

# Preliminary screening for sarcopenia and related risk factors among the elderly

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## Abstract

The aim of this study is to survey the prevalence of sarcopenia and the factors that influence its development in Southern Taiwan's community-dwelling aged people.

This is an observational cross-sectional study using the 6-meter walking test, body composition, handgrip strength, body measurements, and basic personal information to identify sarcopenia in the participants. This study included 200 participants aged 65 or over living in Taiwan, but excluded the following:

1. people with neuromuscular diseases affecting limb function and balance (such as stroke, Parkinson disease, spinal stenosis, and peripheral nerve compression);
2. people with fractures in the lower extremities or with arthritis, which could affect mobility;
3. people with pacemakers or other medical implant devices; and
4. people who declined to participate in the research and people who could not complete all aspects of the research.

The prevalence of sarcopenia in the elderly community is approximately 6.0%. It is less prevalent in females (1.5%) than in males (14.3%). The incidence of sarcopenia increases with age. Significantly related risk factors for sarcopenia are gender, age, smoking, and body mass index (BMI) ( $P < .05$ ). Further analysis of the risk factors for sarcopenia reveal that the odds ratios (ORs) of having low muscle mass increase with every 1 year in age by a factor of 1.19 ( $P < .05$ ); those who smoke show a higher incidence than those who do not smoke (OR = 2.69,  $P < .05$ ). For every 1 kg / m<sup>2</sup> increase in BMI, the odds of sarcopenia decrease by a factor of 0.45.

For the elderly, the lower the BMI, the higher the risk of sarcopenia. Maintaining good exercise habits and keeping body weight in check might help to prevent sarcopenia by increasing functional ability and improving muscle strength.

**Abbreviations:** BIA = bioelectrical impedance analysis, BMI = body mass index, OR = odds ratio, SMI = skeletal muscle mass index, SMM = skeletal muscle mass.

**Keywords:** age-related, older people, prevalence, sarcopenia

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## 1. Introduction

The medical and public health fields maintain a strong emphasis on the prevention of falls and bone fractures among the elderly. Musculoskeletal function declines with age as the production of hormones in the body decreases. Neuromuscular system degeneration contributes to the increased risk of falls, which can lead to bone fractures in the hips, spine, wrists, and elsewhere in the body. Aging intensifies the decline of musculoskeletal function.<sup>[1]</sup> Furthermore, with aging, muscle mass is reduced, which leads to limited mobility, and as a result, an increased risk of falls. Among those who recover from hip surgery (after a hip fracture due to a fall), only 20% are able to walk independently again. Bone fractures can also lead to complications, which can create significant burdens on health and social resources. Approximately 30% of the elderly in the community are reportedly affected by sarcopenia. Sarcopenia is positively correlated with falls, physical disability and death.

Taiwan has an aging population that is accompanied by an increasing prevalence of numerous slow-onset diseases, of which sarcopenia in the elderly is one. This creates a significant burden on personal well-being as well as on the public health system.<sup>[2]</sup>

The skeletal muscles reach their peak at 25 years of age and will have declined by 5% by the age of 50. The muscles continue to

rapidly decline at a rate of 1% to 2% each year after the age of 50. By age 80, the decline will reach 30%.<sup>[3]</sup> Sarcopenia is defined as gradual systemic loss of skeletal muscle and strength brought on by aging, and it leads to difficulties in engaging in daily activities as well as an increased risk of falls. Sarcopenia is present in 13% of the population aged between 60 and 70, and as much as 50% of the population over 80.<sup>[4]</sup> The prevalence of sarcopenia can be as high as 58% among those with preexisting osteoporotic hip fractures.<sup>[5]</sup>

