Fall Prediction in Thai Elderly with Timed Up and Go and Tandem Walk Test: A Cross-Sectional Study

Thanwarat Chantanachai BSc*,
Sopa Pichaiyongwongdee MSc*, Chutima Jalayondeja DrPH*

* Faculty of Physical Therapy, Mahidol University, Nakhon Pathom, Thailand

Objective: *To examine the timed up and go (TUG) and tandem walk test (TWT) as fall prediction assessments in Thai elderly.*
Material and Method: *Elderly subjects aged between 60 and 86 years and living in Nakhonpathom and Samutsakhon provinces were classified as fallers and non-fallers by self-report in the past six months. The TUG and TWT were used to predict falls. The optimal cutoff score and validity indexes were determined by plotting the receiver operating characteristic (ROC) curve and crosstabs analysis.*
Results: *One hundred and sixty-one elderly subjects were classified as fallers (7 males and 43 females) and non-fallers (24 males and 87 females). The area under the curve (AUC) of ROC were 0.62 (95% CI = 0.59, 0.76; p = 0.0001) for TUG and 0.605 (95% CI = 0.514, 0.696; p = 0.033) for TWT error score. The cutoff scores were 10.5 seconds for TUG (74% sensitivity and 57.7% specificity) and five scores for TWT error (62% sensitivity and 55% specificity).*
Conclusion: *TUG and TWT error were useful tools to explain faller status in Thai community-dwelling for the elderly. TWT time was not sensitive enough to detect the elders who were at risk of falls.*

Keywords: *Falls, Timed up and go test, Tandem walk test, Thai elderly*

Approximately 25% of Thai community-dwelling for the elderly reported one or more falls during the last six months[1,2]. Determining a fall risk screening tool is a priority to plan fall prevention programs. The Timed Up and Go (TUG) test is a functional mobility and balance test that is commonly used to identify fallers in the elderly[3-7]. However, many studies reported the TUG cutoff score for falling prediction in the elderly who lived in Western countries[3-6]. They proposed TUG cutoff scores differently from 10-13 seconds. The tandem walk test (TWT) is a clinical assessment of dynamic balance that has been correlated with falls in many studies[8-11]. However, they did not illustrate the TWT cutoff score for falling classification. Both tests are recommended as simple tools for determining those who at risk of falls[3-6,8,10]. The cutoff score and validity indexes including sensitivity, specificity, predictive values and likelihood ratios of TUG and TWT have not been explored in Thai elderly. Therefore, the present study determined the TUG and TWT for faller and non-faller classifications in Thai elderly. The authors also described the cutoff scores, sensitivity, specificity, predictive values and likelihood ratios of these tests.

Material and Method

The cross-sectional study was conducted and Thai community-dwelling for the elderly was enrolled from the suburban Nakhonpathom and Samutsakhon provinces. The subjects were 60 to 90 years old, able to walk without assisting devices, and having cognitive function (Thai mental state examination (TMSE) scores $\geq$24 points)[12]. The subjects were classified as fallers and non-fallers by self-report of falling ($\geq$1 time) in the past six months. Faller was defined as "those who had inadvertently came to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects[13]". The present study recorded the history of falls including location, time, circumstances and consequences by interviewing. The exclusion criteria included having history of neurological disorders, sudden symptomatic cardiovascular symptoms, impaired vision, and severe sensory impairment and took medicine or alcohol affecting their balance. The present study protocol was approved by the Mahidol University Institutional Review Board (COA No. 2013/025.2602).

Correspondence to:
Pichaiyongwongdee S, Faculty of Physical Therapy, Mahidol University, Nakhon Pathom 73170, Thailand.
Phone: 0-2441-5450, Fax: 0-2441-5454
E-mail: sopa.pic@mahidol.ac.th

The demographics including age, sex, body mass index, and assisting devices were collected. The self-record of confidence to perform activities measured by the activities-specific balance confident (ABC) scale was also collected. The TUG and TWT were randomly performed to reduce testing effect. Each subject performed each test once. The TUG score was determined by timing when the subject stood up from a chair, walked three meters, turned around, and then walked back and sat on the chair[7,14]. The chair was 43 cm high with backrest and armrest. For the TWT, the subjects were asked to fold their arms across their chest and walk as fast as they could for 30 steps. They walked with heel to toe stepping pattern on a tape 3.5 cm wide and 5 m long. The time and error episodes were recorded for 20 steps. Such episodes were not collected during the five steps at initial and end of distance, and were not recorded. The criteria of error comprised: 1) the foot was not in heel to toe stepping position, 2) at least one foot stepped off the tape, and 3) unable to fold arms and grasp an object or the examiner[9]. Two examiners recorded the data and scored each test. The intra-rater reliability for TUG, TWT time and TWT error of each examiner were excellent as shown by the intraclass correlation coefficient [$ICC_{(3,1)}$] of 0.95, 0.99, and 0.97, respectively.

