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ORIGINAL ARTICLE

Prevalence, physical characteristics, and fall risk in older adults with and without possible sarcopenia

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Abstract

Background Recently, the Asian Working Group for Sarcopenia (AWGS) 2019 consensus redefined the sarcopenia including possible sarcopenia, sarcopenia and severe sarcopenia and grip strength cutoff value by sex.

Aims This study aimed to assess the prevalence, physical characteristics, physical fitness, and fall risk in older adults living in local communities, with possible sarcopenia using the diagnostic criteria suggested by the AWGS 2WG.

Methods A total of 431 participants (123 men and 308 women) aged 65–97 years were enrolled in this study. Based on the diagnostic criteria of possible sarcopenia suggested by AWGS 2, study participants were divided into normal and possible sarcopenia (grip strength: < 28 kg and < 18 kg for men and women, respectively) groups. Independent *t*-tests and logistic regression analyses were conducted to compare the differences between the two groups.

Results The possible prevalence of sarcopenia was 23.7%. Possible sarcopenia was present in older adults with lower weight, body mass index (BMI), skeletal muscle mass, and fat-free mass ($P < 0.05$) than those in the normal group. Older men with possible sarcopenia had poorer upper and lower body strength, aerobic endurance, lower body flexibility, agility and dynamic balance, and a higher fall risk than those in the normal group ($P < 0.05$). Older women with possible sarcopenia had a 2.5-fold and 3.3-fold higher fall risk than women in the normal group in both an unadjusted model ($P = 0.001$) and in a model adjusted for age and BMI ($P < 0.001$). However, there were no significant differences in fall risk among older men.

Conclusion The diagnostic criteria suggested by AWGS 2 may be highly useful for screening for declining physical function.

Keywords Sarcopenia · Grip strength · Physical fitness · Falls · Older adults

Introduction

Sarcopenia produces important changes in body composition and function [1], including decreased muscle mass. Decreased muscle function was added to the definition of sarcopenia in 2012 [2], resulting in a diagnosis of sarcopenia based on the evaluation of muscle strength, rather than muscle mass [3]. Muscle strength decreases faster than muscle mass as people age [4, 5], and it is a better predictor of negative health consequences, including physical disabilities, falls, decreased quality of life, and even death [6, 7]. The grip strength test, which is used to measure muscle strength in older adults, is also an inexpensive method for stratifying the risk of all-cause mortality, cardiovascular mortality, and cardiovascular disease [6]. Consequently, this test has been used in several large-scale cohort studies [8, 9]. Both the European Working Group on Sarcopenia in Older People (EWGSOP) 2 and the Asian Working Group for Sarcopenia (AWGS) 2 consider the grip strength test to be the preferred method for diagnosing sarcopenia, although they provide different grip strength cut-off points [3, 10].

The EWGSOP 2 guidelines indicate that muscle quantity and quality can be assessed using grip strength before confirming the diagnosis of sarcopenia. This is referred to as "probable sarcopenia" by EWGSOP 2, with a cut-off point of < 27 kg in men and < 16 kg in women [3]. AWGS 2 shares

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the same definition for sarcopenia as EWGSOP 2; however, it provides different algorithms and diagnostic criteria. The AWGS 2 guidelines recommend the assessment of grip strength prior to confirming sarcopenia diagnosis, similar to the EWGSOP 2 recommendations, the AWGS 2 guidelines also recommend the assessment of grip strength prior to confirming sarcopenia diagnosis. This is defined as "possible sarcopenia" by AWGS 2, using cut-off values (grip strength: < 28 kg and < 18 kg for men and women, respectively) as provided by AWGS 2 [10]. Thus, assessment of muscle function rather than muscle mass is becoming increasingly common in the diagnosis of sarcopenia. Earlier studies of the physical ability of older adults and the diagnosis of sarcopenia have mostly focused on mobility, including gait speed [11], agility and dynamic balance [12], and mobility disorders [13], rather than on physical fitness. A decrease in muscle strength and mass will inevitably be accompanied by a decrease in physical fitness, thus impacting the ability of older adults to perform normal activities of daily living. The cut-off value proposed by AWGS 2 is based on the lowest quintile for the strength value [14]. The EWGSOP [10] uses − 2.5 standard deviations of the general adult population as the cut-off values to define weak handgrip strength. The clinical significance of whether the grip strength limit suggested by AWGS 2 reflects physical fitness and fall risk factors should be investigated accordingly. Furthermore, the relationship between the new definition of sarcopenia and overall physical fitness has not been fully elucidated.

