ORIGINAL ARTICLE

Assessment of fall risk, cognitive impairment, fear of falling in relation to functional mobility, and balance impairments in older adults

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ABSTRACT

Among older adults, falls are the most common injury and may increase the risk of mortality. This study aimed to investigate factors associated with functional mobility and balance impairments among community-dwelling older adults. A cross-sectional study was conducted among a total of 515 older adults. The questionnaires recorded demographic characteristics and health data, including the mental state examination T10 version (MSET10) and fear of falling (FOF). Functional mobility and balance impairments were assessed using the timed up and go (TUG) test. Leg strength and endurance were assessed using the sit to stand (STS) test. Demographic factors that were associated with significant differences for TUG and TUG-cognitive included age, education, occupation, history of falls in the previous year, and comorbidities. The TUG-cognitive, STS, and TUG tests at higher risk of falling were 42.5%, 18.6%, and 14.2%, respectively. The Pearson correlation coefficient analysis showed that STS and FOF were positively associated with TUG and TUG-cognitive, while the MSET10 was negatively associated with TUG and TUG-cognitive. Multiple linear regression analysis showed that increasing FOF was associated with increasing TUG and TUG-cognitive after adjusting for confounding variables ($p < 0.001$ and $p = 0.015$, respectively). Several risk factors need to be considered to determine the effectiveness of preventive measures and interventions to reduce the risk of falling. In particular, interventions for older adults should focus on functional mobility and balance impairments.

Key words:
falls; cognitive impairment; fear of falling; mobility and balance impairments; older adults

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INTRODUCTION

The world's older population aged 60 and over is expected to rapidly increase from 12% in 2015 to 22% in 2050.[1,2] The number of elderly individuals over 60 years in the world is predicted to double from an estimated 1.4 billion in 2030 to 2.1 billion by 2050.[1] The most common diseases and health problems in older adults are reduced mobility, falls, frailty, dementia, depression, and cognitive impairment, including multiple chronic diseases.[2-5] These health problems due to pathological conditions faced by older adults have changed and result in decreased in physical and mental health.[2,6,7]

Falls are the most common injury and may increase the risk of mortality and morbidity in older adults.[4,8,9] More than one-third of adults aged 65 and over experience falls each year, which can result from various diseases and health problems.[9-11] Importantly, falls are caused by a decrease in muscle mass, a decline in muscle strength, and physical inactivity.[7,9,11] These risk factors can cause falls in older adults due to impaired mobility and balance performance.[7,12]

According to a Centers for Disease Control and Prevention (CDC) report, in 2020 approximately 36,000 deaths of adults aged 65 and older were associated with falls.[13] Moreover, the CDC reported in 2018 that the incidence of fall-related injuries was found to be approximately 10.2% among adults aged 65 and over, while 27.5% of adults in this age group had experienced at least one fall in the past year.[14] Falls and fall-related injuries are classified into four categories: biological, behavioural, environmental, and socioeconomic factors.[15] Importantly, previous studies have identified several risk factors for falls in older adults, including sex, age, history of falls, fear of falling (FOF), balance disorders, visual impairment, gait problems, medication, and environmental factors.[16,17]

Previous studies conducted in Thailand found that the prevalence of falls was 4.7% for accidental falls, 25.2% for falls with a previous history, and 12.1% for one or more falls in the past year.[18,19] Previous studies in Thailand found several factors related to falls, including age, gender, living alone, physical inactivity, alcohol consumption, smoking, impaired balance, and functional impairment.[18,19] The expected outcomes of this study are the identification of functional mobility and balance impairments in areas to inform the design of future intervention programmes. Therefore, this study aimed to assess factors associated with functional mobility and balance impairments among community-dwelling older adults in Chiang Mai Province, Northern Thailand.

