ORIGINAL ARTICLE

Comparison of Sarcopenia Indices Based on Fall History and Level of Fear of Falling Among Community-dwelling Older Adults in Selangor, Malaysia

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ABSTRACT

Introduction: Sarcopenia, one of the geriatric syndromes characterized by changes in muscle mass, muscle strength and physical performance, may lead to falls in older adults. Objective: This study aimed to compare sarcopenia indices, fall history, and fear of falling (FoF) among community-dwelling older adults. **Methods:** : This cross-sectional study involved 201 participants (mean age = 68.45 ± 6.30 years). Fall history and FoF were recorded through assisted questionnaires and the short Fall-Efficacy Scale-international, respectively. Sarcopenia indices were measured including muscle mass (bioelectrical impedance analysis), muscle strength (JAMAR hand dynamometer), and physical performance (5-time chair stand test). Analysis of covariance (ANCOVA) was conducted to compare sarcopenia indices between fall history and FoF while controlling for age and gender. The level of statistical significance was set at $p<0.05$. **Results:** A total of 71 (35%) participants reported of a fall during the past 12 months, while approximately half of the participants demonstrated a higher concern for falls (50.2%). Those without a fall history scored significantly better in all sarcopenia indices (all $p<0.05$). Additionally, participants with a lower concern of falling had significantly better sarcopenia indices ($p<0.05$) compared to those with a greater concern of falls, except for muscle mass ($p=0.052$). **Conclusion:** Fall history and fear of falling may lead to symptoms of sarcopenia. These findings can provide evidence for promoting health education and continuous screening among older adults at risk of falls and sarcopenia.
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INTRODUCTION

The ageing phenomenon affects the body's ability to perform its functions optimally (1), reduces functional independence, and contributes to falling incidence (2). According to the World Health Organization, falls often occur among individuals older than 60 years and is defined as ‘inadvertently coming to rest on the ground, floor, or other lower levels, excluding intentional change in position to rest in furniture, wall, or other objects’ (3). The incident of falling is also known as the unintentional event that occurs as a person starts to lose consciousness and falls against their will (4). Falls represent a significant health care issue among older adults because of its detrimental effects such as fractures, depression, and passive attitudes towards physical activities (5).

Due to the tremendous impact of falls, especially among the older population, fear of falling (FoF) should also be considered because it may influence individuals' conditions. FoF is often associated with an individual's level of dependence (6) and may occur as one starts to have reduced confidence in executing daily tasks independently without falling (7). FoF affects many aspects of life, including an individual's confidence, strength, and balance (6). It may also cause avoidance of daily-life activities (8), further contributing to a sedentary lifestyle and a cycle of recurrent falls.

Previous studies have demonstrated some predictors of falls and FoF incidence, including the progressive and generalized changes on skeletal muscle known as sarcopenia (8, 9). Sarcopenia has been recognized as one of the geriatric syndromes (9) that cause reductions in muscle mass, muscle strength and physical performance (5). Various algorithms have been recommended to be used for screening sarcopenia. Specifically, the Asian Working Group for Sarcopenia (AWGS) provides an Asian-specific algorithm to screen for sarcopenia as the characteristics of sarcopenia may vary between differing populations (10). Through the use of AWGS, screening for sarcopenia is made simpler and can be performed within a shorter amount of time using the SARC-F questionnaire as an early assessment. The SARC-F is a questionnaire used for the subjective assessment of sarcopenia status in an individual, according to aspects of daily routine including strength, walking ability, rising from a chair, stair climbing, and falls (11).

Sarcopenia is often noticeable only in the critical phase; for example, when individuals frequently experience adverse events such as falls (12). However, there is a lack of studies comparing which sarcopenia indices may be impacted following a fall history and among those with different levels of fear of falling. Understanding these impacts may encourage early detection of sarcopenia among those with a history of falls and fear of falls, or vice versa. Thus, the current study aimed to compare the sarcopenia indices (muscle mass, strength, physical performance, and subjective sarcopenia status) and other characteristics among older adults with and without a history of falls and those with high and low levels of FoF who reside in the community.

