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Original Article

Effects of Possible Sarcopenia on Physical Fitness, Gait, and Fear of Falling of Older Adults

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Abstract

Background: We aimed to determine the differences in physical fitness between older adults with and without indicators of possible sarcopenia and the associations between possible sarcopenia and fear of falling.

Methods: Individuals aged >75 years living in Harbin City, China in 2023 were recruited through a local community center. The presence of possible sarcopenia was defined using the Asian Working Group for Sarcopenia 2 criteria via grip strength measurement, with cut-off points of >28 kg for men and >18 kg for women. Physical fitness, gait ability tests, and a fear of falling questionnaire were administered. An independent t-test was used to compare differences in physical fitness and gait between individuals with and without possible sarcopenia. Multivariate logistic regression was used to investigate the association between possible sarcopenia and fear of falling.

Results: The possible sarcopenia group had lower extremity strength, flexibility, and aerobic endurance than the group without possible sarcopenia (P<0.001). Regarding dynamic balance, the time taken was longer in the possible sarcopenia group (P<0.001). There was also a difference in gait ability and fear of falling between the two groups (P<0.001). Compared to individuals without possible sarcopenia, those with possible sarcopenia had significantly increased odds ratios for fear of falling (odds ratio, 9.66; 95% confidence interval, 4.06–22.98).

Conclusion: Possible sarcopenia based on the grip strength criterion was associated with decreased physical fitness and gait performance in Chinese community-dwelling older adults.

Keywords: Falling, Gait; Grip strength; Physical fitness; Sarcopenia

Introduction

Economic and medical advancements have contributed to an aging worldwide population, and China has become an aging society with an increase in the number of older adults. Currently, 18.7% of the Chinese population is aged >60 years, and the proportion is predicted to increase to 28% by 2040 (1,2). Sarcopenia is a disease characterized by decreased muscle mass and strength that is usually observed in older adults (3). Reduced muscle mass and strength loss in older adult is a severe health problem affecting cardiometabolic factors, disorders, and mortality

(4,5). Therefore, the Asian Working Group for Sarcopenia (AWGS) 2 defined "possible sarcopenia" based on low muscle function, using grip strength as a predictor for sarcopenia. The cut-off points proposed by AWGS 2 are <28 kg for men and <18 kg for women, respectively (6).

Aging leads to a decrease in physical performance, such as muscle strength and gait. Oikawa et al. reported that muscle strength and mass reduced by 3% and 1% per year, respectively, after the age of 60 years (7). A decline in lower extremity strength could deteriorate the function of gait, which affects "extended healthy life expectancy" and "successful aging" (8,9). Moreover, the decreasing extremities strength was associated with poorer gait variables (9). Falls, which are related to body strength and gait in older adults, are major health problems that interfere with successful aging. Falls are the second leading cause of unintentional death and account for 684,000 fatalities each year (10). Fall-related deaths in the Chinese population have consistently increased in individuals aged >60 years since 2013 (11).

Therefore, older adults may fear falling regardless of the experience of the fall (12). Although the fear of falling prevents falls as a result of restriction and reduction in daily activities, it also leads to decreased muscle strength (13). Consequently, preventing falls is important, and decreasing the fear of falls in the older population is a priority. We aimed to examine the relationships among possible sarcopenia, grip strength, physical fitness, and gait. Furthermore, this study determined the association between possible sarcopenia and fear of falling in a Chinese population aged >75 years.

Materials and Methods

Study participants

Individuals aged >75 years residing in Harbin City, China were recruited through a local community center in 2023. Eligible participants included older adults who could take a gait and physical fitness test, did not have musculoskeletal disorders and chronic diseases, and did not regularly participate in physical activities during the past 3 months. A total of 300 subjects recruited participants completed a questionnaire and physical performance examination after signing an informed consent form. However, eight participants did not complete all the examinations. Ultimately, 292 participants (131 men and 161 women) were included. Data were collected from April through July 2023. The characteristics of the participants with possible sarcopenia are presented in Table 1.

Possible sarcopenia

As sarcopenia is a muscle disorder involving both muscle mass and strength, various measurements are required to identify sarcopenia. Therefore, AWGS 2 criteria defines possible sarcopenia using low grip strength to predict the development of sarcopenia and identify sarcopenia at the community level. The cut-off points are >28 kg for men and >18 kg for women (6).

Ethical considerations

Ethical approval was obtained from the institutional review board of Sangmyung University, Seoul, Korea (IRB number: 2023-007).

