Research Article

The ability of timed-up and go test and five times sit-to-stand test to screen risk of fall in well-functioning elderly

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Abstract

Aging process can naturally affect the restriction of physical function, which result in an increased risk of fall even though in well-functioning elderly. Therefore, an early detect of functional ability in those with risk of fall should be concerned. Evidence supported that the timed-up and go test (TUG) and five times sit-to-stand test (FTSST) are commonly used to assess balance impairment and leg muscle weakness, which were common risk factors of fall. However, there were no any studies reported the cut-off scores of the TUG and FTSST for determining risk of fall in well-functioning elderly. Thus, this study aimed to identify the cut-off scores of the TUG and FTSST for determining risk of fall in these individuals, which were classified into the age of 65-74 years and 75 years and older. They were screened their risk of fall using the tandem stand test and history of fall within the past 6 months, then they were investigated the TUG and FTSST. The findings reported the cut-off scores of the TUG as more than 9.50 seconds (70.21% sensitivity, 56.99% specificity) and 10.50 seconds (81.82% sensitivity, 66.67% specificity); additionally, the cut-off scores of FTSST more than 11.50 seconds (73.91% sensitivity, 62.64% specificity) and 12.10 seconds (61.54% sensitivity, 50.00% specificity) represented risk of fall in elderly, who aged 65-74 years and 75 years and older, respectively. The findings suggested the suitable cut-off scores of the TUG and FTSST as screening criteria to early detect risk of fall in well-functional elderly.

Keywords: Cut-off score, Balance ability, Leg muscle strength, Risk of fall, Healthy elderly

Introduction

An advancing age usually relates to deterioration of several body systems which affect the physical, psychological, and socioeconomic functions [1]. These aging processes can naturally affect the restriction of physical function, which may result in an increased risk of fall even though in well-functioning elderly with gradual decline [2]. The evidence supported that the elderly aged at least 65 years were experienced fall approximately 30% in each year, and it obviously increased in those aged 75 years and older [3, 4]. Aging is correlated with an increased number and severity of falls [5, 6].

Previous study reported that the first two common causes of fall relating to physical function as perceived by the elderly included balance impairment and leg muscle weakness [4]. Unfortunately, fall are serious negative impacts even in mild to severe physical injuries [5, 7]. Although some events of fall do not refer to any physical consequences, those may lead to psychological consequences, such as fear of falling [8]. All of these consequences result in substantial medical expenditures to treat falls related injuries [9]. Therefore, an early detect of functional ability is recommended for prevention fall strategies in elderly with risk of fall, particularly in view of common self-perceived functional problems related to activities of daily living [10, 11].

Evidence supports that the activities of daily living requires good balance control while moving the position, and enough leg muscle strength to perform the tasks [1]. Although there are several functional static and dynamic balance tests [1], the timed-up and go test (TUG) is one of the recommendations dynamic balance test in elderly [12]. The TUG is a practical reliable and valid functional test to represent basic mobility task and identifying risk of fall in community-dwelling elderly, which strongly related to the level of functional mobility [12-14]. Moreover, a weakness of leg muscle strength is associated with balance ability [15]. The evidence supported that leg muscle strength significantly affected the generation of force, which led to balance and functional impairment [16]. Additionally, the five times sit-to-stand test (FTSST) is commonly used to measure leg muscle strength in elderly [15, 17]. These functional tests were reported with an acceptable reliability and validity, when was conducted in elderly (ICC = 0.64-0.99, r = 0.61-0.87, respectively) [13, 18-21]. Therefore, these are the reason to apply the TUG and FTSST in the elderly. Previously, the cut-off scores of the TUG and FTSST were reported in elderly who aged at least 60 and 65 years, which they were defined risk of fall using a history of one fall within the past 6 months [12, 14, 22, 23]. Although previous studies reported that the ability to perform the tandem stand test less than 10 seconds [11], or having history of at least 2 falls within the past 6 months were able to identify risk of fall [24], these criteria were not applied in well-functioning elderly. The evidence supported that these criteria can be significantly differentiated the elderly with and without risk of fall [24]. However, none of the studies reported on a specific cut-off score of the TUG and FTSST for determining risk of fall in well-functioning elderly among aged groups (65-74 years and 75 years and older). The findings may assist health practitioners to identify risk of fall and plan an appropriate intervention for these individuals.

