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Body Mass Index and Its Impact on Speed, Mobility, and Daily Activities in the Elderly: A Cross-Sectional Study

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Abstract

Introduction: Aging in the elderly leads to various issues due to degenerative processes. These processes cause a decline in physical function, affecting walking speed, mobility, and the ability to perform Activities of Daily Living (ADL). Body Mass Index (BMI), as an indicator of body composition, is often associated with walking speed, mobility, and ADL in the elderly. This study aims to examine the relationship and direction of the association between BMI and walking speed, mobility, and ADL in elderly individuals.
Methods: This study employed an analytical observational method with a cross-sectional approach, as the data were not normally distributed. The research was conducted from March to December 2024. A total sampling technique was used, resulting in 72 participants who met the inclusion and exclusion criteria. BMI was calculated based on knee height and body weight. Walking speed was measured using the 10-Meter Walking Test, mobility was assessed with the Timed Up and Go (TUG) Test, and ADL was evaluated using the Barthel Index.
Results: Spearman's Rho correlation analysis indicated no significant relationship between BMI and walking speed ($p = 0.762$). However, a significant correlation was found between BMI and mobility ($p = 0.029$, $r = -0.258$) and between BMI and ADL ($p = 0.024$, $r = -0.267$). The negative correlation suggests that higher BMI is associated with lower mobility levels and decreased independence in performing ADL among the elderly.
Conclusion: This study demonstrates that BMI is not significantly associated with walking speed but has a significant relationship with mobility and independence in ADL. The negative correlation indicates that higher BMI is linked to reduced mobility and lower levels of independence in daily activities among elderly individuals.

Keywords: Activities of Daily Living, Body Mass Index, Walking Speed, Elderly

Introduction

Human life progresses through various stages that change with age, from infancy to old age. This process involves a reduction in muscle mass (sarcopenia), a decline in sensory function, a slowdown in metabolism, and an increase in body fat, all of which can affect the functional capacity of older adults.[1] One of the primary impacts of aging is the degeneration of the nervous system, which contributes to multiple physiological changes, including sarcopenia, sensory function decline, metabolic slowdown, and increased body fat, all of which influence the physical condition of the elderly.[2,3]

These degenerative processes affect the physical fitness of older adults, defined as the ability to perform physical activities optimally while maintaining sufficient energy reserves.[4] One crucial component of physical fitness is walking speed, which reflects the functional status and overall health of older adults. Walking speed serves as an essential indicator of functional status and is influenced by various factors, including Body Mass Index (BMI).[5] In older adults, metabolic decline leads to a 3–8% loss of muscle mass, while visceral fat increases, altering body composition.[3] A higher BMI requires greater energy expenditure for movement, causing overweight or obese older adults to walk more slowly to conserve energy and maintain postural stability.[6,7] Previous studies have reported a negative correlation between obesity-level BMI and walking speed in older women ($r = -0.703$, $p = 0.002$).[8]

Beyond walking speed, BMI also affects mobility—the ability to move from one point to another—which is a critical component of elderly fitness and is closely linked to fall risk and reduced independence.[9] In 2015, the World Health Organization (WHO) emphasized that healthy aging depends on maintaining functional ability. As individuals age, mobility limitations increase, with 35% of older adults aged 70 and the majority of those aged 85 experiencing a decline in mobility.[10]

The ability to perform Activities of Daily Living (ADL), such as eating, bathing, and dressing, is also a key indicator of independence in older adults.[11] Studies in Indonesia have shown an increasing limitation in ADL with age, rising from 51% among individuals aged 55–64 years to 62% among those aged 65 and older.[12] Research has demonstrated a significant relationship between BMI and ADL ($p = 0.001$), indicating that older adults with lower body weight are more vulnerable to degenerative and cardiovascular diseases, which can impact their independence.[13,14]

While some studies have found significant associations between BMI, walking speed, mobility, and ADL, others suggest that additional factors may influence these relationships. Based on this background, this study tests the hypothesis that there is a negative relationship between BMI and walking speed, mobility, and daily activities in older adults. Therefore, this study aims to analyze the relationship between BMI and walking speed, mobility, and ADL in older adults residing in Singapadu Tengah Village, Sukawati District, Gianyar Regency.