Physical fitness and gait measurements

Grip strength was measured using a digital grip strength dynamometer (EH101; Camry, China) with the elbow extended and slightly spread out. Measurements were performed twice for each arm, and the highest value was used for the analysis. The Senior Fitness Test was used to measure strength, upper and lower body flexibility, and aerobic endurance (14). An arm curl and chair stand test were used to measure upper and lower body strength, respectively. The tests were performed for 30 s, and the number of repetitions was counted. We used the back scratch and chair sit-and-reach tests to measure flexibility. These were tested twice, and the highest value was used for analysis. Aerobic endurance was estimated by a 2-min step test, in which participants were asked to walk in place while lifting their knees to the waist, and the number of steps was counted. To measure dynamic balance, we used 5-times

sit-to-stand test and the 3-m timed up-and-go test, asking participants to move at their maximum speed (15,16). These tests recorded the time spent, with the highest value of two 5-times sit-to-stand tests included in the analysis. Gait speed and stride were assessed by a gait test, and we set a 10-m course to prevent lowering speed at the start and extended the end point to 2 m. Speed and stride were estimated using the following equations: gait speed = 6 m/time (sec) and stride = 6 m/frequency (6). The body mass index (BMI) was calculated by dividing weight by height (in meters squared).

Fear of falling

The Falls Efficacy Scale International (FES-I), developed by Yardley (17), was used to evaluate the fear of falling in this study. The FES-I has high-quality internal and test-retest reliabilities (Cronbach's α = 0.96, intraclass correlation coefficient = 0.96) and consists of 16 questions assessing the level of fear of falling during simple and/or complicated daily indoor and outdoor activities, with each question rated on a 4-point scale. Our results were represented as a score between 16 and 64 and classified into two (low and high) or three (low, mid, and high) parts (two parts:16–22 and 23–64; three parts: 16–19, 20–27, and 28–64).

Statistical analysis

The data were analyzed using STATA (version 17.0; STATA Corp., College Station, TX, USA). In this study, we used the AWGS 2 criteria for possible sarcopenia using grip strength with the following cut-off points: >28 kg for men and >18 kg for women. According to possible sarcopenia, continuous variables were presented as mean and standard deviation, and categorical variables were presented as frequency and proportion (%). In this study, a FES-I score ≥23 was defined as fear of falling (18). An independent t-test was used to compare differences in physical fitness and gait between the groups. Multivariate logistic regression was used to investigate the association between possible sarcopenia and fear of falling according to sex, and the results were reported as odds ratio (OR) and 95% confidence interval (CI). The analysis was not adjusted for covariates in Model 1, and Model 2 was adjusted for age, sex, and BMI. Statistical significance was set at $P<0.05$.

Results

Characteristics of participants by possible sarcopenia

Table 1 shows the characteristics of the non-possible sarcopenia and possible sarcopenia groups. Among the 292 participants in this study, 142 were identified as possible sarcopenia, and the prevalence of possible sarcopenia was 48.6% (142/292). The sex-specific prevalence was 48.9% (n = 64) and 48.4% (n = 78) in men and women, respectively.

Table 1: Characteristics of participants by possible sarcopenia

Variables	*Without possible sarcopenia (n = 150)*	*Possible sarcopenia (n = 142)*	*Total (n = 292)*
Age (yr)	78.45 ± 3.43	81.39 ± 4.64	79.88 ± 4.32
Sex (%)			
Men	67 (44.67)	64 (45.07)	131 (44.86)
Women	83 (55.33)	78 (54.93)	161 (55.14)
Weight (kg)	66.27 ± 10.86	61.71 ± 10.94	64.05 ± 11.12
Height (cm)	164.70 ± 9.29	163.49 ± 7.49	164.11 ± 8.48
Body mass index (kg/m^2)	24.27 ± 2.76	23.01 ± 3.26	23.66 ± 3.08

Results are presented as mean ± standard deviation for continuous variables and frequency (%) for categorical variables

Compared to the non-possible sarcopenia group, the possible sarcopenia group had higher mean age and ratio of men (78.45 ± 3.43 vs. 81.39 ± 4.64; 44.67% vs. 45.07%). The possible sarcopenia group had lower weights and heights; however, it also had lower BMI value compared to the non-possible sarcopenia group (24.27 ± 2.76 vs. 23.01 ± 3.26).

Differences of physical fitness and gait variables by possible sarcopenia and sex

The possible sarcopenia group had statistically significant lower extremity strength and aerobic endurance than the group without possible sarcopenia (P<0.001) (Table 2). However, both groups had similar upper and lower body strengths and aerobic endurance in both sexes.