Comorbidities are often clinically observed among the elderly during the initial stages of aging. During the later stages, many factors contribute to skeletal muscle loss, such as the aging process, bed rest, a sedentary lifestyle, malnutrition, chronic diseases, and drug treatments.<sup>[4]</sup> The onset of skeletal muscle loss indicates a deterioration in health. Not only are daily activities restricted, but the risk of falls and fractures increases resulting in a loss of function, along with an increase in follow-up medical treatment expenses and the risk of death.<sup>[6]</sup> A measure called bioelectrical impedance analysis (BIA) has been developed to calculate skeletal muscle mass (SMM), which is widely used in epidemiology research.<sup>[7]</sup> According to the newest sarcopenia diagnostic guidelines recommended by the European working group on sarcopenia in older people,<sup>[4]</sup> in Taiwan, by using the European working group on sarcopenia in older people criteria, the prevalence of sarcopenia is reported to be 10.8% in males and 3.7% in females among community-dwelling Chinese adults aged 65 years or more.

## 2. Material and methods

### 2.1. Samples

This study collected data from February 2019 to February 2020 from 200 participants aged 65 or older in Taiwan. By taking the population that is over 65 years old in southern Taiwan in 2018 as the maternal population, with a confidence interval of 95% and a sampling error of  $\pm 5\%$  (confidence level = 95%, margin of error  $\pm 5\%$ ), we should accept 384 people; however, due to reasons such as project funding and the deadline for accepting cases, only 200 people were accepted, and the sampling error was  $\pm 6.93\%$  (confidence level = 95%, margin of error  $\pm 6.93\%$ ). This study excluded the following:

1. people with neuromuscular diseases affecting limb function and balance (e.g., stroke, Parkinson disease, spinal stenosis, and peripheral nerve compression);
2. people with fractures in the lower limbs or with arthritis, which could affect mobility;
3. people with pacemakers or other medical implant devices; and
4. people who declined to participate in the research and people who could not complete all aspects of the research.

### 2.2. Bioethics

Before collecting the data, this study received approval from the Institutional Review Board—the Board of Kaohsiung Veterans General Hospital (VGHKS19-CT2-12). The data collection process was initiated once informed consent had been obtained, and the participant's names and personal identifiers were omitted in order to comply with research ethics. At any time during the data collection process, participants were permitted to clarify any points they did not understand before deciding either to proceed

or exit this study. Participants were also able to decline the progression of the testing at any stage if they felt uncomfortable or concerned. Data was collected from a total of 200 successful elderly participants, and each participant took an average of 20 to 30 minutes to complete the tests. Because this study was not conducted at a hospital, 2, and sometimes 3 professionally trained researchers assisted and monitored it.

### 2.3. Measurements

This is an observational cross-sectional study. This study utilized:

1. muscle mass;
2. muscle strength (indicated by handgrip strength); and
3. mobility (indicated by a walking speed).<sup>[8]</sup>

Participants in this study were considered sarcopenic if they had low muscle mass as well as if they failed the 6-meter walking test and/or the handgrip strength test.

Further discussion on the measures follow:

**2.3.1. The 6-meter walking test.** A 6-meter distance was marked on the ground with an additional 1 meter at the start and finish points to act as a buffer. Participants were asked to walk at a comfortable pace starting at the additional 1-meter mark prior to the starting point and continuing up to the 1-meter mark after the finishing point. The timer was initiated at the starting point of the 6-meter mark and stopped at the finishing mark. The walking speed was then calculated as meter/second (m/s).<sup>[8]</sup> If the participant's speed was less than 0.8m/s,<sup>[9]</sup> then muscle loss was considered.

**2.3.2. Body measurements.** The participant's height (cm), weight (kg), and waistline (cm) were measured. The body mass index (BMI) for the participant was then calculated by using the formula  $BMI = \text{weight (kg)}/\text{height}^2 \text{ (m}^2\text{)}$ .

**2.3.3. Body composition analysis.** This study used BIA to measure SMM; however, the BIA measurement does not directly reveal the participant's SMM (kg). Body composition was calculated by using the BIA conversion method developed by Janssen et al (2002).<sup>[7]</sup> The formula used was  $SMM, \text{ kg} = (\text{Height}^2 [\text{cm}]/\text{Bioelectrical Impedance [R]} \times 0.401) + (\text{Gender [Male} = 1, \text{Female} = 0] \times 3.825) + (\text{Age} \times -0.017) + 5.102$ . The skeletal muscle mass index (SMI) was then calculated by using  $SMI (\text{kg}/\text{m}^2) = SMM (\text{kg})/\text{Height}^2 \text{ (m}^2\text{)}$ .