Sarcopenia, as defined using previously established diagnostic criteria, is associated with falls in older adults [15–17]. The annual incidence rate of falls among older Korean adults is approximately 13–33.1% [18, 19], and the annual direct cost of falls is estimated to be $122,707,347.28 (1.378 trillion won) [18]. Therefore, falls present a challenge that needs to be overcome in Korean society. Early detection of sarcopenia and the implementation of appropriate interventions in high-risk groups are essential matters that should be urgently addressed to prevent falls in older adults. Several studies have demonstrated a relationship between sarcopenia and falls in older adults [16, 20–22], the relative risk (RR) of falls in patients with sarcopenia can vary from 1.82 (95% confidence interval [CI] 1.24–2.69) to 0.61 (95% CI 0.24–1.55), depending on the definition used to diagnose sarcopenia [23], with most studies using the European diagnostic criteria for sarcopenia [2, 3]. However, Asians have a smaller average body size, higher adiposity, and different lifestyles when compared to Westerners. Therefore, the diagnostic criteria for sarcopenia suggested by the EWGSOP 2 may not be suitable for Asians [10, 24]. Furthermore, to the best of our knowledge, no study has previously assessed the risk of falls using the AWGS 2 diagnostic criteria for sarcopenia [10].

This study aimed to assess the prevalence, physical characteristics, physical fitness, and risk of falls in older adults with possible sarcopenia using the newly proposed diagnostic criteria of the AWGS 2.

Materials and methods

Participants

A total of 431 participants aged between 65 and 97 years who had lived or are currently living in S city, Korea, were enrolled; 123 (28.5%) and 308 (71.5%) participants were men and women, respectively. Based on the possible sarcopenia criteria proposed by AWGS 2, 329 (76.3%) participants had normal grip strength, while 102 (23.7%) participants had decreased grip strength. The physical characteristics of the participants are presented in Table 1. This study was approved by the Institutional Review Board of Sungkyunkwan University (approval number: SKKU 2021-07-024).

Definition of possible sarcopenia and grip strength test

Possible sarcopenia is a concept proposed by AWGS 2 to promote healthy aging through early detection of sarcopenia and timely intervention and prevention. According to the AWGS 2 guidelines, older men and women with a grip

Table 1 Physical characteristics of study participants

	Men ($n = 123$, 28.54%)	Women ($n = 308$, 71.46%)	Total ($n = 431$)
Age (years)	75.89 ± 6.63	77.47 ± 6.00	77.02 ± 6.22
Height (cm)	163.31 ± 5.61	149.10 ± 6.72	153.1 ± 9.06
Weight (kg)	63.90 ± 10.28	54.80 ± 8.69	57.37 ± 10.04
BMI (kg/m^2)	23.89 ± 3.15	24.71 ± 3.31	24.47 ± 3.29
Body fat percentage (%)	26.86 ± 6.34	35.85 ± 6.91	33.3 ± 7.87
PS (n, %)	27 (21.95%)	75 (24.35%)	102 (23.67%)

Results are presented as mean ± standard deviation. *BMI* body mass index, *PS* possible sarcopenia

strength < 28 kg and < 18 kg, respectively, are considered to have possible sarcopenia [10].

In this study, grip strength was measured using a digital grip strength dynamometer (TKK 5401, Japan) with the elbow joint extended accordingly. Measurements were made twice for the left and right sides, and the highest value was used for analysis.