MATERIALS AND METHODS

Participant recruitment

This cross-sectional study recruited community-dwelling older adults from selected villages around Selangor. The recruitment was performed using purposive sampling. The participants were invited to the study through pamphlets and social media before undergoing screening based on the predetermined selection criteria.

In this study, the participants were included based on the following criteria: age 60 years old and above; males and females; with no acute illness such as stroke and Parkinson's disease (<6 months); and no cognitive impairment (based on the Mini-Cog test >4). Those with severe hypertension (systolic >180 at the time of assessment); inability to understand the study procedure; history of cardiac problems; gastrointestinal tract disease; musculoskeletal injury such as a bone fracture or sprain (<6 months); and recent surgery (<6 months) were excluded from the study.

Ethical Clearance

This study was approved by Research Ethics Committee, Universiti Teknologi MARA (Approval No. REC/02/2021).

Outcome measures and data collection

The participants gave their consent and completed the study questionnaires, including demographic data and health status questionnaires. To improve the validity and accuracy of the outcomes, mainly due to the inclusion of a self-administered questionnaire, the Mini-Cog was used to briefly assess participants' level of cognitive function (13). The anthropometric and body composition measurements were divided into the calf, hip, and waist circumferences using a non-elastic measuring cloth tape on the broadest region of both calves, buttocks, and midway between the lower rib and iliac crest circumferences, respectively. These measurements were followed by assessing height (cm) using the same type of tape that was vertically attached against the wall. Bodyweight (kg), appendicular skeletal muscle mass (ASM), body mass index (kg/m^2), and fat percentages (%) were measured through bioelectrical impedance analysis (BIA) using the body composition monitor, HBF-375 (OMRON HEALTHCARE Co., Kyoto, Japan). As a non-invasive and validated tool to assess body composition, BIA is recommended to be applied in field studies because it can evaluate a large population in a short time despite the variety of characteristics (14).

Assessment of sarcopenia indices

Low muscle mass is a crucial indicator of sarcopenia (9). The relative muscle mass in the current study was calculated using the height-adjusted formula ASM/height^2 (15). An individual's absolute muscle mass is highly correlated with height and may influence the results (16). Thus, height squared in the formula was used to convert the absolute muscle mass to appendicular muscle mass index (17), minimizing the correlation of the height index across different study populations (16). The cut-off points used to identify muscle mass deterioration for men and women were <7.0 kg/m^2 and <5.7 kg/m^2, respectively (15).

Next, muscle strength was assessed through handgrip strength using a Jamar dynamometer, following the American Society of Hand Therapists's protocol (18) proposed in the AWGS. Handgrip strength is a validated and reliable measure to assess muscle strength (18). Participants were seated on an armless chair with hips and knees in 90° position while holding the Jamar dynamometer (elbow in 90° flexion, forearm in neutral, and wrist between 15° and 30° of extension and 0°–15° of ulnar deviation) as the starting position. The cut-off points for reducing grip strength were <28 kg for men and <18 kg for women, considering the highest reading in either hand, both hands, or the dominant hand in a maximal force through an isometric contraction (15).

The 5-time chair stand was used to measure the participants' physical performance. This method is a reliable and valid clinical tool, which can measure lower extremity function in a limited space and short amount of time (19). The test involved the sit-to-stand movement where participants were instructed to stand up from a seated position for five (5) times consecutively with their arms folded across the chest. The time was taken from the start command 'go' until the participant's buttocks touched the chair on the fifth repetition. This test was used as a substitute for gait speed assessment, where the indication for reduction upon physical performance was when the recorded time is more than 12 seconds, which corresponds to a gait speed of 10 m/s (15).

The SARC-F questionnaire was also used in the current study as suggested in the AWGS. The SARC-F is a self-reported questionnaire with good validity and consistency in identifying people with a risk of sarcopenia, despite its low-to-moderate sensitivity in predicting individual muscle strength (11). The classification of participants based on SARC-F is less time-consuming by identifying sarcopenia subjectively without neglecting the important aspects to be considered in a sarcopenic individual (15).