**2.3.4. Handgrip test.** This study utilized an electronic grip meter to measure the participant's maximum handgrip strength with the arm fully extended. The simple procedure is as follows:

1. adjust the handles on the meter to allow for smooth operation;
2. at the initiation of the test, the participant stands while holding the meter;
3. the participant extends his/her arm fully on either side of the body; and
4. the participant squeezes the meter as much as possible until the numbers on the meter screen stop changing.

If the reading is less than 26 kg for males or 18 kg for females, then a muscle mass measurement is required to determine possible muscle loss.

**2.3.5. Collection of basic personal information.** Information collected included participant's gender, date of birth, medical history, past medication history, smoking status, alcohol consumption, and level of physical activity.

## 2.4. Statistical analysis

Excel 2007 and Statistical Package for Social Science version 20.0 were used for the analysis of the data, which included

1. The participants' basic information (continuous variables were expressed as mean  $\pm$  the standard deviation, and categorical variables were expressed as descriptive statistics [percentage %]);
2. The correlation between each variable with sarcopenia was analyzed by using the *t* test or ANOVA, along with the Chi-Squared test; and
3. Multivariate analysis was conducted by using the multiple logistic regression analysis with sarcopenia as the dependent variable and the relevant factors as the independent variables. By going through the different independent variables, the most impactful factor was identified by setting  $P < .05$  as statistically significant.

## 3. Results

This study recruited 130 (65.0%) females and 70 (35.0%) males. The mean age was  $74.90 \pm 7.58$  years old with the majority in the age group of between 65 and 74 years old ( $n=113$ , 56.5%). The mean height was  $157.75 \pm 8.33$  cm and the mean weight was  $65.52 \pm 10.30$  kg. The mean BMI was  $24.96 \pm 3.54$  kg/m<sup>2</sup>, and the majority of the participants had a BMI that was categorized as overweight ( $n=113$ , 56.5%). The participants had a mean speed of  $1.12 \pm 0.31$  m/s during the 6-meter walking test and a mean handgrip strength of  $24.49 \pm 7.46$  kg. The mean SMI was  $6.90 \pm 0.82$  kg/m<sup>2</sup>.

After categorizing the participants by using various lifestyle habits and diseases, it was found that 191 (95.5%) of participants were nonsmokers and 123 (61.5%) of participants did not have tea-drinking habits. Furthermore, 70 (35.0%) of participants had a family history of hypertension, 44 (22.0%) of participants were diagnosed with diabetes, and 14 (7.0%) of participants were diagnosed with fatty liver, as shown in Table 1.

The majority of the participants had an exercise habit of at least 5 times per week ( $n=149$ , 74.5%) and 113 (80.0%) of participants exercised for over 30 minutes each time (data not shown).

Screening tests for sarcopenia included a 6-meter walking test, a handgrip strength test and SMI calculation. 39 (19.5%) of participants fell below the standard speed for the 6-meter walking test: 21 (53.8%) were females and 18 (44.3%) were males. 88 (44.0%) of participants had a handgrip strength that was weaker than the standard cut-off: 51 (58.0%) were female and 37 (42.0%) were male. 17 (8.5%) of participants had a lower SMI than the standard cut-off: 2 (11.8%) were female and 15 (88.2%) were male.

Sarcopenia screening results and prevalence. The result was then extrapolated and used to calculate the prevalence of sarcopenia among the elderly living in the southern part of Taiwan. The overall prevalence of sarcopenia among the elderly who were 65 years old or over was 6.0%. 1.5% of the females and 14.3% of the males had sarcopenia. Further categorized by age, the group between the ages of 65 and 74 had 0.9%, the group between the ages of 75 and 84 had 6.8%, and the group equal to or older than the age of 85 had 25.0% sarcopenia.

