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DIFFERENCES IN WALKING BALANCE ACROSS BODY MASS INDEX AND FALL RISK CATEGORIES AMONG OLDER ADULTS

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ABSTRACT

Objective: This study aimed to examine differences in walking balance across body mass index (BMI) categories and fall risk categories among community-dwelling older adults. Methods: A cross-sectional study was conducted among 55 community-dwelling older adults. BMI was classified using Asia–Pacific criteria. Fall risk was assessed using the Morse Fall Scale, and walking balance was evaluated using the 8-Foot Up and Go test (cut-off 8.5 seconds). Associations were analyzed using chi-square or Fisher's exact test, with effect sizes reported as Cramer's V. Multivariable logistic regression was performed adjusting for age and sex. Results: Impaired walking balance was observed in 69.1% of participants. BMI was not significantly associated with walking balance (χ^2 = 4.78, p = 0.188, Cramer's V = 0.29). Fall risk showed a significant association (χ^2 = 11.61, p = 0.003, Cramer's V = 0.46). After adjustment, moderate and high fall risk were associated with increased odds of balance impairment (OR = 3.12, 95% CI: 1.10–8.85; OR = 5.48, 95% CI: 1.62–18.54). Conclusion: Walking balance impairment among older adults was significantly associated with fall risk category but not with BMI classification. These findings suggest that fall risk assessment may provide additional clinical insight into functional balance impairment compared to anthropometric measures alone.

Keywords

older adults; walking balance; body mass index; fall risk; mobility

INTRODUCTION

Population ageing is accompanied by a rising prevalence of balance impairments and mobility limitations, which substantially increase the risk of falls among older adults (Montero-Odasso et al., 2022). Falls represent a major public health concern because they are closely associated with injury, loss of independence, and reduced quality of life (Oseni et al., 2025). Walking balance is a critical component of functional mobility and is central to fall prevention

strategies in community-dwelling older adults (Nordling et al., 2024)

Body mass index (BMI) is widely used as a simple anthropometric indicator linked to balance and mobility (Cho et al., 2018). Both underweight and overweight conditions have been associated with impaired postural control, altered biomechanics, and reduced functional capacity in older adults, although these relationships are increasingly understood to be mediated by body composition and neuromuscular function rather than body mass alone (Nordling et al., 2024). However, BMI does not capture body composition or neuromuscular function, which are key determinants of balance among older adults (Nordling et al., 2024).

In contrast, fall risk assessment tools such as the Morse Fall Scale incorporate functional and behavioral dimensions, including gait characteristics and fall history, and therefore may better reflect dynamic balance performance during functional tasks (Beck Jepsen et al., 2022; Strini et al., 2021)

Recent studies also show that the Morse Fall Scale demonstrates good predictive performance for falls in older adults across various care settings (Cai et al., 2025). Understanding how walking balance differs across BMI and fall risk categories is important to refine clinical screening and guide targeted intervention planning in geriatric populations (Thiamwong et al., 2023). Despite prior research on BMI and fall risk, it remains unclear whether anthropometric measures provide comparable clinical value to multidimensional fall risk tools in predicting dynamic balance impairment in community-dwelling older adults. Fall risk assessment tools incorporate mobility-related components, such as gait and transfer ability, which may overlap conceptually with balance measures. This overlap may inflate the observed associations and should be considered when interpreting the findings. This study aimed to examine differences in walking balance across body mass index categories and fall risk categories among community-dwelling older adults.

METHOD

This study employed a cross-sectional design. Participants aged ≥50 years were included to capture both early ageing and older populations, a pattern relevant in Southeast Asian contexts, where functional decline may begin earlier. However, analyses were interpreted with consideration of standard geriatric definitions (≥60 years). A total of 55 participants were included using total sampling from the available population. The study was conducted in a community setting in Sragen, Central Java, Indonesia. Participants were recruited from community health posts (Posyandu Lansia). All eligible individuals present during the data collection period were invited to participate. While total sampling was used, potential selection bias from voluntary participation is acknowledged. Data collection was carried out on May 2025. This study received ethical approval from the Health Research Ethics Committee of Dr. Moewardi General Hospital. All participants provided written informed consent before participation. A minimum sample size of 52 participants was required to detect a moderate association (effect size $w = 0.3$) with 80% power and $\alpha = 0.05$ using a chi-square test. The final sample of 55 participants met this requirement.

