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Use of Timed Up and Go Test to Predict Risk of Fall in Indian Elderly

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Authors' contributions

This work was carried out in collaboration among all authors. Author PK designed the study, wrote the first draft of the manuscript, author PJ collected data and reviewed literature, author LP reviewed the data and manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background: Although the TUG has been recommended as a key test for screening the risk of fall, the optimal cut-off value to detect older adults who are at an elevated fall risk remains controversial as wide range of threshold values have been reported in the literature. The validation of TUGT is yet to be performed for the Indian population.
Objective: To determine cut off value for TUG to predict risk of falls among Indian population.
Methods and Measures: In this cross sectional study, 121 participants, meeting inclusion-exclusion criteria and willing to participate were included. On the basis of BBS scores, participants were divided in risk of fall group (BBS< 45) and no risk of fall group (BBS2 >/=45). TUG Test was performed and time was measured using stop watch.
Results: Pearson correlation between BBS and TUG had shown statistically significant negative correlation (r= -0.852), (p=0.000). Considering the different sensitivity and specificity, the best predictive value to predict risk of fall was 14.5 seconds at 97.4% sensitivity, 96% specificity.
Conclusion: Best cut off value to predict risk of fall is 14.5 Sec for older adults in India. Increasing age, Knee pain and sedentary life significantly affects TUG Scores and increased Risk of fall.

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Keywords: Risk of falls; balance; BBS; TUG test; older adults.

1. INTRODUCTION

A fall is one of the external causes of unintentional injury. It is coded as E880-E888 in International Classification of Disease-9 (ICD-9), and as W00-W19 in ICD-10.These codes include a wide range of falls including falls on the same level, upper level, and other unspecified fall. A fall is often defined as "inadvertently coming to rest on the ground, flooror other lower level, excluding intentional change in position to rest in furniture, wall or other objects" [1] The risk factors for falls are broadly classified as intrinsic and extrinsic risk factor. The WHO [1], in addition identifies behavioral and socioeconomic risk factors and stated that as the exposure to risk factors increases, the risk of falls and injuries also increases [2].

There are numerous sophisticated and simple clinical tests which have been used for identifying people with risk of fall. Several researchers have used external perturbation and a force platform to study balance [3,4]. Studies have been also conducted on the sensory organization balance test and Modified Clinical Test for Sensory Interaction on Balance (SOT). The SOT and the Modified CTSIB examine postural sway during different sensory challenging conditions [5,6]. But examinations of balance through expensive and sophisticated instrument do not necessarily improve the efficiency of fall assessment. Clinical screening instruments for identifying older people at high risk of falling have been proposed, and these vary in complexity from a single clinical test to scales involving 10 or more assessments. Functional clinical tests are easy to apply, low cost with more apparent therapeutic implications. Commonly used are the Berg Balance Scale (BBS), the Clinical Test of Sensory Integration and Balance (CTSIB), Functional Reach, Tinetti Balance Scale and the Timed Up and Go Test (TUGT). Each of these tests assesses different factors related to balance, and each has its advantages and disadvantages [5]. A reliable and a valid test should increase the ability of the therapist to predict who are in the risk of fall and at the same time should be easily available, simple and less expensive [7].

The BBS used to assess the balance of elderly people and recommend it as consider it the gold standard with inter rater reliability (ICC=0.98) and intra rater reliability (ICC=0.68) [8] It assesses both dynamic and static aspects of balance and an individual's risk of falls. Older adults who scored higher than the cutoff score, 45 out of 56, were less likely to fall than were those adults who scored below the cutoff score [9]. The BBS test although valid and reliable takes 15 to 20 minutes to perform. Simpler 5 minute test such Timed Up & Go (TUG) Test is available with high inter rater reliability (ICC-0.99) and intra rater reliability (ICC0.98) and also well correlated with BBS Test.