The SPSS Package, version 18, was used for data analysis. The Mann-Whiney U test and Chi-square were used to compare the demographics between faller and non-faller groups. The received operating characteristic (ROC) illustrated the optimal cutoff score of TUG and TWT (time and error score) for faller and non-faller classification. The area under the curve (AUC) represented the overall accuracy of TUG and TWT. The AUC ranged from 0-1 with 0.5 indicating accuracy by chance. The validity indexes including sensitivity, specificity, positive and negative predicted values and likelihood ratios were calculated by crosstabs analysis.

Results

Fifty fallers (7 males and 43 females) and 111 non-fallers (24 males and 87 females) were identified by self-reported questionnaire. Table 1 shows the demographics of faller and non-faller groups. No significant differences were observed in demographics between faller and non-faller groups except the ABC scale, TUG and TWT. The TUG's cutoff score was 10.5 seconds with 74% sensitivity and 57.7% specificity for faller and non-faller classification as shown in Fig. 1. The TWT's cutoff score was 22.5 seconds (sensitivity 64% and specificity 54%) with 5 error scores (62% sensitivity and 55% specificity). The AUC and validity indexes of TUG and TWT are illustrated in Table 2.

Discussion

Based on the results, the TUG can be used to identify elderly who were fallers and non-fallers. These findings were similar to previous studies[3,4]. Shumway-Cook et al[3] proposed 13.5 seconds of TUG score for identifying faller and non-faller, which was higher than the findings in the present study (TUG 10.5 seconds). They classified frail elderly subjects who completed TUG into faller and non-faller groups and compared their TUG time (22.2 seconds vs. 8.4 seconds). The faller group was significantly older than the non-faller group and some of them used an assisting device to

Table 1. Demographics of faller and non-faller groups

|	Fallers (n = 50)	Non-fallers (n = 111)	p-value
Age (years), mean (SD)	72.04 (6.44)	70.09 (6.43)	0.075
Female, n (%)	43 (86%)	87 (78%)	0.256
Assisting devices, n (%)			
Cane	5 (10)		
None	45 (90)	111 (100)	
Body mass index, mean (SD)	24.22 (4.47)	23.37 (3.84)	0.464
Thai mental state examination, mean (SD)	26.78 (2.27)	26.96 (1.89)	0.586
Activities-specific balance confident scale, mean (SD)	66.26 (19.73)	73.48 (18.39)	0.029*
Timed up and go (sec), mean (SD)	11.70 (2.17)	10.43 (2.08)	0.0001*
Tandem walk test, mean (SD)			
Time (sec)	24.37 (6.25)	23.41 (5.76)	0.388
Error score	6.58 (4.71)	5.23 (4.96)	0.032*

* Statistically significant at *p*<0.05
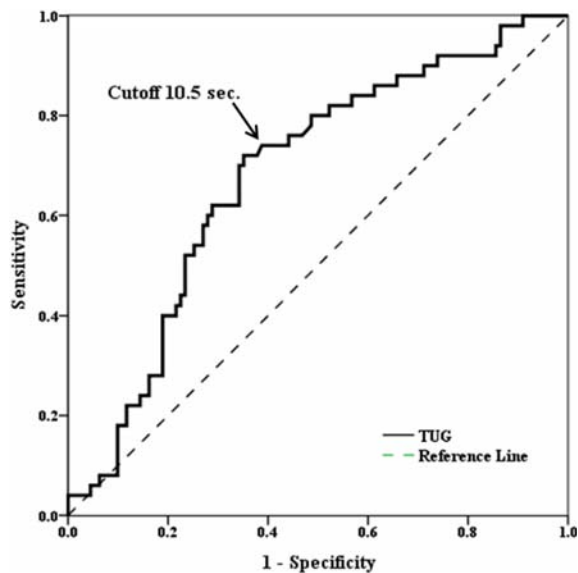
Fig. 1 The ROC curve of the TUG test.

perform the test. In contrast to the present study, faller and non-faller subjects were selected for the same age and none used the assisting device to perform the TUG test.