Body weight and height were measured to calculate BMI, which was classified according to Asia–Pacific criteria (underweight, normal, overweight, and obesity class I). Fall risk was assessed using the Morse Fall Scale and categorized as low, moderate, or high risk. Walking balance was assessed using the 8-Foot Up and Go test.

Performance was categorized as: Balanced (≤8.5 seconds) and impaired (>8.5 seconds)

This cut-off was based on normative values for older adults reported in the Senior Fitness Test. Although originally developed for hospital settings, the Morse Fall Scale has demonstrated acceptable reliability and validity in older adult populations, including adaptations for non-hospital environments. The 8-Foot Up and Go test is a reliable measure of dynamic balance and functional mobility in older adults and has been recommended for fall risk screening in geriatric populations.

Data analysis included descriptive statistics to summarise participant characteristics. Associations between categorical variables were analyzed using Pearson's chi-square test. When expected cell counts were less than five, Fisher's exact test was applied. Effect sizes were reported using Cramer's V. Multivariable logistic regression analysis was conducted to examine the independent association between fall risk, BMI, and walking balance, adjusting for age and sex. Results were presented as odds ratios (OR) with 95% confidence intervals (CI). Statistical significance was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics version 26.

RESULTS

Table 1. Baseline Characteristics of Study Participants (N = 55)

Variable	Mean ± SD	Min–Max
Age (years)	63.16 ± 8.60	50–90
Body Mass Index (kg/m²)	22.02 ± 3.86	15.4–29.7
Morse Fall Scale score	32.82 ± 24.81	0–85
8-Foot Up and Go time (seconds)	12.62 ± 6.43	6–47

Table 1 summarizes the baseline characteristics of the study participants. The mean age of the older adults was 63.16 years, indicating that most participants were in the early elderly age group. The mean BMI was within the normal range according to the Asia-Pacific criteria, although substantial variability suggests heterogeneous nutritional status. The mean Morse Fall Scale score indicated an overall moderate level of fall risk, while the average 8-Foot Up and Go completion time exceeded commonly used cut-off values for optimal mobility.

Table 2. Distribution of Participant Characteristics (Sex, BMI, Fall Risk, and Walking Balance)

Categorical Variables	n	%
Sex		
Female	33	60.0
Male	22	40.0
BMI Category		
Underweight	12	21.8
Normal	20	36.4
Overweight	7	12.7
Obesity class I	16	29.1
Fall Risk Category		
Low risk	18	32.7
Moderate risk	21	38.2
High risk	16	29.1
Walking Balance Status		
Balanced	17	30.9
Impaired balance	38	69.1

Note: Percentages are presented as column percentages.

As shown in Table 2, the majority of participants were female. Normal BMI constituted the largest proportion, followed by obesity class I and underweight categories. A total of 69.1% of participants

were classified as having impaired walking balance. Regarding fall risk, 38.2% and 29.1% of participants were categorized as moderate and high risk, respectively.

Table 3. Distribution of Walking Balance Status across Fall Risk Categories

BMI Category	Balanced n (%)	Impaired n (%)	Total
Underweight	2 (16.7)	10 (83.3)	12
Normal	6 (30.0)	14 (70.0)	20
Overweight	1 (14.3)	6 (85.7)	7
Obesity class I	8 (50.0)	8 (50.0)	16

$\chi^2 = 4.78$, $p = 0.188$

Table 3 shows the distribution of walking balance status across BMI categories. No statistically significant association was found between BMI category and walking balance ($\chi^2 = 4.78$, p = 0.188, Cramer's V = 0.29).

Table 4. Distribution of Walking Balance Status across Fall Risk Categories

Fall Risk Category	Balanced n (%)	Impaired n (%)	Total
Low risk	11 (61.1)	7 (38.9)	18
Moderate risk	4 (19.0)	17 (81.0)	21
High risk	2 (12.5)	14 (87.5)	16

$\chi^2 = 11.61$, $p = 0.003$

Table 4 shows the distribution of walking balance across fall risk categories. The association was statistically significant ($\chi^2 = 11.61$, p = 0.003, Cramer's V = 0.46).