Materials and Methods

The study was cross- sectionally conducted in elderly who lived in rural and semi-rural communities in northeastern of Thailand. Participants were the elderly who aged at least 65 years, both male and female with a body mass index (BMI) between 18.5 and 29.9 kg/m^2. They were screened their demographic characteristics and risk of fall. Elderly with risk of fall was defined as people who had balance impairment (unable to take full tandem stand test for 10 seconds) or having history of two or more falls within the past 6 months [11, 24]. Additionally, the participants were able to walk or perform the activities without assistive devices, and also needed to understand simple commands of the test to complete the protocol of the study. However, they were excluded if they had any signs or symptoms that might affect the study; for examples, the inflammation of lower extremity joints and muscles with pain more than 5 out of 10 scores on a verbal numerical rating scale, sequelae of neurological disease (e.g., stroke and Parkinson's disease), dizziness, visual and auditory deficits that cannot correct using glasses or hearing aids, acute illness or injury, unstable heart disease (e.g., angina), and uncontrolled hypertension. In addition, the participants were withdrawn if they were unable to follow protocol of the study. The study protocols and consent procedures were approved by the Khon Kaen University Ethics Committee for Human Research (HE602302). Furthermore, all participants were asked to sign the inform consent prior to participate the study.

The eligible participants were investigated their dynamic balance ability and leg muscle strength using the TUG (timed-up and go test) and FTSST (five times sit-to-stand test), respectively. The protocol of TUG and FTSST are as follow;

***TUG*:** The participants were instructed to stand up from a standard armrest chair (approximate seat height of 43 cm.) and walk 3 meters, turn around the cone in front of the chair, and walk back to sit down on the chair at fast and safe speed. The assessor recorded a time from the command "Go" until the participants went to sit down, and their back touched the backrest of the chair. The measurement was repeated 3 trials; then, the average time was recorded in term of seconds [10, 13].

FTSST: The participants were asked to sit on a standard armless chair (approximate seat height of 43 cm.) with their arms on the sides. Then, they were instructed to rise from a chair with fully extension of hips and knees joints and return sit down as quickly as possible for 5 repetitions. The assessor recorded a time from the command "Go" until the participants went to sit down, and their back touched the backrest of the chair at the fifth repetitions. The measurement was repeated 3 trials; then, the average time was recorded in term of seconds [10].

During administration of the test, a tester (physiotherapist) was always beside a participant without interruption to ensure participant's safety and accuracy of the tests. Furthermore, the participants had to wear appropriate shoes which were prepared by the researchers and they were assessed blood pressure and heart rate for safety and ensuring enough rest.

The data were analyzed using the SPSS for Windows (SPSS Statistic version 17.0, IBM Corporation, 1 New Orchard Road Armonk, New York 10504-1722, USA, serial number: 5068054). The descriptive statistics (mean, standard deviation, 95% confidence intervals, and the percentage) was applied to explain characteristics of participants and the findings. The independent sample t-test (for continuous variable) and the Chi-square test (for categorical variable) were used to compare the differences of demographic characteristics between elderly with and without risk of fall. Finally, the receiver operating curve (ROC) was used to utilize the cut-off score, sensitivity, specificity, and area under curve (AUC). A level of significant difference was set at less than 0.05.

Results

Four hundred and fifty-five participants interested to participate the study; however, 200 of them were excluded in a screening phase due to they were missing the inclusion criteria. Finally, there were 255 eligible participants which were divided into the age of 65-74 years (187 participants) and the age of 75 years and older (68 participants) (Figure 1).

