

Original Research

Correlation Between Handgrip Strength And Hand-Eye Coordination With Fall Risk Among Older Adults

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ABSTRACT

Background: Fall risk is a major health concern among older adults, as it can lead to a decline in quality of life and increased morbidity. Previous studies have predominantly focused on balance and lower limb muscle strength, despite the multifactorial nature of falls. Increased fall risk in older adults is associated with a decline in neuromuscular function, particularly muscle strength and motor coordination. Handgrip strength, as an indicator of overall muscle strength, and hand-eye coordination, as a representation of motor control, may influence postural stability and movement control; however, their roles are often overlooked in the assessment of fall risk.

Methods: This study employed a cross-sectional design. A total of 127 older adults were selected using purposive sampling. Handgrip strength was measured using a handgrip dynamometer, hand-eye coordination was assessed using the Box and Block Test (BBT), and fall risk was evaluated using the Modified Indonesian Fall Risk Assessment Tool (M-IFRAT). The data were analyzed using Somers' d test to examine the relationships between variables.

Results: Statistical analysis showed a significant relationship between handgrip strength ($p = <0.001$; $r = -0.429$) and hand-eye coordination ($p = <0.001$; $r = -0.545$) with fall risk.

Conclusion: Handgrip strength and hand-eye coordination are significantly associated with fall risk among older adults at Puskesmas Sudiang, Makassar. These findings have practical implications for geriatric physiotherapy, particularly in fall prevention, as interventions incorporating muscle strengthening and coordination training may support postural stability and appropriate motor responses.

ARTICLE HISTORY

Received: July 2nd, 2026

Accepted: September 16th, 2026

KEYWORDS

handgrip strength, hand-eye coordination, fall risk, older adults, neuromuscular control;

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Cite this as: Correlation Between Handgrip Strength And Hand-Eye Coordination With Fall Risk Among Older Adults. (2026). *Jurnal Keterapian Fisik*, 11(2), 112-121. <https://jurnalketerapianfisik.com/index.php/jpt/article/view/518>

INTRODUCTION

Population ageing is a global phenomenon that continues to increase, with the number of older adults projected to reach 1.4 billion by 2030 and double by 2050 (WHO, 2025). In Indonesia, older adults comprise approximately 12% of the total population, indicating that the country has entered an ageing population phase (BPS, 2024). Declines in physical and cognitive function among older adults cause challenges in maintaining their quality of life.

In addition, falls represent the major health problem among older adults, as it can lead to injury, disability, and reduced quality of life. The prevalence of falls tends to increase with age, particularly among individuals aged over 60 years, reaching 67.1% in Indonesia (Nurjannah & Hartati, 2024). Falls are multifactorial, meaning they are influenced by various factors such as decreased muscle strength, impaired coordination, and sensorimotor function. A decline in muscle strength is one of the factor contributing to increased fall risk. In older adults, muscle strength decreases by approximately 12–15% per decade, leading to reduced functional ability and a higher risk of falling (Nowakowska-Lipiec et al., 2025).

Age-related musculoskeletal decline also contributes to metabolic disturbances and functional impairment in older adults. Therefore, musculoskeletal problems are a significant concern in this population, as they are closely associated with an increased risk of falls and various chronic musculoskeletal conditions (Nguyen et al., 2025). Handgrip strength is widely used as an indicator of overall muscle strength and neuromuscular function. It reflects the physical condition of older adults and plays a role in maintaining body stability and postural balance (You et al., 2024). However, muscle strength alone is insufficient to fully explain fall risk, as falls involve the interaction of multiple body systems.

In addition to muscle strength, hand-eye coordination also plays an important role in controlling movement and maintaining dynamic balance. Hand-eye coordination refers to the ability to integrate visual and motor systems in responding accurately to stimuli. The ageing process leads to a decline in nervous system function, including slower reaction time and reduced motor control, which in turn affects coordination ability (Gordleeva et al., 2025). In daily activities, hand-eye coordination facilitates goal directed hand movements based on visual input. Impairment in this system may indicate a decline in neuromuscular function, contributing to an increased risk of falls (Selvakumar et al., 2025).