As seen in Table 2, within the 200 participants, the mean age of those without sarcopenia was  $74.39 \pm 7.26$  years, and the mean

**Table 1**

Characteristics of the participants		N = 200.	
Variables	N (%)	Range	Mean $\pm$ SD
Gender			
Female	130 (65.0)		
Male	70 (35.0)		
Marital status			
Single	10 (5.0)		
Married	174 (87.0)		
Widowed/Divorced	16 (8.0)		
Education status			
Junior high school	87 (43.5)		
Above High school	69 (31.5)		
College/University	50 (25.0)		
History of fractures			
No	151 (75.5)		
Yes	49 (24.5)		
Family history of HT			
No	130 (65.0)		
Yes	70 (35.0)		
Smoking status			
No	191 (95.5)		
Current smoker	9 (4.5)		
Diabetes			
No	156 (78.0)		
Yes	44 (22.0)		
Fatty liver			
No	186 (93.0)		
Yes	14 (7.0)		
Age		65–98	74.90 $\pm$ 7.58
65 to 74	113 (56.5)		
75 to 84	59 (29.5)		
84 and over	28 (14.0)		
6 meter walking speed		0.32–2.26	1.12 $\pm$ 0.31
$\geq$ Standard	170 (85.0)	0.81–2.26	1.19 $\pm$ 0.26
<Standard	30 (15.0)	0.32–0.80	0.67 $\pm$ 0.13
Hand grip strength		9.60–46.80	24.49 $\pm$ 7.46
$\geq$ Standard	112 (56.0)		
Female	79 (70.5)		
Male	33 (29.5)		
< Standard	88 (44.0)		
Female	51 (58.0)		
Male	37 (42.0)		
Skeletal muscle mass index		5.53–9.58	6.89 $\pm$ 0.82
$\geq$ Standard	183 (91.5)		
Female	128 (69.9)		
Male	55 (30.1)		
< Standard	17 (8.5)		
Female	2 (11.8)		
Male	15 (88.2)		
Height (cm)		125.00–181.00	157.78 $\pm$ 8.33
Weight (kg)		41.40–98.00	62.52 $\pm$ 10.30
BMI (kg/m <sup>2</sup> )		18.00–36.50	24.96 $\pm$ 3.54
Underweight (BMI<18.5)	2 (1.0)		
Healthy (18.5–24.0)	85 (42.5)		
Overweight (BMI>24.0)	113 (56.5)		

age of those with sarcopenia was  $83.67 \pm 7.33$  years. This showed that those without sarcopenia were significantly younger than those with sarcopenia ( $t=-4.31$ ,  $P=.000$ ). Nonsarcopenic participants had a mean BMI of  $25.24 \pm 3.42$  kg/m<sup>2</sup> while sarcopenic participants had a mean BMI of  $20.58 \pm 2.30$  kg/m<sup>2</sup>. This showed that nonsarcopenic participants had a significantly higher BMI compared to sarcopenic participants ( $t=4.65$ ,  $P=.000$ ).

**Table 2**  
Overview of sarcopenia screening results in the participants

N = 200.

Variables	Nonsarcopenic (n = 188) n (%)	Sarcopenic (n = 12) n (%)	t/ $\chi^2$	P value
Gender				
Female	128 (68.1)	2 (16.7)	13.11	.001**
Male	60 (31.9)	10 (83.3)		
Age	74.39 ± 7.26	83.67 ± 7.33	-4.31	.000**
65–74	112 (59.6)	1 (8.3)	23.23	.000**
75–84	55 (29.3)	4 (33.3)		
> 85	21 (11.2)	7 (58.3)		
BMI	25.24 ± 3.42	20.58 ± 2.30	4.65	.000**
Underweight	0 (0.0)	2 (16.7)	39.75	.000**
Healthy	76 (40.4)	9 (75.0)		
Overweight	112 (59.6)	1 (8.3)		
Family history of HT				
No	119 (63.3)	11 (91.7)	3.99	.060
Yes	69 (36.7)	1 (8.3)		
History of fractures				
No	140 (74.5)	11 (91.7)	1.80	.300
Yes	48 (25.5)	1 (8.3)		
Smoking status				
No	181 (96.3)	10 (83.3)	17.62	.000**
Current smoker	7 (3.7)	2 (16.7)		
Diabetes				
No	146 (77.7)	10 (83.3)	0.21	1.000
Yes	42 (22.3)	2 (16.7)		
Fatty liver				
No	174 (92.6)	12 (100.0)	0.96	1.000
Yes	14 (7.4)	0 (0.0)		