Most of the participants with risk of fall in both aged groups had deficit to complete the tandem stand test for 10 seconds (92.80%). The participants who aged 75 years and older with risk of fall were reported shorter time to complete tandem stand test than those aged 65-74 years (6.09 ± 12.09 sec and 7.33 ± 13.07 sec, $p = 0.587$, respectively). Regarding to the experience of multiple falls in the last 6 months, there were reported 29.00% in those with risk of fall. More than a half of multiple falls (56 out of 93 times) caused by intrinsic factor, such as loss of balance, leg muscle weakness, and postural hypotension during changing position. The extrinsic factor included slipping, tripping, stumble over uneven paths, and too-long dress. Other demographic characteristics were shown in Table 1. The cut-off scores of the TUG and FTSST for determining risk of fall in each age range were presented in Table 2. However, there were some participants who aged at least 75 years unable to complete the FTTST (2 and 5 persons in the group of no risk of fall and risk of fall, respectively).

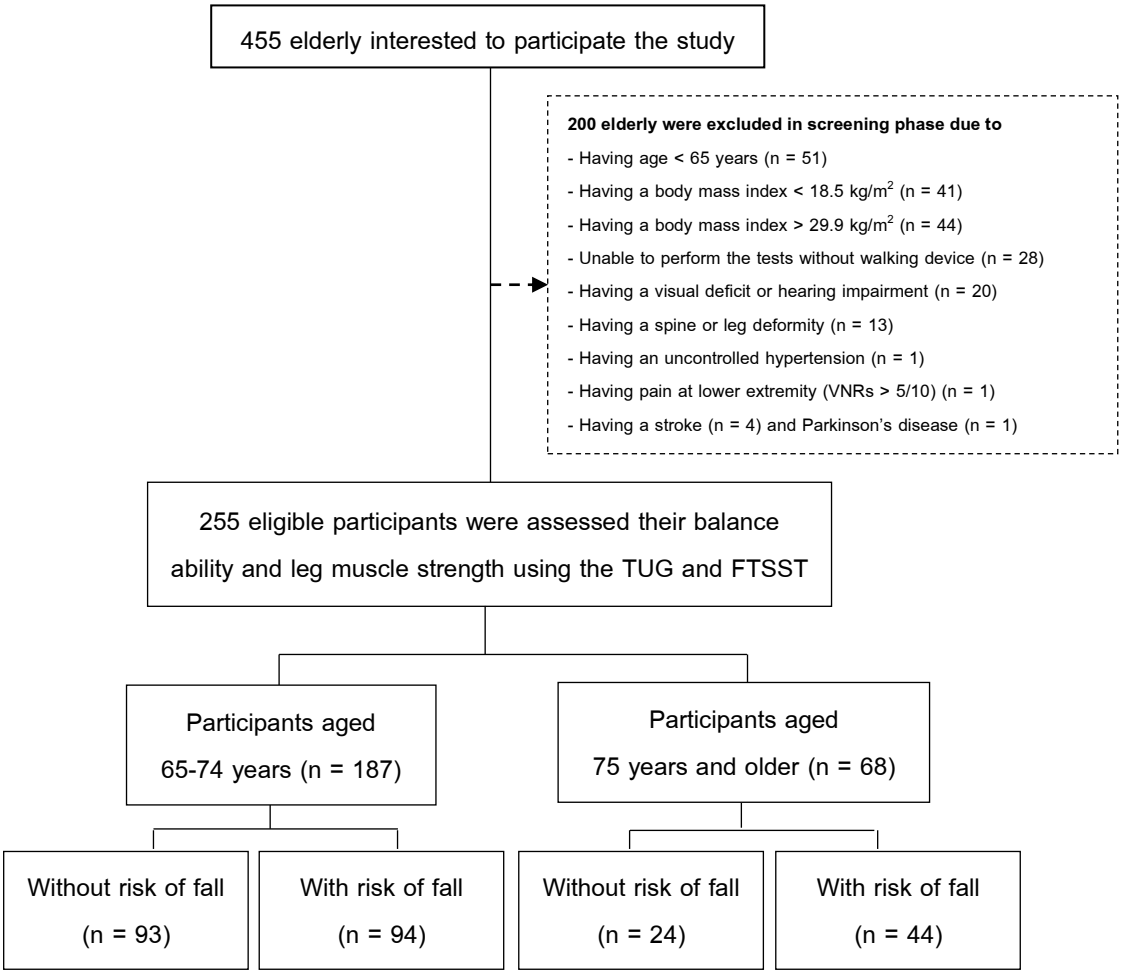

Figure 1 Participants flow chart

Table 1 Demographic characteristics in elderly with and without risk of fall

Variable	65-74 years		p-value	At least 75 years		p-value
	No risk of fall (n = 93)	Risk of fall (n = 94)		No risk of fall (n = 24)	Risk of fall (n = 44)	
Gender [female][a]	63.00 (67.74)	73.00 (77.89)	< 0.001*	13.00 (54.20)	35.00 (79.50)	0.001*
Age (year)[b]	69.09 (2.73) (68.52 – 69.65)	69.92 (3.12) (69.28 – 70.55)	0.055	77.71 (2.54) (76.63 – 78.78)	78.98 (3.77) (77.83 – 80.12)	0.104
BMI (kg/m^2)[b]	23.26 (3.04) (22.63 – 23.90)	24.45 (2.94) (23.84 – 25.06)	0.008*	23.60 (3.04) (22.32 – 24.88)	23.55 (2.94) (22.66 – 24.44)	0.952
TUG (s)[b]	9.33 (1.48) (9.02 – 9.63)	10.88 (2.89) (10.29 – 11.47)	< 0.001*	10.30 (2.44) (9.27 – 11.33)	13.16 (4.05) (11.93 – 14.39)	0.001*
