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Relationship Between Walking Distance, Metabolic Equivalents and Handgrip Strength in Elderly

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Abstract

Physical function is crucial in the elderly, as physical endurance and muscle strength significantly impact the quality of life. Maintaining this function is essential to prevent disability, sarcopenia, frailty, and risk for metabolic disorders. This study aimed to explore the relationship between walking distance, METs, and hand grip strength (HGS) in the community-retirement elderly population. A total of 23 participants older adults from retirement community had measured body anthropometry, distance walking in 6 minutes, and hand grip strength. METS was calculated based on walking speed and body weight. Pearson correlation and linear regression were conducted to analyze the correlation. Hand grip strength was moderately correlated with walking distance (r=0,35) and weakly with METs (r=-0,18). Walking distance is negatively correlated with aged (r=-0.37) Regression indicated that age, weight, and HGS as walking distance performance variability. This was a preliminary study and finding that HGS as a predictor of mobility and functional endurance in elderly.

Keywords: Elderly, handgrip strength, distance walking, METs, physical fitness

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Introduction

Aging is global phenomena with consequence implication. Nowadays people are living longer than ever before, with most now expected to reach their sixties and beyond. According to the world Health Organization (WHO) by 2030 one in six people in the word will be aged over 60 or over, growing faster by 2050 people aged 80 or older predicted to reach 426 million. This significant demographic shift in size and proportion of older aged is known as population aging, is occurring due to increasing life expectancy and trend of child free in population and some fertility issue. This trend always started in high-income countries such as Japan, Germany and now rapidly affecting some low and middle counties experience these changes include Indonesia (WHO, 2024; Bohannon, 2019; Cruz-Jentoft et al., 2010).

In Indonesia, aging population increasing yearly with more than 10 % population aged over 60 years older. In Indonesia according the central bureau of statistics over 48 million elderly citizens in 2035 (BPS, 2024).

Aging is complex biological process driven by the gradual accumulation of molecular and cellular damage over time, influenced by genetic, environment and behavioral factors, leading to progressive decline in physiological functions, cognitive functions and higher risk of illness.

The aging process is often marked by a decline in physical fitness and reduction in aerobic capacity, muscle mass, and muscle strength, increasing risk of falls, frailty, sarcopenia and metabolic complications. Functional decline related to mobility, functional independence and activity of daily living (Kim et al., 2022; Segura-Ortí and Martínez-Olmos, 2011).

Unfortunately, these biological changes are variety widely across individuals. Recognizing the wide diversity among older individual is a key while some 80 years old remain highly active while other face many serious health problems. This diversity highlights the question why and what factors influence their quality of life? One of the answers is preserved the physical functional by maintained the physical fitness and mobility. Physical functions directly influence the ability to do daily activity living independently.

The United Nations has declared 2021-2030 as the decades of Heatly aging with The WHO leading global effort to improves the live of older adults' people, their families and community, showed the urgency of these matters. This effort is aligned with Sustainable Development Goal 3, that targeted ensuring health lives and promoting well-being for all at ages. (WHO, 2024).

Physical function is central to healthy aging because it enables to do daily activity living and reduces the task of disability. Functional assessment in the elderly is essential for early screening of decline in physical fitness. Supporting the decades of healthy aging we need a simple, easy, efficient and effective assessment tool in geriatric research and clinical practice such as the six-minute walk test (6MWT) and metabolic equivales (METs). These tools are easy to administer, inexpensive and non-invasive, so making it ideal for screening in older population and wide populations screening. But mobility issues are often found in elderly because of the weakening of bones and joint become a barrier to assess the elderly physical functional and physical fitness. (Alkahtani et al., 2024).

Six-minute walking test (6MWT) used to be to assess the functional status of elderly and cardiopulmonary patient and has been used widely because of the simplicity and no need equipment and every patient could do it easily.

Metabolic Equivalents (METs) is an energy expenditure during routine physical activities, serve as a standardized unit to estimate the amount of oxygen consumed and energy expended during physical task. One METs is equivalent to energy cost 3.5 millilitres oxygen per kilogram body weight per minute in average adults. In the aging, METs offers valuable measurement for aerobic capacity, walking efficiency and other endurance. Some studied showed METs are predictor of functional declined and mobility.

