Original Article :

Comparison of Three Fall Risk Assessment Tools in Community-Dwelling Saudi Elderlies

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Abstract

Background and Aims:
Falls are common in the elderly population. The Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and Five Times Sit-to-Stand Test (5xSTS) are evidence-based clinical performance-based measurements of the risk of falls among elderlies. This study aimed to compare the validity of these assessment tools in predicting falls in community-dwelling elders in Saudi Arabia. Moreover, the cut-off point, sensitivity, specificity, and post-test accuracy percentage for these assessment tools were determined.

Methods:
One hundred fourteen ambulatory community-dwelling individuals aged 65 or older were recruited for this study. Demographic information and a history of falling were collected before all participants were assessed with BBS, TUG, and 5xSTS.

Results:
The BBS was sensitive to group differences between fallers and non-fallers (P = 0.0001). Results from the receiver operating characteristic curve analyses showed that the accuracies of the BBS and TUG at classifying participants with and without a fall history were high-to-moderate (area under the curve [AUC], 0.73 and 0.71, respectively). In contrast, the accuracy of the 5xSTS for the same was low (AUC, 0.67). The cut-off points for the BBS, TUG, and 5xSTS were 42, 20, and 34 seconds, respectively. The highest post-test accuracy was that of the BBS at 84.39%, followed by that of the TUG at 68.05%, and 5xSTS had the lowest accuracy at 25.29%.

Conclusions:
The BBS was a sensitive tool to distinguish fallers among community dwelling elderly as compared to TUG and 5xSTS tests.

Keywords:
Falls, Berg Balance Scale, Risk assessment tools, Timed Up and Go test, Five Times Sit-to-Stand test, Predictive fall.

Introduction

Falls are a leading cause of both mortality and hospitalization due to non-fatal injuries among older individuals [1]. Additionally, falls can result in the development of "post-fall syndrome," which includes challenges such as social isolation and fear of falling [2]. Approximately one-third of individuals aged 65 and older who reside in community settings experience one or more falls annually[3]. It was reported that falls among the elderly range from 31.6% to 49.9% in various cities in Saudi Arabia[4,5].

In the past two decades, various fall risk assessment tools have been developed to screen and identify individuals with high risk for falls. Self-administrated questionnaires, laboratory tests, and physical performance measures are the three types of assessments of balance ability [6]. Performance measures are more reliable than self-reports because self-reports require individuals to recall and interpret questions in a questionnaire. Tools involving performance evaluation can help overcome these obstacles[7,8].

Numerous physical performance measures to predict the risk of falls are available. According to the findings of a previous study, the Berg Balance Scale (BBS), Timed Up and Go (TUG), and Five Times Sit-to-Stand (5xSTS) tests are physical performance measurement tools that currently have the most supporting evidence[9]. Additionally, a recent systematic review [10] revealed that the clinical Practice Guidelines on Fall Prevention and Management for Older Adults, BBS and TUG were the most recommended instruments for assessing fall risk. Previous studies [9,11-12] found that the BBS cut-off points were between 30 and 50, with a sensitivity of 19%–77% and a specificity of 60%–100%. Additionally, TUG cut-off points ranged from 12 to 20 seconds, with sensitivity ranging from 26% to 87% and specificity ranging from 65% to 100% [9,13,14,15]. Furthermore, 5xSTS cut-off points ranged from 12 to 20 seconds, with sensitivity ranging from 55% to 66% and specificity ranging from 45% to 65% [9,16,17]. This inconsistency may be explained by the heterogeneity of the population [18].

The capacity of elderly people to maintain balance can be significantly hindered by age and chronic conditions [19]. Therefore, it is essential to prevent falls and reduce the associated damage. Successful fall prevention begins early by identifying elderly people with a high risk of falling [20], in whom fall prevention programs should address the risk factors and minimize possible falls in the future [13]. For instance, the risk of falling can be reduced in patients with balance and mobility problems by en-

gaging them in correct physical activities[21].

To the best of my knowledge, comparisons on efficacy to determine the best-suited measurement of these physical performance assessments have not yet been performed in community-dwelling individuals aged 65 years and older in Saudi Arabia. Therefore, this study aimed to compare the validity of these three frequently used fall risk assessment tools in predicting falls in community-dwelling elderlies in Saudi Arabia. Moreover, the cut-off point, sensitivity, specificity, and post-test accuracy percentage for each of the three physical performance measures were determined.

