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Article

# Prevalence estimation of sarcopenia using bioelectrical impedance analysis in elderly people in Lahore

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**Abstract:** Sarcopenia is the loss of muscle mass and strength, or both, and physiological functions through aging. Early detection of muscle weakness results in better care and interventions regarding dietary habits and protein intake in older adults. The objective of this study was to investigate the prevalence of sarcopenia in a Pakistani population and to correlate dietary habits and lifestyle with the prevalence of sarcopenia. A sample size of 150 individuals, both male and female, of age sixty and above was used. Cardiovascular disease and renal failure patients were excluded. The research field was the community of Lahore. Muscle power was calculated using a handgrip strength dynamometer, and gait speed was calculated using a pedometer. After screening, muscle mass was calculated using bioelectrical impedance analysis, from which sarcopenia was diagnosed. In the age group of 60–65 years, 123 individuals (82%) had low muscle strength and 93 (83%) had low muscle mass. In the age group of 66–70 years, 15 individuals (83.3%) had low muscle strength. In the age group of 71–75 years, 9 individuals (90%) had low muscle strength. The percentage of low muscle strength in the age group of 76+ years was 100%. The percentage of severe sarcopenia was 6%, and moderate sarcopenia was approximately 10% for individuals 60 years of age and older. The prevalence rates of sarcopenia were 21.53% in males and 11.76% in females. Sarcopenia is an emerging health issue in older adults, and early detection and lifestyle modification will lead to a better health outcome and correlate dietary habits and lifestyle with the prevalence of sarcopenia.

**Keywords:** sarcopenia; older adult; muscle mass; muscle strength, handgrip strength

## 1. Introduction

Sarcopenia is defined by the European Working Group on Sarcopenia in Older People (EWGSOP) as "loss of muscle mass and strength, or both, and physiological functions" [1]. Sarcopenia occurs mainly due to a sedentary lifestyle, low nutritional status, bed rest, chronic disease, and drug usage. The process of aging is also a major contributor to the progression of sarcopenia [2], which is also defined as a progressive and generalized skeletal muscle disorder that is associated with an increased likelihood of adverse outcomes [3], including mobility problems and mortality [4].

Sarcopenia is categorized as pre-sarcopenia, sarcopenia, and severe sarcopenia. Low muscle mass without any change in muscle strength and physical performance is known as pre-sarcopenia. Severe sarcopenia is a critical stage, in which there is loss of muscle mass, loss of physical performance, and loss of muscle strength, and thus all three criteria are fulfilled.

In Caucasian people, the prevalence of sarcopenia was reported as 9.6%–22.1% in men and 7.7%–21.8% in women [5]. In Asia, sarcopenia is highly prevalent in accordance with low muscle mass and varies from 6.7%–56.7% in men and 0.1%–33.6% in women [6]. As per our knowledge, there is no previously reported data from Pakistan regarding the prevalence of sarcopenia.

Different assessment tools are used for the identification of sarcopenia, including bioelectrical impedance analysis (BIA), which is a non-invasive, easy-to-use, low-cost, and readily available method of detection in both healthy and bedridden individuals. BIA is used for the detection of lean body tissues and to estimate the lean body mass volume. BIA is the most reliable method for comparison with magnetic resonance imaging (MRI) calculations [7].

Early detection of sarcopenia has proved beneficial in improving lifestyle, decreasing mortality rates, and reducing the length of hospitalization [8]. Early detection of muscle weakness results in better care and interventions regarding dietary habits and protein intake of older adults [9].

The objective of this study was to determine the prevalence of sarcopenia in a Pakistani population and to correlate dietary habits and lifestyle with the prevalence of sarcopenia.

## 2. Materials and methods

### 2.1. Study design

The total sample size was 150 older adults selected from community centers in the city of Lahore, Pakistan. The sample size was calculated using the formula of $z^2q/r^2p$ [10]. Written and verbal consent were obtained from participants before the study. The Ethical Review Committee of the University of Veterinary and Animal Sciences approved this study under number FSHN5071.

### 2.2. Inclusion criteria

The study included both males and females aged sixty and above. Some participants included in the study suffered from chronic diseases of hypertension and diabetes, while others suffered from non-chronic diseases. Only community-dwelling individuals who were ambulatory and independent in activities of daily living were considered and included in the study.