The cutoff score of TWT error for healthy elderly was five scores and it demonstrated 62% for sensitivity and 55% for specificity. Others have found a cutoff score of two errors to identify elderly people at risk of falls[8-11]. Shimada et al[10] reported that the optimal cutoff score on TWT was 2 steps of 10 steps. This cutoff score correctly classified fallers and non-fallers at 52% sensitivity and 65% specificity. These differences may be explained by the different testing designs. When a cutoff score of two errors was adopted, the high sensitivity (90%) but a very low specificity (27%) in classification of fallers and non-fallers was found. The specificity indicated 27% accuracy for non-faller classification, which was lower than Shimada's findings. Therefore, this study proposed the TWT of five error scores.

The present study had some limitations. Our research design was a cross-sectional to classify fallers and non-fallers using the TUG and tandem walk. The self-report of fall incidence may have been misclassified. However, the subjects in the present study had no cognitive impairment and their fall status including location, time and consequences were recorded to reduce recall bias. Fallers may have performed the test differently from non-fallers as a consequence of their previous fall. A prospective study

Table 2. The area under the curve (AUC), cutoff score, and validity indexes of TUG and TWT for fall prediction in Thai elderly

Test	AUC	Cutoff score	Sensitivity % (n)	Specificity % (n) value %	Positive predicted value %	Negative predicted ratio	Positive likelihood ratio	Negative likelihood
Timed up and go (TUG)	0.62** (95% CI = 0.59, 0.76)	10.5	74.0 (37/50)	57.7 (64/111)	44.3	83.1	3.87	0.451
Tandem Walk Test (TWT)								
Time	0.54 (95% CI = 0.442, 0.644)	22.5	64.0 (32/50)	54.1 (60/111)	38.6	76.9	2.09	0.665
Error score	0.61* (95% CI = 0.514, 0.696)	5.0	62.0 (31/50)	55.0 (61/111)	38.3	76.3	1.99	0.691

* Statistically significant at *p*-value <0.05; ** Statistically significant at *p*-value <0.005

is recommended to examine if these tests can be used to predict falls.

Conclusion

The TUG and TWT errors were useful tools for fall classifications in a Thai community-dwelling for the elderly with the optimal cutoff score of 10.5 seconds and five errors, respectively. The TWT time was not sensitive enough to detect risk of falls.

What is already known on this topic?

The TUG is a standard clinical test for fall prediction and was used to identify fallers in the elderly. However, the previous studies were mostly conducted in Western elderly. The TWT was used to assess balance performance, but the cutoff score to predict fall was not explored in Thai elderly. Moreover, the validity indexes including sensitivity, specificity, predictive values and likelihood ratios of the TUG and TWT in Thai elderly people were not established.

What this study adds?

The present study established new cutoff scores and validity indices of the TUG and TWT for fall prediction in Thai elderly.

Potential conflicts of interest

None.

References

1. Jitapunkul S, Songkhla MN, Chayovan N, Chirawatkul A, Choprapawon C, Kachondham Y, et al. Falls and their associated factors: a national survey of the Thai elderly. J Med Assoc Thai 1998; 81: 233-42.
2. Assantachai P, Praditsuwan R, Chatthanawaree W, Pisalsarakij D, Thamlikitkul V. Risk factors for falls in the Thai elderly in an urban community. J Med Assoc Thai 2003; 86: 124-30.
3. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther 2000; 80: 896-903.
4. Rose DJ, Jones CJ, Lucchese N. Predicting the probability of falls in community-residing older adults using the 8-foot upand-go: a new measure of functional mobility. J Aging Phys Activ 2002; 10: 466-75.
5. Bischoff HA, Stahelin HB, Monsch AU, Iversen MD, Weyh A, von Dechend M, et al. Identifying a cut-off point for normal mobility: a comparison of the timed 'up and go' test in community-dwelling and institutionalised elderly women. Age Ageing 2003; 32: 315-20.
6. Whitney JC, Lord SR, Close JC. Streamlining assessment and intervention in a falls clinic using the Timed Up and Go Test and Physiological Profile Assessments. Age Ageing 2005; 34: 567-71.
7. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991; 39: 142-8.
8. Cho BL, Scarpace D, Alexander NB. Tests of stepping as indicators of mobility, balance, and fall risk in balance-impaired older adults. J Am Geriatr Soc 2004; 52: 1168-73.
9. Nelson HD, Nevitt MC, Scott JC, Stone KL, Cummings SR. Smoking, alcohol, and neuromuscular and physical function of older women. Study of Osteoporotic Fractures Research Group. JAMA 1994; 272: 1825-31.
10. Shimada H, Suzukawa M, Tiedemann A, Kobayashi K, Yoshida H, Suzuki T. Which neuromuscular or cognitive test is the optimal screening tool to predict falls in frail community-dwelling older people? Gerontology 2009; 55: 532-8.
11. Chu LW, Pei CK, Chiu A, Liu K, Chu MM, Wong S, et al. Risk factors for falls in hospitalized older medical patients. J Gerontol A Biol Sci Med Sci 1999; 54: M38-43.
12. Train The Brain Forum Committee. Thai Mental State Examination (TMSE). Siriaj Med J 1993; 45: 359-74.
13. World Health Organization. WHO global report on falls prevention in older age [Internet]. Geneva: WHO; 2007 [cited 2012 Dec 25]; Available from: http://www.who.int/ageing/publications/Falls_prevention7March.pdf
14. Jalayondeja C, Sullivan PE, Pichaiyongwongdee S. Six-month prospective study of fall risk factors identification in patients post-stroke. Geriatr Gerontol Int 2013 Oct 28. doi: 10.1111/ggi.12164.