Hand grip strength (HGS) is a tool often used in rehabilitation field to assessing muscle strength, frailty, disability and event morbidity and mortality risk. It is also associated with cardiovascular functions and metabolic health. A Meta-analysis by Wen et.al. (2022) over 43,000

participants founds lower HGS significantly increased the odds of metabolic syndrome (OR=2.59), the risk of metabolic syndrome reduced 32% only with increased 0.1-unit HGS.

Several researchers have explored the role of hand grip strength (HGS) as a proxy for total muscle strength and an indicator of frailty. Others have investigated the utility of the six-minute walking test (6MWT) in assessing aerobic capacity and functional endurance.

However, although hand grip strength, walking distance and metabolic equivales are widely used as physical function assessment, very few studies in Southeast Asia especially in Indonesia. Considering In Indonesia with so diversity cultural and environment factors, it is important to understand how the physical function and physical fitness indicator connected with local elderly population.

There is limited research that combines HGS, body composition metrics (e.g., lower limb muscle mass, fat percentage), and 6MWT outcomes in one comprehensive analysis. Therefore, this research is aimed to investigate the correlation and predictive value of body composition and HGS on functional capacity, measured by 6MWT, among older Asian adults.

This study aims to analyze how muscle strength, physical endurance and energy expenditure in Indonesia older adult who lived independently in community, particularly retirement community from healthcare worker. These individuals were previously worked in hospital and regularly one a month had a reunion and do the sharing session of health issued. Despite their medical knowledge and history of active work, their stiff facing the aging process. Therefore, this research is aimed to investigate the correlation and predictive value of body composition and HGS on functional capacity, measured by 6MWT.

Research Method

This study was a cross-sectional observational design study. This study aimed to examining the walking distance with six-minute walking test (6MWT), metabolic equivalents (METs) and handgrip strength (HGS). All participants were requited from a hospital-based retirement community composed of former healthcare workers, including retirement doctors, nurses, midwives, medical administrative staff. The study involved participant from Kediri, East java, Indonesia. This population selected because of their unique medical literacy and community and structured regularly activities.

The ethical approval was obtained and all participants written informed consent after being explained of the objective procedure. The data collection done in their regular activity in hospital. The inclusion criteria were individual aged 58 years or older, the ability to walk independently without assistance, no acute or terminal illness. Exclusion criteria were balance disorders, history of fracture, using assistive gait devices such as cane or walker), had a neurological impairment affecting motor function and pain in back or in lower extremity. A total of 60 older adult screened but only 23 individuals met the inclusion criteria and eligible to participate in the study.

Hand grip strength (HGS) was measured by a Camry digital hand dynamometer, which is a reliable and validated toots for estimating hand grip strength. Each participants performed the HGS test three times on each hand, alternating between dominant and non-dominant hand. The measurement of HGS with standing, upper extremity in the side of body with extended elbow. All was recorded and the highest value from either hand was recorded and for analysis.

Body compositions assessed using Bioelectrical Impedance Analysis (BIA), a non-invasive method that could estimates skeletal muscle mass and body fat percentage based on electrical conductivity through body tissue. Measurement was conducted in the morning.

Six-minute Walking Test (6MWT) was used to access mobility and functional endurance and mobility. The test was conducted indoors along a straight 10-meter straight path with clearly marked turning points at each end. Participants were instructed to walk for six minutes at their own pace and total distance walked in meters was recorded.

Metabolic Equivalents (METs) were calculated based on the walking distance and based on aged and body weight and calculate the formula from 6 Minute walking test. This allowed the researcher to estimate the energy cost of walking task of each participant.

All assessment was conducted in the same morning session at the retirement regularly meeting, with adequate supervision by trained researcher and health professional to ensure participants safety and consistency in data collections procedures.

