitation hospital after their condition had stabilized. The exclusion criteria were cardiac pacemaker, loss of any of the four extremities, disturbance of consciousness or severe cognitive impairment, pregnancy, and refusal to participate. The study was approved by the hospital's ethics review board (approval number ERB-C-2713) and conducted in accordance with the Declaration of Helsinki and Ethical Guidelines for Medical and Biological Research Involving Human Subjects. All study participants or their proxies provided oral and written informed consent.

2. Clinical setting

Demographic data collected were age, sex, height, weight, body mass index, reason for admission, time (days) from onset of main condition (e.g., stroke, skeletal conditions), comorbidities, dysphagia, nutritional status, and Functional Independence Measure. Comorbidities were assessed using Charlson's comorbidity index [12]. Dysphagia was assessed using the Food Intake LEVEL Scale [13], and nutritional status was assessed using the Geriatric Nutritional Risk Index [14]. Body composition was measured in the morning (9:00 to 12:00) via the bioelectrical impedance analysis method using a body composition analyzer (InBody S10; InBody Japan Inc., Tokyo, Japan), and body fat percentage, extracellular water/total body water (ECW/TBW), and muscle quantity were recorded. The skeletal muscle mass index (SMI) was calculated by dividing the total lean muscle mass in the four extremities by the square of the height.

3. Sarcopenia diagnosis

Sarcopenia was diagnosed using the criteria of AWGS2019 [10] as follows: using a body composition analyzer when SMI and grip strength were decreased; and without using a body composition analyzer when CC and grip strength were decreased. Grip strength was measured using a digital hand dynamometer (TKK-5401; Takei Scientific Instruments Co., Ltd., Niigata, Japan), and the maximum value was recorded after measuring each side twice. CC was measured using a commercial measuring device, and the maximum value was recorded after measuring the thickest part of both lower legs. The cutoff values for sarcopenia diagnosis were: SMI <7.0 kg/m^2 in men and <5.7 kg/m^2 in women; grip strength <28.0 kg in men and <18.0 kg in women; and CC <34.0 cm in men and <33.0 cm in women. From these results, the prevalence of sarcopenia was calculated for both techniques, i.e., with and without using a body composition analyzer.

4. Statistical analysis

EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria), was used to perform statistical analyses [15]. P values <0.05 were considered statistically significant. Using descriptive statistics, a histogram was created to present age as a frequency distribution. Demographic data were presented as mean (standard deviation) for ratio scales, median (lower quartile, upper quartile) for ordinal scales, and as percentage (number) for nominal scales. The two-sample t test was used for ratio scales, Mann-Whitney U test for ordinal scales, and Fisher's exact test for nominal scales when comparing the demographic data of patients diagnosed with sarcopenia with and without using a body composition analyzer. To describe the accuracy of the method for diagnosing sarcopenia without a body composition analyzer, sensitivity, specificity, positive predictive value, and negative predictive value were calculated. To identify potential

confounding factors associated with CC, associations between SMI, body fat percentage, and ECW/TBW as explanatory variables were calculated using multiple regression analysis.

Results

One hundred-nine patients were enrolled in the present study. A flow diagram showing reasons for exclusion and the number of patients included in the final analysis group (*N*=85) is presented in Figure 1. Table 1 shows patient demographic data, and Figure 2 illustrates the frequency distribution of participant age. More than half of the patients were in their seventies to eighties, and the majority were of advanced age. The mean of the Functional Independence Measure motor

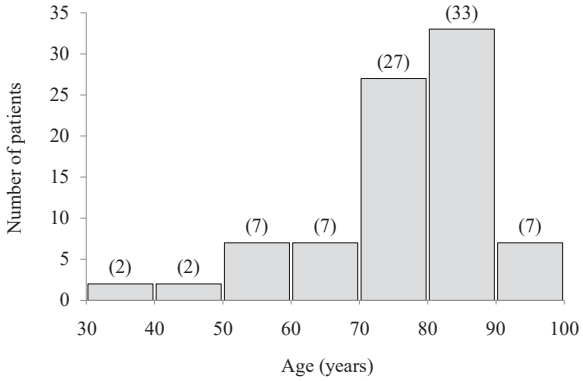


Figure 2. Age distribution of patients in the analysis group.
The X-axis shows patient age, grouped in 10-year age ranges. The Y-axis indicates the number of patients.