The Timed Up & Go Test (TUG) is commonly used to examine functional mobility in community-dwelling older adults. Test complete time is correlated to level of functional mobility [8]. Older adults who complete the test in less than 20 seconds are shown to be independent in activities of daily living. Older adults requiring 30 seconds or longer to complete the task tend to be more dependent in activities of daily living [10].

The fall prevention guidelines from the American Geriatric Society, the British Geriatric Society and The Nordic Geriatricians Meeting, recommend the use of the TUG as one of the bedside tests to screen for the presence of gait and balance disorders in older adults. But to date, although the TUG has been recommended as a key test for fall risk screening, the optimal cut-off value to detect older adults at an elevated fall risk remains controversial as there have been a wide range of reported threshold values in the literature (10 to 33 seconds). The validation of TUGT is yet to be performed for the Indian population. Aim of this study is to determine cut off value for TUG to predict risk of falls among Indian population.

2. METHODOLOGY

2.1 Study Design

This was Cross sectional study.

2.2 Method

Necessary permission from concerned authorities of 3 old age homes were obtained which were vicinity of Vadodara city to recruit the subjects and to conduct the study. The study was conducted for a period of 9 months and the study was a preliminary part of a larger study aimed at developing a method to identify risk of falls in Indian elderly considering socio economic and

cultural aspects. Older adults aged 65 years or older, living independently in the community, with or without an assistive device but without the assistance of another person, able to follow simple instructions was recruited for the study. Convenient sampling method was used to select the subjects. Study population from 3 old age homes [N=57], 3 community areas [N=50] and 1 public garden [N=14] have been approached N=318, out of which N=177 were eligible. Older adults with known neurological diagnosis that could account for possible imbalance and falls, such as cerebrovascular accident, Parkinson disease, cardiac problems, transient ischemic attacks, or lower-extremity joint replacements were [N=141] excluded from the study. Nature and purpose of study was explained to the participants. Non consent [N=54] were also excluded. Signed Informed consent was obtained from participants. Upon agreement to participate, demographic data in form of name, age, sex residential area was obtained. General screening test was administered which comprised of Functional ROM. Functional MMT. All participants underwent Balance evaluation using the Berg Balance Scale. which rates performance from 0 (cannot perform) to 4 (normal performance) on 14 different tasks, including ability to sit, stand, reach, lean over, turn and look over each shoulder, turn in a complete circle, and step.BBS Score was counted out of total of 56.

There were 121 participants, on the basis of BBS scores, participants were divided in risk of fall group (BBS<45) and no risk of fall group (BBS >=45). After BBS all the participants underwent TUG Test. In Time up and Go Test, 3 m distance was measured measuring tape on flat surface from the chair and was marked with cone on the other end. Verbal instructions were given to stand up from a chair, walk 3 m as quickly and as safely as possible, cross a line marked on the floor, turn around, walk back, and sit down. Those subjects who used an assistive device when walking in the community were requested to use that device. Stop watch was used to record the time in second. As the study was among older adults all the necessary safety measures were considered.

3. RESULTS AND DISCUSSION

3.1 Results

Collected data was entered in MS Excel sheet and statistical analysis was done using SPSS software, version 14. Total of 121 elderly participated in the study and their age ranged between 65 to 92 years.

3.2 Discussion

The study aimed at use of TUG to predict risk of falls among older adults. There were 121 participants. The mean score of BBS and TUG for all participants were 48.16± 6.24 and 13.42 +5.23 respectively.

On the basis of BBS scores, participants were divided in 'risk' of fall group (BBS <45) and 'no risk' of fall group (BBS>=45). 39 participants were in 'risk' of fall group and 82 in 'no risk' of fall group, and the mean age of risk of fall group was higher (76.56 ± 7.19) than the no risk of fall group (71.34 ± 49) which was statistically significant (p=0.000). Though both the groups fall in the same 7th decade, No risk of fall group was in the early part of 7th decade whereas the risk of falls group was 5 years higher. This increase in risk of fall with increase in age, more specifically in the 7th decade has been reported in the earlier literature. Tinetti et al [11] reported Prevalence of risk factors for fall increases steeply after 70 years. Older people have stiffer, less co-ordinate and more dangerous gaits than do younger people. Posture control, body-orienting reflexes, muscle strength and tone, and height of stepping all decline with ageing and impair ability to avoid a fall after an unexpected trip or slip.