Methods

This study employed an observational analytic design with a cross-sectional approach. The research was conducted across various *banjars* in Singapadu Tengah Village from March to December 2024, involving a total of 72 subjects selected using a total sampling technique. The study subjects were older adults aged over 60 years who were able to communicate, read, and write proficiently and were willing to participate until the study's completion. Exclusion criteria included individuals with total immobilization, a history of fractures within the past six months that could affect walking speed, mobility, and Activities of Daily Living (ADL),[15,16] as well as neurological disorders such as vertigo, which impact balance and increase the risk of falls.[17,18]

The independent variable in this study was Body Mass Index (BMI), calculated based on body weight and height. Since older adults experience postural changes, height was estimated using knee height with the Chumlea equation. Knee height was measured from the heel to the top of the tibia while the knee was flexed at 90 degrees. The Chumlea equation for males is 64.16 – (0.04 × age in years) + (2.02 × knee height in cm), whereas for females, it is 84.88 – (0.24 × age in years) + (1.83 × knee height in cm). Body weight was measured using a weighing scale, and the obtained height was used to calculate BMI with the formula BMI = Weight (kg) / Height (m)².[14,17]

The dependent variables in this study were walking speed, mobility, and ADL. Walking speed was measured using the 10-Meter Walking Test, which has an intraclass correlation coefficient (ICC) reliability of 0.96–0.98.[15] Mobility was assessed using the Timed Up and Go Test (TUG) with an ICC reliability of 0.89, while ADL was evaluated using the Barthel Index, which has a Cronbach's α reliability of 0.938. Measurements were conducted by trained research personnel to ensure data accuracy.[16]

This study received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Udayana University, under approval number 0906/UN14.2.2.VII.14/LT/2024, along with permissions from the respective *banjars* in Singapadu Tengah Village. Participants provided informed consent before enrollment. The BMI measurements were classified into three categories based on the Indonesian Ministry of Health (2018) guidelines: underweight (<18.5 kg/m²), normal (18.5–22.9 kg/m²), and overweight (≥23 kg/m²).[17] Walking speed was categorized according to the cut-off points from Peters et al. (2013),[20], while TUG scores were classified following McKinley (2022).[18]. ADL was assessed using the Barthel Index and categorized according to Pertamita and Ulliya (2017) as follows: total dependence (0–4), severe dependence (5–8), moderate dependence (9–11), mild dependence (12–19), and independent (20). This study confirmed that the Barthel Index is a valid tool for assessing independence levels in older adults.[16]

Data collection involved structured interviews, ensuring completeness through standardized questionnaires. All data were checked and verified before analysis to prevent missing information. To minimize bias, researcher training, the use of reliable instruments, and standardized measurement environments were implemented. Data re-evaluation ensured consistency before analysis. Sensitivity analysis was not conducted, as the measurement and analytical methods used were appropriate for depicting the studied conditions, maintaining the validity of the research findings.

Data processing was performed using SPSS version 24.0, with univariate analysis to examine variable distributions and bivariate analysis to assess the relationships between BMI, walking speed, mobility, and ADL. Data normality was tested using the Kolmogorov-Smirnov test, which indicated that all variables were non-normally distributed ($p < 0.05$). Consequently, Spearman's Rho correlation test was used for bivariate analysis.

Results

The subjects in this study were active older adults in Singapadu Tengah Village who met the inclusion criteria. The identification process of study subjects is illustrated in Figure 1.