Handgrip strength and hand-eye coordination can serve as important indicators in predicting fall risk. However, most studies have focused on only one of these variables. For instance, Huang et al. (2024) reported that higher handgrip strength and lower body mass index were associated with a reduced risk of falls (Huang et al., 2024). In contrast, studies specifically examining the relationship between hand-eye coordination and fall risk remain limited. Patel et al. (2025) explored the correlation between hand-eye coordination and reaction time in older adults (Patel et al., 2025), but did not directly assess fall risk. In addition, evidence regarding the relationship between hand-eye coordination and fall risk among older adults in community-based primary healthcare settings remains limited. Therefore, this study addresses a research gap by examining handgrip strength and hand-eye coordination simultaneously in relation to fall risk in community-based primary healthcare.

MATERIAL AND METHODS

This study employed a quantitative approach with an observational analytic design using a cross-sectional method. This design was selected to examine correlation between handgrip strength and hand-eye coordination with fall risk in older adults, measured simultaneously at a single point in time.

The study was conducted at Puskesmas Sudiang, Makassar, South Sulawesi, from February to March 2026. A total of 127 participants were recruited using purposive sampling with the slovin formula. Slovin formula was used with the margin of error 5%

and the total population is 185. Therefore, the calculation of the formula results in sample size of 127 people. The inclusion criteria were older adults aged ≥ 60 years who were able to communicate and follow instructions adequately. Exclusion criteria included individuals with movement disorders, a history of extremity fractures limiting activity, and visual impairments that interfered with object recognition. The independent variables were handgrip strength and hand-eye coordination, while the dependent variable was fall risk. Primary data were obtained through direct measurements of handgrip strength using a handgrip dynamometer, hand-eye coordination using the Box and Block Test (BBT), and fall risk using the Modified Indonesian Fall Risk Assessment Tool (M-IFRAT).

The researcher first explained the measuring instrument to the respondent. The Camry handgrip dynamometer was then adjusted according to the respondent's age. The respondent was instructed to hold the dynamometer with one hand, with the elbow flexed at 90° and the wrist in a neutral position. The respondent was then instructed to squeeze the dynamometer as firmly as possible for 3 seconds.

Hand-eye coordination measured by explained the measuring instrument to the respondent. The respondent was then instructed to sit facing the box. The respondent was asked to transfer the blocks one at a time using one hand, ensuring that each block passed over the partition positioned in the center of the box. A block that passed over the partition but was accidentally thrown was still counted as one block. If two blocks passed over the partition simultaneously, they were counted as one block. Subsequently, the respondent was instructed to transfer as many blocks as possible within 60 seconds.

Data collection was carried out through direct measurements and interviews using standardized instruments. Data were analyzed using univariate analysis to describe the frequency distribution of each variable, while bivariate analysis using Somers' d test was performed to examine the relationships among variables.

This study was conducted in accordance with ethical research standards by applying appropriate procedures and standardized instruments. Ethical approval was obtained from the Ethics Committee of Hasanuddin University prior to data collection with the ethical approval number is 127/UN4.18.3/TP.01.02/2026s.

RESULTS

The study was conducted from 14 February to 19 March 2026 in the working area of Puskesmas Sudiang, Makassar. A total of 127 older adults were selected using purposive sampling and met the inclusion criteria. This study utilized primary data obtained through direct measurements of the respondents.

Table 1. Characteristics of respondents

Characteristics of Respondents		Frequency (n)	Percentage (%)
Age	Elderly (60-74 years)	107	84.2
	Old (75-90 years)	19	15.0
	Very old (90+ years)	1	0.8
	Total	127	100.0
Sex	Male	46	36.2
	Female	81	63.8
	Total	127	100.0
Occupation	Retired	88	69.3
	Housewife	25	19.7

Characteristics of Respondents	Frequency (n)	Percentage (%)
Self-employed	8	6.3
Community Leader	4	3.1
Laborer	2	1.6
Total	127	100.0

This table presents the respondent characteristics included in this study. The majority of respondents were classified in the elderly age group (60–74 years), accounting for 107 individuals (84.2%), while a smaller proportion belonged to the very old group. Based on sex, female respondents predominated, with 81 (63.9%) compared to males with only 46 (36.2%) individuals. In terms of occupation, most respondents were retired, totaling 88 (69.3%) individuals, followed by housewives with 25 (19.7%) individuals.

