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# Lower Limb Muscle Endurance and Its Relationship to Functional Mobility in the Elderly of Puskesmas II Tabanan

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**Abstract**

This study aims to determine the relationship between lower limb muscle endurance and functional mobility among elderly individuals at Puskesmas II Tabanan. This observational analytic study employed a cross-sectional design and included 63 elderly individuals aged 60–69 years with normal BMI based on Asian adult standards. Participants were selected through simple random sampling. Lower limb muscle endurance was assessed using the 30-Second Chair Stand Test (30s-CST), while functional mobility was measured using the Timed Up and Go Test (TUGT). Data were analyzed using the Spearman's Rho correlation test due to non-normal distribution. The Spearman's correlation test showed a strong and statistically significant negative correlation between lower limb muscle endurance and functional mobility ($r = -0.535$, $p = 0.000$). Participants with higher repetition counts in the 30s-CST completed the TUGT in shorter times, indicating better mobility performance. There is a significant inverse relationship between lower limb muscle endurance and functional mobility in older adults. Routine assessment and targeted interventions focusing on muscle endurance should be integrated into geriatric healthcare programs to enhance mobility and reduce fall risk.



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## INTRODUCTION

Aging represents a natural biological progression marked by gradual functional decline across multiple body systems, particularly the musculoskeletal system. Among its notable impacts is the diminished endurance of lower limb muscles, which plays a critical role in reducing physical capability and increasing fall risk in the elderly(Hunter et al., 2016). This deterioration significantly hampers the ability of older adults to perform routine tasks independently, such as ambulating, ascending stairs, and transitioning from sitting to standing positions.

Muscular endurance of the lower limbs is defined as the capacity of leg muscles to sustain repeated movements over time without experiencing excessive fatigue. This component is essential for preserving physical mobility, balance, and the ability to perform everyday functional tasks (Cruz-Jentoft et al., 2019). Advancing age is frequently associated with sarcopenia—a degenerative condition marked by the gradual reduction in skeletal muscle mass and strength—most notably affecting the lower limbs (Govindasamy et al., 2025). The onset and progression of this condition are influenced by multiple factors, including reduced physical activity, hormonal fluctuations, persistent low-grade inflammation, suboptimal nutrition (such as insufficient protein or vitamin D), and the presence of chronic illnesses like cardiovascular disease and diabetes (Chang et al., 2025)

Indonesia is undergoing a demographic shift toward an aging society. According to data from Statistics Indonesia approximately 11.75% of the national population or over 32 million people were aged 60 years or older in 2023. This proportion is projected to rise significantly in the coming decades. In Bali Province, the older adult population accounted for 12.98% in 2020, with some areas, such as Tabanan Regency, reaching 17.2% Badan Pusat Statistik (2023). The increasing proportion of older individuals underscores the critical need to mitigate age-associated deterioration in muscular function, in order to preserve their independence and overall well-being.

Functional mobility refers to an individual's capacity to navigate their surroundings autonomously and effectively, encompassing essential elements such as walking speed, balance control, and the ability to shift between seated and standing positions(Kuo et al., 2024). A decline in lower limb endurance leads to difficulty in maintaining walking speed and balance, ultimately reducing the ability to perform daily tasks and increasing the risk of injury and dependency (H. Wang et al., 2022).

The 30-Second Chair Stand Test (30s-CST) is among the most commonly employed assessments for evaluating lower limb muscle endurance in the elderly. During the test, participants repeatedly rise from and return to a seated position on a standard chair over a 30-second period, keeping their arms crossed and avoiding the use of hands for support.

This procedure offers a practical, dependable, and validated approach to measure endurance and strength of the lower extremities in aging individuals (Ensink et al., 2025). Performance on the 30s-CST has been associated with general physical function and fall risk, making it an effective screening tool in geriatric assessments (ROONGBENJAWAN & SIRIPHORN, 2020).

Conversely, functional mobility is commonly evaluated through the Timed Up and Go (TUG) Test, which involves timing how long it takes for a person to stand up from a chair, walk a distance of three meters, turn around, walk back, and sit down(Gatenio-Hefling et al., 2024). This test is widely recognized for its reliability and sensitivity in assessing dynamic balance, walking ability, and overall mobility in older adults (Ortega-Bastidas et al., 2023). Higher TUG scores (i.e., longer times) are associated with decreased mobility, a higher risk of falls, and potential functional limitations (Eagles et al., 2018).