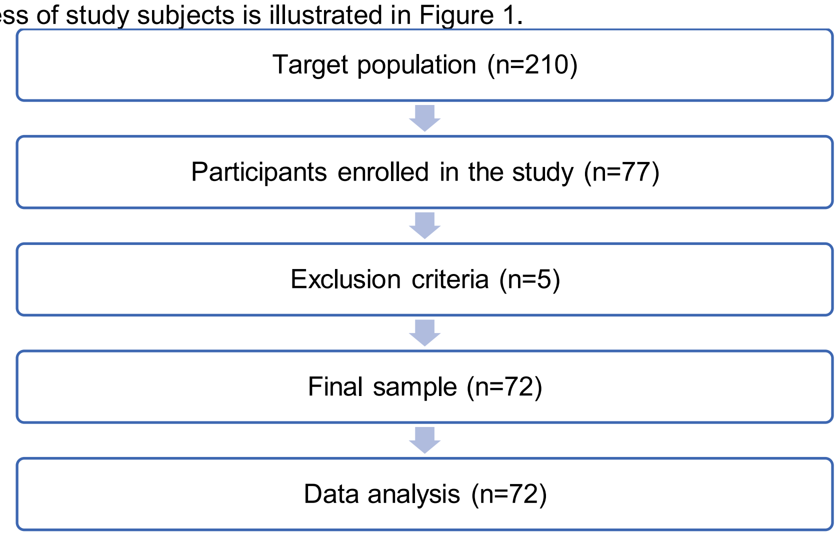

Figure 1. Study Subject Identification Process

Out of 210 older adults in the target population, 133 individuals did not participate for various reasons: 85 individuals declined to participate, 28 had acute health conditions, and 20 could not be contacted. Additionally, five individuals were excluded based on the exclusion criteria due to neurological disorders. As a result, the final number of respondents was 77 older adults.

The sample characteristics include age distribution, gender, BMI, gait speed, mobility, and ADL. Table 1 presents the frequency distribution of the study sample characteristics.

Table 1. Frequency Distribution of Study Sample Characteristics

Characteristic	Frequency (n)	Percentage (%)
Age		
60-69 years	37	51.4
70-79 years	17	23.6
80-99 years	18	25.0
Gender		
Female	44	61.1
Male	28	38.9
Body Mass Index (BMI)		
Underweight	15	20.8
Normal weight	23	31.9
Overweight	34	47.2
Gait Speed		
Fast	24	33.3
Normal	6	8.3
Slow	42	58.3
Mobility		
Normal	25	34.7
Good mobility	44	61.1
Impaired mobility	3	4.2
Activities of Daily Living (ADL)		
Total dependence	0	0.0
Severe dependence	0	0.0
Moderate dependence	2	2.8
Mild dependence	34	47.2
Independent	36	50.0

Table 1 shows that the majority of respondents were aged 60–69 years (51.4%), followed by 70–79 years (23.6%) and 80–99 years (25.0%). The sample was predominantly female (61.1%), while males accounted for 38.9%. Based on BMI, most participants were classified as overweight (47.2%), followed by those with normal weight (31.9%) and underweight (20.8%).

Regarding gait speed, most older adults had a slow gait speed (58.3%), while 33.3% had a fast gait speed, and 8.3% had normal gait speed. In terms of mobility, 61.1% had good mobility, 34.7% had normal mobility, and 4.2% experienced mobility impairment. Regarding ADL, half of the respondents (50.0%) were independent, 47.2% had mild dependence, and 2.8% had moderate dependence.

The following tables present the results of statistical analyses examining the relationship between Body Mass Index (BMI) and functional outcomes in older adults. Table 2 shows the relationship between BMI and gait speed. Table 3 presents the analysis of the relationship between BMI and mobility. Table 4 outlines the relationship between BMI and the ability to perform Activities of Daily Living (ADL).

Table 2. Analysis of the Relationship Between BMI and Gait Speed in Older Adults

Variable	Correlation Coefficient	p	N
BMI - Gait Speed	-0.036	0.762	72

Table 2 presents the results of the Spearman's Rho test assessing the relationship between BMI and gait speed in older adults. The correlation analysis indicated a non-significant relationship (p = 0.762) with a correlation coefficient of -0.036, suggesting a very weak and insignificant correlation.

Table 3. Analysis of the Relationship Between BMI and Mobility in Older Adults

Variable	Correlation Coefficient	p	N
BMI - Mobility	-0.258	0.029	72

Table 3 illustrates the relationship between BMI and mobility in older adults. The correlation analysis showed a significant negative relationship (p = 0.029) with a correlation coefficient of -0.258. This negative correlation indicates that higher BMI is associated with lower mobility levels in older adults.