Physical fitness test

In this study, InBody 520 (InBody Co., Seoul, Korea) was used to measure the body composition, body weight, body fat percentage (%), skeletal muscle mass (kg), and fat-free mass (kg) of the participants. The physical fitness test of participants was conducted as described in the Senior Fitness Test manual [25], and the chair stand test was conducted to assess their lower body strength. We also measured the number of times the participants were able to complete full stands within 30 s. The arm curl test was conducted to evaluate upper body strength using 3- and 2-kg dumbbells for men and women, respectively, measuring the number of repetitions completed therein within 30 s. The 2-min step test was used to assess aerobic endurance. Participants were asked to raise their knee to the middle of the area between the iliac crest and patella, and the number of steps performed within 2 min was measured accordingly. The chair sit-and-reach test was performed to measure lower body flexibility, and the back scratch test was performed to assess upper body flexibility. Upper and lower body flexibilities were measured twice, and the highest values were included in the analysis. The 2.44-m up-and-go test was performed to assess agility and dynamic balance. After one practice session, the test was conducted twice, and the highest value was included in the analysis.

Fall risk

Fall risk was assessed using the fall assessment chart proposed by Suzuki [26], as used in previous studies [27–29]. The chart includes 15 items, and participants with a score of ≥ 5 were considered to have a high fall risk.

Statistical analysis

Data were analyzed using STATA version 15.0 (STATA Corp., College Station, TX, USA). All variables are presented as mean and standard deviation. According to the proposed AWGS 2 sarcopenia diagnostic criteria, study participants were divided into the normal (grip strength: ≥ 28 kg and ≥ 18 kg for men and women, respectively) and possible sarcopenia (grip strength: < 28 kg and < 18 kg for men and women, respectively) groups. An independent t-test was conducted to compare the differences in physical characteristics and fitness between the two groups. Logistic regression analysis was conducted to calculate the odds ratio (OR) of fall risk in both groups. A cut-off value of five points was used for fall risk, as described in previous studies [26–29]. Model 1 used unadjusted data, whereas Model 2 was calculated by adjusting for age and BMI. Statistical significance was set at $P < 0.05$.

Results

Differences in the subject characteristics by group

Table 2 shows the physical characteristics of the normal and possible sarcopenia groups, diagnosed using the AWGS 2 sarcopenia criteria. A total of 27 (21.95%) men and 75 (24.35%) women were included in the sarcopenia group.

Age ($p = 0.023$), weight ($p < 0.001$), BMI ($p = 0.001$), skeletal muscle mass ($p = 0.001$), and fat-free mass ($p < 0.001$) were significantly different between the two groups in older men. However, there were no significant differences in height and body fat percentage between the two groups ($p > 0.05$). Age ($p < 0.001$), height ($p = 0.003$), weight ($p < 0.001$), BMI ($p < 0.001$), skeletal muscle mass ($p < 0.001$), and fat-free mass ($p < 0.001$) were significantly different between the groups in older women. However, there were no significant differences in body fat percentage between the groups ($p > 0.05$).

Differences in physical fitness and fall risk by group

As shown in Table 3, lower body strength ($p = 0.007$), upper body strength ($p < 0.001$), aerobic endurance ($p = 0.005$), lower body flexibility ($p = 0.023$), agility and dynamic balance ($p < 0.001$), and fall risk score ($p = 0.026$) were significantly different between the groups in older men. However, there were no significant differences in upper body flexibility between the groups ($p > 0.05$). Lower body strength, upper body strength, aerobic endurance, lower body flexibility, upper body flexibility, agility and dynamic balance, and fall risk were significantly different between the groups in older women ($p < 0.001$).

