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RESEARCH ARTICLE **OPEN ACCESS**

BMI Status, Balance Impairment, and Fear of Falling Among Older Adults in Rural Northern Thailand

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Abstract:

Background: Fear of falling is a prevalent concern among older adults and is associated with physical inactivity, reduced independence, and decreased quality of life. Although various factors contribute to the fear of falling, limited evidence exists regarding the relationship between body mass index status, balance impairment, and fear of falling, particularly in rural populations.

Objective: This study aimed to examine the association between body mass index, balance impairment, and fear of falling among community-dwelling older adults in a rural area.

Methods: A cross-sectional study was conducted among 439 older adults aged 60 years and above residing in rural Thailand. In the initial phase, a list of older adults was obtained from primary care center records, and simple random sampling was employed to select participants according to the inclusion criteria. Data were collected on demographic characteristics, body mass index, balanced performance (measured using the Berg Balance Scale and the Timed Up and Go test), and fear of falling (assessed using the Short Falls Efficacy Scale-International). Multiple linear regression analysis was conducted to determine the factors significantly associated with fear of falling.

Results: The results showed that 56.7%, 18.5%, and 24.8% of the elderly had low, moderate, and high fear of falling, respectively. Multiple regression analysis revealed that balance performance, as measured by the Berg Balance Scale, was the only significant predictor of fear of falling ($\beta = -0.298$, $p < 0.001$), whereas the Timed Up and Go test and body mass index were not significantly associated.

Conclusion: Balance impairment is a key determinant of fear of falling among older adults in rural areas. Interventions to improve balance may be effective in reducing fear of falling and preventing functional decline in this population.

Keywords: Fear of falling, Body mass index, The Berg Balance Scale, TUG, Older adults.

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1. INTRODUCTION

A complete-aged society is defined as one in which the population aged 60 years or older exceeds 20% of the total population or the population aged 65 years or older exceeds 14%. As of 2023, Thailand had 13.19 million people aged 60 years or older, representing approximately 19.97% of the total population of 66.05 million, indicating that Thailand was nearing the status of a complete-aged society [1]. As the global population ages, maintaining independence and quality of life among older adults has

become a growing public health concern. One critical issue affecting this population is the fear of falling (FOF), which is not only common but also closely linked to reduced physical activity, social withdrawal, functional decline, and increased risk of actual falls [2-4].

FOF is more commonly observed with increasing age due to age-related physical decline. This deterioration affects the musculoskeletal system responsible for balance, leading to unstable gait and reduced confidence in mobility and postural control. As a result, older adults are more likely to lose balance and experience falls. In Thailand, the prevalence of FOF among older adults has been reported to be approximately 35.8% [5], indicating a substantial portion of the aging population is affected. Individuals with FOF often limit their daily activities and avoid physical movement, which can lead to muscle weakness, impaired balance, and further functional decline [6].

Among the various indicators of physical health, Body Mass Index (BMI) is frequently used as a measure of nutritional and functional status in older adults. While some studies have suggested that being underweight or overweight may contribute to fall risk and FOF, findings remain inconsistent [7, 8]. Balance impairment, on the other hand, has been consistently associated with FOF and fall risk. Tools such as the Berg Balance Scale (BBS) and the Timed Up and Go (TUG) test are widely used to assess balance and mobility, providing objective insight into an individual's fall risk and functional capacity [9, 10]

Importantly, fear of falling is an internal psychological state rather than a diagnosable disease. Many older adults, particularly those living in rural areas, may lack awareness or understanding of this condition and may not recognize it as a problem. As a result, they may not seek help or take preventive measures, which can increase their risk of physical decline, functional limitations, and reduced quality of life [11, 12]. There is a need to better understand how BMI status, balance function, and FOF interrelate in this population, particularly in low-resource rural communities where targeted fall prevention strategies may be limited.

This study aims to examine the association between BMI, balance impairment (BBS and TUG), and fear of falling among community-dwelling older adults in a rural area. The findings may inform the development of more effective fall prevention programs tailored to the needs of older adults in rural settings.

2. MATERIALS AND METHODS

2.1. Study Design and Participants

A cross-sectional study was conducted among 1,500 community-dwelling older adults aged 60 years and over residing in Maeka Sub-district, Phayao Province, Northern Thailand, during the period of 2023–2024. The sample size was calculated using the n4studies application based on the standard formula for an infinite population [13]. The expected proportion (p) was derived from a previous study in Thailand, which reported a fear of falling (FOF) prevalence of 35.8% [5]. To achieve a precision level of 5% and a margin of error (d) of 0.04, the calculated sample size was 439 participants.