Table 2. Research variables

Variables	Mean	Min	Max
Handgrip Strength	21.459	5.6	42.3
Hand-eye coordination	60.83	21	83
Fall Risk	8.18	2	14

Based on Table 2, the mean, minimum, and maximum values of age, handgrip strength, hand-eye coordination, and fall risk are presented. The mean age of respondents was 67.01 years, ranging from 60 to 94 years. The mean of handgrip strength was 21.459, with values ranging from 5.6 to 42.3. Hand-eye coordination had a mean of 60.83, with values ranging from 21 to 83. Meanwhile, the mean of fall risk score was 8.18, ranging from 2 to 14.

Table 3. Distribution of handgrip strength, hand-eye coordination, and fall risk

Variables	Category	Frequency (n)	Percentage (%)
Handgrip Strength	Weak	47	37.0
	Normal	77	60.6
	Strong	3	2.4
	Total	127	100.0
Hand-eye coordination	Low	46	36.2
	Moderate	80	63.0
	High	1	0.8
	Total	127	100.0
Fall Risk	Low Fall Risk	70	55.1
	High Fall Risk	57	44.9
	Total	127	100.0

Based on Table 3, the distribution of handgrip strength across three categories shows that most older adults were in the normal category, with 77 individuals (60.6%), followed by the weak category with 47 individuals (37.0%), and only 3 individuals (2.4%) in the strong category. For hand-eye coordination, which was also classified into three categories (low, moderate, and high), the majority of respondents were in the moderate category, with 80 individuals (63.0%), followed by the low category with 46 individuals (36.2%), and only 1 individual (0.8%) in the high category. Meanwhile, the

distribution of fall risk indicates that a greater proportion of older adults were in the low-risk category, with 70 individuals (55.1%), compared to 57 individuals (44.9%) in the high-risk category.

Table 4. Somers' d correlation test

Correlation Test	Correlation Coefficient (r)	Significance (p)	Sample (n)
Handgrip Strength and Fall Risk	-0.373	0.000	127
Hand-Eye Coordination and Fall Risk	-0.485	0.000	127

Correlation analysis demonstrated a significant association between handgrip strength and fall risk ($p < 0.001$), with a correlation coefficient of -0.373, reflecting a weak negative association. In addition, hand-eye coordination was also significantly associated with fall risk ($p < 0.001$), with a correlation coefficient of -0.485, indicating a moderate negative relationship.

DISCUSSION

The result of this study showed that handgrip strength and hand-eye coordination were significantly related to fall risk in older adults, with a negative correlation. This finding suggests that better handgrip strength and coordination are associated with a lower risk of falls.

Based on the distribution of handgrip strength, only 3 older adults were categorized as having strong grip strength (2 males and 1 female). The majority of respondents were in the normal category, although the proportion of those with weak grip strength remained relatively high. This condition may be influenced by several factors, including physical activity levels and nutritional status in older adults (Mahapatra & Karri, 2025).

Physiologically, muscle strength declines with age due to neuromuscular degeneration, which affects functional capacity (Eskandarzadeh et al., 2024). However, in this study, the weak category was not only found in older age groups, indicating that other factors such as chronic diseases and physical activity levels also play a role. This finding suggests that handgrip strength does not solely reflect the ageing process but also represents the overall health condition of the individual.

As muscle strength is one component of overall neuromuscular function, it is important to consider other functional abilities that may also influence fall risk in older adults, including hand-eye coordination. Most respondents were classified in the moderate hand-eye coordination category. This condition may be influenced by the continued involvement of older adults in daily activities, which helps prevent a substantial decline in coordination function. Hand-eye coordination involves the integration of visual and motor systems, and impairment in this integration can lead to delayed responses and reduced motor control. Variations observed across sex and age groups suggest that hand-eye coordination is influenced not only by biological factors but also by functional status and individual activity levels (Wu et al., 2026).

The distribution of hand-eye coordination in this study shows that the moderate category was more prevalent among females (37.8%) compared to males (25.2%), with the high category observed only in females. This finding is consistent with previous

studies reporting higher Box and Block Test (BBT) scores in females, which may be attributed to differences in hand anatomy and the characteristics of the measurement tool (K. yi Li et al., 2020). However, this result is not entirely consistent with other studies that report higher hand–eye coordination in males, associated with anatomical differences in brain structures such as the cerebellum and pons, which are involved in motor control (Swathi et al., 2023).