In old age, the 'strategy' for maintaining balance after a slip shifts from the rapid correcting 'hip strategy' (fall avoidance through weight shifts at the hip) to the step strategy (fall avoidance via a rapid step) [12]. The mean scores of BBS for risk of fall and no risk of fall group were 41.79 ± 2.3 and 51.19 ±-3.02 respectively and the difference was statistically significant. (p=0.000). This suggests sharp declining of balance in elderly as they age during their 7th decade.

Table 1. Participants age

Gender	No. of Participants	Mean	Standard Deviation
Male	68	72.96	6.27
Female	53	72.76	5.98

**Age in years (rounded up to near maximum)*

Table 2. Mean values of age, TUG and BBS in both group

	Risk of fall group Mean (SD)	"No Risk of fall group Mean (SD)	P value
Age (Years)	76.56±7.19	71.34±4.9	0.000
BBS (out of 56)	41.79±2.3	51.19±3.02	0.000
TUG Score (sec)	17.74±2.40	11.37±1.90	0.000

Table 3. One Way ANOVA Comparison of Time Taken (in Seconds) to complete the TUG in 'risk' of fall group (n=39) and in 'no risk of fall group (n=82)

	Mean TUG Score (see)	Std.. Error	p-value	F value
No Risk of fall group	11.37±1.90	0.21013	0.000	248.56
'Risk' of fall group	17.74±2.40	0.38480		
Total	13.42±3.63	0.33025		

For TUG, Shumway cook et al. have reported a cut off value of less than 14 to identify the risk of fall in community dwelling elderly. In the present study also the mean values of No risk of fall and risk of fall group follow a similar pattern (11.37±1.90, 17.74±2.40 respectively). One Way ANOVA Comparison of time Taken to complete the TUG test showed statistically significant differences between the means of 'risk' of fall group and 'no risk of fall group. Results from the One way ANOVA showed that the older adults in 'risk' of fall group were slower (F248.56, p=0.000) than the older adults in 'no risk of fall group. Similar difference was found in study conducted by Shumway cook at el [10] (F 522.97.p=001). It is probably because there was significant statistical difference in age between the older adults in fall risk and no fall risk group.(p=0.000).

Though BBS is a valid and reliable tool in assessing balance and predicting the risk of fall it is time consuming and it takes approximately 20 minutes to perform. A Simpler and more easier to test within 5 minutes mobility test such as TUG is available [8]. We contend that TUG appears to be a valid method for screening for both level of functional mobility and risk for falls as several authors had used it [10,13,14,15,16].

Podsiadlo and Richardson et al [14] reported a significant negative correlation between TUG and BBS (r= -0.72). Berg et al [17] reported highly significant correlation between BBS and TUG (r= -0.76). In present study also the Pearson product moment correlation coefficient (r) was used to determine the correlation between TUG and BBS which shows negative correlation between BBS and TUG Score with r value (-0.823) and p value (0.000).

It is important to determine the accuracy of TUG as a substitute for BBS to predict risk of fall. Several authors used Receiver operating characteristic (ROC) curves to predict accuracy of TUG test and to analyze its sensitivity and specificity [13,16,18]. In present study also ROC curve was constructed for the cut off value and analysis of sensitivity and specificity TUG. Analyzing the different sensitivity, specificity and likelihood ratio values, the best predictive value for discriminating elderly individuals who were at risk of was 14.5 seconds, with 97.49% sensitivity, 96% specificity and area under the ROC curve of 0.98.

