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CORRELATION OF SIMPLE ANTHROPOMETRY AND BODY COMPOSITION WITH HANDGRIP STRENGTH IN OLDER ADULTS: CROSS-SECTIONAL STUDY

Ernawati Ernawati[1], Alexander Halim Santoso[2], Bryan Anna Wijaya[3], Vincent Aditya Budi Hartono[4], Andini Ghina Syarifah[4], Jonathan Hadi Warsito[4], Yohanes Firmansyah[5]

[1]Departemen Kesehatan Masyarakat, Fakultas Keokteran, Universitas Tarumanagara
**Email: ernawati@fk.untar.ac.id*
[2] Departemen Nutrisi, Fakultas Kedokteran, Universitas Tarumanagara
Email: alexander@fk.untar.ac.id
[3]Program Studi Profesi Kedokteran, Fakultas Kedokteran, Universitas Tarumanagara
Email: bryan.406242072@stu.untar.ac.id
[4]Program Studi Sarjana Kedokteran, Fakultas Kedokteran, Universitas Tarumanagara
Email: vincent.405210085@stu.untar.ac.id, andini.405210033@stu.untar.ac.id, jonathan.405210162@stu.untar.ac.id
[5]Departemen Fisiologi, Fakultas Kedokteran, Universitas Tarumanagara
Email: yohanes@fk.untar.ac.id

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ABSTRAK

Latar Belakang: Kekuatan genggam tangan (*Handgrip Strength/HGS*) merupakan indikator kesehatan fisik secara umum pada lansia. HGS mencerminkan keseimbangan antara massa otot dan lemak serta membantu dalam diagnosis sarkopenia. Memahami hubungan antara ukuran antropometri, komposisi tubuh, dan HGS penting untuk mengatasi penurunan kesehatan otot akibat penuaan. **Tujuan:** Studi ini mengevaluasi korelasi antara parameter antropometri sederhana, komposisi tubuh, dan HGS pada lansia, guna mendukung deteksi dan intervensi dini sarkopenia. **Metode:** Studi potong lintang dilakukan pada 31 lansia (≥60 tahun) di Panti Wreda Santa Anna tahun 2024. Pengukuran antropometri mencakup lingkar pinggang, pinggul, betis, leher, dan lengan atas. Komposisi tubuh seperti distribusi lemak dan otot rangka dianalisis menggunakan Omron Karada Scan HBF 375. HGS diukur dengan dinamometer terkalibrasi. Uji korelasi Spearman's Rho digunakan dengan signifikansi $p<0,05$. **Hasil:** Terdapat korelasi signifikan antara HGS dan beberapa parameter, terutama berat badan, tinggi badan, lingkar betis, lemak viseral, dan indeks otot rangka. Otot rangka tungkai menunjukkan korelasi kuat dengan HGS ($r=0,653$; $p<0,001$). Hasil ini menegaskan keterkaitan antara kesehatan otot, komposisi tubuh, dan perubahan terkait usia. **Kesimpulan:** HGS, yang dipengaruhi oleh parameter antropometri dan komposisi tubuh, merupakan indikator yang andal untuk sarkopenia pada lansia. Intervensi yang menargetkan faktor-faktor ini dapat meningkatkan fungsi otot dan kualitas hidup lansia.

Kata kunci: Komposisi Tubuh; Kekuatan Genggam Tangan; Lansia; Sarkopenia; Antropometri Sederhana.