### 2.3. Exclusion criteria

Individuals less than 60 years old and patients with acute renal failure, ascites (i.e., cirrhosis), end-stage renal disease, cardiac insufficiency, and cancer were excluded from the study.

### 2.4. Demographic characteristics

Socio-demographic characteristics included in the questionnaire [11] were name, age, occupation, and income.

## 2.5. Anthropometric measurements

Anthropometric measurements included height, weight, and body mass index (BMI). Height was measured using a stadiometer, weight was measured using a weighing balance, and BMI was calculated using the formula: weight (kg)/height ($m^2$).

## 2.6. Medical history

Subjects were interviewed using a structured questionnaire format. Information about current medical conditions was obtained [11].

## 2.7. Screening criteria

Three types of assessment tools were used for the detection of sarcopenia. Dynamometer and gait speed measuring tools were used for the screening of individuals, and the final assessment of muscle mass was done using BIA.

## 2.8. Muscle mass measurement

BIA was used to assess muscle mass and diagnose sarcopenia. Using different BIA equations, several components that represent muscularity can be assessed. Total skeletal muscle mass and appendicular skeletal muscle mass normalized to height (skeletal muscle mass index and appendicular skeletal muscle index, respectively) are the most common terms based on BIA equations [12]. Body composition was assessed using BIA (Maltron Bio Scan 920-2S, Maltron International Ltd., UK) with subjects lying supine with four surface electrodes placed on the right wrist and ankle. The recommended conditions for BIA measurements were explained to the subjects, which were (i) fasting for four hours before measurement, (ii) bladder closure before measurement, and (iii) no exercise in the eight hours before measurement [13].

## 2.9. Muscle strength measurement

The muscle strength of each hand was assessed using an electronic hand dynamometer (EH101, Camry, China). Multiple assessments were made. The highest value, indicating the greatest degree of strength, was used for the diagnosis of sarcopenia with hand grip strength. The cutoff values were $<28$ kg for men and $<18$ kg for women.

## 2.10. Physical performance

Physical performance was assessed based on the usual gait speed. Participants were asked to walk forward for 12 m at normal speed. Walking speed reached a steady value within the first 10 to 12 m. The number of seconds required to cover a distance of 10 m was used to determine gait speed (m/s).

## 2.11. Statistical analyses

The data obtained were represented as a percentage, a mean, and a standard deviation. The Spearman correlation test was used to examine the relationship between sarcopenia, muscle mass, age, income, handgrip strength, and gait speed. The chi-square test was used to determine whether there was a significant difference between the expected frequencies and the observed frequencies in one or more categories. The student's *t*-test was used for the comparison of general characteristics and nutritional and anthropometric data between low muscle mass female and male groups. SPSS version 22 software (IBM Corporation) was used.

### 2.12. Dietary habits

The dietary habits of individuals were answered in the questionnaire, where they were asked for their daily meal intake habits, along with specific dietary food groups. The individuals were asked about their daily consumption of breakfast, lunch, and dinner, along with their fruit and vegetable intake, eggs, meat (chicken, beef, mutton, and fish), lentils, and milk. The intake of supplements was also evaluated.

The food frequency questionnaire included 25 food items, and there were 7 intake frequency categories: once a week, twice a week, three times a week, four times a week, daily, never, and seldom, in which the serving size was categorized as small, medium, or large.

In this investigation, the dietary habits of individuals were evaluated, and the estimated values were calculated from the food frequency questionnaire.

### 2.13. Protein intake

Foods with similar protein content were arranged in one category and calculated on average. The frequency of food intake was written as the number per week or month. Foods that contain protein were included in the protein assessment, while fruits and vegetables were excluded as they have no protein content.

The average value for protein intake in older adults was 1.2 g per kg of body weight. From these values, the mean and standard deviation of protein intake were evaluated, from which it was concluded that the individuals were consuming less protein than their daily needs.

## 3. Results

### 3.1. General characteristics

There were significant differences between gender and muscle strength, muscle mass, and gender of individuals (**Table 1**). The mean and standard deviation values for muscle mass were 2.69 ± 0.635 for males and 2.84 ± 0.450 for females. Similarly, the mean and standard deviation values for muscle strength were 1.246 ± 0.434 for males and 1.117 ± 0.324 for females (**Table 1**). A significant difference ($p$-value = 0.137; $p < 0.05$) was only identified between the muscle strength and the age of both genders. The mean and standard deviation values for protein intake in males and females were 32.74 ± 9.24 and 34.36 ± 5.75 g per day, respectively. There was a significant difference ($p < 0.05$) in physical activity between male and female participants.