ROC Curve

Area under ROC Curve = 0.987

The cut off value is similar to 14 sec given by Shumway cook et al [10] the present study followed a methodology which was almost similar to the Shumway cook's in terms of instructing the subjects to perform the test as quickly as safely possible. Also the mean ages of participants were similar in both studies and also the age of faller groups were significantly higher than non faller groups. However this cutoff point does not remain constant across various populations in terms of age or any other variable as found in several literatures. In one such literature, the cut of vale given by Tiago et al. [13] is 12.47 seconds, is much lesser than the present cut off value. This difference in cut off value may be attributed the age of population studied, as the mean age of study population of both fallers and non fallers in Tiago's study was lower than the present study (fallers and non fallers mean age was 66.68 (SD-5.57) and 66.36 (SD=4.60), respectively). It is important to note there was no significant

difference in age between fallers and non fallers in study by tiago whereas in present study it was statistically significant. Cut off value in this present study differs also from that of Podsiadlo and Richardson [14] which was greater than 30 seconds. The differences in time values may reflect the differences in participants used in the 2 studies. Podsiadlo and Richardson's study included older adults with a wide range of neurological pathologies whereas the present study excluded such neurological pathologies.

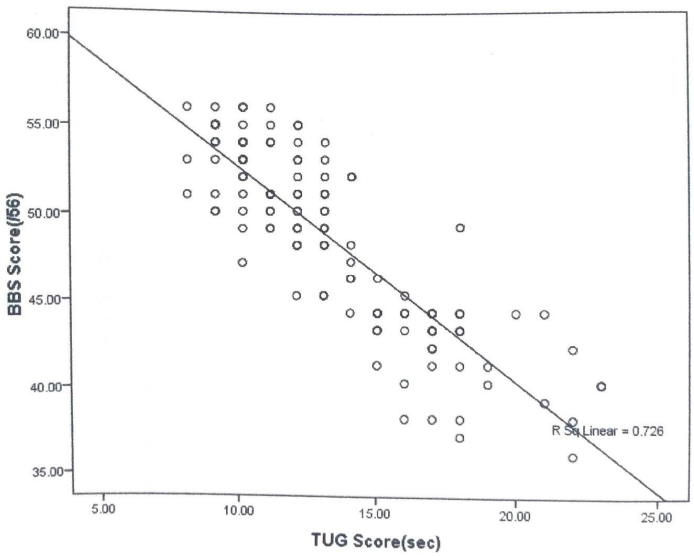

Fig. 1. Graph Shows Significant Negative Correlation between TUG Score (Sec) and BBS Score (out of 56) With R-Value Of -0.823 And p-Value of 0.000

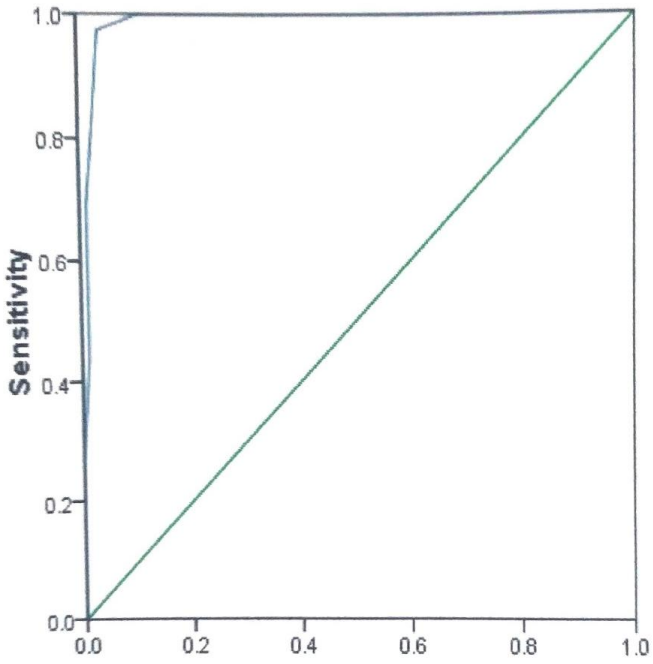

Fig. 2. ROC Curve of TUGT as Predictor of fall among Elderly Individuals.