FTSST (s)[b]	11.38 (2.59) (10.84 – 11.92)	13.43 (3.70) (12.67 – 14.20)	< 0.001*	12.26 (2.90)† (10.97 – 13.55)	13.99 (3.20)†† (12.95 – 15.02)	0.037*

Note: * Indicates statistically significant difference, [a] The data were demonstrated using number of participants (%) using the Chi-square,

[b] The data were represented using mean ± standard deviation (95% confidence interval) and compared using the independent sample t-test,

† There were 2 persons who were unable to complete the test, †† There were 5 persons who were unable to complete the test.

Abbreviation: BMI = body mass index, TUG = timed up and go test, FTSST = five times sit-to-stand test.

Table 2 Cut-off point of the TUG and FTSST to determine risk of fall

Items	Cut-off point	Sensitivity (%)	Specificity (%)	Correctly classified	AUC
TUG					
65-74 yr	9.50	70.21	58.06	64.17	0.70
At least 75 yr	10.50	81.82	66.67	76.47	0.76
FTSST					
65-74 yr	11.50	73.91	62.64	68.31	0.70
At least 75 yr	12.10	61.54	50.00	59.02	0.66

Abbreviation: TUG = timed up and go test, FTSST = five times sit-to-stand test, AUC = area under the curve.

Discussion and Conclusion

This study investigated the cut-off scores of the TUG and FTSST for determining risk of fall in well-functioning elderly, which were categorized into the age of 65-74 years and 75 years and older. The present study reported the cut-off scores of TUG more than 9.50 seconds (70.21% sensitivity and 56.99% specificity) and 10.50 seconds (81.82% sensitivity and 66.67% specificity); additionally, the cut-off scores of FTSST more than 11.50 seconds (73.91% sensitivity and 62.64% specificity) and 12.10 seconds (61.54% sensitivity and 50.00% specificity) represented risk of fall in well-functioning elderly, who aged 65-74 years and 75 years and older, respectively.