ABSTRACT

Background: *Handgrip strength (HGS) is a proxy for overall physical health in older adults. It reflects the balance between muscle and fat mass and aids in diagnosing sarcopenia. Understanding the interplay between anthropometric measures, body composition, and HGS is crucial for addressing age-related muscle health decline.* ***Objectives:*** *This study evaluates the correlation between simple anthropometric parameters, body composition, and handgrip strength in older adults, contributing to early detection and intervention for sarcopenia.* ***Methods:*** *A cross-sectional study was conducted involving 31 older adults (≥60 years) from Santa Anna Nursing Home in 2024. Anthropometric measures included waist, hip, calf, neck, and upper arm circumferences, while body composition parameters such as fat and skeletal muscle distribution were analyzed using Omron Karada Scan HBF 375. HGS was measured using a calibrated dynamometer. Spearman's Rho correlation was applied to assess associations, with significance set at $p<0.05$.* ***Results:*** *The study exhibited significant correlations between HGS and various parameters, notably body weight, height, calf circumference, visceral fat, and skeletal muscle indices. Leg skeletal* *muscle strongly correlated with HGS (r=0.653, p<0.001). These findings underscore the interconnectedness of muscle health, body composition, and age-related changes.* ***Conclusion:*** *HGS, influenced by anthropometric and body composition parameters, is a reliable indicator of sarcopenia in older adults. Targeting these factors can guide interventions to enhance muscle function and quality of life in aging populations.*

Keywords: *Body Composition; Handgrip Strength; Older Adults; Sarcopenia; Simple Anthropometry*

1. INTRODUCTION

Handgrip strength (HGS) reflects an elderly's health and function. It is an essential index for diagnosing sarcopenia, which is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength (Frisca Frisca et al., 2024; Yoo et al., 2017). It is estimated to affect 10% to 16% of the elderly population worldwide (Yuan & Larsson, 2023). The elderly will naturally experience a loss of muscle mass and strength, which often profoundly affects their overall health and quality of life. This problem will limit their ability to perform activities of daily living and is worsened by an increased risk of falls and fractures, which may result in a loss of independence and an increased risk of mortality (Riviati & Indra, 2023; Trombetti et al., 2016). Despite aging being a primary factor in the onset of sarcopenia, reduced physical activity and poor nutrition also play substantial roles. A sedentary lifestyle accelerates muscle deterioration, and insufficient protein consumption impedes muscle repair and growth (Cho et al., 2022).

On the other hand, anthropometry and body composition are also used to determine an individual's physical and nutritional state. A previous study explored the relationship between HGS and several anthropometric variables. Nutritional status changes are accompanied by changes in physical state, such as the reduction of lean mass, mainly muscle mass, and the redistribution of body fat towards the trunk and visceral areas. HGS has been related to different variables: body weight, height, body mass index (BMI), fat mass, fat-free mass, waist circumference, and calf circumference (Maranhao Neto et al., 2017; McGrath, 2019; NEVILL et al., 2022; Silva et al., 2015).

Understanding this relationship is crucial, as these parameters provide valuable insights into an individual's health and functional capacity, particularly within the elderly population. This study aims to determine how these physical measures correlate with handgrip strength in older adults. By uncovering these connections, we seek to provide insights that can assist in the early detection of muscle weakness and related health challenges, such as sarcopenia. Ultimately, this knowledge can lead to more effective interventions, allowing healthcare professionals to develop strategies that enhance functional independence and improve older adults' overall quality of life.

2. METHODS

Study Design

The research design for this study is a cross-sectional analysis of 31 older adults residing at Santa Anna Nursing Home. All older adults aged 60 years and above who can cognitively understand and be willing to give informed consent were recruited using total sampling in 2024. Exclusion criteria include participants with an acute illness or injury affecting grip strength or participation, those with neuromuscular disorders significantly affecting hand function, or those with severe cognitive impairments affecting informed consent or compliance to the procedures. Participants who recently had surgery to the upper or lower limbs, mobility issues such as advanced stages of Parkinson's disease, and musculoskeletal disorders that prevent them from standing were also excluded.

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Variables and Instruments

In this study, we evaluated the relevant variables of body composition and anthropometric measurements to have a complete knowledge of the physical status of the participants. Body composition variables (total body fat (%), visceral fat (%), basal metabolic rate (kcal/day), and body mass index (kg/m)), total subcutaneous fat (%) and divided it into trunk, arm and leg subcutaneous fat (%), and total skeletal muscle (%) and divided it into trunk, arm and leg muscle (%). Body composition and weight (kg) were measured using Omron Karada Scan HBF 375; height (cm) was measured using a microtoise, and waist, hips, calf, neck, and upper arm circumferences (cm) were measured by a flexible measuring tape of high quality. The hand grip strength (kg) was assessed using the Omron Handgrip Strength Dynamometer. The measuring instruments were calibrated before data collection.