Odds ratios for fall risk by group

As shown in Table 4, in model 1, which calculated OR without adjustment, the OR for fall risk for men in the possible sarcopenia group compared to the normal group was 2.50 (0.95–6.55), which was not significant ($p = 0.062$). In model 2, which calculated OR after adjusting for age and BMI, the OR for fall risk for men in the possible sarcopenia group

compared to the normal group was 3.12 (1.00–9.74), which was not significant ($p = 0.050$).

In model 1, the OR for fall risk for women in the possible sarcopenia group compared to the normal group was 2.50 (1.47–4.26), and there was a significant increase in fall risk ($p = 0.001$). In model 2, the fall risk for women in the possible sarcopenia group was significantly higher than that of the normal group, with an OR of 3.33 (1.81–6.12).

Discussion

This study assessed the prevalence of possible sarcopenia and the characteristics, physical fitness, and fall risk for older adults living in local communities using the diagnostic criteria for possible sarcopenia proposed by the AWGS 2. In this study, the prevalence of sarcopenia was found to be 23.7%. Older adults with possible sarcopenia had lower physical fitness than those in the normal group. Furthermore, older adult women with possible sarcopenia had a 3.3-fold higher fall risk than women in the normal group.

In a previous study, Kim and Won [30] reported a probable sarcopenia prevalence of 2.2%. However, in this study, the possible sarcopenia prevalence was 23.7%. This difference may be attributed to differences in the evaluation methods for possible sarcopenia. Kim and Won used a simple five-item–Strength, assistance with walking, rising from a chair, climbing stairs, and falls (SARC-F) questionnaire using the EWGSOP 2 diagnostic criteria to screen for probable sarcopenia [30]. However, in this study, the grip strength criteria, as proposed by AWGS 2 in 2019, were used to screen for possible sarcopenia. Thus, the differences in the screening method may have led to a higher prevalence of possible sarcopenia in our study.

Warzecha, Amarowicz, Berwecka, Czerwiński, and Kumorek [16] reported that the EWGSOP 1 criteria lead to more sarcopenia diagnoses than the EWGSOP 2 criteria (18.0% vs. 4.1%). In a study by Yang, Yao, Shen, Sun, Sun, Tian et al. [31], sarcopenia was diagnosed in 22.3% and 11.7% of older men and women, respectively, using the EWGSOP 1 criteria and in 6.5% and 3.3% of older men and women, respectively, using the EWGSOP 2 criteria. These two previous studies have shown that the EWGSOP 2 criteria lead to more sarcopenia diagnoses than the EWGSOP 1 criteria, suggesting that sarcopenia incidence may vary depending on the criteria. However, in our study, possible sarcopenia, and not sarcopenia itself, was diagnosed using the AWGS 2 criteria. Thus, our results cannot be readily compared to those of previous studies.

Body fat percentage was not significantly different between the normal and possible sarcopenia groups in our study; however, the possible sarcopenia group had reduced skeletal muscle mass and fat-free mass compared

Table 2 Differences in characteristics of the normal and possible sarcopenia groups

	Men ($n = 123$)			Women ($n = 308$)		
	Normal group (GS ≥ 28 kg; $n = 96$)	Possible sarcopenia group (GS < 28 kg; $n = 27$)	*p*-value	Normal group (GS ≥ 18 kg; $n = 233$)	Possible sarcopenia group (GS < 18 kg; $n = 75$)	*p*-value
Age	75.17 ± 6.48	78.44 ± 6.64	0.023*	76.28 ± 5.66	81.19 ± 5.55	< 0.001**
Height (cm)	163.80 ± 5.72	161.57 ± 4.89	0.073	149.75 ± 6.60	147.08 ± 6.75	0.003*
Weight (kg)	65.63 ± 9.68	57.75 ± 10.16	< 0.001**	56.07 ± 8.32	50.79 ± 8.68	< 0.001**
BMI (kg/m^2)	24.39 ± 2.86	22.10 ± 3.54	0.001*	25.11 ± 3.20	23.44 ± 3.38	< 0.001**
Body fat percentage (%)	27.07 ± 6.05	26.1 ± 7.37	0.494	36.20 ± 6.59	34.75 ± 7.77	0.118
Skeletal muscle mass (kg)	25.84 ± 3.00	22.58 ± 3.18	0.001*	18.70 ± 2.43	16.84 ± 2.56	< 0.001**
Fat-free mass (kg)	47.45 ± 5.17	42.18 ± 5.40	< 0.001**	35.61 ± 4.10	32.74 ± 4.45	< 0.001**