Table 4. Analysis of the Relationship Between BMI and ADL in Older Adults

Variable	Correlation Coefficient	p	N
BMI - ADL	-0.267	0.024	72

Table 4 describes the relationship between BMI and ADL in older adults. The analysis revealed a significant negative correlation (p = 0.024) with a correlation coefficient of -0.267. This finding suggests that an increase in BMI is associated with a decrease in the level of independence in performing daily activities among older adults.

Discussion

This study examines the relationship between Body Mass Index (BMI) and gait speed, mobility, and Activities of Daily Living (ADL) in older adults. The analysis results indicate no significant relationship between BMI and gait speed (p = 0.762), whereas significant negative correlations were found between BMI and mobility (p = 0.029) and between BMI and ADL (p = 0.024).

Sample Characteristics

This study involved a sample of individuals aged 60 years and older, totaling 72 participants. The majority were aged 60–69 years (51.4%), followed by 70–79 years (23.6%) and 80–99 years (25.0%). According to McPhee et al. (2016), older adults tend to be more active at 60–69 years of age compared to older age groups due to declining physical conditions such as muscle strength, flexibility, and endurance.[19]

The gender distribution of the sample showed a higher proportion of females (61.1%) compared to males (38.9%). Thornton (2019) states that, on average, women live four to five years longer than men,[20] due to healthier lifestyle behaviors, such as consuming nutritious foods and avoiding risky behaviors, as well as the protective effects of estrogen on cardiovascular health.[21,22]

The BMI categories in this study included overweight (47.2%), normal weight (31.5%), and underweight (20.8%). Changes in body composition in older adults are influenced by reduced nutritional needs, leading to energy imbalances and dietary intake issues. A high proportion of overweight individuals across all age categories is associated with decreased metabolism and lower calorie expenditure.[23,24]

Gait speed distribution showed that most participants had slow gait speed (58.3%), followed by fast (33.3%) and normal (8.3%). Reduced gait speed in older adults is due to the decline in muscle mass and strength, as well as bone density, which affects mobility and increases sedentary behavior.[25]

Most participants in this study had good mobility (61.1%). Older adults who remain engaged in daily activities and social interactions tend to have better mobility, with or without assistive devices. Rural environments with natural surroundings and strong social interactions also contribute to maintaining physical activity.[26,27]

Regarding ADL, half of the participants (50%) were independent, while 47.2% had mild dependence, and 2.8% had moderate dependence. Wahyuni et al. (2021) found that independence in older adults is associated with nutritional status, where those with abnormal BMI are more likely to depend on others. A supportive and accessible environment also plays a crucial role in enhancing confidence for independent activities.[28,29]

Relationship Between BMI and Gait Speed in Older Adults

As shown in Table 2, the correlation analysis between BMI and gait speed in older adults yielded a significance value of p = 0.762, where p > 0.05. This result indicates no significant relationship between BMI and gait speed among older adults in Singapadu Tengah Village.

With aging, bodily functions decline due to weakened physical conditions. Walking is a crucial indicator for assessing functional health and life expectancy in older adults. Gait ability is essential for daily activities, and reduced gait speed can lead to neuromuscular control impairments and decreased physical capacity, increasing the risk of conditions such as sarcopenia.[30] Walking also serves as a measure of functional ability with aging. The risk of falls in older adults rises due to changes in the body's center of mass while stepping. Older adults who have experienced falls tend to develop a fear of falling again, leading them to restrict their activities to avoid risks.[31]

A study by Vitriana and Defi (2020) found no significant relationship between BMI and gait speed. This is attributed to other factors having a greater impact on gait speed in older adults, particularly muscle strength.[32] Older adults with low activity levels tend to experience a decline in aerobic capacity, contributing to reduced gait speed.[33] Gait speed is influenced by multiple factors, including muscle strength and mass. Decreased muscle strength affects gait ability due to the progressive loss of type IIb muscle fibers, slower muscle metabolism, and suboptimal neuromuscular activation. These factors collectively contribute to muscle strength decline.[34]

