



The Relationship Between Arm Fat Free Mass and Hand Grip Strength in Elderly Women

Arinena Brethaza¹, Noortje Anita Kumaat¹, Mokhamad Nur Bawono¹, Dita Yuliasrid¹, Awang Firmansyah²

¹Faculty of Sports Science and Health, Universitas Negeri Surabaya, Indonesia

²Allied Health Sciences, College of Medicine, National Cheng Kung University, Taiwan

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Keywords

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Abstract

Introduction: As they age, elderly women experience a decline in muscle mass and function, which affects their physical abilities and independence. Muscle strength can be measured through Handgrip Strength (HGS), while Fat Free Mass (FFM) is the component of the body that reflects muscle tissue. Both indicators play an important role in assessing muscle function and detecting the risk of sarcopenia in elderly women. **Purpose:** This study aims to analyze the relationship between right and left arm FFM and HGS in elderly women. **Methods:** This study used a cross-sectional approach with 33 subjects (age 62.18 ± 9.19 years; height 150.95 ± 5.38 cm; weight 61.09 ± 9.79 kg; BMI 26.81 ± 4.09 kg/m²). Body composition was measured using InBody 270 and HGS with a Takei handgrip. Data analysis used SPSS 27 with the Shapiro–Wilk test and Pearson correlation ($p < 0.05$). **Results:** The mean FFM of the right arm was 1.89 ± 0.39 kg, the left 1.87 ± 0.40 kg; right HGS 20.64 ± 5.50 kg, and the left 17.89 ± 3.89 kg. There was a significant positive correlation between right and left FFM and right and left HGS ($p < 0.05$; $r = 0.50$ – 0.58) with moderate strength. **Conclusion:** This study proves that the higher the fat-free mass of the arm, the greater the grip strength in elderly women.

INTRODUCTION

As they age, elderly women tend to experience a decline in muscle mass and function, or sarcopenia, which impacts their physical abilities, limits their daily activities, and increases their risk of various health problems such as cognitive and brain function decline, increased body fat, and higher mortality rates (Cipolli et al., 2021; Stuck et al., 2023; Yeung et al., 2019). The massive aging of the population at the global level, especially in Asia, has caused the number of elderly women with sarcopenia to continue to increase (Chew et al., 2022). A study of 541 elderly women in Korea aged 60-95 years showed that 26.3% of subjects were diagnosed with sarcopenia, characterized by low handgrip strength (HGS) of 16.58 kg (Park et al., 2025). In line with this study, a national survey in Korea involving 4,102 postmenopausal women aged 45-65 showed that 17.8% of respondents had an HGS value < 18 kg, which is an indicator of sarcopenia risk in the female population (Lee & Park, 2024). In Indonesia, data from the 2023 Indonesia Longitudinal Aging Survey (ILAS) confirms that age > 60 years, female gender, and malnutrition are indicators of sarcopenia risk in elderly women (Nurjanah et al., 2025). This condition causes the elderly to lose their independence and feel incapable, which contradicts their desire to remain healthy, independent, and able to perform basic activities such as bathing and dressing without relying on others (Dewi et al., 2021; Qodariyah et al., 2023). In various countries, the loss of independence in elderly women due to decreased muscle function poses a major challenge to health and social systems (Beaudart et al., 2025). Therefore, sarcopenia necessitates serious attention due to its extensive impact on public health, as it is clinically defined by detrimental body composition changes involving a reduction in muscle mass concurrent with an increase in fat mass (Bian et al., 2020; Moncada-Jiménez et al., 2023). Prior research indicates that the elderly population may experience a decline of up to 38% in both bone density and muscle mass (A.P. & Hakim, 2023). According to the diagnostic criteria established by the Asian Working Group for Sarcopenia (AWGS), the prevalence of sarcopenia among Asia's elderly population is reported to be between 4.1% and 11.5% (Wang et al., 2025). These figures indicate that sarcopenia has developed into a significant health phenomenon among the elderly population in Asia, in line with increasing life expectancy (Hwang & Park, 2022). Furthermore, the mass of skeletal muscle typically begins to diminish around the age of 40, continuing to be lost at a rate that increases to between 6% and 8% every decade (C. Chen & Liao, 2024).