**Table 1.** Comparison of baseline characteristics of older adults in community.

| Characteristic | Gender | N | X ± SD | *P*-value |
|---|---|---|---|---|
| Age (years) | M | 65 | 1.65 ± 0.943 | 0.00 |
| | F | 85 | 1.16 ± 0.553 | |

**Table 1.** (*Continued*).

| Characteristic | Gender | N | X ± SD | *P*-value |
|---|---|---|---|---|
| Income | M<br>F | 65<br>85 | 1.11 ± 0.312<br>1.16 ± 0.373 | 0.322 |
| Muscle mass | M<br>F | 65<br>85 | 2.69 ± 0.635<br>2.84 ± 0.450 | 0.083 |
| Height (m) | M<br>F | 65<br>85 | 1.55 ± 0.121<br>1.53 ± 0.067 | 0.151 |
| Weight (kg) | M<br>F | 65<br>85 | 62.98 ± 11.42<br>61.49 ± 11.36 | 0.428 |
| BMI | M<br>F | 65<br>85 | 25.35 ± 4.534<br>25.98 ± 4.936 | 0.428 |
| Muscle strength | M<br>F | 65<br>85 | 1.246 ± 0.434<br>1.117 ± 0.324 | 0.04 |
| Physical activity | M<br>F | 65<br>85 | 2.15 ± 1.064<br>2.14 ± 0.953 | 0.487 |
| Protein | M<br>F | 65<br>85 | 32.74 ± 9.24<br>34.36 ± 5.75 | 0.197 |
| Physical activity | M<br>F | 65<br>85 | 2.15 ± 1.064<br>2.14 ± 0.953 | 0.487 |

Note: Independent-sample *t*-tests for continuous variables and Pearson chi-square or Fisher exact test (where an expected cell count was < 5) were used for categorical variables. During testing, $p < 0.05$ was considered statistically significant.

### 3.2. Sarcopenia prevalence in different age groups

Individuals aged 60–65 were more sarcopenic than others. Five individuals (4.3%) were severely sarcopenic and 8 individuals (6.9%) were moderately sarcopenic in this age group (**Table 2**). In the age group of 66–70 years, only 1 individual (5.6%) was severely or moderately sarcopenic. In the age group of 71–75 years, 2 individuals (20%) were severely sarcopenic and 4 individuals (40%) were moderately sarcopenic (**Table 2**).

**Table 2.** Status for sarcopenic muscle in population of older adults.

| Age (years) | Severe sarcopenia ($n$ = 150) | Moderate sarcopenia ($n$ = 150) | Normal muscle ($n$ = 150) |
|---|---|---|---|
| 60–65 | 5<br>4.3% | 8<br>6.9% | 103<br>88.8% |
| 66–70 | 1<br>5.6% | 1<br>5.6% | 16<br>88.9% |
| 71–75 | 2<br>20.0% | 4<br>40.0% | 4<br>40.0% |
| 76 and above | 1<br>16.7% | 2<br>33.3% | 3<br>50.0% |

Note: Values are significantly different with *p*-value of 0.681.

### 3.3. Prevalence of sarcopenia by gender

The prevalence rates of sarcopenia were 21.53% in males and 11.76% in females. Six males (9.2%) were severely sarcopenic and 8 males (12.3%) were moderately sarcopenic (**Table 3**). Three females (3.5%) were severely sarcopenic and 7 females (8.2%) were moderately sarcopenic (**Table 3**).

**Table 3.** Status for sarcopenia muscle by gender in a population of older adults.

| Gender | Severe sarcopenia | Moderate sarcopenia | Normal muscle |
|---|---|---|---|
| Male (*n* = 65) | 6<br>9.2% | 8<br>12.3% | 51<br>78.5% |
| Female (*n* = 85) | 3<br>3.5% | 7<br>8.2% | 75<br>88.2% |

Note: Values are significantly different with *p*-value of 0.22.