Methods

Participants

Using a convenience sample, ambulatory community-dwelling individuals aged 65 years and older were recruited voluntarily through personal communications. Individuals with balance-disturbing neurologic or orthopedic disorders, uncontrolled hypertension, cardiovascular disease, or inability to walk and communicate independently were excluded from the study. The research proposal (UT-249-95-2023) was granted approval by the Local Research Ethics Committee at the University of Tabuk, as it met the ethical approval criteria in accordance with the guidelines and regulations of the National Committee of Bioethics. All participants signed the informed consent.

Procedures

Before collecting data from the participants, the author trained a physical therapist with 10 years of experience in the study procedures. A single therapist collected data to ensure consistency in implementing and scoring measures, and to enhance the interpretation of the collected data. The participants who met the study criteria were invited to enroll. The data were gathered at two outpatient physical therapy departments. The therapist collected demographic data including age, gender, height, weight, chronic medical conditions (diabetes and hypertension), marriage status, and educational level. Subsequently, the participants were queried by the therapist regarding their occurrence of a fall within the preceding 12-month period. All participants were requested to undergo the BBS, TUG, and 5xSTS whereby the examiner randomized the order of the tests to avoid an order effect.

BBS

BBS with excellent validity and reliability is an instrument used to evaluate risk of fall in older adults and geriatric care[11,22]. It includes 14 activities that measure the following elements: (1) postural adjust-

ment to voluntary motions, (2) reaction to environmental disturbances, and (3) position maintenance. The ideal score for each task was 56 on a five-point ordinal scale extending from 0 to 4, with 0 representing the poorest level of performance and 4 reflecting the highest performance level. Participants were shown how to perform every task. In addition, participants were instructed to attempt to maintain balance while performing the tasks. Participants received fewer points if cueing or assistance was necessary during the task.

TUG

TUG with excellent validity and reliability is utilized for evaluating fall risk in the elderly[23,24,25]. It measures the duration, in seconds, that is necessary for an individual to rise from a typical armchair (with a height of approximately 45 cm), ambulate a distance of 3 meters at an average pace, pivot, return to the starting point [23]. The study's subjects were permitted to utilize their upper limbs as a means of support while assuming a standing or seated position on a chair. The duration of the task was documented through employment of a digital timing device.

5xSTS

5xSTS with excellent to adequate validity and reliability evaluates an individual's performance in transitioning from a seated position to a standing position and vice versa, for a total of five repetitions [17,26,27]. The study involved requesting the participants to maintain an upright sitting posture with their arms crossed over their chest while seated on an armless chair with a seat height of 43 cm. They were then instructed to stand up without any external support and subsequently sit back down as swiftly as possible for five consecutive rounds [28]. The evaluator exhibited the examination procedure to every individual involved in the study. The starting point of time measurement was initiated by the examiner's verbal cue of "go", and subsequently concluded upon completion of the fifth stand-up-sit-down cycle, marked by the participants' buttocks making contact with the seat [28].

Statistical analysis

In the univariate analysis, the chi-square test was used for categorical variables and the parametric t-test for continuous variables, to examine the differences in demographic characteristics between individuals who reported falls and those who did not. For the 5xSTS, due to the large number of participants with a score of zero (inability to perform the test or low performance of the test), the average of the three largest scores were included in place of the zeroes; higher scores indicated low-

er performance on the test. Thereafter, logistic regression was used to evaluate the AUC and determine the proper cut-off point for each test separately. All statistical tests were two-sided. A P-value of < 0.05 was considered statistically significant. All analyses were conducted using the SAS statistical software (version 9.4; SAS Institute Inc. Cary, NC).

Results

There were 114 participants, and 47.36% (54) reported a history of falls, while 52.63% (60) reported no history. A large proportion of the cohort that reported falls were men (59.26%) and those aged between 65 and 69 years (33.33%). The proportion of married individuals who reported falls (72.22%) was lower than that of married individuals who did not report falls (91.67%). Individuals who reported falls were nearly five times more likely to report being "very afraid of falling" (16.67%) compared to individuals who did not report falls (3.33%) (Table 1).