METHODS

Design and sample

A cross-sectional study was conducted among community-dwelling older adults aged 60 and above in Amphoe Saraphi, Chiang Mai Province, Northern Thailand between June and September 2021. From the sample group, 25.2% had a previous history of falls.[19] The sample size was determined by using the population proportion formula,[20,21] where the size of the population (N) is 20,834, the proportion of falls (p) is 25.2%, alpha is 0.05, Z-score is 0.975, and the margin of error (d) that is acceptable, 5% (0.05). We added at least 80% to the estimated sample size to allow for potential losses. The total sample size of this study was 515 older people. The inclusion criteria were older adults aged 60 and above who had the ability to read or communicate verbally and agreed to be respondents. The exclusion criteria were older adults who had mental or severe cognitive impairment and those who did not

agree to participate in the study. The study was approved by the Research Ethics Committee of Chiang Mai Provincial Public Health Office, Ministry of Public Health, Thailand (REC No. 18/2564).

Measures

The timed up and go (TUG) test

TUG and TUG-cognitive are tests for predicting fall-related risks in older adults. Importantly, TUG and TUG-cognitive are physical performance tests that were developed to assess functional mobility and balance impairments. Participants were tested by walking in a straight line for 3 metres from the starting point to a turning point, before returning to the starting point and sitting down in the chair again. A TUG score of ≥13.5 seconds was used to indicate a higher risk of falling, while a score of <13.5 seconds was used to indicate a lower risk of falling. This cut-off value was adopted from a previous study that used TUG for predicting fall-related risks.[22]

The sit to stand (STS) test

The 5-repetition STS test was used to indicate leg strength and endurance by the 30 second chair stand test. An STS score of ≥15 seconds was used to indicate a higher risk of falling while a score of <15 seconds was used to indicate a lower risk of falling. The cut-off value was adopted from a previous study that used the five times sit to stand test (FTSS) for predicting fall-related risks.[23,24]

Mental state examination T10 version (MSET10)

MSET10 was developed from the mini-mental state examination Thai version 2002 (MMSE-Thai 2002), which was used to evaluate mild cognitive impairment with a cut-off value from a previous study that assessed mild cognitive impairment in older adults.[25] The criteria consist of two levels of education. First, an MSET10 score of >17 was used to indicate a low risk of cognitive impairment, while an MSET10 score of ≤17 was used to indicate a high risk of cognitive impairment for those whose highest level of completed education was ≤primary school. Second, an MSET10 score of >22 was used to indicate a low risk of cognitive impairment, and an MSET10 score of ≤22 was used to indicate a high risk of cognitive impairment for those whose highest level of completed education was >primary school.

Fear of falling (FOF)

The short falls efficacy scale-international (Short FES-I) was used to indicate the FOF that consisted of seven items and had four subscales (1 = not at all, 2 = a little worried, 3 = somewhat worried, and 4 = very worried). A FOF score of 7-8 was used to indicate a low risk of FOF, a FOF score of 9-13 was used to indicate a moderate risk of FOF, and a FOF score of 14-28 was used to indicate a high risk of FOF.[26]

Data analysis

Descriptive statistics were used to describe the findings, including frequency, percentages, mean, and standard deviation (SD). Independent-sample t-test, analysis of variance (ANOVA), and Pearson correlation coefficient were used to compare between independent variables, TUG, and TUG-cognitive. Multiple linear regression analysis was also used to estimate associations among MSET10, FOF, TUG, and TUG-cognitive variables.

RESULTS

Demographic characteristic of participants

Table 1 illustrates the general characteristics of the 515 study participants. The mean age and body mass index (BMI) (±SD) of the participants were 67.6±6.4 years and 24.4±5.3 kg/m^2, respectively. Of the participants, 19.6% had a history of falls in the previous year. Moreover, for comorbidities, 41.0% of the participants had more than three diseases, while 29.5%

had one to two diseases. The results indicate that age, education, occupation, history of falls in the previous year, and comorbidities were associated with significant differences in TUG and TUG-cognitive variables.