### 3.4. Muscle strength in age groups

Low muscle strength was a key factor in the sarcopenia diagnosis. The result of this study showed that in the age group of 60–65 years, 123 individuals (82%) had low muscle strength and 93 (83%) had low muscle mass (**Table 4**). In the age group of 66–70 years, 15 individuals (83.3%) had low muscle strength. Nine individuals (90%) in the age group of 71–75 years had low muscle strength. The percentage of low muscle strength in the age group of 76 years old and above was 100%. As age increases, muscle strength declines. Thus, for older age groups, low muscle strength was more prevalent.

**Table 4.** Status for muscle strength in population of older adults.

| Age (years) | Low muscle strength (*n* = 150) | Normal muscle (*n* = 150) |
|---|---|---|
| 60–65 | 93<br>83.0% | 19<br>17.0% |
| 66–70 | 15<br>83.3% | 3<br>16.7% |
| 71–75 | 9<br>90.0% | 1<br>10.0% |
| 76 and above | 6<br>100% | 0<br>0% |

Note: Values are significantly different with *p*-value of 0.681 in all age groups.

The procedure described by EWGSOP to determine the presence of sarcopenia used a dynamometer to assess hand grip strength and walking speed. These measurements have also been used in other studies where sarcopenia was assessed. A positive correlation of 0.06 was found between handgrip strength and sarcopenia in this study.

### 3.5. Muscle strength by gender

The prevalence rates of low muscle strength were 88.1% in females and 79% in males (**Table 5**). Hence, low muscle strength leads to a high rate of sarcopenia in older adults, which is exacerbated by malnutrition.

**Table 5.** Status for muscle strength by gender in a population of older adults.

| Gender | Severe sarcopenia | Moderate sarcopenia | Normal |
|---|---|---|---|
| Male (*n* = 65) | 6<br>9.2% | 8<br>12.3% | 51<br>78.5% |
| Female (*n* = 85) | 3<br>3.5% | 7<br>8.2% | 75<br>88.2% |

Note: Low muscle strength was significantly greater in females than in males, with *p*-value of 0.137.

### 3.6. Spearman's rank correlation between characteristics and sarcopenia

Positive correlations were observed between income and sarcopenic muscles, between protein intake and sarcopenic muscles, and between handgrip strength and sarcopenic muscles (**Table 6**). Negative correlations were observed between physical activity and sarcopenic muscles and between gait speed and sarcopenic muscles (**Table 6**).

**Table 6.** Spearman correlation between characteristics and sarcopenia in a population of older adults.

| Characteristic | ***R*** **(correlation factor)** | ***P*** **(*p*-value)** |
|---|---|---|
| Income | 0.022 | 0.789 |
| Physical activity | −0.064 | 0.437 |
| Protein intake | 0.331 | 0.000 |
| Hand grip strength | 0.068 | 0.407 |
| Gait speed | −0.052 | 0.526 |

Note: Physical activity and gait speed were negatively correlated, while other factors were positively correlated.

## 4. Discussion

Different cutoff values have been used as a reference for diagnosis in different sarcopenia surveys. Muscle mass loss was defined as skeletal muscle index values of <7.00 kg/m$^2$ for men and <5.70 kg/m$^2$ for women in a study conducted in China [14]. The cutoff value for sarcopenia in a study in Rochester, Minnesota, USA, was 6.0 kg/m$^2$ for women and 8.70 kg/m$^2$ for men [15]. Optimal cut-off points associated with the high instrumental activity of daily living disability risk in the National Health and Nutrition Examination Survey in the USA were 5.75 kg/m$^2$ for women and 8.50 kg/m$^2$ for men [16]. These reference values were used to diagnose sarcopenia in this study. Using these criteria, prevalence values for sarcopenia in men and women were 21.53% and 11.7%, respectively.

The total recommended protein intake for older adults is 1.0–1.2 g/kg of body weight, with a recommendation to ingest 20–25 g/kg of protein at every meal to help build muscles 24 hours a day [17]. A low protein intake was observed in older adults in this study. The total protein intake values for all daily meals were 32.74 g/kg for males and 34.36 g/kg for females, which is possibly the major cause of sarcopenia identified in this study. A previous study showed that good nutrition plays an important role in building muscle mass and maintaining good health. A healthy diet that includes fruits, vegetables, oily fish, healthy white lean meat, and whole wheat cereals provides an excellent basis for good muscle strength in older adults [18]. A systematic review of 14 studies showed that dairy protein helps increase the muscle mass of older adults aged 61–81 years [19].