A study by Ossowski et al. (2019) found a significant relationship between lower extremity muscle strength and gait speed in older adults, with a result of p = 0.03 (p < 0.05).[35] This finding is further supported by research from Stotz et al. (2023), which also established a connection between muscle strength and gait speed, with p = 0.047 (p < 0.05). Functionally, the flexor/extensor and plantar/dorsiflexor muscles in the lower extremities play a crucial role in gait speed.[36]

Research by Firdaus et al. (2024) found no significant relationship between underweight BMI and gait speed (p = 0.520) or between overweight-obese BMI and gait speed (p = 0.231).[37] This result may be due to a limited sample size and other influencing factors, such as gender, comorbidities, medical history, muscle mass, and muscle strength. In addition to BMI, gait speed is affected by various factors, including chronic diseases, regular medication use, history of falls, fracture incidents, dementia, cardiovascular conditions, and physical activity levels.[30]

Environmental factors also play a role in influencing gait speed in older adults. An unsupportive environment can hinder their motivation and ability to walk. Uneven and rough walking surfaces, lack of warning signs, and absence of walking aids can increase anxiety about falling, leading to slower walking speeds. Research by Cauwenberg et al. (2016) found that street characteristics, such as sidewalk quality and safety, significantly affect older adults' ability to walk.[38] Poorly maintained sidewalks and unsafe pedestrian crossings reduce older adults' confidence in walking, ultimately leading to decreased gait speed.[39]

Relationship Between Body Mass Index and Mobility in the Elderly

Table 3 presents the results of the analysis examining the relationship between Body Mass Index (BMI) and mobility in the elderly, showing a p-value of 0.029 (p<0.05), indicating a significant relationship between BMI and mobility. The correlation coefficient of -0.258 suggests a weak negative correlation, meaning that higher BMI values are associated with lower mobility scores and vice versa.

Elderly individuals experience metabolic changes that often lead to overweight or obesity. Mobility in the elderly is influenced by various factors, including nutritional status, disease, lifestyle, and living environment.[40] Barbosa et al. (2018) found that individuals with abdominal obesity had a higher likelihood of experiencing mobility limitations, with a p-value of 0.01 (p<0.05). Excess weight can also lead to psychological issues, such as increased anxiety due to high BMI, which promotes sedentary behavior and reduces physical activity. This decline in physical activity ultimately has a negative impact on mobility in the elderly.[41]

According to a literature review by Arsyad et al. (2022), a significant relationship exists between nutritional status and mobility in the elderly.[42] Elderly individuals with an above-normal or excessive BMI tend to experience mobility difficulties due to excessive body fat, which restricts movement. This aligns with the study by Tay et al. (2019), which states that an increase in BMI contributes to physical inactivity, leading to a gradual decline in physical function. Reduced physical capability due to inactivity negatively affects mobility in the elderly.[43]

Based on the data analysis in this study, the correlation between BMI and mobility is weak because other factors also influence mobility in the elderly, such as physical activity, environmental conditions, muscle strength, joint flexibility, and balance. Physical activity is a key factor affecting mobility, as it involves skeletal muscle movement and requires energy. Thus, good mobility strongly depends on the elderly's ability to engage in physical activity. Apart from existing diseases, the health status of elderly individuals can also be assessed based on their physical mobility. Elderly individuals with good mobility tend to have a higher quality of life, as good mobility is associated with increased life expectancy.[44]

An increase in BMI also affects the range of motion (ROM) in the elderly. ROM is used to measure joint flexibility, which ultimately influences mobility. Higher BMI is one factor that leads to decreased ROM, negatively impacting joint flexibility. A study by Siada et al. (2024) found a significant negative relationship between BMI and ankle dorsiflexion (p=0.004; r=-0.397) as well as BMI and ankle plantarflexion (p=0.001; r=-0.435). This means that higher BMI values are associated with lower joint flexibility, ultimately affecting elderly mobility.[45]

Relationship Between Body Mass Index and Activities of Daily Living in the Elderly

Table 4 presents the analysis results, indicating a significant relationship between BMI and Activities of Daily Living (ADL), with a p-value of 0.024 (p<0.05). The correlation coefficient of -0.267 shows a weak negative correlation.