Fall assessments

Participants' fall histories were recorded based on self-reported questions that queried the number of falls, how the falls occured and the consequences of falls over the past 12 months. Meanwhile, FoF was assessed via the short Fall Efficacy Scale International (FES-I). The FES-I uses a four-point Likert scale and it is widely utilized among researchers to evaluate the fear of falls. The test administration of FES-I is simple. Not only is it quick to complete, it can also determine the level of concern both inside and outside the home during 16 social and physical activities including cleaning, walking, and socializing (20). The FES-I questionnaire is available in many language versions, including the Malay language. It has been proven to have good internal consistency and responsiveness (7) as well as excellent internal validity and test-retest reliability (21). The cut-off points for lower and higher concerns used in the current study ranged from 7–11 to 12–28, respectively (7).

Data Analysis

The data were analyzed using the Statistical Package for Social Science (SPSS) for Windows 25 (SPSS Version 25, IBM Corp, New York, NY, USA). The normality of dependent variables was analyzed using the Kolmogrov-Smirnov test. Descriptive statistics described the mean, standard deviation, frequencies and percentages of the variables. The parametric independent t-test was used to compare characteristics of participants, sarcopenia indices, and other characteristics between those with and without a history of falls as well as those with high and low levels of FoF. Analysis of covariance (ANCOVA) was used to compare the sarcopenia indices between the fall history and FoF while controlling for age and gender. All statistical significance was accepted at the level of $p<0.05$.

RESULT

Two hundred one participants aged 60 years old (68.45 ± 6.30) and above were enrolled in the current study. Table I summarizes the descriptive data of the study population. The majority of the participants were women, and most reported to have comorbidities and polypharmacy. Approximately 71 (35.0%) participants experienced falls during the last 12 months. Additionally, half of the study population at 50.2% had high concerns of falling.

Table I: Descriptive data of the study population (N=201)

	Participants (N=201)	
	n, %	Mean ± SD
Age (years)		68.45 ± 6.30
Gender		
Women	104(52.0)	
Men	97(48.3)	
Ethnicity		
Malay	155(77.0)	
Chinese	24(12.0)	
Indian	22(11.0)	
Comorbidities		
Yes	157(78.1)	
No	44(22.0)	
Surgery		
Yes	44(22.0)	
No	157(78.0)	
Vision		
Normal	81(40.0)	
Abnormal	120(60.0)	
Polypharmacy		
Yes	116(58.0)	
No	85(42.0)	
Height (cm)		160.22 ± 9.26
Weight (kg)		69.08 ± 13.26
BMI		26.91 ± 4.67
Waist circumference		93.76 ± 14.23
Hip circumference		98.41 ± 13.91
Fall assessments		
Fall history		
Yes	71 (35.0)	
No	130 (65.0)	
Fear of falling (FoF)		
Lower concern	100 (49.8)	
Higher concern	101(50.2)	
Sarcopenia assessments		
Muscle mass (Kg/m^2)		6.44 ± 1.31
Muscle strength (Kg)		25.34 ± 11.02
Physical performance (Sec)		14.59 ± 6.95
SARC-F		1.77 ± 2.04

Values are presented as frequency, n (%) or mean ± standard deviation (SD)

Table II shows the results comparing sarcopenia indices and other characteristics based on fall history (yes/no) and level of FoF (low concern/ high concern).

Participants with a fall history showed significantly lower muscle mass and strength, poorer physical performance, and higher SARC-F scores (all p<0.05). Meanwhile, with regards to participants' levels of FoF, participants with higher levels of concern for falls had significantly lower muscle strength, poorer physical performance, and higher SARC-F score (all p<0.05). Those with a low concern of falls presented with a higher muscle mass than those with higher concerns, but this result was not significantly different (p>0.05).