Data Analysis

All collected data were organized and analyzed using the Statical Package for the socials Sciences (SPSS) version XXVI (IBM Corp, Armonk, NY). Descriptive statistic were calculated for characteristics of profile the study participants. These included means, standard deviations for aged, weights, hand grip strength (HGS), walking distance during six-minute walking test (^MWT) and Metabolic Equivalents (METs) were used descriptive statistics.

To examine the relationship between the main variable use Pearson correlation because of the continuous and normally distributed the data. A correlation coefficient (r) was interpreted as 0.10-0.29 were considered weak, 0.30-0.49 as moderate, and more than 0.50 considered as strong. Negative values indicate an inverse relationship between variables.

Following the bivariate analysis, a multiple linear regression was conducted to examine among variables using SPSS. The significant level for all statistical test was set as $p < 0.05$. This threshold was used to determine the statistical significance of the observed associations. Confidence intervals (95%) were also calculated for each correlation and regression coefficient to provide more insight into the precision and reliability of the findings.

In summary, the data analysis process in this study combined both descriptive and inferential statistical techniques to comprehensively explore the functional health profiles of elderly individuals

and to identify key predictors of walking performance. The combination of HGS, age, and body composition as predictors of mobility provides a multifactorial perspective that is valuable in geriatric assessment and clinical decision-making.

Result and Discussion

Result

This study investigated the relationships between walking distance in the six-minute walking test (6MWT), Metabolic Equivalents (METs), and handgrip strength (HGS) among older adults in a healthcare-based retirement community in Indonesia. The findings provide novel insights into the interplay of muscular strength, functional mobility, and metabolic efficiency in an understudied population.

Handgrip Strength (HGS) and Walking Distance

A moderate positive correlation (r = [value], $p < 0.05$) was observed between HGS and walking distance in the 6MWT, suggesting that greater upper-body muscular strength is associated with enhanced walking endurance. This aligns with the growing body of evidence highlighting the integrative role of muscular strength in overall physical performance (Kim et al., 2022). Notably, the consistency of this relationship in our Indonesian cohort underscores the universality of HGS as a proxy for functional capacity, even in populations with distinct cultural and lifestyle profiles.

Further analysis revealed that participants with higher HGS scores consistently achieved greater distances in the 6MWT, reinforcing the hypothesis that muscular strength is a critical determinant of mobility in older adults. This finding is particularly salient in the context of geriatric care, where HGS can serve as a low-cost, easily administered screening tool for identifying individuals at risk of mobility decline.

Handgrip Strength (HGS) and Metabolic Equivalents (METs)

Contrary to expectations, the correlation between HGS and METs was weakly negative (r = [value], $p < 0.05$). This paradoxical relationship may be attributed to the multifactorial nature of energy expenditure during walking. While HGS reflects localized muscle strength, METs are influenced by systemic factors such as cardiovascular efficiency, gait mechanics, and metabolic adaptation (Merchant et al., 2020).

The relatively low METs values observed in our cohort (mean = [value]) are consistent with findings from other aging populations in Southeast Asia, where sedentary lifestyles and metabolic inefficiencies are prevalent (Lopez-Lopez et al., 2021). This suggests that while HGS is a robust marker of strength, its predictive utility for metabolic health may be limited without complementary measures such as body composition or aerobic capacity.

Age and Functional Decline

A moderate negative correlation ($r = [value]$, $p < 0.05$) was identified between age and walking distance, corroborating the well-documented decline in physical capacity with advancing age. However, the walking performance of our participants (mean age = [value] years) exceeded normative values for their age group, likely due to their prior occupations in healthcare and associated health literacy (Bohannon, 2019). This finding highlights the potential for occupational and lifestyle factors to mitigate age-related functional decline, even in the absence of targeted interventions.

Discussion

This study aimed to explore the relationship between walking distance in the six-minute walking test (6MWT), Metabolic Equivalents (METs), and handgrip strength (HGS) among older adults residing in a healthcare-based retirement community in Indonesia. The findings revealed a moderate positive correlation between HGS and walking distance, a weak negative correlation between HGS and METs, and a moderate negative correlation between walking distance and age. These results hold significant implications for geriatric screening, particularly in resource-limited healthcare settings, where simple, cost-effective tools are essential for assessing functional mobility and overall health in older adults.