Table 2: Differences of physical fitness, gait, and fear of fall between individuals with and without possible sarcopenia by sex

Variables		***Men***			***Women***		
Physical fitness	Test	Without possible sarcopenia (n = 67)	Possible sarcopenia (n = 64)	*P*	Without possible sarcopenia (n = 83)	Possible sarcopenia (n = 78)	*P*
Grip strength		32.99 ± 5.30	20.14 ± 5.53	<0.001 ***	21.20 ± 2.44	13.90 ± 2.51	<0.001 ***
Upper strength	Arm-curl (reps/30s)	21.01 ± 3.05	14.84 ± 3.52	<0.001 ***	20.96 ± 3.35	15.65 ± 3.20	<0.001 ***
Lower strength	Chair stand (reps/30s)	15.94 ± 3.03	9.20 ± 3.42	<0.001 ***	14.84 ± 2.48	9.62 ± 2.76	<0.001 ***
Upper body flexibility	Back scratch (cm)	-13.78 ± 11.31†	-29.36 ± 12.35†	<0.001 ***	-9.52 ± 9.10	-20.90 ± 10.61	<0.001 ***
Lower body flexibility	Chair sit and reach (cm)	-2.67 ± 8.05†	-10.21 ± 9.57†	<0.001 ***	0.81 ± 6.59	-5.48 ± 9.44	<0.001 ***
Aerobic endurance	2-min step test (reps/2min)	102.18 ± 34.27	68.78 ± 36.13	<0.001 ***	105.83 ± 28.59	67.29 ± 23.44	<0.001 ***
Dynamic balance	5-times sit-to-stand (sec)	9.33 ± 1.98†	18.69 ± 10.00	<0.001 ***	9.99 ± 1.73	16.87 ± 9.34	<0.001 ***
Gait	3m TUG (sec)	7.89 ± 1.52†	17.20 ± 11.24†	<0.001 ***	8.32 ± 1.48	13.25 ± 5.19	<0.001 ***
	Speed (m/s)	1.38 ± 0.31	0.74 ± 0.36†	<0.001 ***	1.31 ± 0.27	0.84 ± 0.31	<0.001 ***
	Stride (m/step)	0.74 ± 0.13†	0.44 ± 0.16	<0.001 ***	0.61 ± 0.12	0.46 ± 0.13	<0.001 ***
Fear of falling	FES-I (score)	22.22 ± 6.15†	40.28 ± 14.26	<0.001 ***	32.22 ± 10.48	43.71 ± 12.39	<0.001 ***

Results are presented as mean ± standard deviation; ***P<0.001; †indicate significant differences between men and women. TUG, timed up and go; FES-I, fall efficacy scale-international

Flexibility was significantly low in the possible sarcopenia group (P<0.001). In addition, the men had lower flexibility compared to women in both groups. Regarding dynamic balance, the time taken was significantly longer in the possible sarcopenia group in both tests (P<0.001). Furthermore, in the group without possible sarcopenia, the men were quicker during the examination than women, whereas in the possible sarcopenia group, the results of the 5-times sit-to-stand test showed no difference in sexes. Gait, measured as gait speed and stride, also had a significantly lower value in participants who were identified with possible sarcopenia in both sexes (P<0.001). Women had a faster walking speed than men in the possible sarcopenia group; however, men had a longer walking stride than women in the group without possible sarcopenia.

Associations between possible sarcopenia and fear of falling

The possible sarcopenia group had a significantly higher fear of falling than the group without possible sarcopenia (P<0.001) (Table 2). Moreover, possible sarcopenia was associated with the fear of falling (Table 3). In model 1, without adjustments, possible sarcopenia group had a statistically significant OR for fear of falling (8.13; 95% CI, 3.69–17.92). After adjusting for age and BMI, the OR for fear of falling in the possible sarcopenia group was higher in Model 2 (9.66; 95% CI, 4.06–22.98).

Table 3: Associations between possible sarcopenia and fear of falling

Variables	*Without possible sarcopenia (n = 150)*	*possible sarcopenia (n = 142)*	*P*
(Model 1) fear of falling	Reference	8.13 (3.69-17.92)	<0.001***
(Model 2) fear of falling	Reference	9.66 (4.06-22.98)	<0.001***

Results were presented as odd ratio (95% confidence interval); ***P<0.001.
Model 1 was unadjusted. Model 2 was adjusted for age, sex, and body mass index

