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The Correlation Between Blood Pressure, Basic Anthropometric Measurements, Hemoglobin, Hematocrit, Blood Sugar, and Uric Acid With Grip Strength in Elderly Women

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Abstract. *Grip strength is a key indicator of muscle function and health in elderly women, influencing mobility and independence. Factors such as blood pressure, body composition, and metabolic biomarkers influence grip strength. This study examines the relationship between blood pressure, anthropometric measurements, hemoglobin, hematocrit, blood sugar, and uric acid with grip strength. A cross-sectional study was conducted on 34 elderly women (mean age: 72.24 years) in the St. Asisi Elderly Community, Tebet. Blood pressure, anthropometric parameters, and venous blood samples were analyzed. Grip strength was assessed using the Camry Electronic Hand Dynamometer. Statistical analysis used the Spearman correlation test ($p < 0.05$). Age showed a significant negative correlation with right-hand ($p = 0.023$) and average grip strength ($p = 0.026$), indicating muscle decline with age. Other factors, including blood pressure, hemoglobin, hematocrit, blood sugar, and uric acid, had no significant correlations. Among anthropometric measures, calf circumference showed the strongest positive correlation with grip strength ($p = 0.063$). Age is the primary factor affecting grip strength in elderly women, with weak or no significant associations for other parameters. Strength training and neuromuscular conditioning may help mitigate age-related muscle decline and support functional independence.*

Keywords: *Anthropometric Measurements, Blood Parameters, Blood Pressure, Elderly, Hand Grip Strength,*

Abstrak. Kekuatan genggaman adalah indikator utama fungsi otot dan kesehatan pada wanita lanjut usia, yang berkaitan erat dengan kemandirian, kualitas hidup, dan kemampuan melakukan aktivitas sehari-hari. Faktor-faktor seperti tekanan darah, komposisi tubuh, dan biomarker metabolik memengaruhi kekuatan genggaman. Penelitian ini mengeksplorasi hubungan antara faktor-faktor tersebut dengan kekuatan genggaman pada wanita lanjut usia untuk mengidentifikasi faktor risiko yang dapat dimodifikasi dan mendukung intervensi untuk mencapai penuaan yang sehat. Penelitian cross-sectional dilakukan terhadap 34 wanita lanjut usia (usia rata-rata: 72,24 tahun) di Komunitas Lanjut Usia St. Assisi, Tebet. Tekanan darah, parameter antropometri, dan sampel darah vena dianalisis. Kekuatan genggaman dinilai menggunakan Camry Electronic Hand Dynamometer. Analisis statistik menggunakan uji korelasi Spearman ($p < 0,05$). Usia menunjukkan korelasi negatif yang signifikan dengan kekuatan genggaman tangan kanan ($p = 0,023$) dan kekuatan genggaman rata-rata ($p = 0,026$), yang menunjukkan penurunan otot seiring bertambahnya usia. Faktor-faktor lain, termasuk tekanan darah, hemoglobin, hematokrit, gula darah, dan asam urat, tidak memiliki korelasi yang signifikan. Di antara ukuran antropometri, lingkar betis menunjukkan korelasi positif terkuat dengan kekuatan genggaman ($p = 0,063$). Usia merupakan faktor utama yang memengaruhi kekuatan genggaman pada wanita lanjut usia, dengan sedikit atau tidak ada kaitan signifikan untuk parameter lainnya. Latihan kekuatan dan pengondisian neuromuskular dapat membantu mengurangi penurunan otot terkait usia dan mendukung kemandirian fungsional.

Kata kunci: Antropometri, Kekuatan Genggaman Tangan, Lansia, Tekanan Darah, Parameter Darah

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1. INTRODUCTION

Grip strength is a recognized indicator of overall muscle function and health in older adults, particularly in elderly women. It is strongly associated with the ability to perform activities of daily living, independence, and quality of life. A decline in grip strength often signals a higher risk of frailty, mobility limitations, and increased morbidity and mortality. As such, understanding the factors that influence grip strength in older women is critical for promoting healthy aging and preventing physical decline. (Norman et al., 2011; Ossowski et al., 2016)

Several physiological and metabolic factors contribute to variations in grip strength, including blood pressure, anthropometric measurements, and metabolic biomarkers. Blood pressure is a key factor, as hypertension can impair vascular function, leading to reduced blood flow to muscles, which may hinder their strength. (Madina et al., 2021) Basic anthropometric measurements, such as body weight, body mass index (BMI), waist circumference, and limb circumferences, provide important insights into body composition and its effect on muscle mass and strength. Higher levels of adiposity, particularly central obesity, have been linked to muscle weakness and a decrease in grip strength. (Iwamoto et al., 2024; Kesehatan Masyarakat et al., 2018)

Hemoglobin and hematocrit, which reflect the body's oxygen-carrying capacity, are also crucial for maintaining muscle performance. Low levels of hemoglobin and hematocrit can cause fatigue and decreased physical capacity, leading to a decline in muscle strength. (Madina et al., 2021) Additionally, elevated blood sugar, especially in individuals with diabetes, has been associated with nerve damage and muscle dysfunction, contributing to diminished grip strength. (Ossowski et al., 2016) Uric acid, often elevated in conditions like gout and metabolic syndrome, may induce inflammation, leading to joint pain and muscle weakness, thereby impacting grip strength. (Iwamoto et al., 2024)

This study aims to explore the relationship between these factors: blood pressure, anthropometric measurements, hemoglobin, hematocrit, blood sugar, and uric acid with grip strength in elderly women. By investigating these associations, this research seeks to identify modifiable risk factors for grip strength decline and provide evidence to support clinical interventions that could help maintain or improve muscle function in older women. Through a better understanding of these relationships, healthcare providers can develop more effective strategies for preventing frailty and promoting better physical health in elderly women.