In the initial phase, a list of older adults was obtained from primary care center records, and simple random sampling was employed to select participants. At the time of data collection, 439 older adults were available to participate in the study. The inclusion criteria required that older adults be residents of the selected villages for at least one year and provide informed consent to take part in the study. Exclusion criteria included immobility, physical disability, dyspnea, psychological or neurological disorders, severe illness, and dementia, as indicated by a Mini-Mental State Examination–Thai version (MMSE-Thai 2002) score of less than 10 [14].

2.2. Instrument

Data collection was conducted using a structured questionnaire, the Berg Balance Scale (BBS), the Timed Up and Go (TUG) test, and the Short Falls Efficacy Scale-International (Short FES-I). The questionnaire comprised four sections.

The first section addressed sociodemographic characteristics and health conditions, including gender, age, marital status, education level, monthly income, and living arrangement. Health conditions included the presence of comorbidities and Body Mass Index (BMI). BMI was calculated by dividing body weight in kilograms by height in meters squared (kg/m^2). Classification followed the Asian-specific BMI criteria: individuals with a BMI ≥25.0 kg/m^2 were classified as obese, 23.0–24.9 kg/m^2 as overweight, 18.5–22.9 kg/m^2 as healthy weight, and <18.5 kg/m^2 as underweight.

The second section of the measurement involves the Timed Up and Go (TUG) test. To perform the test, the participant sits back in a standard armchair, wearing regular footwear and using a walking aid if needed. A line is marked 3 meters away on the floor as the walking target. The participant is instructed to stand up from the chair, walk at a normal pace to the marked line, turn around, walk back, and sit down again. Timing begins when the participant starts to move and stops when they are seated again. The recorded time reflects their mobility efficiency, with a completion time of ≥12 seconds indicating an increased risk of falling [15].

The third section of the measurement involves the Berg Balance Scale (BBS). The Berg Balance Scale (BBS) consists of 14 items assessing functional movements essential for daily activities, including sitting, standing, and positional changes. Each task is rated on a five-point scale (0 to 4), with a maximum possible score of 56. A lower score indicates reduced stability and a higher risk of balance impairment [16].

The four section of the measurement involves Fear of Falling (FOF). The Short Falls Efficacy Scale-International (Short FES-I) was used to assess Fear of Falling (FOF). It consists of seven items, each rated on a four-point scale (1

= not at all worried, 2 = a little worried, 3 = somewhat worried, 4 = very worried). FOF scores were categorized as follows: 7–8 indicates low risk, 9–13 indicates moderate risk, and 14–28 indicates high risk of FOF [8, 17].

2.3. Measurement

The measurement instruments used in this study were the Thai versions that had been validated for reliability and validity.

Part 1: Measurement of Timed-Up-and-Go (TUG): To perform the test, the participant sits back in a standard armchair, wearing regular footwear and using a walking aid if needed. A line is marked 3 meters away on the floor as the walking target. The participant is instructed to stand up from the chair, walk at a normal pace to the marked line, turn around, walk back, and sit down again. Timing begins when The participant starts to move and stops when they are seated again. The recorded time reflects their mobility efficiency, with a completion time of ≥12 seconds indicating an increased risk of falling [15].

Part 2: Measurement of Berg Balance Scale (BBS): The Berg Balance Scale (BBS) consists of 14 items assessing functional movements essential for daily activities, including sitting, standing, and positional changes. Each task is rated on a five-point scale (0 to 4), with a maximum possible score of 56. A lower score indicates reduced stability and a higher risk of balance impairment [16].

Part 3: Measurement of Fear of Falling (FOF): The Short Falls Efficacy Scale-International (Short FES-I) Thai version was used to assess Fear of Falling (FOF). It consists of seven items, each rated on a four-point scale (1 = not at all worried, 2 = a little worried, 3 = somewhat worried, 4 = very worried). FOF scores were categorized as follows: 7–8 indicates low risk, 9–13 indicates moderate risk, and 14–28 indicates high risk of FOF [8, 17].

2.4. Statistical Analysis

SPSS version 26.0 (IBM, New York, NY, USA) was used to perform all data analysis. We assessed the normality of distribution with the Kolmogorv-Smirnov test. The descriptive statistics of all variables were calculated, and continuous variables were expressed as mean ± SD, while categorical variables were presented as numbers and percentages. The Pearson's correlation coefficient was used to compare the FOF and the results for balance assessment tests (BBS, TUG) and BMI. Multiple linear regression analysis was also used to estimate associations among BMI, BBS, TUG, and FOF. A *p*-value of less than 0.05 was considered to be statistically significant.

The study was approved by the Research Ethics Committee of the University of Phayao, Thailand (HREC-UP-HSST 1.2/010/67).