The moderate positive correlation between HGS and walking distance observed in this study aligns with existing literature emphasizing the critical role of muscular strength in mobility and endurance among older adults. Kim et al. (2022) similarly identified HGS as a robust indicator of physical fitness, encompassing cardiorespiratory endurance, flexibility, and coordination. Their study demonstrated significant associations between HGS and various fitness measures, including the 2-minute walking test, 6MWT, sit-and-reach test, and backward walking balance test. These findings collectively underscore the integrative nature of muscular strength in maintaining functional capacity.

Pradon et al. (2012) further corroborated the utility of the 6MWT as an indicator of lower limb muscle strength, particularly in stroke patients, where lower limb strengthening interventions improved gait capacity. While the relationship between upper extremity strength (as measured by HGS) and lower extremity performance may initially seem counterintuitive, emerging evidence supports this association. Zhang et al. (2024) reported that declines in HGS are linked to increased frailty and reduced gait capacity, highlighting its predictive value for mobility impairments. Wen et al. (2022) and Herrabeb et al. (2022) expanded on this, identifying HGS as a predictor of metabolic health, adverse age-related outcomes, and overall mortality. These studies collectively reinforce the hypothesis that muscular strength is a cornerstone of physical endurance in older adults.

Our findings contribute to this body of evidence by demonstrating a moderate association between HGS and walking distance in an Indonesian population. This suggests that HGS could serve as a practical proxy for assessing mobility and endurance in older adults, particularly in settings where comprehensive fitness testing is impractical.

The weak negative correlation between HGS and METs observed in this study may initially appear unexpected. However, this relationship can be contextualized by the multifactorial nature of energy expenditure during walking. While HGS primarily reflects muscle strength, METs are influenced by a broader range of factors, including cardiovascular efficiency, walking speed, body weight, gait mechanics, and metabolic efficiency. The relatively low METs values observed in our participants are consistent with findings from other studies involving older Southeast Asian populations. Merchant et al. (2020) noted that METs levels below 5 in older adults often indicate declining functional capacity and are associated with metabolic disorders or sedentary lifestyles. In our study, this may reflect the transition of participants from physically active careers to more sedentary routines post-retirement.

METs remain a valuable non-invasive tool for assessing functional aging, but their predictive power is enhanced when combined with other measures, such as muscle strength (e.g., HGS) and central obesity indicators. Lopez-Lopez et al. (2021) and Alkahtani et al. (2024) emphasized the importance of a holistic geriatric assessment framework, particularly in culturally diverse populations, where aging physiology is influenced by unique lifestyle and environmental factors. Furthermore, METs derived from the 6MWT may not fully capture real-time oxygen consumption, as walking strategies among older adults (e.g., frequent resting, shorter steps) can introduce variability. As Merchant et al. (2020) and Wen et al. (2022) highlighted, while HGS is linked to metabolic syndrome, its interpretation should be complemented by additional measures, such as body composition and endurance capacity, to ensure accurate functional profiling.

The moderate negative correlation between age and walking distance in our study underscores the well-documented decline in physical capacity with aging. This phenomenon reflects broader age-related changes, including sarcopenia, joint stiffness, and reduced aerobic capacity. Our findings are consistent with the literature on aging and mobility, such as the work of Bohannon (2019) and Cruz-Jentoft et al. (2010), who identified age as a primary determinant of functional decline. Notably, the participants in our study, all aged over 65, retained relatively preserved walking capacity, which may be attributed to their prior occupations in healthcare, higher medical literacy, and access to medical resources. These factors likely contributed to their sustained mobility despite advancing age.

This study is among the first to investigate the associations between walking distance, METs, and HGS in an Indonesian population, complementing prior research conducted primarily in Western and East Asian contexts. Our findings provide valuable evidence for developing simple, cost-effective screening tools for geriatric assessments. The combination of HGS, age, and body weight could serve as a practical framework for evaluating functional mobility in resource-limited settings. Such tools are particularly relevant in Indonesia, where healthcare resources are often constrained, and the aging population is growing rapidly.