2. METHODS

This study employs a cross-sectional approach conducted in the St. Asisi Elderly Community, Tebet. The inclusion criteria for this study are a minimum age of 60 years and willingness to participate in the research by signing an inform consent. The exclusion criteria include a history of surgery, a history of pacemaker implantation, the presence of metal objects in the body. Parkinson disease, and Stroke.

Blood pressure was measured following standard medical procedures. Basic anthropometric measurements were assessed using the Omron HBF-375 Karada Scan Body Composition Scale and an elastic measuring tape. Hemoglobin, hematocrit, blood sugar, and uric acid levels were measured using venous blood samples, with a minimum fasting period of 8 hours, utilizing the Fora 6 Plus device. The dependent variable, grip strength, was measured using the Camry Electronic Hand Dynamometer EH 101, adhering to standardized examination procedures. Data presentation includes descriptive analysis in the form of proportions and measures of central tendency. Analytical data analysis was conducted using Spearman correlation, with a significance threshold set at 5%.

3. RESULT AND DISCUSSION

This study involved 34 elderly respondents. All participants were women, with an average age of 72.24 years old. Blood pressure values were within normal limits, with mean systolic and diastolic measurements of 124.74 mmHg and 69.91 mmHg. The participants' blood profiles showed an average hemoglobin level of 11.98 g/dL and hematocrit of 32.35%. Blood sugar levels averaged 120.21 mg/dL, while mean uric acid levels were 5.54 mg/dL.

The average body weight was 57.41 kg, with a mean height of 150.82 cm, and body mass index (BMI) of 25.25. Measurements using measurement tape showed an average mid upper arm circumference of 27.44 cm, waist circumference of 92.97 cm, and calf circumference of 34.20.

Muscle strength assessments highlighted an average left-hand grip strength of 13.39 kg and right-hand grip strength of 15.83 kg, while the combined average grip strength was 14.88 kg. (Table 1)

Table 1. Respondents Characteristics

Variable	Results
Gender (%)	
- Women	34 (100)
- Men	
Age, mean (SD) years	72.24 (6.77)
Systolic Blood Pressure, mean (SD) mmHg	124.74 (10.84)
Diastolic Blood Pressure, mean (SD) mmHg	69.91 (8.82)
Hemoglobin, mean (SD) g/dL	11.98 (5.88)
Hematocrit, mean (SD) %	32.35 (5.92)
Blood Sugar, mean (SD) mg/dL	120.21 (75.78)
Uric Acid, mean (SD) mg/dL	5.54 (1.57)
Body Weight, mean (SD) Kg	57.41 (12.28)
Body Height, mean (SD) cm	150.82 (4.39)
Body Mass Index, mean (SD)	25.25 (5.34)
Mid upper arm circumference, mean (SD) cm	27.44 (3.79)
Waist Circumference, mean (SD) cm	92.97 (11.35)
Calf Circumference, mean (SD) cm	34.20 (6.18)
Left Hand Grip Strength, mean (SD) kg	13.39 (4.66)
Right Hand Grip Strength, mean (SD) kg	15.83 (5.23)
Average Hand Grip Strength, mean (SD) kg	14.88 (4.60)

The correlation analysis results for let hand grip strength and various physiological and anthropometric parameters revealed several noteworthy trends, although none reached statistical significance. Age showed a weak negative correlation with hand grip strength, suggesting a slight decline in grip strength as age increases, but this relationship was not significant ($r = -0.290$; $p = 0.096$). Systolic ($r = 0.105$; $p = 0.553$) and diastolic blood pressures ($r = 0.208$; $p = 0.237$) exhibited weak positive correlations with grip strength, indicating minimal influence of blood pressure on grip performance.

Hemoglobin ($r = -0.067$; $p = 0.705$) and hematocrit ($r = -0.025$; $p = 0.887$) both demonstrated negligible negative correlations with hand grip strength, reflecting minimal association between these blood parameters and grip performance. Similarly, blood sugar ($p = 0.368$) and uric acid ($r = 0.159$; $p = 0.263$) levels showed weak positive correlations, indicating that metabolic factors may have limited impact on grip strength in this sample.