Results are presented as mean ± standard deviation; *GS* grip strength, *BMI* body mass index

*$p < 0.05$, and **$p < 0.001$

Table 3 Differences in physical fitness and fall risk in normal and possible sarcopenia groups

Variables	Test	Men ($n=123$)			Women ($n=308$)		
		Normal group (GS ≥ 28 kg; $n=96$)	Possible sarcopenia group (GS < 28 kg; $n=27$)	p -value	Normal group (GS ≥ 18 kg; $n=233$)	Possible sarcopenia group (GS < 18 kg; $n=75$)	p-value
Lower body strength	Chair stand (number of reps/30 s)	15.67 ± 3.99	13.12 ± 4.48	0.007*	13.35 ± 7.54	9.72 ± 3.51	< 0.001**
Upper body strength	Arm curl (number of reps)	17.49 ± 3.86	11.54 ± 5.30	< 0.001**	16.95 ± 3.63	11.82 ± 4.24	< 0.001**
Aerobic endurance	2-min step test (number of reps)	74.05 ± 26.05	56.17 ± 30.46	0.005*	60.14 ± 27.90	38.77 ± 28.12	< 0.001**
Lower body flexibility	Chair sit-and-reach test (cm)	0.24 ± 8.65	− 4.09 ± 7.88	0.023*	10.38 ± 6.42	5.63 ± 6.50	< 0.001**
Upper body flexibility	Back scratch test (cm)	− 19.36 ± 14.57	− 24.50 ± 16.71	0.126	− 9.12 ± 13.23	− 18.63 ± 13.34	< 0.001**
Agility and dynamic balance	2.44-m up-and-go test (s)	5.29 ± 1.14	6.31 ± 1.47	< 0.001**	6.08 ± 1.45	7.95 ± 3.54	< 0.001**
Fall risk	Fall assessment chart (score)	2.51 ± 1.80	3.44 ± 1.92	0.026*	3.54 ± 1.78	4.58 ± 1.89	< 0.001**

Results are presented as mean ± standard deviation; GS, grip strength;
*$p < 0.05$, and **$p < 0.001$

Table 4 Odds ratios for fall risk in the normal and possible sarcopenia groups

	Men ($n=123$)			Women ($n=308$)		
	Normal group (GS ≥ 28 kg; $n=96$)	Possible sarcopenia group (GS < 28 kg; $n=27$)	p-value	Normal group (GS ≥ 18 kg; $n=233$)	Possible sarcopenia group (GS < 18 kg; $n=75$)	p-value
Model 1						
Self-reported fall risk (cut-off score, ≥ 5)	Reference	2.50 (0.95–6.55)	0.062	Reference	2.50 (1.47–4.26)	0.001*
Model 2						
Self-reported fall risk (cut-off score, ≥ 5)	Reference	3.12 (1.00–9.74)	0.050	Reference	3.33 (1.81–6.12)	< 0.001**

Results are presented as mean ± standard deviation; GS, grip strength; *$p < 0.05$ and **$p < 0.001$
Model 1 used unadjusted data, and model 2 was adjusted for age and BMI

to the normal group. These findings suggest that although decreased muscle strength in older adults cannot fully explain the decrease in muscle mass [32, 33], the AWGS 2 grip strength diagnostic criteria is a useful indicator that can simultaneously assess reduction in muscle mass and function.