In the multivariable analysis, after adjusting for age and sex, fall risk remained significantly associated with walking balance. Participants with moderate fall risk had higher odds of impaired balance (OR = 3.12, 95% CI: 1.10–8.85), and those with high fall risk had even greater odds (OR = 5.48, 95% CI: 1.62–18.54). BMI category was not significantly associated with walking balance (p > 0.05).

DISCUSSION

This study demonstrated that walking balance impairment was significantly associated with fall risk category but not BMI classification. However, this association should be interpreted cautiously due to potential conceptual overlap between fall risk assessment and balance measures. This finding suggests that BMI alone may not adequately capture the complex biomechanical and neuromuscular factors that influence walking balance (Kruse et al., 2025).

The Morse Fall Scale includes mobility-related components such as gait and transfer ability, which overlap with constructs measured in dynamic balance tests. Therefore, the observed association may partly reflect shared measurement domains rather than independent predictive relationships.

The absence of a significant association between BMI category and walking balance in this study is consistent with emerging evidence suggesting that anthropometric indices alone provide limited insight into functional performance in older adults. Several studies have highlighted that muscle strength, neuromuscular coordination, and body composition play a more decisive role in balance control than total body mass. Consequently, older adults with similar BMI values may exhibit substantially different balance capabilities depending on their functional and neuromuscular status (de Maio Nascimento et al., 2022).

From a biomechanical perspective, dynamic balance during walking requires coordinated control of the center of mass

relative to the base of support. While excess or insufficient body mass may alter this relationship, adaptive strategies such as increased step width or reliance on visual input may partially compensate for these changes. Such compensatory mechanisms may explain why BMI categories did not show a statistically significant association with walking balance in this sample (Wang et al., 2025).

From a statistical perspective, the non-significant association between BMI category and walking balance may also be influenced by the limited sample size within certain BMI subgroups, which reduced the power to detect small-to-moderate effects. This observation is consistent with the presence of several cells with low expected frequencies, which may have reduced the statistical power to detect differences in balance performance across BMI categories. Larger sample sizes or more precise measures of body composition may be required to identify such associations (Abdul Rahman et al., 2025).

In contrast, fall risk category showed a strong and significant association with walking balance impairment (Table 2). Participants with moderate and high fall risk exhibited markedly higher proportions of impaired balance compared with those classified as low risk. This result supports the use of fall risk assessment tools as sensitive indicators of functional balance performance (Muir et al., 2010). The Morse Fall Scale captures multiple dimensions relevant to balance, including gait characteristics, history of falls, and use of assistive devices. These components directly reflect real-world mobility challenges, making fall risk classification a more sensitive indicator of balance impairment than static anthropometric measures (Strini et al., 2021).

The findings indicate that functional risk profiling may be more clinically relevant than anthropometric classification in identifying older adults at risk of balance impairment. Fall risk assessment integrates multiple dimensions of mobility and behavior, which may explain its stronger association with walking balance outcomes (Phelan et al., 2015).

The findings of this study have important implications for nursing and geriatric care practice. Fall risk assessment may provide additional insight into functional balance impairment; however, it should complement, rather than replace, direct balance assessment in clinical practice. In contrast, reliance on BMI classification alone may be insufficient to identify older adults at risk of balance impairment, highlighting the need for functional assessments in clinical decision-making (Beck Jepsen et al., 2022).

For nursing, prosthetist orthotist and community health practice, these findings emphasize the need to prioritize functional screening over reliance on body size indicators. Incorporating routine fall risk and balance assessments into community-based health services may enable nurses and other health professionals to identify high-risk individuals earlier and implement targeted interventions, such as balance exercises, environmental modification, and patient education, to reduce fall-related morbidity (Phelan et al., 2015).

Several limitations should be considered. First, the cross-sectional design limits causal inference. Second, the relatively small sample size may reduce statistical power, particularly for subgroup analyses. Third, adjustment for potential confounders was limited. Fourth, conceptual overlap between fall risk and balance measures may have influenced the observed associations. Finally, the findings may not be generalizable beyond this community-

based sample. BMI does not account for body composition or muscle strength, which may play a critical role in balance performance among older adults (Hiol et al., 2021).

CONCLUSIONS

Walking balance impairment was associated with fall risk category but not BMI in this sample. However, given the potential overlap between fall risk and balance measures, these findings should be interpreted cautiously. Further studies with larger samples and multivariable approaches are needed to confirm these relationships.

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