Table 1. Demographic characteristics and factors related to TUG, and TUG-cognitive (n = 515)

Variables	n (%)	TUG, p-value	TUG-cognitive, p-value
Sex			
Male	87 (16.9)	0.871[a]	0.978[a]
Female	428 (83.1)		
Age (years)	67.6±6.4	<0.001[b]***	<0.001[b]***
<65	229 (44.5)	<0.001[a]***	<0.001[a]***
≥65	286 (55.5)		
BMI (kg/m^2)	24.4±5.3	0.365[b]	0.254[b]
<18.5	34 (6.6)	0.109[c]	0.074[c]
18.5 – 24.9	288 (55.9)		
25.0 – 29.9	150 (29.1)		
≥30.0	43 (8.3)		
Marital status			
Single	47 (9.1)	0.130[c]	0.086[c]
Married	303 (58.8)		
Divorce	165 (32.0)		
Education			
≤Primary school	390 (75.7)	<0.001[a]***	<0.001[a]***
>Primary school	125 (24.3)		
Occupation			
Agriculture	81 (15.7)	0.004[c]**	0.003[c]**
Daily hired workers	98 (19.0)		
Own business	87 (16.9)		
Unemployed	232 (45.0)		
Others	17 (3.3)		
History of falls in the previous years			
No	414 (80.4)	<0.001[a]***	<0.001[a]***
Yes	101 (19.6)		
Comorbidities			
No	152 (29.5)	<0.001[a]***	<0.001[a]***
1-2	152 (29.5)		
≥3	211 (41.0)		

[a]Independent - sample t test, [b]Pearson correlation coefficient, [c]ANOVA. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Frequencies and percentages of comorbidities

Table 2 shows that the most common comorbidities were hypertension (54.0%), diabetes (25.6%), arthritis (23.1%), high blood lipids (6.2%), arrhythmia (4.7%), osteoporosis (3.9%), coronary heart disease/ischemic heart disease (3.5%), stroke or cerebrovascular disease (2.3%), cancer (2.3%), and emphysema (2.3%).

Table 2. Frequencies and percentages to describe the comorbidities (n = 515)

Variables	n (%)
Hypertension	278 (54.0)
Diabetes	132 (25.6)
Arthritis	119 (23.1)
High blood lipids	32 (6.2)
Arrhythmia	24 (4.7)
Osteoporosis	20 (3.9)
Coronary heart disease/ischemic heart disease	18 (3.5)
Stroke or cerebrovascular disease	12 (2.3)
Cancer	12 (2.3)
Emphysema	12 (2.3)

Frequencies, percentages, and mean±SD of STS, MSET10, FOF, TUG, and TUG-cognitive variables

Table 3 shows the risk of falls, with the mean (±SD) of TUG, TUG-cognitive, and STS recorded as 10.7±3.9 seconds, 14.3±5.6 seconds, and 12.1±4.5 seconds, respectively. The mean scores (±SD) of MSET10 at low levels of education and high levels of education were 20.9±3.3 and 23.5±2.8 scores, respectively. These findings indicate that the TUG-cognitive, STS, and TUG tests at levels of high risk were 42.5%, 18.6%, and 14.2%, respectively. The percentage of elderly individuals with high scores of MSET10 at low levels of education and high levels of education were 86.7%, and 61.6%, respectively. For FOF, 39.8% had a high score, 33.8% had a low score, and 26.4% had a moderate score.