Elderly individuals tend to have higher BMI due to age-related physiological changes. Aging affects various bodily functions involved in daily activities and metabolism. According to Borda et al. (2021), a significant relationship exists between BMI and ADL, with a p-value of 0.001. Increased BMI impacts the elderly's ability to perform daily activities independently due to changes in body composition that may hinder movement.[12] Similarly, Takagi and Kageyama (2022) reported that sarcopenic obesity reduces the elderly's ability to perform daily activities and limits bodily movements essential for energy expenditure, thereby increasing the risk of overweight.[46]

A study by Lestari et al. (2017) found that elderly individuals with lower body weight tend to have higher physical activity levels compared to overweight elderly individuals, leading to better physical and mental health. Good physical health enhances the ability of the elderly to perform daily activities with ease.[47] This finding is supported by Anggreni et al. (2023), who noted that elderly individuals with lower body weight are at greater risk of degenerative diseases such as diabetes and cardiovascular diseases, which can affect their ability to carry out daily activities.[13]

The strength of the relationship between BMI and ADL is weak due to other influencing factors, one of which is age. According to Papalia (2015), as individuals age, their ability to perform daily activities, particularly self-care tasks, declines, increasing their dependence on others.[48]

Another factor influencing ADL is physical condition and mobility. Declining physical function and mobility can be caused by chronic diseases such as stroke, arthritis, and diabetes, which limit the ability to perform daily activities. The risk of falls in the elderly is influenced by various factors, including fall history, age, medication use, mobility disorders, gait patterns, cognitive impairments, and lower extremity conditions. Additionally, environmental factors such as uneven walking surfaces, inappropriate footwear, and the use of assistive devices can increase the risk of falls. Lower extremity impairments, such as muscle weakness, affect functional mobility in the elderly, leading to increased dependence in performing daily activities.[49]

The findings of this study highlight the importance of considering factors beyond BMI when aiming to enhance mobility and independence in the elderly. Interventions focusing solely on weight management are insufficient to improve walking speed and mobility; instead, they should be combined with strength training programs, balance exercises, and regular physical activities to support optimal elderly mobility. Health policies should incorporate promotive and preventive programs for the elderly, including education on appropriate physical activities, improved environmental accessibility, and social support to maintain independence in ADL.

This study has several limitations, including its cross-sectional design, which only establishes associations between variables without proving causality between BMI and walking speed, mobility, and ADL. Additionally, using BMI as an indicator of nutritional status does not account for body fat distribution, which may have a more significant impact on mobility and activity levels in the elderly. The sample characteristics were limited to a specific region, restricting the generalizability of the findings, especially for populations in different environmental conditions. Sampling bias should also be considered, as the majority of respondents were women, potentially influencing the study results due to biological and lifestyle differences between men and women.

The implications of this study suggest that maintaining a healthy weight and increasing physical activity are crucial for preserving mobility and independence in the elderly. Interventions such as light aerobic exercises, including walking or stationary cycling, may help improve musculoskeletal function and slow mobility decline. Future research should employ more precise body composition measurement methods, such as bioelectrical impedance analysis, and explore environmental factors affecting elderly activity levels in greater depth.

Conclusion

Based on the study results, it can be concluded that Body Mass Index (BMI) is not significantly associated with walking speed in older adults. However, a significant negative relationship was found between BMI, mobility, and Activities of Daily Living (ADL), indicating that an increase in BMI may contribute to decreased mobility function and reduced independence in daily activities.

The implications of these findings emphasize the importance of maintaining physical function in older adults to enhance their quality of life and promote healthy aging. One recommended strategy is engaging in regular physical activity, such as light aerobic exercises like walking for 20–30 minutes daily, to support mobility and independence in daily tasks. Additionally, a multidisciplinary approach involving nutritional education, physiotherapy, and tailored exercise programs can serve as a preventive measure in managing BMI and preserving the functional capacity of older adults.

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