These inconsistencies indicate that hand–eye coordination performance is not solely determined by biological factors but is also influenced by age, activity level, and overall functional condition. Therefore, the interpretation of hand–eye coordination outcomes in older adults should consider these factors comprehensively.

Furthermore, the distribution of fall risk shows a relatively balanced proportion between low and high risk, although the low-risk category was slightly more dominant. This may be associated with respondents who remain physically active and live in relatively supportive environments (Y. Li et al., 2023). However, nearly half of the respondents were classified as high risk, indicating that falls remain a significant concern. Fall risk is multifactorial, influenced not only by physical factors but also by psychological conditions, history of falls, and sensory function, thus requiring a multidimensional approach.

Based on sex, females were more frequently classified in the low-risk category (37.0%) compared to the high-risk category (26.8%), whereas males showed a relatively balanced distribution. This finding suggests that, in this study, females tended to have a lower fall risk than males. This contrasts with previous studies reporting higher fall susceptibility among females due to intrinsic factors. The difference may be influenced by variations in the ability to respond to and anticipate balance disturbances (Patton et al., 2022).

The analysis showed a significant association between handgrip strength and fall risk, characterized by a weak negative correlation. This indicates that higher handgrip strength tends to be associated with a lower risk of falls. These findings are consistent with Neri et al. (2021), who reported that reduced handgrip strength was associated with an increased fall risk among older women (Neri et al., 2021).

This finding are consistent with the present study, which identified a weak negative correlation between handgrip strength and fall risk ($r = -0.373$). Therefore, interpretation of handgrip strength as a measure of overall muscle function should be approached cautiously, as it may not fully represent changes in lower limb strength that directly contribute to fall risk (Michel et al., 2024).

However, hand–eye coordination showed a significant association with fall risk, with a moderate negative correlation. This indicates that coordination ability contributed more strongly than handgrip strength in this study. Previous studies have identified coordination as an objective measure in predicting fall risk, explaining approximately 68.8% of the variance in fall risk among individuals aged 60 years and above, with a negative relationship. This suggests that fall risk is more influenced by specific functional abilities rather than general physical fitness (Tóth et al., 2025).

However, the correlation coefficient in this study ($r = -0.485$) indicates only a moderate relationship, suggesting that hand–eye coordination alone is insufficient as the only indicator for assessing fall risk. This is supported by prior research reporting no significant association between hand–eye coordination and balance in physically active older adults, highlighting that motor ability and functional performance in this

population are complex and cannot be explained by a single parameter (Aditi Nileshtikle & Dr. Nidhi Ladha, 2024).

The findings of this study confirm that handgrip strength and hand-eye coordination collectively contribute to fall risk in older adults. These variables represent different domains physical strength and neuromotor control which are essential in guiding appropriate prevention strategies and physiotherapy interventions in the elderly population.

This result is supported by previous studies, such as Dong et al. (2025), which explain that decreased muscle strength reflects a systemic decline that also affects lower limb strength and coordination. In addition to musculoskeletal factors, reduced handgrip strength is associated with neurological decline, leading to impaired motor control (Dong et al., 2025).

Furthermore, hand-eye coordination is closely related to the integration of sensory and motor systems, which is essential for accurate and rapid movement control. Declines in visual function such as depth perception and visual acuity as well as slowed motor responses, have been shown to contribute to increased fall risk in older adults (Wang et al., 2025).

However, some studies report contrasting findings. A review by Szaflilik et al. (2025) found that the correlation between handgrip strength and overall muscle strength is not always consistent (Szaflilik et al., 2025), while Selvakumar et al. (2025) reported that hand-eye coordination training improves motor performance but does not significantly affect balance (Selvakumar et al., 2025). These inconsistent findings highlight that the relationship between handgrip strength, hand-eye coordination, and fall risk is complex and influenced by factors such as study design, measurement instruments, and participant characteristics.

Overall, handgrip strength and hand-eye coordination play important roles in influencing fall risk among older adults. Handgrip strength reflects general muscle capacity related to functional ability, while hand-eye coordination represents the integration of sensory and motor systems required to respond effectively to environmental changes. Together, these aspects contribute to maintaining balance and postural stability, thereby reducing the risk of falls in the elderly population.