Anthropometric measurements, including body weight, height, body mass index, mid upper arm circumference, waist circumference, and calf circumference, exhibited varying degrees of positive correlation with grip strength. Among these, calf circumference showed the strongest positive correlation, suggesting a potential link between lower limb muscle mass and hand grip strength, although this was not statistically significant ($r = 0.322$; $p = 0.063$). Body weight ($r = 0.273$; $p = 0.118$), mid upper arm circumference ($r = 0.235$; $p = 0.181$), and BMI ($r = 0.214$; $p = 0.224$) also showed modest positive associations, highlighting potential contributions of overall and regional body composition to grip performance. (Table 2)

Table 2. Parameters Correlation to Left Hand Grip Strength

Parameter	**Hand grip strength (left hand)**	
	Correlation-r	***p***
Age	-0.290	0.096
Systolic blood pressure	0.105	0.553
Diastolic blood pressure	0.208	0.237
Hemoglobin	-0.067	0.705
Hematocrit	-0.025	0.887
Blood Sugar	0.159	0.368
Uric Acid	0.197	0.263
Body Weight	0.273	0.118
Body Height	0.152	0.391
Body Mass Index	0.214	0.224
Mid upper arm circumference	0.235	0.181
Waist Circumference	0.109	0.538
Calf Circumference	0.322	0.063

The correlation analysis for right hand grip strength and various physiological and anthropometric parameters revealed a statistically significant negative correlation with age (p = 0.023). This result indicates that grip strength declines as age increases, highlighting the potential impact of aging on muscle function.

Systolic blood pressure (r = -0.036; p = 0.841) displayed a negligible negative correlation with grip strength, while diastolic blood pressure (r = 0.134; p = 0.449) showed a weak positive relationship; however, neither reached statistical significance. Similarly, hemoglobin (r = -0.213; p = 0.225) and hematocrit (r = -0.181; p = 0.307) both demonstrated weak negative correlations, suggesting limited associations between these blood parameters and grip strength in the right hand. Blood sugar (r = -0.016; p = 0.930) and uric acid (r = -0.070); p = 0.695) also showed minimal negative correlations, indicating that metabolic factors likely do not play a significant role in right-hand grip strength in this sample.

Among the anthropometric parameters, body weight and height exhibited weak positive correlations with grip strength, with body height showing a slightly stronger relationship, though not statistically significant (r = 0.220; p = 0.212). Body mass index (r = 0.006); p = 0.972), mid upper arm circumference (r = 0.008; p = 0.965), and calf circumference (r = 0.068; p = 0.704) all demonstrated negligible or very weak correlations, suggesting these factors had limited impact on grip performance in this analysis. Waist circumference showed a weak negative correlation, but this relationship was also not significant (r = -0.097; p = 0.586). (Table 3)

Table 3. Parameters Correlation to Right Hand Grip Strength

Parameter	**Hand grip strength (right hand)**	
	Correlation-r	***p***
Age	-0,389	0,023
Systolic blood pressure	-0,036	0,841
Diastolic blood pressure	0,134	0,449
Hemoglobin	-0,213	0,225
Hematocrit	-0,181	0,307
Blood Sugar	-0,016	0,930
Uric Acid	-0,070	0,695
Body Weight	0,054	0,761
Body Height	0,220	0,212
Body Mass Index	0,006	0,972
Mid upper arm circumference	0,008	0,965
Waist Circumference	-0,097	0,586
Calf Circumference	0,068	0,704

The analysis of the correlation between average hand grip strength and various physiological and anthropometric parameters highlights several key findings. A significant negative correlation with age (r = -0.381; p = 0.026) indicates that average grip strength decreases with age, emphasizing the impact of aging on muscle function.

Systolic blood pressure (r = 0.026; p = 0.884) showed a negligible positive correlation with grip strength, while diastolic blood (r = 0.194; p = 0.273) pressure displayed a weak positive association. However, neither relationship was statistically significant. Similarly, hemoglobin (r = -0.172; p = 0.330) and hematocrit (r = -0.129; p = 0.466) exhibited weak negative correlations, suggesting limited influence of these blood parameters on average grip strength. Blood sugar (r = 0.066; p = 0.712) and uric acid (r = 0.063; p = 0.722) showed minimal positive correlations, further indicating that metabolic markers may have little impact on grip strength in this study sample.

Regarding anthropometric factors, body weight (r = 0.173; p = 0.327) and height (r = 0.215; p = 0.222) demonstrated weak positive correlations with grip strength, with body height showing a slightly stronger relationship, though not statistically significant. Body mass index (r = 0.113; p = 0.524), mid upper arm circumference (r = 0.126; p = 0.479), and calf circumference (r = 0.210; p = 0.253) all displayed weak positive associations, yet these were not significant, suggesting minimal contributions to average grip strength. Waist circumference exhibited a negligible negative correlation, reinforcing the limited role of this parameter in influencing grip strength (r = -0.008; p = 0.963). (Table 4)

Table 4. Parameters Correlation to Average Hand Grip Strength

Parameter	Hand grip strength (average)	
	Correlation-r	***p***
Age	-0,381	0,026
Systolic blood pressure	0,026	0,884
Diastolic blood pressure	0,194	0,273
Hemoglobin	-0,172	0,330
Hematocrit	-0,129	0,466
Blood Sugar	0,066	0,712
Uric Acid	0,063	0,722
Body Weight	0,173	0,327
Body Height	0,215	0,222
Body Mass Index	0,113	0,524
Mid upper arm circumference	0,126	0,479
Waist Circumference	-0,008	0,963
Calf Circumference	0,201	0,253