Table II: Comparisons of sarcopenia indices and other characteristics among older adults with and without fall history and those with high and low level of FoF

Variable	Fall assessments							
	Fall history				Level of FoF			
	All (N=201)	**Yes** (n=71)	**No** (n=130)	**Sig. diff** (*P*-value)	**All** (N=201)	**Low concern** (n=100)	**High concern** (n=101)	**Sig. diff** (*P*-value)
	n(%) / Mean ± SD				n(%) / Mean ± SD			
Age (years)	68.45 ± 6.30	70.80 ± 7.04	67.17 ± 5.47	**0.001** [a**]	68.45 ± 6.30	66.61 ± 5.80	70.28 ± 6.27	**0.001**[a**]
Comorbidities								
Yes	157 (78.1)	60 (30)	97 (48.3)	0.105[b]	157 (78.1)	73 (36.3)	84 (42.0)	0.081[b]
No	44 (22.0)	11 (5.4)	33 (16.4)		44 (22.0)	27 (13.4)	17 (8.4)	
Surgery								
Yes	44 (22.0)	14 (7.0)	30 (15.0)	0.582[b]	44 (22.0)	18 (9.0)	26 (13.0)	0.184 [b]
No	157 (78.1)	57 (28.3)	100 (50.0)		157 (78.1)	82 (41.0)	75 (37.3)	
Polypharmacy								
Yes	116 (58.0)	45 (22.4)	71 (35.3)	0.229[b]	116	45 (22.4)	71 (35.3)	**0.001**[b**]
No	85 (42.3)	26 (13.0)	59 (29.4)		85	55 (27.4)	30 (15.0)	
Height (cm)	160.22± 9.26	158.03 ± 9.27	161.42 ± 9.07	**0.013** [a*]	160.22 ± 9.26	162.00 ± 9.40	158.47 ± 8.82	0.007[a**]
Weight (kg)	69.08 ± 13.26	66.75 ± 13.21	70.35 ± 13.17	0.066 [b]	69.08 ± 13.26	69.56 ± 14.51	68.61 ± 11.95	0.611[a]
BMI (kg/m^2)	26.91 ± 4.67	26.84 ± 5.44	26.95 ± 4.22	0.881 [b]	26.91 ± 4.67	26.37 ± 4.42	27.45 ± 4.87	0.101[a]
Waist circumference	93.76 ± 14.23	91.48 ± 16.72	95.00 ± 12.57	0.094[b]	93.76 ± 14.23	92.70 ± 14.26	94.80 ± 14.20	0.296 [a]
Hip circumference	98.41 ± 13.91	96.95 ± 16.26	99.21 ± 12.43	0.272[b]	98.41 ± 13.91	96.69 ± 14.74	100.12 ± 12.87	0.080 [a]
Sarcopenia assessment								
Muscle mass (Kg/m^2)	6.44 ± 1.31	6.12 ± 1.50	6.62 ± 1.17	**0.009** [a**]	6.44 ± 1.31	6.62 ± 1.32	6.26 ± 1.29	0.052 [a]
Muscle strength (Kg)	25.34 ± 11.02	21.35 ± 9.61	27.51 ± 11.16	**0.001**[a**]	25.34 ± 11.02	28.90 ± 10.88	21.80 ± 10.02	**0.001**[a**]
Physical performance (Sec)	14.59 ± 6.95	16.20 ± 5.81	13.71 ± 7.36	**0.015** [a*]	14.59 ± 6.95	12.64 ± 4.77	16.51 ± 8.15	**0.001**[a**]
SARC-F	1.77 ± 2.04	2.93 ± 2.16	1.13 ± 1.65	**0.001** [a**]	1.77 ± 2.04	0.67 ± 1.08	2.85 ± 2.17	**0.001**[a**]

Values are presented mean ± standard deviation (SD), ANCOVA by controlling for age and gender,
**significant at *p*<0.01, *significant at *p*<0.05, [a] independent t-test, [b] Chi-square

DISCUSSION

Sarcopenia implicates physiological and functional deterioration, such as low muscle mass, strength, and physical performance (11), which could lead to falling and increasing FoF (8, 17). In the present study, we compared the sarcopenia indices between older adults with and without fall history for the last 12 months and their FoF levels. After adjusting for age and gender as the potential confounding variables (22), our findings indicated that all sarcopenia indices were significantly impacted among participants with a fall history. Similar findings were also found in those with a higher FoF, except for the muscle mass.