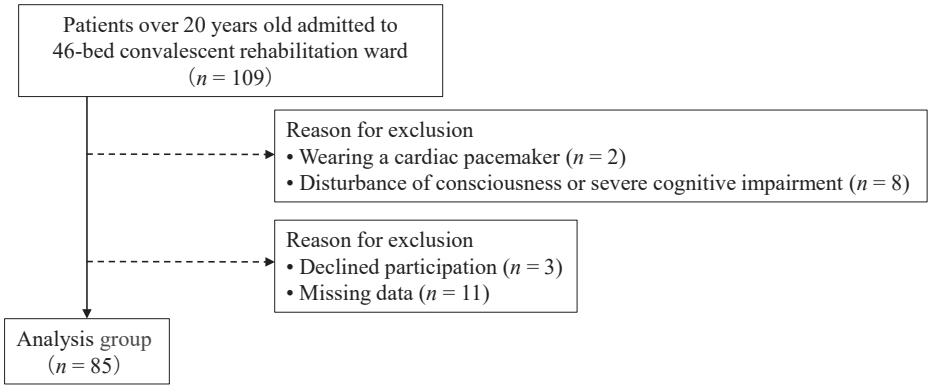


Figure 1. Patient flow diagram of the study.

Table 1. Demographic data for participants in the analysis group.

Age, years	76.2 (12.5)
Sex, % (number)	
Male	40.0 (34)
Female	60.0 (51)
Height, cm	156.9 (10.3)
Weight, kg	53.2 (12.6)
Body mass index, kg/m^2	21.4 (3.7)
Reason for admission, % (number)	
Stroke	55.3 (47)
Brain infarction	34.1 (29)
Brain hemorrhage	20.0 (17)
Subarachnoid hemorrhage	1.2 (1)
Skeletal conditions	28.2 (24)
Proximal femoral fracture	23.5 (20)
Distal femoral fracture	2.4 (2)
Lumbar compression fracture	2.4 (2)
Total hip arthroplasty	1.2 (1)
Total knee arthroplasty	3.5 (3)
Others	11.8 (10)
Time from onset of main condition, days	71.9 (54.2)
Functional Independence Measure	
Motor total score	60.8 (21.8)
Cognitive total score	24.6 (7.7)

Data are mean (standard deviation) or percentage (number of patients).

total score was 60.8 (12.5); the majority of patients required assistance with activities of daily living. There were no significant differences in the demographic data of patients diagnosed with sarcopenia with and without using a body composition analyzer (Table 2). The prevalence of sarcopenia was 58.8% (male: 18 patients, female: 32 patients, total: 50 patients) when using a body composition analyzer, and 64.7% (male: 20 patients, female: 35 patients, total: 55 patients) without using a body composition analyzer (Figure 3). Table 3 shows the cross tabulation of the results for sarcopenia diagnoses with and without a body composition analyzer. The diagnostic accuracy of a sarcopenia diagnosis without using a body composition analyzer, versus using a body composition analyzer, was: sensitivity, 0.94 (95% confidence interval [CI], 0.84–0.99); specificity, 0.77 (95% CI, 0.60–0.90); positive predictive value, 0.86 (95% CI, 0.73–0.94); and negative predictive value, 0.90 (95% CI, 0.74–0.98). The multiple linear regression model equation between CC and potential confounding factors was statistically significant ($p < 0.01$). The validity of the model equation was 0.69 with adjusted R-squared. SMI (regression coefficient, 2.26; 95% CI, 1.84–2.69; $p < 0.01$), body fat percentage (regression coefficient, 0.21; 95% CI, 0.16–0.26; $p < 0.01$), and ECW/TBW (regression coefficient, −51.0; 95% CI, −93.2 to −8.8; $p < 0.05$) were all significant as explanatory variables. There was no multicollinearity with SMI (variance inflation factor [VIF] = 1.27), body fat percentage (VIF = 1.15), and ECW/TBW (VIF = 1.16).

Discussion

The present study investigated the diagnostic accuracy of the method for diagnosing sarcopenia without using a body composition analyzer recommended by the AWGS2019 in patients admitted to a convalescent rehabilitation ward. In our cohort, diagnosing sarcopenia without using a body composition analyzer provided high accuracy.