3. RESULTS

Of the 439 study population, 57.2% were female, 63.8% were married, and the mean age was 68.9 ± 6.9 years. The educational level was less than the elementary level (84.5%). Most individual incomes were 1,000-5,000 baths per month (41.9%). In the past year, 8.2% of participants reported a fall. The 64.5% of participants had more than one disease. The mean BMI was 23.1 ± 3.7 kg/m^2, the mean BBS score was 50.3 ± 4.8, and the mean TUG time was 14.4 ± 5.7 seconds, as shown in Table **1**.

Table 1. Baseline characteristics according to fear of fall categories.

Characteristics	Overall (n=439)	Low Fear (n=249), 56.7%	Moderate Fear (n=81), 18.5%	High Fear (n=109), 24.8%	*P*-value
Gender[a]					
Male	188 (42.8)	131 (69.7)	25 (13.3)	32 (17.0)	<0.001**
Female	251 (57.2)	118 (47.0)	56 (22.3)	77 (30.7)	
Age (y)[b], Mean±SD	68.9±6.9	67.3±5.8	69.8 ±7.0	72.1±8.0	<0.001**
60-69	270 (61.5)	177 (65.6)	52 (19.3)	41 (15.2)	
70-79	130 (29.6)	61 (46.9)	21 (16.2)	48 (36.9)	
80 and above	39 (8.9)	11 (28.2)	8 (20.5)	20 (51.3)	
Marital status[a]					
Single	25 (5.7)	15 (60.0)	2 (8.0)	8 (32.0)	0.013**
Married	280 (63.8)	172 (61.4)	52 (18.6)	56 (20.0)	
Widow/divorced/separated	134 (30.5)	62 (46.3)	27 (20.1)	45 (33.6)	
Education level[a]					
<Elementary school	371 (84.5)	206 (55.5)	70 (18.9)	95 (25.6)	0.494
>Elementary school	68 (15.5)	43 (63.2)	11 (16.2)	14 (20.6)	
Individual income (Bath/month)[a]					
<1,000	103 (23.5)	49 (47.6)	13 (12.6)	41 (39.8)	<0.001**
1,000–5,000	184 (41.9)	80 (43.5)	53 (28.8)	51 (27.7)	
>5,000	152 (34.6)	120 (78.9)	15 (9.9)	17 (11.2)	

Characteristics	Overall (n=439)	Low Fear (n=249), 56.7%	Moderate Fear (n=81), 18.5%	High Fear (n=109), 24.8%	*P*-value
Fall experience					
Yes	36 (8.2)	6 (16.7)	8 (22.2)	22 (61.1)	<0.001**
No	403 (91.8)	243 (60.3)	73 (18.1)	87 (21.6)	
Disease					
No disease	156 (35.5)	106 (67.9)	16 (10.3)	34 (21.8)	0.001
More than one disease	283 (64.5)	143 (50.5)	65 (23.0)	75 (26.5)	
BMI [+](kg/m^2)[b], Mean±SD	23.1±3.7	23.2±3.0	23.1±4.5	22.8±4.3	0.644
18.5–22.9 (Normal weight)	218 (49.7)	130 (59.6)	33 (15.1)	55 (25.2)	
<18.5 (Underweight)	13 (3.0)	2 (15.4)	2 (15.4)	9 (69.2)	
23 – 24.9 (Overweight)	164 (37.4)	101 (61.6)	34 (20.7)	29 (17.7)	
≥ 25 (Obese)	44 (10.0)	16 (36.4)	12 (27.3)	16 (36.4)	
Balance assessment[b]					
BBS, score, Mean±SD	50.3±4.8	51.2±4.1	51.3±3.6	47.4±6.0	<0.001**
TUG, sec, Mean±SD	14.4±5.7	14.0±4.9	12.2±3.9	17.1±7.5	<0.001**

[a]Chi-square test for categorical data, [b]One-Way ANOVA test for continuous data, **P*-value < 0.05, ***P*-value < 0.001, BMI used the Asian cut point.

Correlations between Age and other variables are summarized in Table **2**. Age showed a significant positive correlation with Fear of Falling and TUG scores, while it was negatively correlated with Berg Balance Scale (BBS) scores.

Table **3** presents the association between BMI, BBS, TUG, and Fear of Falling (FOF) using multiple linear regression analysis, adjusted for age, gender, comorbidities, and fall history in the past year. Among the predictors, BBS (β = -0.298, p < 0.001) was the only significant factor.

4. DISCUSSION

This study investigated the association between BMI, BBS, TUG, and FOF among older adults in a rural area. The findings indicate that BBS was the strongest predictor of FOF, suggesting that poorer balance is significantly associated with a higher fear of falling. Additionally, age was positively correlated with both Fear of Falling and TUG time, while it was negatively correlated with BBS, highlighting the decline in balance and mobility with aging. Consistent with the findings of previous studies [18], the prevalence of FOF was reported to be significantly higher among the elderly population. This finding aligns with a systematic review conducted previously [16] identified the Berg Balance Scale as an effective clinical screening tool for predicting fall risk in older adults. This is also consistent with another study [19] that found that BBS was effective in assessing falls in the elderly.