Several studies have demonstrated a significant relationship between lower limb muscle function and mobility performance in older adults. For example, (Peoples et al., 2024) reported that strength and endurance in the legs were positively associated with performance in tasks such as standing from a chair and walking. Understanding this relationship is critical for designing preventive strategies against disability and improving functional independence in aging populations(Futrell et al., 2022).

Hence, this research seeks to explore the association between lower extremity muscle endurance and the functional mobility of elderly individuals.

## METHODS

This study utilized an analytical observational design with a cross-sectional approach and was conducted at Puskesmas II Tabanan. This design allows researchers to observe and analyze the relationship between the variables studied at a single point in time without any intervention. The cross-sectional approach is commonly used to identify patterns or associations between risk factors and health conditions in a specific population.

### Participants

The target population consisted of elderly individuals in Tabanan City, while the accessible population included elderly individuals registered at Puskesmas II Tabanan. Participants were individuals aged 60 to 69 years, with a normal Body Mass Index (BMI) as per Asian adult standards, who were willing to participate and signed an informed consent form. Individuals with comorbidities, under medication, with secondary illnesses, or using mobility aids were excluded from the study.

### Sampling Procedures

Simple random sampling technique was applied, whereby each eligible participant from the accessible population was assigned a number, and selections were made randomly using a computer-generated number system. This method ensures that every individual in the population has an equal chance of being selected, thereby reducing the risk of selection bias and increasing the representativeness of the sample. The required sample size was calculated using the correlation hypothesis test formula, resulting in a total of 63 participants.

**Materials and Apparatus**

In this study, a set of tools and materials was utilized to measure lower limb muscle endurance and functional mobility through the Timed Up and Go Test (TUGT) and the 30-Second Chair Stand Test (30s-CST). A standard armless chair with a seat height of approximately 43–45 cm was used as the primary equipment for the 30s-CST, serving as the medium for repeated sit-to-stand movements. For the TUGT, a stable chair with a backrest and no wheels was used as the starting and ending point of the test. A three-meter walking distance was marked on the floor using a measuring tape and visible floor markers to indicate the turnaround point. A digital stopwatch was employed to accurately record the time taken to complete the TUGT, while a data recording sheet and writing instruments were used to document the number of repetitions in the 30s-CST and the completion time in the TUGT. All tests were conducted under the supervision of trained personnel who provided standardized instructions and ensured participant safety throughout the procedures, considering the elderly population's increased risk of imbalance and falls.

**Procedures**

The preliminary phase involved obtaining ethical approval from the Litbang FK Unud/RSUP Sanglah Ethics Committee, securing permissions from relevant authorities, and preparing informed consent documents. During implementation, eligible participants were selected and briefed about the study's purpose and procedures. Demographic data such as age, height, and weight were collected, followed by the administration of the 30s-CST and TUGT. All results were recorded and documented.

30-Second Chair Stand Test Measurement Procedure Endurance of the lower limb muscles was evaluated using the 30-second Chair Stand Test (30s-CST). To ensure stability, a standard armless chair was positioned against a wall. Participants were instructed to sit on the front half of the chair while keeping their arms folded across their chest. Upon the command "start," participants stood up fully and sat back down repeatedly for 30 seconds. The number of complete repetitions was recorded to indicate lower limb muscle endurance.

Timed Up and Go Test Measurement Procedure Functional mobility was assessed using the Timed Up and Go Test (TUGT). A 3-meter flat and obstacle-free path with adequate lighting was prepared. Participants began in a seated position. At the command "start," they stood up, walked 3 meters, turned around at a marked point, returned to the chair, and sat down again. The time taken from standing to sitting back down was measured using a stopwatch. The results were categorized as follows: <10 seconds indicated normal mobility, <20 seconds indicated good mobility, and <30 seconds indicated potential mobility issues.