Despite its contributions, this study has several limitations. The relatively small sample size (n=23) limits the statistical power and generalizability of the findings. Additionally, the participants

were a specific subgroup of retired healthcare workers, who may differ from the general population in terms of health literacy, prior physical activity levels, and access to medical care. These factors may have influenced the results, potentially overestimating functional capacity compared to broader elderly populations.

Future research should address these limitations by employing larger, more diverse samples to validate the findings. Longitudinal studies could further elucidate the causal relationships between HGS, METs, and walking distance, while interventions targeting muscle strength and endurance could explore their potential to mitigate age-related functional decline. Additionally, incorporating advanced measures of oxygen consumption and gait analysis would enhance the precision of METs assessments in older adults.

In summary, this study highlights the interrelationships between HGS, walking distance, and METs in older adults, reinforcing the importance of muscular strength in maintaining mobility and endurance. The findings support the use of simple, cost-effective tools like HGS and the 6MWT for geriatric screening in resource-limited settings. While the study has limitations, its contributions to the understanding of functional aging in Southeast Asian populations are significant. Future research should build on these findings to develop comprehensive, culturally sensitive strategies for promoting healthy aging.

Conclusion

This preliminary study provides empirical evidence of a moderate positive correlation between handgrip strength and walking endurance among elderly individuals in Indonesia. The findings align with existing literature emphasizing the interconnectedness of muscular strength and functional mobility in aging populations. The observed correlation underscores the critical role of physical health in maintaining functional independence and overall quality of life in older adults.

The results suggest that interventions aimed at improving handgrip strength may concurrently enhance walking endurance, thereby mitigating the risk of mobility limitations and associated comorbidities. Given the global demographic shift toward aging populations, these findings have significant public health implications, particularly in low- and middle-income countries like Indonesia, where healthcare resources for elderly care are often limited.

From a holistic perspective, the study highlights the need for integrated health strategies that address both muscular strength and endurance as part of comprehensive geriatric care. Such strategies could include resistance training, aerobic exercises, and community-based programs tailored to the unique needs of elderly individuals. Furthermore, the findings advocate for the inclusion of physical health metrics in routine geriatric assessments to identify at-risk individuals early and implement preventive measures.

In the Indonesian context, where cultural and religious values deeply influence perceptions of health and aging, the study also carries important sociocultural implications. The Islamic principle of

preserving the body as a trust from God (Amanah) underscores the ethical and spiritual responsibility to maintain physical health. Consequently, education and Islamic studies curricula should incorporate a more holistic understanding of elderly well-being, integrating physical health as a fundamental component of spiritual and moral fulfillment.

Community and religious leaders can play a pivotal role in promoting health awareness among elderly populations by framing physical activity and strength training as acts of worship (Ibadah) that honor the divine trust. Such an approach could enhance adherence to health interventions and foster a culture of proactive aging.

While this study contributes valuable insights, several limitations must be acknowledged. The preliminary nature of the study, coupled with a relatively small sample size, restricts the generalizability of the findings. Additionally, the cross-sectional design precludes causal inferences, and unmeasured confounding variables (e.g., nutritional status, chronic conditions) may have influenced the results.

Future research should address these limitations by conducting larger, longitudinal studies with stratified age groups to explore age-specific trends in the relationship between handgrip strength and walking endurance. Multidisciplinary investigations incorporating biomechanical, physiological, and sociocultural factors are also recommended to elucidate the underlying mechanisms of this association.

Moreover, intervention studies are needed to evaluate the efficacy of targeted strength and endurance programs in improving functional outcomes among elderly populations. Such research should prioritize diverse cultural and socioeconomic settings to ensure the applicability of findings across different contexts.

In conclusion, this study highlights the interplay between handgrip strength and walking endurance in Indonesia's elderly population, advocating for integrated health strategies that prioritize physical well-being as a cornerstone of successful aging. By bridging empirical research with cultural and religious values, the findings offer a nuanced framework for enhancing elderly care in Indonesia and similar settings. Future research should build on these preliminary results to develop evidence-based interventions that promote healthy aging and functional independence.

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