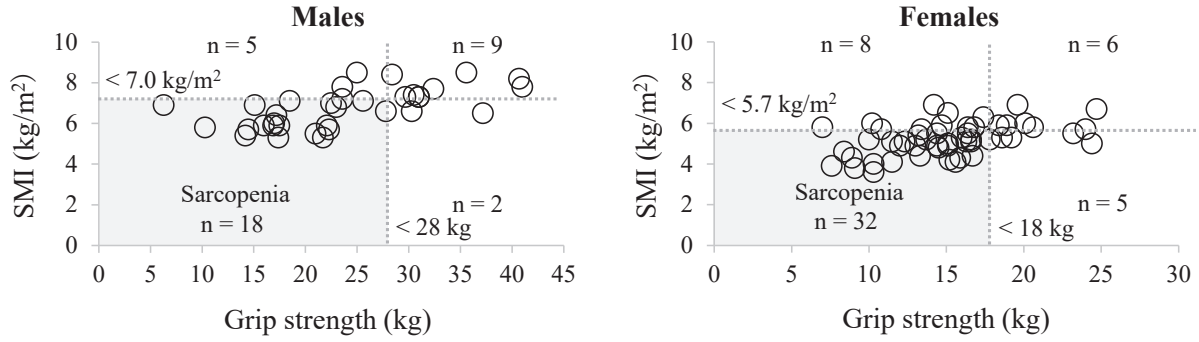
The prevalence of sarcopenia in patients admitted to the convalescent rehabilitation ward has previously been reported to be about 50.0% [5, 6], which is similar to the prevalence in our cohort. However, there is no unified consensus on sarcopenia diagnosis. In particular, based on the criteria published by the Group for the European Working Group on Sarcopenia in Older People in 2010 [2], subsequent reports have set their own algorithm and cutoff values [16–18]. Although these reports all state that it is essential to use a body composition analyzer, the criteria of the AWGS2019 used in this study make it possible to diagnose sarcopenia simply, without a body composition analyzer. Compared with the results for sarcopenia diagnosed using a body composition analyzer, overall, the diagnostic accuracy without using a body composition analyzer was high. In addition, CC and grip strength assessed during the sarcopenia diagnostic process are useful indicators in clinical settings, because both parameters are associated with prognosis and outcome in patients admitted to convalescent rehabilitation wards [19, 20]. Therefore, we believe that diagnosing sarcopenia

Table 2. Comparison of demographic data for patients diagnosed with sarcopenia with and without using a body composition analyzer.

	With a body composition analyzer (n = 50)	Without a body composition analyzer (n = 55)	p Value
Age, years	79.6 (9.5)	78.9 (11.4)	0.75
Sex, % (number)			1.00
Male	36.0 (18)	36.4 (20)	
Female	64.0 (32)	63.6 (35)	
Height, cm	154.7 (9.5)	154.7 (10.2)	0.98
Weight, kg	47.9 (8.0)	48.1 (8.3)	0.92
Body mass index, kg/m^2	20.0 (2.6)	20.0 (2.5)	0.94
Time from onset of main condition, days	71.9 (45.2)	75.7 (44.3)	0.66
Comorbidities			
Charlson's comorbidity index	2.3 (1.5)	2.3 (1.5)	0.98
Dysphagia			
Food Intake LEVEL Scale	9 (8, 10)	9 (8, 10)	0.96
Nutritional status			
Geriatric Nutritional Risk Index	86.6 (9.4)	87.0 (9.8)	0.84
Functional Independence Measure			
Motor total score	55.7 (22.3)	56.5 (22.4)	0.85
Cognitive total score	22.1 (7.7)	22.2 (7.6)	0.97

Data are mean (standard deviation), median (lower quartile, upper quartile), or percentage (number of patients).