Statistical Analysis

We used SPSS version 26 to analyze univariate and bivariate datasets during this study. We used the Shapiro-Wilk test for data normality. The Spearman's Rho correlation test was employed to determine the association between the anthropometric measures, body composition, and hand grip strength. The level of statistical significance was set at $p<0.05$. The strength of the correlation was divided into negligible (0.00-0.10), weak (0.10-0.39), moderate (0.40-0.69), strong (0.70-0.89), and very strong (0.90-1.00) categories. Means and standard deviations were used to summarize the participants' demographic and other key characteristics, thus providing a clear description of the sample population.

3. RESULTS AND DISCUSSION

The study included 31 respondents who met the inclusion criteria. The characteristics and study variables of the respondents are shown in Table 1. Most respondents were female (74.2%), and the average age was 74.70. Anthropometric variables included waist circumference (87.61 cm), hip circumference (95.74 cm), calf circumference (32.77 cm), neck circumference (35.3 cm), and upper arm circumference (27.27 cm). The average weight was 50.96 kg, and the height was 150.76 cm. Handgrip strength was 14.26 kg. Body composition was measured based on total body fat (27.27%), visceral fat (9.32%), and total subcutaneous fat (26.69%), including subcutaneous fat on the trunk (24.16%), arms (41.75%), and legs (34.86%). The distribution of skeletal muscles was total skeletal muscle (22.08%), with trunk (25.43%), arms (15.6%), and legs (33.94%), while the average basal metabolic rate (1095.29 kcal/day) and body mass index (22.45 kg/m²).

Table 1. Respondent Characteristics

Parameter	**Results**
Gender, %	
• Male	8 (25.8)
• Female	23 (74.2)
Age (years)	74.70 (9.26)
Handgrip strength (kg)	14.26 (6.16)
Weight (kg)	50.96 (14.21)
Height (cm)	150.76 (11.73)
Waist Circumference (cm)	87.61 (12.55)
Hip Circumference (cm)	95.74 (8.53)
Calf Circumference (cm)	32.77 (3.95)
Neck Circumference (cm)	35.30 (3.72)
Upper Arm Circumference (cm)	27.27 (4.19)

Parameter	Results
Total Body Fat (%)	34.51 (7.7)
Visceral Fat (%)	9,32 (7.32)
Basal Metabolic Rate ((kcal/day)	1095.29 (324.6)
Body Mass Index (kg/m²)	22.45 (4.07)
Total Subcutaneous Fat (%)	26.69 (6,56)
Trunk Subcutaneous Fat (%)	24.16 (7.02)
Arm Subcutaneous Fat (%)	41.75 (11.82)
Leg Subcutaneous Fat (%)	34.86 (8.62)
Total Skeletal Muscle (%)	22.08 (5.49)
Trunk Skeletal Muscle (%)	25.43 (5.86)
Arm Skeletal Muscle (%)	15.6 (3.28)
Leg Skeletal Muscle (%)	33.94 (7.04)

This study tested the normality of data distribution using the Saphiro-Wilk test, which is appropriate for sample sizes of below 50. The results indicated that all the variable's outcomes showed a non-normal distribution.