The results showed that participants with a higher fear of falling had significantly lower BBS scores and longer TUG times, emphasizing the role of balance and mobility in influencing FOF. Multiple regression analysis further confirmed that BBS (β = -0.298, p < 0.001) was the only significant predictor of FOF, while TUG (p = 0.521) and BMI (p = 0.118) were not significantly associated with FOF.

Table 2. Correlations among the variables.

Variables	Age	BMI	TUG	BBS
Fear of fall	0.257**	-0.072	0.234**	-0.384**
BBS	-0.390**	-0.032	-0.712**	
TUG	0.296**	0.077		
BMI	-0.083			

***P*-value < 0.01

Table 3. Association of BMI, BBS, TUG and FOF using multiple linear regression analysis.

Variables	B	SE	*P*-value
TUG	0.035	0.054	0.521
BBS	-0.298	0.065	<0.001**
BMI	-0.091	0.058	0.118

Dependent Variable: Fear of fall, Adjust with age, gender, comorbidities and history of falls in the previous 1 years, ***P*-value < 0.001.

This observation can be explained by the fact that balance is a direct indicator of an individual's ability to maintain postural control during both static and dynamic activities, such as standing, walking, turning, or transitioning between positions. The Berg Balance Scale evaluates a range of activities that vary in difficulty and postural demands, involving changes in the base of support and alterations in posture. These tasks challenge multiple balance control mechanisms, including anticipatory adjustments and dynamic stability. Perceived difficulties or instability while performing these tasks may heighten awareness of impaired balance and contribute to an increased perception of vulnerability, thereby intensifying fear of falling. [20, 21]. Moreover, impairments in balance are often immediately recognized by older adults and may lead to heightened anxiety about falling [22, 23]. This fear of falling may lead to activity restriction, physical deconditioning, an increased risk of falls, and further psychological distress. [24]

These findings align with previous research [17, 25], indicating that declining balance ability is a major contributor to FOF. However, unlike some studies that found a link between BMI and fall risk, this study did not find a significant association between BMI and FOF, possibly due to a relatively low prevalence of underweight participants. This highlights the need for further research on the role of body composition in fall risk and FOF among older adults.

The findings of this study emphasize the critical role of balance impairment in predicting fear of falling among older adults residing in rural areas. Balance performance, as assessed by the Berg Balance Scale, was identified as the most significant predictor of fear of falling. Therefore, interventions aimed at improving balance function should be prioritized in fall prevention programs. The recommendations from this study are to adopt the Berg Balance Scale as a screening tool to identify older adults at high risk of developing a fear of falling at an early stage and to promote the integration of comprehensive elderly care programs for fall prevention that address both psychological and physical aspects.

CONCLUSION

In conclusion, balance impairment is associated with a fear of falling (FOF). Interventions that focus on improving balance function may be effective in reducing FOF and preventing falls among older adults. Future research should investigate the longitudinal effects of body mass index (BMI), mobility, and comorbidities on fall risk and fear of falling (FOF), as well as explore the relationship between FOF and other contributing factors such as environmental conditions, medication use, psychological well-being, and social support. This would provide a more comprehensive understanding of the underlying mechanisms and help inform the development of targeted prevention strategies.

STUDY LIMITATIONS

This study has certain limitations. First, the cross-sectional design restricts the ability to determine causal relationships between fear of falling (FOF), balance impairment, and related factors such as body mass index (BMI). In addition, there may be other important factors influencing FOF that were not included in this study, such as environmental factors, anxiety, and depression. Future research should incorporate a broader range of variables to gain a more comprehensive and multidimensional understanding of the factors contributing to the fear of falling.

AUTHORS' CONTRIBUTIONS

The authors confirm their contributions to the paper as follows: Study conception and design: US and ST; Data collection: US and ST; Analysis and interpretation of results: US and ST; Draft manuscript preparation: US and ST. All authors reviewed the results and approved the final version of the manuscript.

LIST OF ABBREVIATIONS

FOF	=	Fear of Falling
BMI	=	Body Mass Index
BBS	=	the Berg Balance Scale
TUG	=	the Timed Up and Go test
Short FES-I	=	The Short Falls Efficacy Scale-International
MMST10	=	Mini-Mental State Examination-Thai version 10

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study received approval from the Research Ethics Committee of the University of Phayao, Thailand (HREC-UP-HSST 1.2/010/67).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Written informed consent was obtained from all participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data and supportive information are available within the article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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