The reduction in muscle mass directly compromises physical function, a change that can be reliably assessed using the HGS test (Bohannon, 2019). In a global context, HGS is increasingly used as an early screening tool to detect physical decline in the elderly population (Kim et al., 2022). HGS testing measures not only the strength of the hand muscles but also involves the arm muscles, indicating that variations in body side dominance can influence the resulting performance and scores (Quattrocchi et al., 2024). HGS is recognized as both a simple and accurate technique for evaluating muscle strength and serves as a crucial indicator in the diagnosis of sarcopenia (Cruz-Jentoft et al., 2019; Wiłkniowska-Szurlej et al., 2019). The use of HGS is increasing because this tool is easy to implement in various healthcare facilities, including in developing countries in Asia (Quattrocchi et al., 2024). Even when not at its peak level, sufficient grip strength is important and remains necessary for daily activities, work-related duties, and sports (Quattrocchi et al., 2024). Conversely, a decline in HGS can be an early sign of declining central nervous system function, which plays a role in movement coordination (Han et al., 2025). Therefore, early detection of HGS decline is a crucial step in preventing the more severe effects of sarcopenia in the elderly at the global level.

HGS is influenced by body composition components, particularly FFM, an indicator of muscle mass that encompasses all body components excluding fat mass, such as muscle tissue, internal organs, body fluids, minerals and bones (Renjit et al., 2023). FFM is reflective of the muscle tissue responsible for generating force, an increase in FFM directly contributes to enhanced handgrip strength (Kemala Sari et al., 2024). Consistent with this understanding, prior studies highlight the crucial role of regular strength training in increasing FFM, which simultaneously supports an enhancement in HGS among the elderly (N. Chen et al., 2021). Consequently, the consistent monitoring of FFM can function as a vital metric for tracking the decline of muscle strength and assessing alterations in the functional status of elderly individuals (Vaishya et al., 2024; Xiao et al., 2025). FFM analysis of the arms provides a more accurate picture of HGS than total body FFM because HGS is closely related to the mass and quality of upper extremity muscles, is regional in nature, is influenced by arm dominance, and can change with age (Chan et al., 2022). However, most previous studies have focused on total body FFM,

so scientific evidence regarding the specific role of upper extremity FFM, particularly the right and left arms, on HGS in elderly women remains limited (Chan et al., 2022). Understanding the relationship between FFM in each arm and HGS can provide more specific information for designing more targeted and effective exercise programs (Lai et al., 2025).

Consequently, the purpose of this study is to analyze the association between FFM of the right and left arms and HGS in elderly women, and furthermore to determine the extent of the contribution between these variables. This study also seeks to assess the strength of the relationship between FFM and HGS in both arms. The central hypothesis of this study posits a positive correlation between arm FFM and HGS in the elderly women. This study fills a gap in the literature (Sekarsari & Defi, 2018) regarding the lack of studies that specifically compare the contribution of right and left arm FFM to HGS in the elderly women population. The expected findings of this research will contribute meaningfully to the existing knowledge base on sarcopenia and offer a foundation for health services to establish early detection strategies and strength training-based interventions for preserving both strength and muscle mass.

METHOD

This research employs a quantitative descriptive methodology and utilizes a cross sectional study design. This design was selected because data for all study variables were collected at a single point in time, which makes it appropriate for exploring the relationship between left and right arm FFM and HGS in elderly women. The participants in this study comprised 33 elderly women. All of them were members of the Pelangi Elderly Health Center in Surabaya. Participants were selected based on inclusion and exclusion criteria to suit the research objectives. The inclusion criteria were: 1) Respondents were willing to follow the research procedures as stipulated; 2) They were in good general health and had sufficient stamina to undergo the tests; 3) They were aged ≥ 60 years; 4) They were female; 5) They had no history or complaints of muscle injury or health disorders at the time of data collection. Meanwhile, the exclusion criteria consisted of the following: 1) Respondents who did not meet the requirements or were unwilling to follow the research provisions; 2) Respondents in poor health or unable to complete the test due to limited physical endurance; 3) Respondents aged < 50 years; 4) Respondents who were male; 5) Respondents who experienced muscle injury or health problems at the time of data collection. All participants received an explanation of the objectives, benefits, procedures, and protocols of the study prior to its implementation and expressed their willingness to participate voluntarily.

Body composition was assessed using the InBody 270 device (Seoul, Korea) which employs multifrequency Bioelectrical Impedance Analysis (BIA) and possesses a satisfactory level of relative and absolute reliability, thus making it effective for obtaining accurate body composition data in longitudinal studies (Larsen et al., 2021). The first step in measuring body composition was subject preparation, which included taking off shoes and any metal or iron accessories, like watches, bracelets, and rings. Next, the subjects were required to stand upright on the device with their feet positioned on the electrodes for weight measurement, followed by the entry of their identification details such as user ID, gender, age, and height into the system to calibrate the subsequent analysis results. Subsequently, the subject was then directed to hold the portable electrodes in both hands, place their thumbs on the metal sensors, extend their elbows away from their bodies and look straight ahead. To guarantee a stable position the subject had to stay still during the measurement procedure. After the process is finished, the body composition components are automatically analyzed by the device and the FFM value is taken from the system's data output.