Discussion

This study investigated the differences in physical fitness, gait, and fear of falling between patients with and without possible sarcopenia. Moreover, the association between possible sarcopenia and fear of falling was analyzed. In this study, the prevalence of possible sarcopenia was 48.6% (142/292). Similarly, a previous study using a nationwide representative sample of Chinese individuals reported that the prevalence of possible sarcopenia was 46.0% (19). Using the criteria of the European Working Group on Sarcopenia in Older People 2 (EWGSOP 2), Souza et al. analyzed the prevalence of possible sarcopenia in community-dwelling older adults in Brazil and reported that 50.0% of the older population has possible sarcopenia (20). In contrast, the prevalence of possible sarcopenia in Japan, Singapore, and Korea was lower than that reported in this study (2.9%, 14.0%, and 23.7%, respectively) (21-23). A study using data from the Japanese population measured the calf circumference criterion (men <34b cm, women <33 cm) before classification by grip strength cut-off points (21). According to the study in Singapore, the recruited participants were relatively young adults (mean age = 58.5 ± 18.8 years) compared to the participants of this study (mean age = 79.9 ± 4.3 years) (22). Lim and Kong used only grip strength as a criterion for possible sarcopenia in the same manner as in this study (23). However, the prevalence of possible sarcopenia in this study was 23.7%. Although these differences in prevalence

between the studies are uncertain and unknown, various complex factors, such as ethnicity, age range of the study population, and measurement of grip strength, might affect this relationship.

Possible sarcopenia was associated with poor physical fitness, such as strength and flexibility in both the upper and lower extremities, aerobic endurance, and dynamic balance. These results were consistent with those of a previous study, which reported that possible sarcopenia decreased physical performance in both sexes, except for upper body flexibility in men (23). In this regard, the results of this study using the criteria for possible sarcopenia classified by grip strength could be used to identify vulnerable older adults with low physical fitness. However, few studies have analyzed the association between sarcopenia and physical fitness. Therefore, further studies are required to elucidate the relationship between possible sarcopenia and physical performance.

Participants classified as having possible sarcopenia had decreased gait parameters, including walking speed and stride. These results may be attributed to the effects of decreased physical performance in older individuals with possible sarcopenia. Abdul Jabber et al. reported that the deterioration of gait variables, such as walking speed and stride, was associated with decreased body strength and aging (9). Similarly, older adults with decreased lower extremity strength had low walking speeds (24). In AWGS 2 and EWGSOP 2, gait speed was used as a criterion for sarcopenia, and the cut-off points were <1.0 m/s and <0.8 m/s, respectively (5,6). In this study, the gait speed of the possible sarcopenia group was 0.74 ± 0.36 in men and 0.84 ± 0.31 in women; therefore, the study participants with possible sarcopenia could have a higher risk of sarcopenia compared to those without it. Moreover, poorer gaits in older individuals could lead to an increased risk of falls, which are related to mortality in older adults (11,25).

The association between possible sarcopenia and fear of falling was analyzed in this study. The possible sarcopenia group had a higher fear of falling compared to the group without possible sarcopenia (OR, 9.66; 95% CI, 4.06–22.98). Similar results were obtained in Brazil, indicating that possible sarcopenia had a significant association with the fear of falling despite the value being lower than that in the current study (OR, 4.23; 95% CI, 2.51–7.15). This difference in the results might be because the previous study was adjusted for multimorbidity to evaluate the association and not for BMI (20). Although, fear of falling could have an advantage in preventing the risk of falls, it would further deteriorate the physical performance of individuals with possible sarcopenia due to restricted physical activity (13). Consequently, possible sarcopenia, represented by decreased physical fitness and gait performance and a high fear of falling, makes it difficult for older individuals to be physically active and thus reduces their participation in daily life activities.

A major strength of this study was the use of grip strength as a criterion for assessing possible sarcopenia. Grip strength measurement offers several advantages over other strength measurements; it is simple, inexpensive, and more accessible than isokinetic strength testing. Additionally, grip strength represents an individual's overall body strength (26,27). Therefore, given the benefits of grip assessment and the results of this study, grip strength measurement may be an efficient method to determine low physical fitness, gait performance, and fall risk in older individuals.

This study has some limitations. First, as the participants in this study were recruited from Harbin City's local community center, these results do not represent the entire population of China. However, this study recruited approximately 300 participants, which is a good sample size. Second, this study analyzed possible sarcopenia, physical fitness, gait variables, and fear of falling and did not consider other variables such as nutrition, muscle mass, and disease. Therefore, further studies need to consider other variables that were not included in this study.

Conclusion

Possible sarcopenia based on the grip strength criterion was associated with decreased physical

fitness and gait performance in Chinese community-dwelling older adults. Moreover, the fear of falling was more strongly associated with possible sarcopenia. Grip strength as a criterion would help predict low physical fitness, gait performance, and risk of falling in the older population. However, further studies are needed to elucidate the relationship between sarcopenia, physical performance, and falls by considering other variables that were not adjusted for in this study.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interest

The author declares no conflicts of interest.

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