Additional Measurements and Instruments Body Mass Index (BMI) was determined by dividing body weight in kilograms by the square of height in meters (kg/m²). According to Asian adult standards, a BMI within the range of 18.5 to 22.9 kg/m² was considered normal. Age was recorded in years based on official identification documents. Instruments used in this study included a chair, stopwatch, measuring tape with 0.01-meter accuracy, a weighing scale with 0.01-kilogram accuracy, notebooks, writing tools, a camera for documentation, and a laptop for data processing and storage.

**Design or Data Analysis**

Data were analyzed using IBM SPSS Statistics version 23. Descriptive statistics were used to summarize participant demographics, 30-Second Chair Stand Test (30s-CST) scores, and Timed Up and Go Test (TUGT) results. The Shapiro-Wilk test was conducted to assess the normality of the data distribution. Since the results of both the 30s-CST and TUGT did not meet the assumptions of normality, the non-parametric Spearman correlation test was applied to examine the relationship between lower limb muscle endurance and functional mobility.

## RESULT

Data acquired from the research with appropriate statistical analysis described in the methods section should be included in this section. In this part, the same data/ information given in a table must not be repeated in a figure, or vice versa. Tables and Figures should be self explanatory and it is not acceptable to repeat extensively the numerals from tables into text and give lengthy and unnecessary explanations of the Tables and Figures.

Based on age distribution, the majority of respondents were in the 60–64 years age group, totaling 34 individuals (53.97%), while the remaining 29 individuals (46.03%) were aged 65–69 years. This indicates a relatively balanced distribution within the early elderly age range, with a slight predominance of younger elderly participants.

In terms of gender, most respondents were female, accounting for 48 individuals (76.2%), while only 15 respondents (23.8%) were male. This disparity reflects the general demographic trend of a higher life expectancy among women compared to men.

Lower limb muscle endurance, evaluated using the 30-Second Chair Stand Test, showed that approximately 46.0% of the elderly participants scored below average, 47.7% were within the average range, and just 6.3% exceeded the average. This implies that many older adults in the study demonstrated inadequate endurance in their lower extremities.

**Table 1.** Subject Data Based on Age, Lower Limb Muscle Endurance, and Functional Mobility

| No | Characteristics | (n) | Percentage (%) |
|---|---|---|---|
| 1 | Age (years) | | |
| | 60–64 years | 34 | 53,97 |
| | 65–69 years | 29 | 46,03 |
| 2 | Gender | | |
| | Female | 48 | 76,2 |
| | Male | 15 | 23,8 |
| 3 | Lower Limb Muscle Endurance | | |
| | Below Average | 29 | 46,0 |
| | Average | 30 | 47,7 |
| | Above Average | 4 | 6,3 |
| 4 | Functional Mobility | | |
| | Normal Mobility | 20 | 31,7 |
| | Good Mobility | 42 | 66,7 |
| | Assisted Mobility | 1 | 1,6 |

Functional mobility, as measured by the Timed Up and Go Test, revealed that most participants (66.7%) demonstrated good mobility. Furthermore, 31.7% showed normal mobility levels, while only 1.6% required assistance. These results suggest that the majority of the elderly individuals retained sufficient to strong functional mobility.

According to the results in Table 2 lower limb muscle endurance was the independent variable in this study and was assessed using the 30-Second Chair Stand Test. For male participants aged 60–64 years, endurance was categorized as below average (<14 repetitions), average (14–19 repetitions), and above average (>19 repetitions). In the 65–69 age group, below average was defined as fewer than 12 repetitions, average as 12–18 repetitions, and above average as more than 18 repetitions. For female participants aged 60–64 years, below average performance was indicated by fewer than 12 repetitions, average by 12–17 repetitions, and above average by more than 17 repetitions. For those aged 65–69 years, the classification was: below average (<11 repetitions), average (11–16 repetitions), and above average (>16 repetitions).