Table 1. Demographic characteristics of the participants

	Fall	No-fall	P-value[1]
	n (%)[2]	n (%)	
Total	54 (47.36)	60 (52.63)	
Age (years)			0.01
65-69	18 (33.33)	36 (60.00)	
70-74	6 (29.63)	13 (21.67)	
75-79	7 (12.96)	7 (11.67)	
80 and older	13 (24.07)	4 (6.67)	
Sex			0.31
Male	32 (59.26)	41 (68.33)	
Female	22 (40.74)	19 (31.67)	
Marital status			0.006
Married	39 (72.22)	55 (91.67)	
Divorced/widow	15 (27.78)	5 (8.33)	
Education attained			0.0004
High school	9 (16.67)	12 (20.00)	
Middle School	9 (16.67)	5 (8.33)	
Not literate	22 (40.74)	7 (11.67)	
Primary	5 (9.26)	6 (10.00)	
University/college	9 (16.67)	30 (50.00)	
Body mass index			0.09[3]
Mean	26.78	26.45	
Do you take any medication?			0.32
Yes	39 (72.22)	48 (80.00)	
No	15 (27.78)	12 (20.00)	

	Fall	No-fall	P-value[1]
	n (%)[2]	n (%)	
Total	54 (47.36)	60 (52.63)	
Are you afraid of falling?			0.01
Fairly Afraid	9 (16.67)	7 (11.67)	
Not at all	16 (29.63)	34 (56.67)	
Very afraid	9 (16.67)	2 (3.33)	
Somewhat	20 (37.04)	17 (28.33)	
Chronic disease			0.09
Diabetes & Hypertension	22 (40.74)	23 (38.33)	
Diabetes	2 (3.7)	11 (18.33)	
Hypertension	13 (24.07)	13 (21.67)	
No chronic diseases	17 (31.48)	13 (21.67)	

1 Chi-square test

2 Data expressed as sample size and percentage

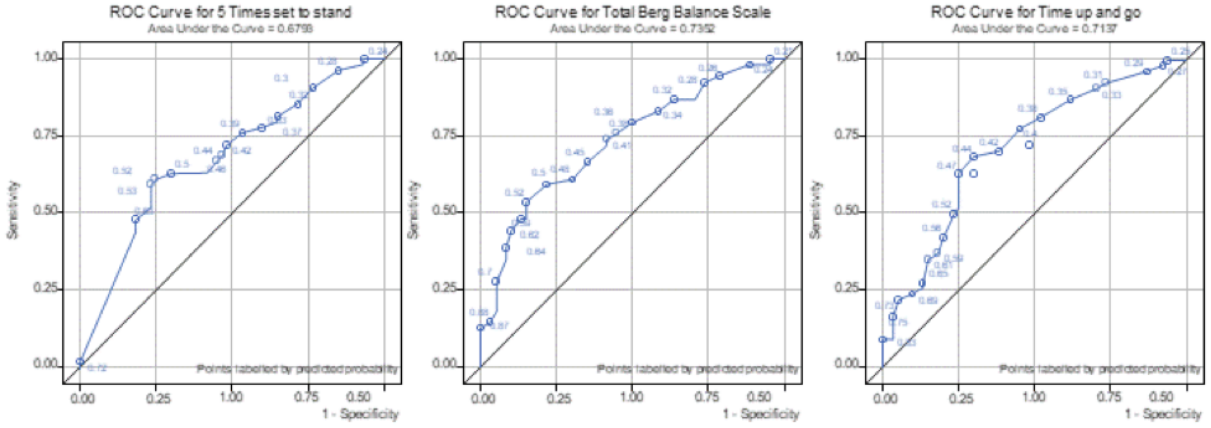
3 t-test for numeric variables

The BBS score was significantly lower (34.44) in individuals who reported falls than in individuals who did not report falls (42.78) (P=0.0001) (Table 2).

Table 2. Comparative analysis of fall assessment score between participants with and without a history of fall

	With a history of fall	Without a history of fall	P-value[1]
Berg Balance Scale score			<0.0001
Mean/standard deviation	34.44/16.04	42.78/11.58	
Five Times Sit-to-Stand test score			0.56
Mean/standard deviation	36.77/1103	29.38/10.32	
Timed Up and Go test score			0.07
Mean/standard deviation	24.46/8.82	18.66/6.97	

1 t-test for numeric variables



The receiver operating characteristic (ROC) curve analysis results are presented in Fig. 1.

As shown in Table 3, the accuracies of BBS and TUG at classifying participants with and without a history of falls were high-to-moderate [area under the curve (AUC), 0.73 and 0.71, respectively], whereas the accuracy of 5xSTS regarding

the same was low (AUC 0.67). The cut-off scores for each scale and their sensitivities and specificities are listed in Table 3. The cut-off points for the BBS, TUG, and 5xSTS were 42, 20, and 34, respectively. Among the three tests, the post-test accuracy of the BBS was the highest at 84.39%, whereas that of the 5xSTS was the lowest at 25.29%.