Furthermore, the researchers considered that the findings of this study have practical implications for planning geriatric physiotherapy interventions, particularly for preventing fall risk among older adults. Exercise approaches incorporating muscle strengthening and coordination training are needed to improve postural stability and facilitate rapid and appropriate motor responses. Fall risk assessment should also be conducted comprehensively by considering both physical and functional aspects, thereby enabling interventions to be more effective and appropriately targeted.

This study has several strengths and limitations. The strengths include examining two neuromuscular components, namely handgrip strength and hand-eye coordination, in relation to fall risk among 127 older adults in a community-based primary healthcare setting, using objective and practical assessment tools such as the Camry handgrip dynamometer, Box and Block Test, and Modified Indonesian Fall Risk Assessment Tool. The limitation include the BBT measurement could not be performed entirely and optimally according to standard operating procedures, and testing conditions may have affected respondents' performance. Moreover, the BBT primarily assesses hand dexterity and may not fully represent hand-eye coordination, while the M-IFRAT includes self-reported information that may introduce reporting bias.

Future researchers are therefore recommended to use alternative HEC measurement methods, such as the *pegboard test* or digital/computerized tests, and to include other factors that may influence fall risk, such as other aspects of muscle strength, nutritional status, cognitive function, and physical activity levels, to provide a more comprehensive analysis.

CONCLUSION

In conclusion, this study demonstrates that handgrip strength and hand–eye coordination are significantly associated with fall risk among older adults at Puskesmas Sudiang, Makassar. Handgrip strength showed a weak negative correlation, whereas hand–eye coordination demonstrated a moderate negative correlation. These findings have practical implications for geriatric physiotherapy, particularly in fall prevention, as interventions incorporating muscle strengthening and coordination training may support postural stability and appropriate motor responses. Therefore, comprehensive fall risk assessment that considers both physical and functional aspects is important to facilitate effective and appropriately targeted physiotherapy interventions.

ACKNOWLEDGMENT

The author would like to express sincere gratitude to Puskesmas Sudiang, Makassar, for the support and facilities provided during the data collection process. This study was conducted as part of the author's undergraduate thesis in partial fulfilment of the requirements for a Bachelor's degree in Physiotherapy at Hasanuddin University.

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Informed Consent

FORMULIR PERSETUJUAN SETELAH PENJELASAN

Saya yang bertandatangan 
Nama : SALAWATY DJUMADI
Umur : 66 THN
Jenis Kelamin : PEREMPUAN
Pekerjaan : PENSUNAN
Alamat : BPS Fa NO 13

setelah mendengar/membaca dan mengerti penjelasan yang diberikan mengenai tujuan, manfaat, dan apa yang akan dilakukan pada penelitian ini, menyatakan setuju untuk ikut dalam penelitian ini secara sukarela tanpa paksaan.

Saya tahu bahwa keikutsertaan saya ini bersifat sukarela tanpa paksaan, sehingga saya bisa menolak ikut atau mengundurkan diri dari penelitian ini. Saya berhak bertanya atau meminta penjelasan pada peneliti bila masih ada hal yang belum jelas atau masih ada hal yang ingin saya ketahui tentang penelitian ini.

Saya juga mengerti bahwa semua biaya yang dikeluarkan sehubungan dengan penelitian ini, akan ditanggung oleh peneliti. Saya percaya bahwa keamanan dan kerahasiaan data penelitian akan terjamin dan saya dengan ini menyetujui semua data saya yang dihasilkan  ini untuk disajikan dalam bentuk lisan maupun tulisan.

Dengan membubuhkan tandatangan saya di bawah ini, saya menegaskan keikutsertaan saya secara sukarela dalam studi penelitian ini.

	Nama	Tanda tangan	Tgl/Bln/Thn
Responden	Salawaty Djumadi	 SALAWATY DJ.	07/03/20
/Wali			
Saksi			

(Tanda Tangan Saksi diperlukan hanya jika Partisipan tidak dapat memberikan consent/persetujuan sehingga menggunakan wali yang sah secara hukum)

Penanggung jawab penelitian :	Penanggung jawab Medis/Non-medis :
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