Aging is a process where physiological function gradually declines. (Gustafsson & Ulfhake, 2024) As individuals age, muscle strength and mass naturally decline, a process known as sarcopenia. (Kirk et al., 2024) This decline is primarily due to changes in muscle fiber composition, with a shift from fast-twitch fibers, which are responsible for strength and power, to slow-twitch fibers, which are more endurance-oriented. Sarcopenia affects both the size and the number of muscle fibers, leading to a reduction in muscle mass, strength, and function. (Gustafsson & Ulfhake, 2024) This is particularly evident in the hands and forearms, which are essential for hand grip strength. (Sakuma & Yamaguchi, 2012)

Moreover, the aging process is associated with a decrease in neuromuscular function, where the efficiency of nerve signals to muscles diminishes over time. (Gonzalez-Freire et al., 2014) This decrease in nerve conduction velocity and the number of motor neurons innervating muscle fibers contributes to the weakening of the muscles involved in hand grip. (Nùñez-Lisboa et al., 2023) Reduced neuromuscular function, combined with age-related muscle loss, results in diminished grip strength. (Gonzalez-Freire et al., 2014; Nùñez-Lisboa et al., 2023)

Physical activity also plays a significant role in maintaining grip strength as people age. (Bilajac et al., 2019) As physical activity levels decline with age, muscle mass and strength can further decrease. (Wyoso et al., 2022) Regular exercise, particularly strength training, can help mitigate these effects by maintaining muscle mass and neuromuscular function. (Murbawani et al., 2021) Therefore, elderly individuals who remain physically active are likely to experience slower declines in grip strength compared to those who are sedentary. (Meng, 2024)

In addition to sarcopenia and reduced physical activity, hormonal changes, particularly decreases in anabolic hormones such as estrogen in women and growth hormone, contribute to muscle loss and weakness with age. (Sakuma & Yamaguchi, 2012) These hormones play crucial roles in muscle protein synthesis, and their decline can accelerate muscle atrophy. (JafariNasabian et al., 2017; Pataky et al., 2021)

Systolic blood pressure, which measures the pressure in the arteries when the heart beats, does not show a meaningful correlation with grip strength. (J. M & Shashikala, 2023) This suggests that while cardiovascular health is crucial for overall well-being, it may not directly affect muscle strength on its own. (Shahid et al., 2024) Systolic blood pressure mainly reflects the heart's pumping ability, influencing overall circulation, but it does not always correlate with muscle strength, particularly in older adults. (Ji et al., 2018) Grip strength is more closely tied to factors like muscle mass, neuromuscular function, and physical activity, rather than the pressure generated by the heart during each beat.

In contrast, diastolic blood pressure, which measures pressure between heartbeats, reflects the health of smaller blood vessels that supply blood to various tissues, including muscles. While its positive relationship with grip strength was modest and statistically insignificant, it hints that better vascular health, which aids in delivering oxygen and nutrients to muscles during physical activity, may subtly enhance muscle function. Efficient blood flow supports muscle endurance and recovery, indirectly influencing strength. However, this effect is likely less significant compared to other factors, such as age, nutrition, and physical activity. (J. M & Shashikala, 2023; Shahid et al., 2024)

Hemoglobin, hematocrit, and blood sugar, do not appear to directly influence grip strength. (Manoharan et al., 2015; Ribeiro et al., 2024) Hemoglobin actively transports oxygen in the blood, ensuring tissues receive the oxygen needed for energy production and metabolic processes. (Manoharan et al., 2015) However, grip strength depends more heavily on the structural and mechanical properties of muscles, such as muscle mass and neuromuscular coordination. (Quattrocchi et al., 2024; Ribeiro et al., 2024)

Muscle mass is the total volume of muscle tissue available to perform an action. (Quattrocchi et al., 2024) Greater muscle mass provides a larger area for force production.

(Ribeiro et al., 2024) When gripping an object, the muscles in the forearm and hand, particularly the flexor muscles like the flexor digitorum profundus and flexor pollicis longus, work together to exert force. (Manoharan et al., 2015; Quattrocchi et al., 2024) Reduced muscle mass, often seen with aging or conditions like sarcopenia, limits the force that can be generated, thereby diminishing grip strength. (Ribeiro et al., 2024)

Furthermore, neuromuscular coordination refers to the ability of the nervous system to recruit and activate muscle fibers effectively. (Quattrocchi et al., 2024) The process of grip strength, involves precise signaling between the brain, spinal cord, and muscles. (Ribeiro et al., 2024) The motor units, comprising motor neurons and the muscle fibers they innervate, must fire in a synchronized manner to generate a smooth and forceful contraction. (Quattrocchi et al., 2024; Ribeiro et al., 2024) The decline of neuromuscular coordination, often seen in aging or neurological disorders, reduces the efficiency of muscle contractions, thereby weakening grip strength. (Manoharan et al., 2015; Ribeiro et al., 2024) In the aging process, the neuromuscular function decrease happened because the efficiency of nerve signals to muscles, diminishes over time. (Nùñez-Lisboa et al., 2023) This contributes to the weakening of the muscles recruitment, resulting in diminished grip strength. (Gonzalez-Freire et al., 2014; Nùñez-Lisboa et al., 2023)