Table 3. Area under the curve, cut-off point, sensitivity, specificity, and likelihood ratio

Assessment scale	Area Under the curve	Cut-off point	Sensitivity	Specificity	Post-test accuracy (%)[1]
Berg Balance Scale	0.73	42	0.75	0.86	84.39%
Five Times Sit-to-Stand test	0.67	34	0.61	0.75	25.29%
Timed Up and Go test	0.71	20	0.68	0.7	68.05%

1 Post-test accuracy (%) was calculated using the selected cut-off score.

Discussion

This study aimed to compare three widely used and most evidence-supported assessment tools to predict falls: the BBS, TUG, and 5xSTS [9]. Previously, it was suggested that studies concerned with the risk of falling, particularly those that apply ROC and AUC values, should always provide cut-off, sensitivity, and specificity values, as well as the number of participants who are "true positives" and "true negatives" [9]. The results showed that the BBS was sensitive to group differences between fallers and non-fallers. TUG showed less sensitivity than BBS; one the other hand, 5xSTS revealed poor sensitivity to group differences between fallers and non-fallers.

Based on the ROC analysis, the BBS and TUG showed significant discriminative power (AUC, 0.73 and 0.71, respectively). These values indicate the ability of these tests to distinguish between fallers and non-fallers. In contrast, the 5xSTS test exhibited insignificant discriminatory capacity as per the ROC analysis (AUC, 0.67). According to the standard protocol for AUC analyses suggested by Hosmer and Lemeshow, the range of AUC is between 0.5 indicating no discriminating accuracy and 1 indicating perfect discriminating accuracy[29]. For acceptable and excellent discriminative power, the AUC should reach at least 0.7 and 0.8, respectively[29]. Therefore, the BBS had the highest and the most acceptable discriminative ability, whereas the 5xSTS had limited discriminative ability. The post-test accuracy of the BBS was the highest, followed by the TUG and 5xSTS. This is consistent with the results of a previous systematic review and meta-analysis [9].

In this study, the BBS cut-off score was

42, with 75% sensitivity and 86% specificity. These results are within the range of scores reported in previous studies [9,11-12], which found that the BBS cut-off scores were between 30 and 50, with a sensitivity between 19% and 77% and specificity between 60% and 100%. At the same time, the TUG cut-off score in this study's population was 20, with 68% sensitivity and 70% specificity. This result is also within the range of values reported in previous studies, which found that the TUG cut-off points ranged from 12 to 20, with sensitivity ranging from 26% to 87% and specificity ranging from 65% to 100% [9,13,14,15]. A study comparing the BBS and TUG[30] reported that the BBS had higher sensitivity but lower specificity than the TUG. The results of this study showed that the BBS had higher sensitivity and specificity than the TUG and 5xSTS.

Several studies indicate that 5xSTS can predict falls among the elderly aged 65 and older years, and the cut-off is between 12–15 seconds [9,17,31,32,33]. However, the results of this study contradict these previous findings and indicate that 5xTST has limitations in distinguishing between fallers and non-fallers, poor discriminative ability (AUC, 0.67), and poor post-test performance (25.28%). This may be attributed to the inclusion of participants who were unable to stand up and perform the test. In this study, approximately 31% of the participants were unable to complete the 5xSTS. A previous study showed that 57.5% of patients at home-care were failed to complete 5xSTS indicating the test's limitation[24]. Zhang et al., 2013, included participants who were unable to perform the test and concluded that 5xSTS was only marginally predictive of subsequent falls[34]. The literature shows a disparity in the scoring system used for the 5xSTS 29. Furthermore, a weak association has been reported between the 5xSTS score and advanced age [27].

The present study has some limitations. First, the chair was not changed to accommodate the height of each participant in the 5xSTS. However, it is necessary to establish whether a person can rise from a chair at the average height seen in the community. Second, follow – up data to assess the participants' fall risk over time was not collected for this study. Third, this study assessed the performance of the three measures, but did not consider other potential fall risk factors such as visual impairment, chronic disease, use of certain medications and fear of fall. These factors may interact with balance. Future research should include follow-up data over time and assessments for other factors that may interact with balance.

Conclusion

The BBS was a sensitive tool to distinguish fallers among community dwelling elderly as compared to TUG and 5xSTS tests.

Ethics approval and consent to participate:

The research proposal (UT-249-95-2023) was granted approval by the Local Research Ethics Committee at the University of Tabuk, as it met the ethical approval criteria in accordance with the guidelines and regulations of the National Committee of Bioethics. All participants who were enrolled in this study provided informed consent.

Competing interests

The author declares that they have no competing interests.

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