For this study the HGS test was administered utilizing a Takei brand handgrip dynamometer (Tokyo, Japan). This methodology is recommended by the EWGSOP as a primary diagnostic indicator for sarcopenia in elderly women owing to its practicality, accuracy, cost effectiveness and high reliability for evaluating muscle function in the elderly (Cruz-Jentoft et al., 2019). Prior to the measurement, subjects performed muscle stretching exercises for warm up and during the test subjects were asked to sit upright, look straight ahead, keep their elbows relaxed and straight, and keep their arms slightly away from their bodies in an extended position. The handgrip was then placed in the subject's hand, and they were asked to grip the device with maximum strength. The right and left hands were measured three times each with a 15 to 30 second rest period in between. The device's screen automatically displayed the handgrip strength data. The maximum value obtained from all recorded measu-

rements was chosen as the final result for subsequent analysis.

The collected data was first compiled using Microsoft Excel and subsequently analyzed using IBM SPSS Statistics version 27. Data normality was tested using the Shapiro-Wilk test with a significance criterion of > 0.05 . Next, the correlation between HGS and FFM was tested using Pearson correlation. The significance of the relationship was determined based on the p-value (< 0.05), while the strength of the relationship was described through the r-value with the following coefficient interval categories: 0.000–0.199 (very low), 0.200–0.399 (low), 0.400–0.599 (moderate), 0.600–0.799 (high), and 0.800–1.000 (very high).

RESULT AND DISCUSSION

Table 1 presents the characteristics of the research subjects and the results of the correlation test. Table 1 shows that female subjects had a mean age (62.18 ± 9.19 years), weight (61.09 ± 9.79 kg), height (150.95 ± 5.38 cm), and body mass index (26.81 ± 4.09 kg/m²). Based on the Asia-Pacific BMI standard, normal values range from 18.5 to 22.9, with obesity starting at >25.0 , indicating that the respondents were in the obese category. For HGS values, the reference used was (L.-K. Chen et al., 2020), which sets a limit of <18.0 kg for women as a sign of low grip strength. Based on this cutoff, the average right HGS was (20.64 kg) in the normal category, while the average left HGS was (17.89 kg) in the low category. The right arm FFM value was (1.89 kg) and the left arm was (1.87 kg), indicating that the right arm muscle mass was greater than the left arm. This finding indicates that the respondent had higher muscle mass and strength on the right side.

Table 1. Normality Test Results for Body Composition and Hand Grip Strength

Variabel	Female (n=33)	
	Mean \pm SD	p-value
Age	62.18 ± 9.19	0.200
Height (cm)	150.95 ± 5.38	0.200
Weight (kg)	61.09 ± 9.79	0.200
BMI (kg/m ²)	26.81 ± 4.09	0.191
FFM Arm Right (kg)	1.89 ± 0.39	0.200
FFM Arm Left (kg)	1.87 ± 0.40	0.200
HGS Right (kg)	20.64 ± 5.50	0.089
HGS Left (kg)	17.89 ± 3.89	0.857

Note. BMI = *Body Mass Index*; FFM = *Fat Free Mass*; HGS = *Handgrip Strength*

Table 2 shows the results of the correlation analysis between right and left arm FFM and right and left HGS in subjects. Right arm FFM (1.89 ± 0.39 kg) with right HGS (20.64 ± 5.50 kg) produced a p-value of 0.003 and $r = 0.502$, indicating a significant correlation with moderate correlation strength. Then, left arm FFM (1.87 ± 0.40 kg) with left HGS (17.89 ± 3.89 kg) produced $p = 0.001$ and $r = 0.579$, indicating a significant correlation with a moderate level of relationship. This means that the greater the arm FFM, the greater the HGS in the elderly women.

Table 2. Variable Correlation Statistics Results

Variable	p-value		r-value	
	HGS R	HGS L	HGS R	HGS L
FFM Arm Right	0.003	-	0.502	-
FFM Arm Left	-	0.001	-	0.579

The results of this study indicate a moderate correlation between FFM in the right and left arms and handgrip strength in elderly women. This confirms that the higher the FFM, the greater the muscle mass and number of active mitochondria within it, allowing the muscles to produce energy more efficiently when performing a handgrip (Burtscher et al., 2023; X. Chen et al., 2023; Jeong

et al., 2024; McKenna et al., 2022; Mølmen et al., 2025). These results are in line with the opinion (Gařárová et al., 2023; Kemala Sari et al., 2024) that the greater the muscle mass a person has, the greater the potential strength that can be generated. This occurs because FFM describes metabolically active body components, such as muscle tissue, which play a direct role in generating power when a person grips or performs other physical activities. An increase in FFM shows a positive relationship with HGS, and research in Indonesia reports that FFM has a significant relationship and can predict HGS values in the elderly (Kemala Sari et al., 2024). This supports the findings (Dai et al., 2021; Gařárová et al., 2023) that state upper extremity body composition, specifically in the arms, plays an important role in HGS, because the ratio of fat to FFM correlates with a decline in health status.