Hematocrit, which measures the proportion of red blood cells in the blood, plays a similar role in oxygen transport and viscosity, impacting circulation. (Lücker et al., 2017) However, as with hemoglobin, its influence on grip strength appears indirect, as muscle performance relies more on localized factors such as fiber recruitment and endurance rather than systemic blood properties. (Kuramotc et al., 1980; Zimmerman et al., 2017)

Blood sugar reflects metabolic control and energy availability, particularly glucose, which serves as a primary energy source for muscle activity. Although poorly regulated glucose levels can impair muscle function over time (e.g., in diabetes-related complications), short-term blood sugar levels might not significantly affect grip strength unless they are extreme or accompanied by metabolic dysfunctions. (Colberg et al., 2016)

Body weight exhibits a positive but weak correlation with hand grip strength, aligning with the understanding that individuals with higher body weight often possess greater muscle mass, which contributes to stronger grip strength. However, this relationship is not straightforward, as it heavily depends on body composition. (Salim et al., 2023) Muscle mass, a key determinant of grip strength, plays a more significant role than total body weight. Individuals with a higher proportion of lean body mass tend to have stronger grip strength compared to those with a similar weight but a higher fat mass. While fat mass adds to overall weight, it does not directly enhance muscle function or grip strength. Furthermore, physical activity and strength training are critical factors that mediate this relationship, as sedentary individuals with higher body weight may not exhibit comparable grip strength to those who are more physically active and maintain muscle mass. (Salim et al., 2023)

In contrast, body height also shows a weak positive correlation with grip strength, likely influenced by biomechanical advantages associated with height. (Bhattacharjya & Goswami, 2022; Byambaa et al., 2023) Taller individuals often benefit from longer limbs, which can enhance leverage and facilitate the application of force during gripping tasks. (Byambaa et al., 2023) Additionally, longer fingers and larger hand spans may allow for a more efficient distribution of force when handling larger objects. Height also correlates with longer muscles and tendons, which may support muscle endurance and strength over a broader range of motion. (Nawangsasi et al., 2021) However, the influence of height on grip strength remains subtle and intertwined with other factors, such as genetic predisposition and overall physical conditioning. (Bhattacharjya & Goswami, 2022)

Body mass index (BMI) has no significant relationships with grip strength, indicating that factors like overall body composition and arm size may not be as directly linked to hand grip strength as commonly believed. (Ramandei et al., 2022) Waist circumference shows a minimal negative correlation, possibly suggesting that fat accumulation around the torso may hinder muscular performance to some extent, though the effect is not strong enough to be statistically significant. (Keevil et al., 2015) This limitation of BMI underscores the importance of assessing muscle mass and body composition separately when examining their impact on muscle function. (Dhananjaya et al., 2017)

Mid upper arm circumference, although related to the size of the upper arm, does not necessarily correlate with the strength of the forearm and hand muscles responsible for grip strength. (Byambaa et al., 2023) Mid upper arm circumference can be influenced by fat accumulation or non-muscular tissue, which might inflate its size without contributing to functional strength. (Chattopadhyay et al., 2024) Moreover, grip strength primarily relies on the forearm flexor muscles, which are not directly measured by arm circumference. (Heidy et al., 2021)

The minimal negative correlation between waist circumference and grip strength may suggest an association between central fat accumulation and reduced muscle performance. (Sarangi et al., 2024) Excess visceral fat, which increases waist circumference, has been linked to chronic inflammation and metabolic dysregulation. (Pettersson-Pablo et al., 2024) These factors can negatively impact muscle quality and function, potentially leading to weaker grip strength. (Xu & Zhou, 2024) Furthermore, individuals with higher waist circumferences may be less physically active or have lower overall fitness levels, which indirectly affects muscle strength. (Sarangi et al., 2024) However, the weak and statistically insignificant correlation indicates that waist circumference alone cannot serve as a robust predictor of grip strength. (Pettersson-Pablo et al., 2024; Sarangi et al., 2024)

The moderate positive correlation between calf circumference and hand grip strength reflects the interconnected nature of muscle development and overall physical fitness. (Byambaa et al., 2023; Wang et al., 2022) Larger calf circumference often indicates well-developed lower limb muscles, which contribute to stability, mobility, and functional strength. (Kemala Sari et al., 2024; Quiñonez-Olivas et al., 2016) This relationship may not be limited to the calves but could serve as a proxy for overall muscle mass and conditioning throughout the body. (Quiñonez-Olivas et al., 2016)

Moreover, larger muscle groups like the calves are associated with better circulation and metabolic health, as they play a significant role in venous return and oxygen utilization during physical activity. Improved vascular and metabolic function supports muscle performance throughout the body, including the hand muscles responsible for grip strength. Additionally, individuals with higher calf circumference may have greater overall lean muscle mass, contributing to their strength capabilities in various regions, including the forearms. (Kondo et al., 2018; Wu et al., 2018)

The connection between lower and upper body strength can also be understood through the concept of neuromuscular efficiency. When one part of the body becomes stronger and more conditioned, the nervous system may optimize muscle recruitment patterns in other areas, enhancing overall strength and performance. In this context, the correlation between calf circumference and grip strength likely reflects a broader measure of general physical fitness and muscle health rather than a direct causal relationship. (Enoka, 2008)

4. CONCLUSION

Hand grip strength in elderly individuals is predominantly influenced by age and localized muscle attributes, with limited impact from systemic biomarkers or general body size. These findings underscore the importance of targeted interventions, such as resistance training and neuromuscular conditioning, to mitigate age related declines in muscle strength and functionality.