The prevalence of fall history and a high concern for FoF were seen among those with a higher mean of age ($p<0.01$). This result can be attributed to several factors, including reduction in certain crucial hormones such as estrogen and insulin-like growth factor-1 (23). The drop in hormones as ageing occurs accelerates the loss of muscle mass and affects muscle functions. In turn, it slowly reduces muscle strength and physical performance, causing individuals to become passive (24), further impacting mobility, and increasing adverse health outcomes such as fall incidence (8).

Next, the results revealed a significant difference in using multiple medicines or polypharmacy variables ($p<0.01$) when comparing the different FoF levels. Polypharmacy has been shown to be linked to the occurrence of multiple morbidities, which subsequently increases the risk of sarcopenia (9). Furthermore, it has been suggested to cause various drug effects such as interference with metabolic processes, homeostasis, and nutritional status (27). These effects may increase the risk of fat mass loss, alter hormones, and increase vulnerability to adverse health outcomes, including the risk of falls, which intensify the probability of FoF (9).

Based on Table II, individuals with a fall history showed lower muscle mass, strength, and physical performance than those without a fall history; these findings may indicate symptoms of developing sarcopenia. The current finding is consistent with previous studies (17, 28) that mentioned the effects of the deterioration of sarcopenia indices which might impact individuals negatively by causing alteration of the postural reflexes (29) and eventually increasing the risk of falling. Besides that, sarcopenia may lead to frailty (9), causing a decline in agility and elasticity, as well as leading to slower reaction times (30) which could impede an individual's daily activities.

Our results demonstrated significantly high concern of FoF among the study population (50.2%). FoF affects individuals mentally because it reduces their confidence to perform activities of daily living. In turn, this often leads to physical activity avoidance and increases the possibility of sarcopenia because of inactivity (9). Ingole and Warikoo indicated that the rate of FoF was higher among sarcopenic individuals, eventually contributing to the deterioration of the physical performances and a variety of adverse outcomes including hospitalization (28).

The current results also showed that all of the sarcopenia indices were significantly affected in those with fall history and those with higher FoF, except for muscle mass. Previous studies reported that falls and FoF incidence increments mainly occurred among those with low muscle mass, muscle strength, and physical performance (28, 29). However, the present study did not find muscle mass differences among participants with a serious concern of falls, which creates conflicting results with the previous study that highlighted this relationship to fall measure (17).

In the current study, we assessed muscle mass using the BIA, which is a cheaper, faster and easier method to measure muscle mass. However, the accuracy of the BIA in determining muscle mass may not be as accurate as other measures such as dual-energy x-ray absorptiometry, which can provide better sensitivity to obtain results. Furthermore, the current study used the 5-time chair stand to test physical performance as proposed in the AWGS instead of gait speed because it is more feasible and could minimize fall risk among participants.

CONCLUSION

This study had certain limitations that need to be highlighted. First, the small sample size induced limitations on the current research to classify participants explicitly based on their severity levels. Second, examining falls among older adults is challenging because this study obtained data through self-reported information, which may have created the possibility for recall bias to occur in the case of individual retrospective evaluations.

The current study suggests that individuals with a fall history and FoF may have lowered muscle strength and physical performance. Screening for sarcopenia in the early stages should be encouraged using the AWGS simple algorithm. With the aid of proper intervention, lifestyles of older individuals can be improved. The current study implicates extended knowledge on the effects of sarcopenia on an individual's functions. Additionally, it promotes early screening of sarcopenia to encourage proper intervention with an aim of improving individuals' lifestyles. Finally, further study is necessary to determine whether sarcopenia indices are associated with fall history and fear of falling.

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