Further, the results reveal statistically significant correlations between hand grip strength and several variables, including body weight, height, calf circumference, neck circumference, upper arm circumference, visceral fat, basal metabolic rate, and skeletal muscle index, respectively. In particular, the highest correlation was observed with leg skeletal muscle, indicating its strong impact on hand grip strength. These provide evidence that these physical parameters should be monitored as good indicators for overall physical health and functional ability. (Table 2 and Figure 1)

Table 2. Correlation of Simple Anthropometry and Body Composition with Hand Grip Strength

Independent Variable	r-correlation	Significance
Age	-0.274	0.136
Body Weight	0.564	<0.001
Height	0.423	<0.001
Waist Circumference	0.332	0.068
Hip Circumference	0.312	0.087
Calf Circumference	0.532	0.002
Neck Circumference	0.615	<0.001
Upper Arm Circumference	0.620	<0.001
Total Body Fat	-0.482	0.006
Visceral Fat	0.429	0.016
Basal Metabolic Rate (BMR)	0.517	0.003
Body Mass Index (BMI)	0.037	0.845
Total Subcutaneous Fat	-0.375	0.037
Trunk Subcutaneous Fat	-0.460	0.009
Arm Subcutaneous Fat	-0.474	0.007
Leg Subcutaneous Fat	-0.413	0.021
Total Skeletal Muscle	0.488	0.005
Trunk Skeletal Muscle	0.473	0.007
Arm Skeletal Muscle	0.538	0.002
Leg Skeletal Muscle	0.653	<0.001

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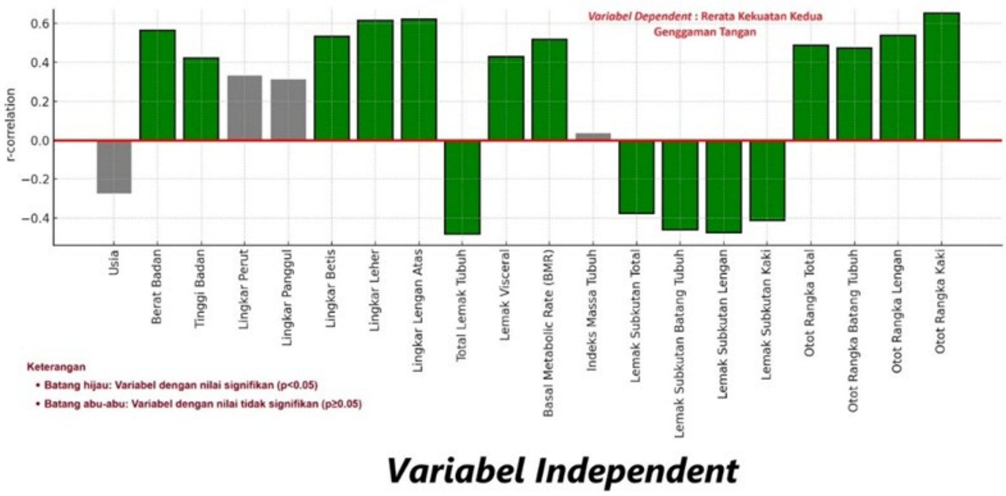

Figure 1. Correlation of Simple Anthropometry and Body Composition with Hand Grip Strength

Almost all the variables were correlated with handgrip strength, which made handgrip strength a valid indicator of sarcopenia in older adults. Handgrip strength is a parameter that represents the balance between fat mass and muscle mass in older adults. Older adults tend to have a decrease in muscle mass and an increase in body fat, which contribute to the development of sarcopenia. Handgrip strength provides a practical measure of muscle function and overall physical health, reflecting these changes in body composition (Cruz-Jentoft & Sayer, 2019; Lee & Gong, 2020).

Sarcopenia is manifested by decreased muscle fibre size and number, with fast-twitch fibres undergoing more significant atrophy since these fibres are responsible for strength and power. Muscle atrophy is caused by decreased physical activity and impaired protein metabolism. In addition, the elevation of inflammatory markers, such as cytokines, also increases with age. This chronic inflammation, termed inflammaging, promotes muscle atrophy by stimulating catabolic pathways that decrease muscle protein and the inhibition of anabolic pathways involved in muscle growth. Cytokines, such as TNF-α, IL-6, IL-1, and chemokines, are important inflammatory molecules that foster the infiltration of inflammatory cells into muscle tissue, leading to muscle atrophy through the activation of NF-κB. This transcription factor links the deregulation of lipid metabolism to inflammation. The activation of NF-κB is relevant because it promotes the activation of the NLRP3 inflammasome. This multiprotein complex orchestrates a series of immune responses, culminating in local and systemic inflammation. The interplay between these molecules underlines the association between the inflammatory process and muscle atrophy in sarcopenia (Boaru et al., 2015; Jimenez-Gutierrez et al., 2022; Zhang et al., 2022).