A) Relationship between SMI and grip strength



B) Relationship between CC and grip strength

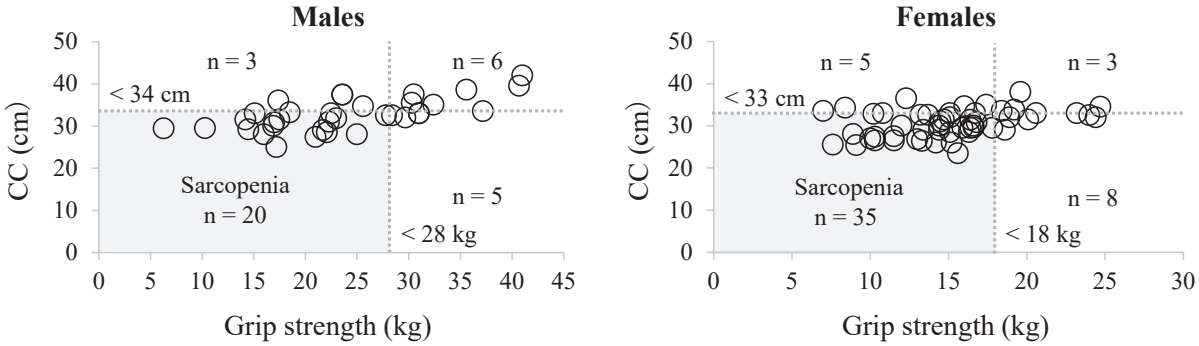


Figure 3. Relationship between SMI or CC and grip strength.
Relationship between A) SMI and grip strength and B) CC and grip strength for males and females in the analysis group. Open circles in the gray frames in A) denote patients diagnosed with sarcopenia using a body composition analyzer and in B) denote patients diagnosed with sarcopenia without using a body composition analyzer. SMI: skeletal muscle mass index, CC: calf circumference.

Table 3. Cross tabulation of diagnostic results for sarcopenia with and without using a body composition analyzer.

		Without a body composition analyzer		
		Sarcopenia	Non-sarcopenia	Total
With a body composition analyzer	Sarcopenia	47	3	50
	Non-sarcopenic	8	27	35
	Total	55	30	85

Data are numbers of patients.

without using a body composition analyzer is valuable in patients admitted to convalescent rehabilitation wards not only because it delivers high diagnostic accuracy but also because the diagnostic process supplies highly useful clinical parameters.

The diagnostic accuracy of screening for sarcopenia without using a body composition analyzer showed high sensitivity with lower specificity. CC assessed in this study can be measured easily in general medical facilities and has been used as a surrogate marker for skeletal muscle mass in other studies [21–25]. However, one limitation of CC is that the influence of factors such as adipose tissue and edema cannot be completely eliminated [26, 27]. In the present study, skeletal muscle mass as well as adipose tissue and edema were independently associated with CC. In patients with increased CC associated with adipose tissue and/or edema despite decreased skeletal muscle mass due to aging and/or disease (e.g., paralysis, skeletal disease), sarcopenia diagnosis without using a body composition analyzer may return a negative result. To address these issues, it is necessary to combine CC with examination and palpation results, which are often used in clinical settings, to make a comprehensive diagnosis because it reduces the influence of adipose tissue and/or edema. SMI, which was used in the diagnosis of sarcopenia using a body composition analyzer, is an index that reflects the

skeletal muscle mass of the extremities. Patients admitted to convalescent rehabilitation wards often have comorbidities, such as hemiplegia or unilateral lower extremity fractures, that tend to be localized to a particular part. Therefore, changes in skeletal muscle mass are more likely to be specific to the affected side. Further studies are necessary to establish an index of skeletal muscle mass that reflects disease characteristics.

The present study had several limitations. First, our study had a small sample size. Consequently, the diagnostic accuracy for sarcopenia without using a body composition analyzer could not be analyzed by sex or cause of admission. Second, the reliability of the body composition data (e.g., skeletal muscle mass) may have been low because the time of day when the parameters necessary for the sarcopenia diagnosis were measured could not be strictly controlled. Third, we used grip strength as a measure of muscle strength, rather than the 5-time chair stand test as a measure of physical function, for the diagnosis of sarcopenia without using a body composition analyzer. Fourth, our study only assessed the diagnostic accuracy of the AWGS2019 method for sarcopenia diagnosis without using a body composition analyzer. Finally, results for grip strength and CC were recorded as the maximum left and right values without considering the dominant arm/leg or the paralyzed/injured limb.

Conclusion

The present study showed that the method recommended by the AWGS2019 for sarcopenia diagnosis without using a body composition analyzer provides high diagnostic accuracy even in patients admitted to a convalescent rehabilitation ward. However, the disadvantage of the CC measurement required in this method is that the influence of factors such as adipose tissue and edema cannot be completely eliminated. To improve the diagnostic accuracy for sarcopenia without using a body composition analyzer, CC should be combined with examination and palpation results, which are commonly used in the clinical setting, to make a comprehensive diagnosis.

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