**Table 2.** Distribution of Lower Limb Muscle Endurance Based on Age Group

| Lower Limb Muscle Endurance | Age Group | | | |
|---|---|---|---|---|
| | 60–64 Years | | 65–69 Years | |
| Below Average | 16 | (47,1%) | 13 | (44,8%) |
| Average | 17 | (50,0%) | 13 | (44,8%) |
| Above Average | 1 | (2,9%) | 3 | (10,4%) |

The table illustrates the distribution of lower limb muscle endurance across two elderly age groups: 60–64 years and 65–69 years. In the 60–64 years age group, 47.1% of subjects had below-average muscle endurance, 50.0% had average muscle endurance, and only 2.9% had above-average muscle endurance. In the 65–69 years age group, 44.8% had below-average muscle endurance, 44.8% had average muscle endurance, and a slightly higher proportion (10.4%) had above-average muscle endurance.

**Table 3.** Distribution of Functional Mobility According to Age Group

| Functional Mobility | Age Group | | | |
|---|---|---|---|---|
| | 60-64 Year | | 65-69 Year | |
| Normal Mobility | 13 | (38,3%) | 7 | (24,1%) |
| Good Mobility | 20 | (58,8%) | 22 | (75,9%) |
| Assisted Mobility | 1 | (2,9%) | 0 | (0%) |

The dependent variable in this research was functional mobility, which was evaluated through the Timed Up and Go Test (TUGT). This assessment involved recording the time it took for older adult participants to stand up from a chair, walk three meters, turn, walk back to the chair, and sit down once more. The interpretation of the test results was as follows: normal mobility (<10 seconds), good mobility (10-19 seconds), and assisted mobility (20-30 seconds). The distribution of functional mobility by age group shows that among participants aged 60–64 years, the majority (58.8%) exhibited good mobility, 38.3% had normal mobility, and only 2.9% required assistance. Meanwhile, in the 65–69 years age group, 75.9% demonstrated good mobility and 24.1% had normal mobility, with no participants needing assistance.

To determine the appropriate statistical analysis method, a normality assessment was performed. The Shapiro-Wilk Test was employed to evaluate whether the data followed a normal distribution. The outcomes of this analysis are displayed in Table 4.

**Table 4.** Normality Test Results of Lower Limb Muscle Endurance and Functional Mobility

| Normality Test Using the Shapiro-Wilk Test | | | |
|---|---|---|---|
| Characteristics | n | Mean ± SD | p |
| Lower Limb Muscle Endurance (repetitions) | 63 | 12,76±3,28 | 0,160 |
| Functional Mobility (seconds) | 63 | 11,84±2,89 | 0,033 |

The Timed Up and Go Test (TUGT) produced a p-value of 0.033 ($p < 0.05$), indicating a deviation from normal distribution. Conversely, the 30-Second Chair Stand Test (30s-CST) showed a p-value of 0.160 ($p > 0.05$), suggesting that these data followed a normal distribution. Given these findings, a non-parametric approach was deemed appropriate for subsequent hypothesis testing due to the non-normal distribution observed in one of the variables.

Based on the cross-tabulation between lower limb muscle endurance and functional mobility, the results indicate a negative correlation with a Spearman's Rho coefficient of $r = -0.535$ and a p-value = 0.000 ($p < 0.05$). This signifies a moderate to strong negative correlation that is statistically significant.

This finding indicates that increased lower limb muscle endurance among older adults is associated with reduced time to complete the functional mobility assessment, thereby signifying improved functional mobility performance.

**Table 5**. Results of Spearman's Rho Association Test Between Lower Limb Muscle Endurance and Functional Mobility

| Spearman's Rho Correlation Test | | | | | |
|---|---|---|---|---|---|
| Functional Mobility | | | | | |
| **Lower Limb Muscle Endurance** | Normal Mobility | Good Mobility | Assisted Mobility | (r) | p |
| Below Average | 3 (4,8%) | 25 (39,7%) | 1 (1,6%) | | |
| Average | 14 (22,2%) | 16 (25,4%) | 0 (0%) | -0,53 | 0,00 |
| Above Average | 3 (4,8%) | 1 (1,6%) | 0 (0%) | | |
| Total | 20 (31,7%) | 42 (66,7%) | 1 (1,6%) | | |

## DISCUSSION

The Spearman's Rho analysis revealed a correlation coefficient (r) of -0.535 and a p-value of 0.000 ($p < 0.05$), signifying a statistically significant and moderately strong negative correlation between the number of repetitions completed in the 30-Second Chair Stand Test and the duration taken to complete the Timed Up and Go Test (TUGT). This outcome suggests that greater lower limb muscle endurance is associated with a shorter TUGT completion time, reflecting better functional mobility among the elderly population. These results underscore the importance of lower limb muscular endurance in supporting functional mobility and sustaining independent living among elderly individuals. Muscle endurance, defined as the ability of a muscle group to sustain repeated contractions over time, is essential for the performance of daily activities such as walking, standing up, and climbing stairs (Kim et al., 2024).