Hormones play an integral role in muscle loss with aging through anabolic hormones, such as insulin-like growth factor-1 (IGF-1), necessary for maintaining muscle protein synthesis and muscle mass. These hormones are responsible for the anabolic action of protein synthesis and muscle accumulation. As the levels of these hormones decline with age, the body's ability to synthesize new muscle protein declines, resulting in a normal progression toward muscle atrophy. The decline of these hormones has been associated with body fat, which is also responsible for fat metabolism. As a result, the imbalance of fat and muscle mass becomes evident as fat accumulates at the expense of lean mass. Furthermore, a decline in IGF-1 is also independently associated with decreased skeletal muscle mass, and lower IGF-1 levels are associated with lower handgrip strength (Bian et al., 2020; van Nieuwpoort et al., 2018; Wiedmer et al., 2021).

Meanwhile, mitochondrial dysfunction is one of the hallmarks of aging cells and is considered the leading cause of muscle decline and sarcopenia. Such dysfunction is directly linked to inflammation, a typical ageing feature. As the cell's power plants, mitochondria are responsible for ATP generation through oxidative phosphorylation. However, with age, mitochondrial ATP production efficiency declines, and ROS generation increases, resulting in oxidative stress. This stress leads to the accumulation of mitochondrial structural damage, reducing muscles' repair and regenerative ability, thereby accelerating muscle wasting. In parallel with the decline of mitochondrial function, hormonal imbalance increases insulin resistance, promoting fat accumulation and muscle wasting. Mitochondrial dysfunction also triggers the activation of NLRP3 inflammasome, a key inflammatory factor, which releases inflammatory cytokines (IL-18 and IL-1β), amplifying systemic inflammation, which, in turn, further enhances mitochondrial dysfunction and muscle wasting. Therefore, it is essential to target mitochondrial dysfunction and inflammation to mitigate sarcopenia (Ferri et al., 2020; Jimenez-Gutierrez et al., 2022; Wiedmer et al., 2021; Zhong et al., 2019).

These findings suggest the complex interplay between simple anthropometry, body composition, and handgrip strength among older adults. However, several limitations need to be acknowledged when interpreting the results of this study. The cross-sectional design does not allow for causal inferences. The study population consisted of a specific group of older adults and may not be representative of other populations or settings, which limits the generalizability of the results. Further, the present study did not account for potential confounding variables, such as nutritional status, physical activity levels, and comorbidities, which could influence the observed associations. Future studies should address these limitations by employing a longitudinal design that can provide a stronger causal relationship. Also, expanding the study to include populations from various geographic and cultural settings would enhance the generalizability of the results. Additionally, controlling for a broader range of confounding variables, including detailed consideration of dietary intake, physical activity levels, and health conditions, would provide a more robust understanding of the factors influencing handgrip strength and body composition among older adults. Such research would be of great value in developing effective interventions for maintaining muscle health and function in the aging population.

4. CONCLUSION

The complex interplay between handgrip strength, simple anthropometry, body composition and in older adults indicates that the decline of muscle health with age is a multi-factorial process. Handgrip strength can be used as a simple and valid proxy of sarcopenia, reflecting an imbalance between muscle and fat mass. In old adults, such imbalance is often characterised by significantly increased fat mass and decreased muscle mass. This process is further impacted by hormonal changes, such as the age-related decline in anabolic hormones, such as the IGF-1 pathway, that regulate muscle protein synthesis and maintenance.

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