REFERENCES

Bhattacharjya, J., & Goswami, B. (2022). Hand Grip Muscle Strength, Endurance and Anthropometric Parameters in Healthy Young Adults: A Cross-sectional Study. *JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH*. https://doi.org/10.7860/JCDR/2022/55381.16897

Bilajac, L., Juraga, D., & Zuljevic, H. (2019). The influence of physical Activity on handgrip strength of elderly. *Archive of Gerontology and Geriatrics Research*, *4*(1), 020–024. https://doi.org/10.17352/AGGR.000011

Byambaa, A., Altankhuyag, I., Damdinbazar, O., Jadamba, T., & Byambasukh, O. (2023). Anthropometric and Body Circumference Determinants for Hand Grip Strength: A Population-Based Mon-Timeline Study. *Journal of Aging Research*, *2023*, 6272743. https://doi.org/10.1155/2023/6272743

Chattopadhyay, A., Ray, S., Chanda, D., & Chakraborti, D. (2024). A study on hand grip strength and its association with body mass index, hand length and mid-upper arm circumference among Eastern Indian medical students using a hand-held dynamometer. *Medical Research Journal*, *9*(1), 35–41. https://doi.org/10.5603/MRJ.98116

Colberg, S. R., Sigal, R. J., Yardley, J. E., Riddell, M. C., Dunstan, D. W., Dempsey, P. C., Horton, E. S., Castorino, K., & Tate, D. F. (2016). Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. *Diabetes Care*, *39*(11), 2065–2079. https://doi.org/10.2337/dc16-1728

Dhananjaya, J. R., Veena, H. C., Mamatha, B. S., & Sudarshan, C. R. (2017). Comparative study of body mass index, hand grip strength, and handgrip endurance in healthy individuals. *National Journal of Physiology, Pharmacy and Pharmacology*, *7*(6), 594–598. https://doi.org/10.5455/njppp.2017.7.1030007022017

Enoka, R. M. (2008). *Neuromechanics of Human Movement-4th Edition*. 549.

Gonzalez-Freire, M., de Cabo, R., Studenski, S. A., & Ferrucci, L. (2014). The neuromuscular junction: Aging at the crossroad between nerves and muscle. *Frontiers in Aging Neuroscience*, *6*(AUG), 100518. https://doi.org/10.3389/FNAGI.2014.00208/BIBTEX

Gustafsson, T., & Ulfhake, B. (2024). Aging Skeletal Muscles: What Are the Mechanisms of Age-Related Loss of Strength and Muscle Mass, and Can We Impede Its Development and Progression? *International Journal of Molecular Sciences 2024, Vol. 25, Page 10932*, *25*(20), 10932. https://doi.org/10.3390/IJMS252010932

Heidy, H., Djuartina, T., & Irawan, R. (2021). THE CORRELATION OF HAND GRIP STRENGHT WITH FOREARM AND HAND ANTHROPOMETRY AND BODY MASS INDEX. *Damianus Journal of Medicine*, *18*(1), 1–7. https://doi.org/10.25170/DJM.V18I1.2189

Iwamoto, K., Kikuchi, Y., Nakano, H., Katsurasako, T., Mori, K., Shiraiwa, K., Horie, J., & Murata, S. (2024). Relationship between Subjective Grip Strength and Physical Functioning among Community-Dwelling Older Women. *Geriatrics 2024, Vol. 9, Page 68*, *9*(3), 68. https://doi.org/10.3390/GERIATRICS9030068

J. M, A., & Shashikala, L. (2023). Association Between Blood Pressure and Hand Grip

Strength Among Adult Population Visiting a Tertiary Care Centre – a Cross-Sectional Study. *Indian Journal of Applied Research*, 37–41. https://doi.org/10.36106/ijar/6101241

JafariNasabian, P., Inglis, J. E., Reilly, W., Kelly, O. J., & Ilich, J. Z. (2017). Aging human body: changes in bone, muscle and body fat with consequent changes in nutrient intake. *Journal of Endocrinology*, *234*(1), R37–R51. https://doi.org/10.1530/JOE-16-0603

Ji, C., Zheng, L., Zhang, R., Wu, Q., & Zhao, Y. (2018). Handgrip strength is positively related to blood pressure and hypertension risk: Results from the National Health and nutrition examination survey. *Lipids in Health and Disease*, *17*(1). https://doi.org/10.1186/S12944-018-0734-4

Keevil, V. L., Luben, R., Dalzell, N., Hayat, S., Sayer, A. A., Wareham, N. J., & Khaw, K. T. (2015). Cross-sectional associations between different measures of obesity and muscle strength in men and women in a British cohort study. *Journal of Nutrition, Health and Aging*, *19*(1), 3–11. https://doi.org/10.1007/S12603-014-0492-6