การทำนายการล้มในผู้สูงอายุไทยด้วยการทดสอบ timed up & go และ tandem walk: การศึกษาภาคตัดขวาง

ธัญวรัตน์ จันทนชัย, โสภา พิชัยยงค์วงศ์ดี, ชุติมา ชลายนเดชะ

วัตถุประสงค์: เพื่อศึกษาการทดสอบ timed up & go (TUG) และการทดสอบการเดินต่อเท้าในการทำนายการล้มในผู้สูงอายุไทย

วัสดุและวิธีการ: ศึกษาในกลุ่มประชากรผู้สูงอายุ 161 รายอายุระหว่าง 60-86 ปี อาศัยในจังหวัดนครปฐมและสมุทรสาคร แบ่งเป็นกลุ่มล้มจำนวน 50 ราย (เพศชาย 7 ราย เพศหญิง 43 ราย) และกลุ่มไม่ล้ม จำนวน 111 ราย (เพศชาย 24 ราย เพศหญิง 87 ราย) ทำการทดสอบ TUG และการเดินต่อเท้า วิเคราะห์ข้อมูลเวลาในการทดสอบ TUG, เวลาในการเดินต่อเท้าและความผิดพลาดในการเดินต่อเท้า เพื่อทำนายการล้ม หาค่าจุดตัดรวมและค่าความถูกต้องในการทำนายการล้มอื่นๆ โดยใช้กราฟ receiver operating characteristic (ROC) curve และการวิเคราะห์แบบ crosstab

ผลการศึกษา: พบว่ากราฟ ROC จากค่าเวลาของ TUG และคะแนนความผิดพลาดของการเดินต่อเท้าสามารถ ใช้จำแนกกลุ่มคนที่ล้มและไม่ล้มได้อย่างมีนัยสำคัญทางสถิติ (p = 0.0001 และ 0.033 ตามลำดับ) แต่ค่าเวลาในการเดินต่อเท้าใช้ไม่ได้ (p = 0.388) ค่าจุดตัดของเวลาที่ใช้ทำนายการล้มจากเวลาของ TUG และคะแนนความผิดพลาดในการเดินต่อเท้ามีค่าเท่ากับ 10.5 วินาที (ความไวร้อยละ 74 และความจำเพาะ ร้อยละ 57.7) และ 5 คะแนนผิดพลาด (ความไวร้อยละ 62 และความจำเพาะร้อยละ 55) ตามลำดับ การศึกษานี้ได้นำเสนอค่าจุดตัดของเวลาเดินต่อเท้าแม้จะใช้บ่งชี้ความเสี่ยงไม่ได้ คือ 22.5 วินาที (ความไวร้อยละ 64 และความจำเพาะร้อยละ 54.1)

สรุป: เวลาของ TUG และคะแนนความผิดพลาดในการเดินต่อเท้า เป็นเครื่องมือที่มีประโยชน์ในการทำนาย ความเสี่ยงต่อการล้มของผู้สูงอายุไทยในชุมชน แต่ค่าเวลาการเดินต่อเท้ามีความไวไม่พอที่จะใช้ตรวจหาความเสี่ยงต่อการล้ม