Ps: SMI = skeletal muscle index.

\* P value &lt; .05.

\*\* P value &lt; .01.

According to Table 2, the Chi-Squared test was used to determine whether each variable correlated with sarcopenia or not. The results showed a statistically significant difference ( $P < .05$ ) between the groups within each variable, such as gender ( $P = .000$ ) and smoking status ( $P = .000$ ) when it came to sarcopenia.

After the Chi-Squared test of all the variables in Table 1 and sarcopenia, the related variables are shown in Table 2, and then the factors related to sarcopenia are shown in Table 2. Logistic regression was used to find the multi-factor variables, and determine if variables such as gender, age, smoking habits and BMI were possible risk factors for sarcopenia, and those results are shown in Table 3. The results demonstrated that for each year, the odds ratio (OR) of being affected by sarcopenia increased by 1.19 times ( $P < .05$ ). Current smokers had a higher risk of being affected by sarcopenia compared to people who had never smoked (OR = 2.69,  $P < .05$ ), current smokers had a higher chance of being affected by sarcopenia compared to people who had never smoked (OR = 2.69,  $P < .05$ ). As BMI increased by 1 kg/m<sup>2</sup>, the OR of sarcopenia decreased by 0.45 times ( $P < .001$ ). Gender did not produce a significant difference ( $P > .05$ ).

#### 4. Discussion

In this study, the overall prevalence of sarcopenia among the elderly aged 65 years and over was 6.0%. Females and males showed a prevalence of 1.5% and 14.3%, respectively. This result agrees with past research that reported a prevalence of 1% to 33%.<sup>[4]</sup>

The prevalence increased with age and was as high as 14.5% in those who are 75 years and over, which is the same result as that in the previous study,<sup>[4]</sup> which found that about 13% of the population aged between 60 and 70 years old have sarcopenia, which is as high as 50% in people over 80. The prevalence in the population of males was of the same trend as in previous studies,<sup>[1,10]</sup> but it was different in females. A study in northern Taiwan found that lifestyles and living habits of people in northern and southern Taiwan differ widely, especially among retirees.<sup>[11]</sup> This could be the main reason for the extremely low prevalence of this research.

**Table 3**  
Risk factors for sarcopenia

Variables	n	Odds ratio	95% CI	P value
Sex				.439
Female	130	1.00	(Reference Group)	–
Male	70	2.35	0.27–20.35	.439
Age	200	1.19	1.03–1.37	.018*
Smoking status				
No	191	1.00	(Reference Group)	–
Yes	9	2.69	6.87–1.05	.047*
BMI	200	0.45	0.28–0.72	.000**

CI = confidence interval.

\* P value &lt; .05.

\*\* P value &lt; .01.

\*\*\* P value &lt; .001.

The number of chronic diseases, according to this study, is not statistically related to skeletal sarcopenia. Although studies have shown that chronic diseases are correlated with sarcopenia, the exact type<sup>[12,13]</sup> and number of diseases have not been established. In this study, the role of chronic diseases in sarcopenia has not been discussed because of the small research population selected. However, the relationship between various chronic diseases and skeletal muscular dystrophy is worthy of further analysis and study in order to verify and discuss the correlations.<sup>[14]</sup>

This study was only able to recruit elderly participants who were able to visit the community exercise clinics themselves. It is, therefore, likely that it underestimates the prevalence of sarcopenia as those who have mobility issues or who are bedridden were excluded. These elderly groups were likely to be in poorer health and not able to reach the clinics due to reduced muscle mass and function, and therefore, they possibly have sarcopenia.