There is also statistical significant difference in BBS and TUG scores among participants with knee pain and asymptomatic knee. Several authors studied the relationship between balance and osteoarthritis of knee. Hee-Sang Kim et al Aimed to investigate balance control according to the severity of knee osteoarthritis using BBS and TUG test. TUG and BBS test results of the knee OA mild and moderate to severe patient groups showed a statistically significant difference compared to the control group and concluded that moderate to severe OA patients had diminished balance control compared to mild OA patients and they were able to deduce that a decrease in muscle strength, proprioception, and increased pain contributes to postural instability. Another reason behind this instability was explained by Alencar et Al [19] that knee pain could results in lower weight bearing by the affected joint, preventing the ability of a person with OA to maintain the center of mass inside the base of support and also Pain due to knee OA might lead individuals to transfer from a sitting to a standing position in a more cautious manner, increasing the time to do the task. This suggests that there might be an underlying dysfunction which can result in a decline in physical functioning and an increase in risk of falls.

Knee pain, a significant comorbidity, is reported to be affecting TUG scores and so the risk of falls in elderly. In present study Pearson chi square shows significant difference in participant with painful knee (p-0.000) it both group. Numbers of participants with painful knee are significantly larger in risk of fall group. Diana L et al [20] also concluded that older people with lower limb arthritis are at increased risk of falling due to deficits in neuromuscular systems. Impaired strength, proprioception, and balance and increased levels of pain may be important underlying mechanisms for both falls and disability.

In addition, the time taken to complete the TUG by the older adults with assistive device was significantly higher than the participants not using assistive device for ambulation. The time taken to complete the TUG with no device was 12.75+/- 3.19 seconds and time taken to complete the TUG with a cane was 17.93 +/- 2.54. Shumway cook [10] also concluded highly significant (r=0.95) correlation between use of assistive device and time taken to complete the TUG in group of fallers.

In the present study the mean value of BBS was lower in old age home subjects than both the morning walker and community dwelling older adults. Similarly the TUG Score was higher among participants residing at old age home than both the morning walker and community dwelling older adults. Rosengren et al [21] concluded that sedentary older adults are known to adopt a more cautious walking style with shorter step lengths and slower step velocities than active older adults. Both BBS and TUG of old age home participants were Scores (46.17 and 15.08 sec respectively) indicating risk of falls. Studies on prevalence of falls have also been conducted in institutions which reported the frequency of falls is considerably higher than among those living in their own homes. Luukinen et al [22] concluded that Falls are common in the elderly, but their incidence and certain characteristics differ considerably between the home-dwellers and those living in institutions.

Table 4. Association of TUG with knee pain

		Mean TUG Score(sec)	Std.Error Mean	P value	t value
Knee Pain	Present	14.52±3.78	0. 46981	0.00*	3.756
	Absent	12.16±3.00	0. 40192		

** Association is significant at 0,001 level*

Table 5. Association of tug with use of assistive device

Use of assistive Device	Mean TUG Score(sec)	Std. Error Mean	p value	t Value
Yes	18.57 ± 2.56	0. .685	0.00**	6.538
No	12.75 +3.19	0. 308		

*** Association is significant at 0.001 level*

4. CONCLUSION

In agreement to the literature TUG' is sensitive and specific indicator to predict risk of falls. There was significant negative correlation between TUG and BBS scores. The best predictive value of TUG for discriminating elderly individuals who are at risk of is 14.5 seconds, with 97.4% sensitivity, 96% specificity. Knee pain significantly affects TUG and BBS scores and increases the risk of falls in older adults. Sedentary older adults are at higher risk of functional decline and risk of falls.

DISCLAIMER

All Authors hereby declare that no competing interests exist.

CONSENT

All authors declare that 'written informed consent was obtained from the participants (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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