Kemala Sari, N., Stepvia, S., & Ilyas, M. F. (2024). The Association between Anthropometric Measurements and Body Composition with Hand Grip Strength among the Elderly Population in Indonesia. *Journal of Clinical Medicine*, *13*(16), 4697. https://doi.org/10.3390/jcm13164697

Kesehatan Masyarakat, J., Dara Novi Handayani, M., Hamim Sadewa, A., Farmawati, A., & Rochmah, W. (2018). Anthropometric Prediction Equations for Estimating Muscle Mass of Elderly Women. *Jurnal Kesehatan Masyarakat*, *14*(2), 195–204. https://doi.org/10.15294/kemas.v14i2.14073

Kirk, B., Cawthon, P. M., Arai, H., Ávila-Funes, J. A., Barazzoni, R., Bhasin, S., Binder, E. F., Bruyere, O., Cederholm, T., Chen, L.-K., Cooper, C., Duque, G., Fielding, R. A., Guralnik, J., Kiel, D. P., Landi, F., Reginster, J.-Y., Sayer, A. A., Visser, M., … Luiking, Y. (2024). The Conceptual Definition of Sarcopenia: Delphi Consensus from the Global Leadership Initiative in Sarcopenia (GLIS). *Age and Ageing*, *53*(3). https://doi.org/10.1093/AGEING/AFAE052

Kondo, T., Yamada, S., Asai, C., Okumura, T., Tanimura, D., & Murohara, T. (2018). Skeletal Muscle Pump Function Is Associated With Exercise Capacity in Patients With Heart Failure. *Circulation Journal*, *82*(4), 1033–1040. https://doi.org/10.1253/CIRCJ.CJ-17-0927

Kuramotc, K., Matsushita, S., Matsuda, T., Mifune, J., Saki, M., Iwasaki, T., Shinagawa, T., Moroki, N., & Murakami, M. (1980). EFFECT OF HEMATOCRIT AND VISCOSITY ON CORONARY CIRCULATION AND MYOCARDIAL OXYGEN UTILIZATION. *JAPANESE CIRCULATION JOURNAL*, *44*(6), 443–448. https://doi.org/10.1253/JCJ.44.443

Lücker, A., Secomb, T. W., Weber, B., & Jenny, P. (2017). The relative influence of hematocrit and red blood cell velocity on oxygen transport from capillaries to tissue. *Microcirculation*, *24*(3). https://doi.org/10.1111/micc.12337

Madina, U. U., Setiati, S., Laksmi, P. W., & Mansjoer, A. (2021). Predictors of Handgrip Strength Changes in Elderly Patients. *Jurnal Penyakit Dalam Indonesia*, *8*(3), 1. https://doi.org/10.7454/jpdi.v8i3.529

Manoharan, V. S., Sundaram, S. G., & Jason, J. I. (2015). Factors Affecting Hand Grip Strength and Its Evaluation: a Systemic Review. *International Journal of Physiotherapy and Research*, *3*(6), 1288–1293. https://doi.org/10.16965/ijpr.2015.193

Meng, F. (2024). A055: The Relationship Between Grip Strength and Quality of Life in the Elderly Based. *International Journal of Physical Activity and Health*, *3*(3).

Murbawani, E. A., Subagio, H. W., Puruhita, N., Probosari, E., & Candra, A. (2021). Correlation of dietary intake and physical activity with nutritional status, body composition and hand grip strength in elderly. *Jurnal Gizi Indonesia (The Indonesian Journal of Nutrition)*, *10*(1), 21–27. https://doi.org/10.14710/jgi.10.1.21-27

Nawangsasi, P., Kalanjati, V. P., Irawan, R., Risdiansyah, & Tirthaningsih, N. W. (2021). Correlation of hand grip strength and body height amongst young adults in Indonesia. *Malaysian Journal of Medicine and Health Sciences*, *17*, 9–12.

Norman, K., Stobäus, N., Gonzalez, M. C., Schulzke, J. D., & Pirlich, M. (2011). Hand grip strength: Outcome predictor and marker of nutritional status. *Clinical Nutrition*, *30*(2), 135–142. https://doi.org/10.1016/J.CLNU.2010.09.010/ASSET/3F4F3582-301B-4366-9910-834EBF1A2541/MAIN.ASSETS/GR2.SML

Nùñez-Lisboa, M., Valero-Breton, M., & Dewolf, A. H. (2023). Unraveling age-related impairment of the neuromuscular system: exploring biomechanical and neurophysiological perspectives. *Frontiers in Physiology*, *14*, 1194889. https://doi.org/10.3389/FPHYS.2023.1194889/BIBTEX

Ossowski, Z., Prusik, K., Kortas, J., Wiech, M., Bielawa, L., & Prusik, K. (2016). Relationship between age and handgrip strength indexes in elderly women with low bone mass. Preliminary study. *Baltic Journal of Health and Physical Activity*, *8*(3), 32–39. https://doi.org/10.29359/bjhpa.08.3.04