Table 3. Frequencies, percentages, and mean±SD to describe characteristics of variables (n = 515)

Variables	n (%)
TUG, (seconds), mean±SD	10.7±3.9
Low risk (<13.5 seconds)	442 (85.8)
High risk ≥13.5 seconds	73 (14.2)
TUG-cognitive, (seconds), mean±SD	14.3±5.6
Low risk (<13.5 seconds)	296 (57.5)
High risk ≥13.5 seconds	219 (42.5)
STS, (seconds), mean±SD	12.1±4.5
Low risk (<15 seconds)	419 (81.4)
High risk ≥15 seconds	96 (18.6)
MSET10	
Education (≤Primary school), mean±SD	20.9±3.3
Low scores (≤17 scores)	52 (13.3)
High scores (>17 scores)	338 (86.7)
MSET10	
Education (>Primary school), mean±SD	23.5±2.8
Low scores (≤22 scores)	48 (38.4)
High scores (>22 scores)	77 (61.6)

Variables	n (%)
FOF, mean±SD	13.4±6.6
Low scores (7-8 scores)	174 (33.8)
Moderate scores (9-13 scores)	136 (26.4)
High scores (14-28 scores)	205 (39.8)

Pearson correlation of STS, MSET10, FOF, TUG, and TUG-cognitive

The Pearson correlation coefficient analysis showed that STS and FOF were positively associated with TUG and TUG-cognitive ($p < 0.001$). MSET10 was negatively associated with TUG and TUG-cognitive ($p < 0.001$) (Table 4).

Table 4. Pearson correlation of STS, MSET10, FOF, TUG, and TUG-cognitive (n = 515)

Variables	TUG	TUG-cognitive
STS	0.657*	0.643*
MSET10	-0.173*	-0.159*
FOF	0.293*	0.225*

[a]Pearson correlation coefficient. * $p < 0.001$

Association of MSET10, FOF, and TUG using multiple linear regression analysis

Multiple linear regression analysis showed that higher STS and FOF were associated with an increasing TUG variable after adjusting for sex, age (years), BMI, marital status, education, occupation, history of falls in the previous year, and comorbidities (Table 5).

Table 5. Association of MSET10, FOF, and TUG using multiple linear regression analysis (n = 515)

Variables	B	SE	p-value
STS	0.466	0.029	<0.001
MSET10	-0.012	0.047	0.803
FOF	0.089	0.023	<0.001

Adjust with sex, age (years), BMI, marital status, education, occupation, history of falls in the previous 1 years, and comorbidities. *$p < 0.001$

Association of MSET10, FOF, and TUG-cognitive using multiple linear regression analysis

Multiple linear regression analysis showed that higher STS and FOF were associated with an increasing TUG-cognitive variable after adjusting for sex, age (years), BMI, marital status, education, occupation, history of falls in the previous year, and comorbidities (Table 6).

Table 6. Association of MSET10, FOF, and TUG-cognitive using multiple linear regression analysis (n = 515)

Variables	B	SE	p-value
STS	0.697	0.044	<0.001**
MSET10	-0.036	0.071	0.613
FOF	0.084	0.034	0.015*

Adjust with sex, age (years), BMI, marital status, education, occupation, history of falls in the previous 1 years, and comorbidities. *$p < 0.05$, **$p < 0.001$

DISCUSSION

The world's older population is expected to increase rapidly from 2015 to 2050, and several risk factors for older adults have changed in terms of physical and mental health.[1,2,6] Importantly, falls in older adults are a common injury and may lead to mortality and morbidity.[4,8,9] The results of the present study indicate a history of previous falls and comorbidities in older adults. In addition, this study reveals that age, education, occupation, history of falls, and comorbidities were associated with significant differences in TUG and TUG-cognitive. Previous studies have shown that age, history of falls, and comorbidities were also significantly associated with TUG.[27-29] Additionally, aging may result in a decline in physiological reserve and result in poor health outcomes such as comorbidities, fear of falling, and risk of falls.[8,30,31] Moreover, previous results indicate that falls can be caused by several risk factors, such as a decline in physical function, mental health, comorbidity, and chronic health impairment.[32-34]