This study found that current smokers had a higher risk of sarcopenia than those who had never smoked, which was consistent with previous studies.<sup>[14,15]</sup> Past studies have also shown that smoking had a negative correlation to muscle strength.<sup>[16,17]</sup> This suggested that those with a smoking habit had less muscle strength than to those without a smoking habit; this is echoed by the present study. Furthermore, Sarcopenia in people with “smoking habits” is 2.69 times that of those with “no smoking habit” ( $P=.05$ ); thus, there is a slight change that could become significant in the number of people with “smoking habits.” The reason is that in Taiwan, the long-term promotion of community health has resulted in a decrease in the smoking population. Hence, the number of people with “no smoking habit” sampled in this study was much larger than the number of people “with smoking habits,” which may lead to statistical deviation. However, this study still found that smoking habits have a significant relationship with sarcopenia.

Age and BMI were found by this study to be significant risk factors for sarcopenia. Multiple studies have shown that both factors are related to sarcopenia. Not only does muscle mass decrease with age, but this study also showed that higher BMI leads to a lower risk of sarcopenia.<sup>[18]</sup> Thus, it can be inferred that the higher the BMI, the better the outcome for the elderly. Nonetheless, it is important to consider the body composition of the elderly. Being overweight can lead to metabolic syndrome, which can later lead to a physiological burden on the elderly. Metabolic diseases can also lead to malnutrition, which can start a vicious cycle between the 2. A study among participants who were 65 years old or older found that they were able to reduce fat and build muscle through exercise and a controlled diet.<sup>[17]</sup> This slowed down the process of osteoporosis due to weight loss.<sup>[19]</sup> Resistance training can also slow osteoporosis down. When coupled with aerobic exercises, the 2 could reduce both osteoporosis and adipose tissue loss.<sup>[20]</sup> The strategy to improve muscle mass and metabolic syndrome is regular exercise and nutrition supplement. Resistance training, or weight training and strength training, uses free-hand weight or weight-bearing equipment to exercise muscle tissue that fights resistance, in order to increase muscle mass and strength, and reduce body fat. Senior citizens are recommended to exercise at least twice a week, with 8 to 10 exercises focusing on large muscle groups and 10 to 15 times in each group. The proper balance of nutrition and exercise is essential, in particular, vitamin D supplementation can help to maintain muscle mass and strength. For those over the age

of 50, the recommended intake of calcium is 1200 mg daily and that vitamin D3 is 800 to 1000 IU, in order to help prevent osteoporosis and sarcopenia.<sup>[21,22]</sup>

This study was subject to several limitations. First, the subjects accepted in this study were limited to those who were able to move to the community activity center for self-examination and those who filled in the questionnaire. If they were in bed, staying in institutions, or unwilling or unable to go out, then they could not be tested, which may have caused an underestimation of skeletal sarcopenia. Second, due to a lower population of smokers in this study, the elderly people in this study were more likely to be health-conscious compared with the average person; for this reason, there is a selection bias. There is likely to be a higher risk of sarcopenia in a smaller sample of smokers; therefore, these results should be interpreted with caution. Third, the details of the daily nutrition of the participants were not recorded. Future studies should consider levels of nutritional intake and help to minimize any possible confounding factors in the analysis.

## 5. Conclusion

This study found that increased age, smoking, and low BMI increases the risk of sarcopenia. Increased age with low BMI also suggests muscle loss. A decline in muscle function and muscle loss leads to a higher risk of falling among the elderly, with the potential risk of bone fractures. Thus, it is recommended that public health education in bone maintenance and in fall prevention should be reinforced. In addition, public health education must emphasize the need to maintain regular exercise habits and a healthy weight as means to reducing muscle loss.

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## Author contributions

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