Pataky, M. W., Young, W. F., & Nair, K. S. (2021). Hormonal and Metabolic Changes of Aging and the Influence of Lifestyle Modifications. *Mayo Clinic Proceedings*, *96*(3), 788–814. https://doi.org/10.1016/J.MAYOCP.2020.07.033/ASSET/AAEE0A0B-7BA2-416A-8019-43FA7BC9D737/MAIN.ASSETS/GR2.JPG

Pettersson-Pablo, P., Nilsson, T. K., & Hurtig-Wennlöf, A. (2024). Relative handgrip strength correlates inversely with increased body fat, inflammatory markers and increased serum lipids in young, healthy adults – The LBA study. *Diabetes Research and Clinical Practice*, *207*, 111057. https://doi.org/10.1016/j.diabres.2023.111057

Quattrocchi, A., Garufi, G., Gugliandolo, G., De Marchis, C., Collufio, D., Cardali, S. M., & Donato, N. (2024). Handgrip Strength in Health Applications: A Review of the Measurement Methodologies and Influencing Factors. *Sensors 2024, Vol. 24, Page 5100*, *24*(16), 5100. https://doi.org/10.3390/S24165100

Quiñonez-Olivas, C. G., Salinas-Martínez, R., Ortiz-Jiménez, X. A., Gámez-Treviño, D. G., Guajardo-Álvarez, G., & González-García, B. (2016). Muscle mass measured using bioelectrical impedance analysis, calf circumference and grip strength in older adults. *Medicina Universitaria*, *18*(72), 158–162. https://doi.org/10.1016/J.RMU.2016.06.005

Ramandei, E., Pesurnay, Y., Pinem, O., Irmayanti, I., & Darwin, D. (2022). The Relationship between Body Mass Index and Grasping Strength in Students of the Medical Education

Study Program, Faculty of Medicine, University of Papua. *Majalah Kesehatan Indonesia*, *3*(2), 43-48–43–48. https://doi.org/10.47679/MAKEIN.202292

Ribeiro, L. W., Berndt, S., Mielke, G. I., Doust, J., & Mishra, G. D. (2024). Factors associated with handgrip strength across the life course: A systematic review. *Journal of Cachexia, Sarcopenia and Muscle*, *15*(6), 2270–2280. https://doi.org/10.1002/JCSM.13586

Sakuma, K., & Yamaguchi, A. (2012). Sarcopenia and Age-Related Endocrine Function. *International Journal of Endocrinology*, *2012*(1), 127362. https://doi.org/10.1155/2012/127362

Salim, S., C, R. D., Salim, S., & C, R. D. (2023). Correlation of body mass index with handgrip strength and blood pressure indices among young adults. *Indian Journal of Physiology and Pharmacology*, *67*(2), 113–117. https://doi.org/10.25259/IJPP_471_2021

Sarangi, S., A., A. S. K., M., V. V., Sarangi, S., A., A. S. K., & M., V. V. (2024). Trop T, hand grip strength and waist circumference as markers of sarcopenic obesity in postmenopausal women: An analytical cross-sectional study. *Indian Journal of Physiology and Pharmacology*, *68*(1), 57–63. https://doi.org/10.25259/IJPP_510_2023

Shahid, M. K., Sohail, M. U., Amjad, A., Azhar, G., Raza, A., & Khokhar, L. (2024). Comparison of Hand Grip Strength in Hypertensive and Non-Hypertensive Middle-Aged People. *Journal of Health and Rehabilitation Research*, *4*(1), 677–681. https://doi.org/10.61919/jhrr.v4i1.470

Wang, P. C., Yeh, W. C., Tsai, Y. W., & Chen, J. Y. (2022). Calf circumference has a positive correlation with physical performance among community-dwelling middle-aged, older women. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/FPUBH.2022.1038491

Wu, C. J., Kao, T. W., Chang, Y. W., Peng, T. C., Wu, L. W., Yang, H. F., & Chen, W. L. (2018). Does the Additional Component of Calf Circumference Refine Metabolic Syndrome in Correlating With Cardiovascular Risk? *The Journal of Clinical Endocrinology & Metabolism*, *103*(3), 1151–1160. https://doi.org/10.1210/JC.2017-02320

Wyoso, A. W., Subadi, I., Wardhani, I. L., Tinduh, D., Sulistiawaty, N. N., & Arfianti, L. (2022). Correlation between physical activity and hand grip strength in elderly with locomotive syndrome. *International Journal of Health Sciences*, *6*(May), 2195–2207. https://doi.org/10.53730/ijhs.v6ns8.12564

Xu, L., & Zhou, H. (2024). The association between weight-adjusted-waist index and muscle strength in adults: a population-based study. *Frontiers in Public Health*, *12*(July), 1–9. https://doi.org/10.3389/fpubh.2024.1429244

Zimmerman, R., Tsai, A. G., Salazar Vázquez, B. Y., Cabrales, P., Hofmann, A., Meier, J., Shander, A., Spahn, D. R., Friedman, J. M., Tartakovsky, D. M., & Intaglietta, M. (2017). Posttransfusion increase of hematocrit per se does not improve circulatory oxygen delivery due to increased blood viscosity. *Anesthesia and Analgesia*, *124*(5), 1547–1554. https://doi.org/10.1213/ANE.0000000000002008