The participants in this study were older adults living in large cities, rather than patients in hospitals or nursing facilities. Therefore, the Senior Fitness Test [25], which was developed to assess physical fitness in the elderly, was used accordingly. Physical fitness was compared between the normal and possible sarcopenia groups. Upper body flexibility was significantly lower in women in the possible sarcopenia group than that in the normal group. However, men and women with possible sarcopenia had poorer upper and lower body strength, aerobic endurance, lower body flexibility, agility and dynamic balance, and a higher fall risk than men and women in the normal group. Our study found that grip strength not only indicates weakening upper body strength but is also related to decreasing overall physical fitness [34–36]. Additionally, the possible sarcopenia diagnostic criteria proposed by AWGS 2 may be useful for screening older adults for reduced physical fitness. Therefore, the grip strength test can be used to promote health in older adults.

In our study, the fall risk score was higher in both men and women with possible sarcopenia than in the normal group. Moreover, the difference in OR for fall risk between the groups was not significant in older men, while older

women had a 2.50- and 3.33-fold higher fall risk when age and BMI were considered. Consequently, the relationship between fall risk and muscle strength observed in older women may have been affected by the speed of changes related to sarcopenia in muscle strength and mass. Auyeung, Lee, Leung, Kwok, and Woo [37] have shown that grip strength was reduced by 0.798 kg/year in older men and 1.239 kg/year in older women and that the rate of loss of appendicular skeletal muscle mass (ASM) [19] was 1.59% in men and 2.02% in women. Older women showed a faster rate of decrease in muscle strength and mass than men and had a higher fall rate and worse fall outcomes than men. Thus, active interventions are necessary to promote healthy aging and prevent falls in older women. In our study, the possible sarcopenia group was identified based on the results of a simple grip strength test. Our results are similar to those of studies based on previously used diagnostic criteria, and the cut-off value of muscle strength presented by AWGS 2 in our study has been shown to detect decreased physical fitness as well as fall risk.

This study has several limitations. First, this study did not compare the reliability and validity of the diagnostic criteria for sarcopenia, as suggested by EWGSOP 2 and AWGS 1 and 2. Thus, this study may not propose the most appropriate criteria for the Asian population. However, we have demonstrated that the diagnostic criteria for possible sarcopenia suggested by AWGS 2 may be useful for the Asian population. Additionally, the study participants were not representative of the older adults in Korea. However, in contrast to previous studies, this study included > 400 participants. Possible sarcopenia and fall risk were explained in connection with decreased physical fitness; however, several other factors were not considered in this study. Falls are affected by many factors including eyesight, multimorbidity, effects of polypharmacy (anticholinergic side effects of medications, multiple antihypertensives), comorbidities such as hypertension, cognitive impairment, and footwear. Therefore, future studies on possible sarcopenia, sarcopenia, or severe sarcopenia based on Asian standards should consider these factors. Our questionnaire included eyesight, medication, disease information, and changes in physical function with age. However, in our study, the results were derived using only the cut-off value of the total score from the questionnaire.

Conclusion

Approximately 23.7% of older adults in local communities were determined to have sarcopenia according to the AWGS 2 criteria. Participants with possible sarcopenia were older and had lower skeletal muscle mass than those in the normal group. However, the body fat percentage was not significantly different between the normal and possible sarcopenia groups. Moreover, older adults with possible sarcopenia had lower physical fitness than those in the normal group. Notably, older women with possible sarcopenia had a 2.25 to 3.33-fold higher fall risk than those in the normal group.

We found that the diagnostic criteria for possible sarcopenia based on grip strength, as suggested by AWGS 2, may be useful for screening for declining physical function in older Korean adults. Our findings also suggest that the diagnosis of possible sarcopenia using grip strength can be used as a criterion for providing an active fall prevention program for older women with possible sarcopenia.

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Declarations

Conflict of interest The authors declare no conflict of interest.

Ethical approval This study was retrospective study and performed with the approval of the Institutional Review Board of Sungkyunkwan University (SKKU 2021-07-024).

Data availability statement Not applicable.

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