With aging, there is a natural decline in muscle mass and endurance, which contributes to decreased mobility and increased risk of falls. Neuromuscular efficiency, defined as the nervous system's capacity to effectively stimulate muscle fibers over an extended period, plays a critical role in determining muscle endurance. Enhanced neuromuscular activation allows muscles to perform sustained functional tasks more effectively (P. Wang et al., 2024). Maintaining postural stability and coordinated movement relies heavily on several lower limb muscles, including the ankle's dorsiflexors and plantar flexors, the knee's flexors and extensors, and the hip's abductors and adductors. Adequate endurance in these muscle groups is necessary for repetitive lower limb tasks such as those assessed in the TUGT(Smith et al., 2024).

Intervention studies have shown that muscle endurance training can yield substantial benefits for the elderly. Resistance training regimen with elastic bands over six weeks led to enhancements in muscular strength, as well as noticeable improvements in balance and functional mobility(Lina et al., 2023). These improvements were evidenced by reduced TUGT times, supporting the value of endurance-based training in geriatric populations.

Declining muscle endurance affects various aspects of physical functioning in the elderly. A lack of endurance can lead to early fatigue, reduced walking capacity, poor balance, and impaired gait all of which are risk factors for falls and loss of independence(Li et al., 2023). When endurance is compromised, tasks like standing, turning, and transitioning between postures become more taxing, increasing the risk of instability and falls (Sun et al., 2021).

The association between low muscle endurance and impaired functional mobility also reflects broader physiological changes related to aging. Sarcopenia the age-related loss of muscle mass and function is a key contributor to reduced endurance and mobility limitations (Zhou et al., 2024). This condition is exacerbated by physical inactivity, nutritional deficiencies, and comorbidities, creating a cycle of declining physical performance(Beaudart et al., 2017).

Multiple studies reinforce the connection between muscle endurance and mobility. Older adults with poor muscle endurance exhibited longer TUGT completion times and higher instability(Roshanravan et al., 2017). Similarly, Yuliadarwati (2020) noted that diminished muscle endurance negatively impacted balance, sit-to-stand transitions, and increased fall risk(Takimoto et al., 2025). These findings emphasize the need for assessments such as the 30s-CST in routine geriatric evaluations.

Maintaining or improving lower limb muscle endurance requires consistent and structured physical activity. Exercise interventions focused on muscular endurance such as repeated bodyweight movements, resistance band workouts, or low-impact aerobic training are proven to enhance endurance capacity and functional outcomes in older adults (Hu et al., 2024).

The findings emphasized the value of incorporating endurance-based training into regular physical activity routines for older adults. The study demonstrated that even minimal engagement such as one 20-minute session per week can lead to observable functional benefits, while participating in three sessions per week yielded the greatest improvements. This highlights the effectiveness of low-frequency yet high-adherence exercise programs in enhancing mobility and mitigating age-related functional decline(Fragala et al., 2019). These results align with current scientific understanding that structured physical activity particularly interventions targeting muscular endurance plays a critical role in preserving functional independence in older adults. The discussion should critically relate these outcomes to existing literature, comparing consistencies or discrepancies with earlier findings, and contributing to a deeper understanding of how muscular endurance impacts functional mobility, fall risk, and overall quality of life in aging individuals(B. Wang et al., 2023).

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## CONCLUSION

In conclusion, this study confirms a significant inverse relationship between lower limb muscle endurance and functional mobility as measured by the 30s-CST and TUGT. Enhancing muscle endurance through appropriate exercise interventions can contribute to improved balance, reduced fall risk, and greater independence among elderly individuals. These findings support the inclusion of muscle endurance assessments and training in geriatric health programs, particularly in community health settings such as Puskesmas II Tabanan.

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