Sarcopenia is influenced by many factors that both directly and indirectly play major roles in affecting the quality and quantity of muscle mass [20], resulting in decreased functional capacity of muscular and musculoskeletal systems in the human body [21]. Good nutrition and physical activity play essential roles in building muscle mass by making available essential muscle proteins. Therefore, these two factors are considered anabolic stimuli for building muscle mass, and it is recommended to address both. Healthy food intake and physical activity help to reduce the risk of sarcopenia in individuals. In older European adults, a linear dose-response pattern was identified between protein intake and sarcopenia, and results indicated that a protein intake above 1.2 g per kg of body weight per day helps in reducing sarcopenia among adults [22].

Sarcopenia detection has been evaluated with older adults living in community, hospital, and both geriatric and home settings. Resistance exercises, such as 12 min of walking and physical performance, including stair climbing and chair rise, help build good muscle mass and strength and improve physical performance, which ultimately results in reducing the risk of sarcopenia. In one study spread over 3–18 months, supervised physical activity was conducted, resulting in a low prevalence of sarcopenia [23].

In Western countries, sarcopenia has been broadly studied and investigated. In South America, the prevalence of sarcopenia was 13.9% for both men and women [24]. In Asian districts, reporting on the prevalence of sarcopenia is rare. One study from Hong Kong showed a low sarcopenia prevalence in an elderly population of 7.6% for women and 12.3% for men [25]. Among the Taiwanese population, the prevalence of sarcopenia was 23.6% in men and 18.6% in women [26].

Calcium, magnesium, phosphorus, antioxidants, B vitamins, and vitamin D have specific and vital roles for muscle function and mass preservation to reduce the risk of sarcopenia. In this study, protein is assessed alongside other vital nutrients because protein intake has a key role in malnutrition and sarcopenia assessment through a food frequency questionnaire [27].

A systematic review of 17 studies showed that sarcopenia in older adults results in a high mortality risk (95% CI 2.9–4.37), with the effect more pronounced in individuals more than 79 years of age. The results of this study are more comparable with those of other community-based surveys conducted in Asia than in Western countries. The prevalence rates of sarcopenia in the USA were reported as 26.8% and 22.6% in women and men, respectively [28]. Low sarcopenia prevalence rates of 6% and 15% were reported for non-Hispanic black and Mexican-American ethnicities, respectively, in the USA. The reasons for differences in prevalence rates were differences in the definition of sarcopenia and the selection of the studied population.

In another study conducted in the USA, a positive correlation was found between sarcopenia and handgrip strength, with a correlation value of 0.6–0.8, indicating low handgrip strength, which leads to weaker muscles and, ultimately, to sarcopenia [29]. The mechanism of strength loss due to sarcopenia was examined in studies conducted in the states of Washington [30] and New Mexico [31] in the USA. The influence of sarcopenia on muscle strength loss was small, and the true mechanism of muscle weakness remains unknown.

A study conducted in Singapore showed that low muscle strength was associated with an increased risk of disability in older adults, leading to sarcopenia [32]. In this study, 115 individuals aged 65 and older were screened for sarcopenia, and 44.3% were found to be sarcopenic. A systematic review of 772 reference studies has shown that low muscle strength in older adults results in an increased risk of functional disability, health decline, and falls that ultimately increase the rate of mortality.

A low level of physical activity was reported in this study, which is considered to be a major risk factor for sarcopenia. In the Taiwanese population, the cause of sarcopenia in older adults is the same as reported herein for Pakistan. In Taiwanese older adults, a greater risk of functional disability and muscle weakness was due to low physical activity [33].

## 5. Conclusion

Sarcopenia was diagnosed in the elderly age group of over 60 years old in Lahore, Pakistan, using BIA. The prevalence rates of sarcopenia in older adults were observed to be 21.53% for males and 11.76% for females. The prevalence of severe sarcopenia was 6%, with 10% moderately sarcopenic. There were positive correlations between income and sarcopenic muscles, between protein intake and sarcopenic muscles, and between handgrip strength and sarcopenic muscles. Thus, a low protein intake led to muscle weakness. The causes of sarcopenia were reduced physical activity and low protein intake. Sarcopenia is an emerging health issue in older adults, and early detection and modification of lifestyle will lead to better health outcomes. It is recommended to obtain sarcopenic muscle data in other large cities using BIA to assess muscle health and physical performance, which will help in the formation of new guidelines for older adults.

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