Our study reveals that the mean values of TUG and TUG-cognitive were 10.7±3.9 seconds and 14.3±5.6 seconds, respectively. A previous study showed that TUG scores of ≥13.5 seconds indicate a higher risk of falling, while TUG scores below this threshold suggest a lower risk of falling.[22] The TUG-cognitive test had a longer completion time when compared with the TUG test because TUG-cognitive can count backwards from a randomly selected number.[29,35] The mean value of STS was 12.1±4.5 seconds. Previous studies showed that an STS score of <15 seconds indicated a lower risk of falling.[23,24] Previous studies revealed that TUG-cognitive was not different from the TUG manual due to the fact that these tools can be predictive of fall risk.[22,29] However, TUG and STS performances are associated with a risk of falls, which can help to evaluate dynamic balance, functional mobility, and performance in older adults.[24,28,36] Moreover, the American Geriatric Society (AGS), the British Geriatric Society (BGS), and the National Institute of Clinical Evidence (NICE) recommend that TUG can be used as a screening test to assess gait, balance, and mobility in older adults.[22,37,38]

The present study reveals that the mean values of mild cognitive impairment (MCI) in lower primary school education and higher primary school education were 20.9±3.3 and 23.5±2.8, respectively. These results indicate a lower risk of MCI when compared with the cut-off value detailed in the MMSE-Thai 2002 standards.[25] However, this study demonstrates that the prevalence of MCI risk for those who had higher primary school education and lower primary school education were 38.4% and 13.3%, respectively. Previous studies have shown that several risk factors are significantly associated with MCI.[39,40] Our study revealed that the prevalence of FOF was high (39.8%), low (33.8%), and moderate (26.4%). Previous studies revealed that the phenomenon of FOF is a psychological cause of falls. FOF is

attributed to several risk factors, such as demographics, individual factors, fall history, neighbourhood environment, and comorbidities.[41-43]

The present study indicates that STS and FOF were positively associated with TUG and TUG-cognitive. Previous studies have revealed that FOF has been linked to the risk of falling and has also been shown to be significantly correlated with TUG in older adults.[22,43] Moreover, TUG is used to measure functional mobility, which is used to identify mobility and balance impairments in older adults.[44,45] Several studies have shown that STS has also been shown to correlate with fall risk in older adults.[23,46] Furthermore, STS is used as a measure of lower limb muscle strength, and the test can assess fall risk in older adults.[23,47,48] The present study reveals that MSET10 is negatively associated with TUG and TUG-cognitive. These results indicate that individuals with a high risk of cognitive impairment are linked to a higher risk of falling. Several studies have shown that TUG can be used as an indicator for detecting early signs of cognitive impairment.[49,50] Furthermore, MMSE is widely used as a screening test for cognitive function, which can contribute to the progression from MCI to dementia.[51,52]

This study shows that increasing FOF is associated with increasing TUG and TUG-cognitive variables after adjusting for confounders using multiple linear regression analysis. Several studies have shown that FOF is associated with TUG and TUG-cognitive.[22,43,53] In addition, TUG increased in fallers compared to non-fallers.[54,55] Nonetheless, FOF may result from poor psychosocial health, a decline in physical function, anxiety, depression, and avoiding activities in daily life.[19,43] The present study is limited by its cross-sectional observational design, which sought to assess exposure and outcomes. Further research is required to provide a multifactorial intervention that can reduce the risk of falls. Interestingly, a multicomponent exercise intervention could reduce the risk of falls, FOF, and TUG.

CONCLUSION

The present study shows that age, education, occupation, history of falls, and comorbidities were associated with significant differences in TUG and TUG-cognitive. STS and FOF were positively associated with TUG and TUG-cognitive, while MSET10 was negatively associated with TUG and TUG-cognitive. Multiple linear regression analysis revealed that increasing FOF was associated with increasing TUG and TUG-cognitive variables after adjusting for confounders. In particular, it provides appropriate health interventions for reducing FOF and MSET10, which can lead to a reduced risk of falling in elderly individuals. Therefore, this study has also provided a useful framework for developing risk-factor preventive measures to reduce the risk of falling among community-dwelling older adults.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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