The present study considered to apply the TUG due to its characteristics represent the essential functional mobility as motor skill for independent lifestyle, such as rising and controlling descent to the chairs, quickly walking a short distance, and changing direction while walking [10]. Evidence supported that almost of fall events occurred while walking and changing posture in basic daily life, in which related to the component of TUG tasks [6]. However, the cut-off score of TUG in the present study (9.50 and 10.5 seconds; aged 65-74 and 75 years and older, respectively) showed slightly shorter than previous studies (ranged from 12.47 to 14.58 seconds) [12, 14, 22]. This might occur due to the difference of criteria to recruit the elderly into detection group. They previously divided the elderly into faller and non-faller groups using a history of 1 or at least 2 falls in the past 6 months [12, 14, 22], while the present study divided them into with and without risk of fall using the ability to perform the tandem stand test for 10 seconds, or a history of at least 2 falls in the past 6 months. However, most of participants were unable to take full tandem stand test for 10 seconds (92.80%), whereas 29.00% of elderly with risk of fall were reported a fall history. It was implied that those with risk of fall might be dispensable to fall but they just took a risk to fall, which needed an early fall prevention. These criteria might be a cause of shorter cut-off score of the TUG than previous reports.

The evidence supported that the tandem stand test was an effective item of the Berg balance scale to screen risk of fall in elderly [11]. Furthermore, regarding to study of the ability of each Thai-FRAT item to identify risk of fall, the finding showed that the ability to perform the tandem stand test less than 10 seconds or having a history of 2 or more falls within the past 6 months can be significantly differentiates the well-functioning elderly with and without risk of fall [24]. These were important reasons to apply the tandem

stand test or a history of fall as a standard screening test in the present study. As mention above, it might a reason to include the elderly who were functioning well and dwelling in the community. Even though they were able to perform independent activities in daily living, their physical functions were gradual decline by aging process. Therefore, the health officers should play attention to plan an early prevention fall strategies in these individuals.

According to the findings of FTSST, the cut-off scores were 11.50 and 12.10 seconds for elderly aged 65-74 and 75 years and older, respectively. The result showed longer duration than the cut-off score to identify risk of fall in previous study (8.85 seconds) [25]. It might occur due to the difference of participants' characteristics. Previous study was conduct in Thai independent elderly who aged at least 60 years, which was less than the present study. Furthermore, they were not categorized participants into age groups [25]. When focusing on the cut-off scores of FTSST in elderly who aged at least 75 years, it showed smaller area under the curve (AUC=0.66) than another group (AUC=0.70). This might occur due to a small sample size, there were only 24 persons (no risk of fall) and 44 persons (risk of fall) participants, who were able to complete the FTSST. However, the area under the curve of 0.50-0.70 was an acceptable level of discriminative ability [25].

Based on the reference value of The TUG and FTSST in Thai elderly, who were well-functioning and able to conduct daily activities independently without a walking device [26]. The cut-off scores of these functional tests in the present study were nearly to Thai elderly's reference values. However, there were some limitations of the study. Firstly, there was a smaller number of participants who aged 75 years and older, even though the power of test was verified and reported of more than 0.80 in each age group. Therefore, further study should recruit a greater number of participants for clearer findings. Secondly, the participants in this study were well-functioning elderly, which they were able to perform the activities without assistive devices used. The clinical implication should carefully concern based on the characteristics of participants. Thirdly, the data were not separately analyzed by gender which might affect results of the study. Therefore, further study should be concerned this limitation for clearer findings. Finally, the study design in this study was a cross-sectional design, in which it cannot identify cause and effect relationship of fall. Therefore, further investigation should design as the prospective study for indicating fall risk factors.

In conclusion, the finding suggested the optimal cut-off score of TUG to determining risk of fall in well-functioning elderly as the time of less than 9.50 seconds (aged 65-74 years) and less than 10.50 seconds (aged 75 years and older); additionally, for the FTSST more than 11.50 seconds (aged 65-74 years) and 12.10 seconds (aged 75 years and older) represented risk of fall in well-functioning elderly. However, these cut-off scores should be applied in the well-functioning and dwelling elderly who able to conduct daily activities independently without a walking device. Moreover, the specific values could assist health practitioners to early detect the well-functioning elderly who had risk of fall from aging process in order to plan an appropriate prevention and promote health status in these individuals.

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