A higher degree of muscle mass suggests more frequent use and training of the muscles, thereby leading to enhanced coordination between the muscular and nervous systems. This state allows individuals to generate a stronger grip force when compared to those with less muscle mass (Bernabei et al., 2022; Chan et al., 2022). Conversely, a drop in FFM in elderly women causes a loss in muscle nerve units which reduces the muscles' ability to contract and support weight, ultimately resulting in a reduction in handgrip strength (Clark, 2023; Sarto et al., 2024). Grip strength is influenced by everyday practices in addition to physiological muscle considerations. Compared to older persons who tend to be inactive, those who are physically active, regularly undertake household tasks or participate in mild exercises like strength training typically have better maintained muscles (Li et al., 2024). These exercises help maintain healthy blood circulation, stable muscular mass and support overall bodily function (Choi et al., 2024). Conversely, engaging in a sedentary lifestyle and an unbalanced diet can accelerate the reduction of FFM and consequently result in diminished handgrip strength (Mo et al., 2023).

Thus, the findings of this study confirm that FFM significantly contributes to an individual's physical capabilities, particularly concerning HGS. Nevertheless, these findings concurrently demonstrate that HGS is not solely reliant on muscle mass but is also influenced by healthy lifestyle habits, muscle quality and consistent physical activity (Wen et al., 2023). This is in line with the findings (Moncada-Jiménez et al., 2023) which confirm that 26 elderly men and 52 elderly women with higher levels of physical activity had better grip strength, even though their FFM was relatively the same. As a result maintaining FFM through an active lifestyle together with balanced nutrition and dietary intake is essential for maintaining body function and facilitating independence as one ages (Fragala et al., 2019; Li et al., 2024). Practically, these research findings emphasize the importance of maintaining muscle mass through regular physical activity, especially resistance training targeting arm muscles, such as using resistance bands or light weights, particularly in elderly women. Such exercises have been proven to improve muscle strength, flexibility, and endurance (Li et al., 2024). In line with research by (Fragala et al., 2019) recommends several forms of exercise suitable for the elderly, such as shoulder presses, chest presses, lat pulldowns, biceps curls, triceps extensions, and lower back extensions. These exercises help to increase strength and muscle mass, which directly affects elderly women's capacity to carry out daily tasks independently and may lower the risk of disability. However, it should be noted that FFM is not the only determinant of HGS, so a comprehensive approach that includes improving muscle quality, nutritional status, and physical activity is still necessary in the prevention of sarcopenia.

This study has several advantages. The measurement procedure is straightforward and easily administered to elderly women without requiring specialized training and the use of HGS as a muscle strength indicator has been reliably demonstrated to be practical, reliable and relevant in assessing sarcopenia risk. Additionally, using the Inbody 270 instrument increases FFM estimation accuracy and the sample's homogeneity helps minimize data variance. However, this study is not without limitations. The sample size is relatively small and only involves elderly women, so the results cannot be generalized to male populations who are known to have different backgrounds or races, such as different muscle mass characteristics, handgrip strength, and patterns of muscle function decline. The limited age range and lack of stratification of elderly women meant that the results of the study were unable to represent the relationship between FFM and HGS in younger elderly women. In addition, factors such as nutritional status, physical activity level, and the presence of comorbidities were not evaluated in depth, which could affect the strength of the relationship between variables. For future research, it is recommended to use a larger sample size involving both male and female participants, as well as considering age and health status variations. Furthermore, analysis of lifestyle factors (physical activity, diet, and supplementation) could provide a more comprehensive picture. Thus, it is hoped

that future research will strengthen the scientific evidence and support the development of more effective strategies for the prevention and treatment of sarcopenia in the elderly population.

CONCLUSION

This study shows that there is a positive and significant relationship between right and left arm FFM and HGS in elderly women who participated in this study. The correlation analysis results show a moderate strength of relationship between the two variables, indicating that the greater the FFM in the arm, the higher the handgrip strength produced. These findings confirm that FFM plays an important role in supporting muscle function and physical ability in elderly women and can be used as an indicator to monitor the risk of muscle strength decline and sarcopenia in the elderly population studied. The results of this study emphasize the importance of maintaining and increasing FFM through regular physical activity, especially strength training that focuses on the arm and upper body muscles. Such efforts have the potential to help the elderly maintain functional independence and a better quality of life. However, generalizing the results of this study to other populations should be done with caution. Further research with larger samples, involving elderly men, varying ages, and diverse clinical and ethnic backgrounds is necessary.

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