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Identifying a cut-off point for Timed Up and Go Test and 30-second Chair Stand Test in dual-task condition: Effects of cognitive status

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Abstract

A decline in mental function is a common problem associated with aging. The most commonly used tests for evaluating functional mobility, fall risk, and lower limb strength of older adults in the clinic are 'Timed Up and Go Test' and '30-second Chair Stand Test'. This study was planned to determine the cut-off point of these tests in cognitive declines. A total of 204 older adults aged 65 years and over participated in this study. To examine the cut-off points of tests for single and dual-tasks, count off by twos was added as a cognitive task. The cut-off points of tests without and with an additional task were determined as 10.54, 12.21 second, 10.5, and 8.5 stands respectively. These results are important to reveal the effects of mental declines should be taken into account when interpreting the results of clinical functional mobility assessments in older adults.

Keywords: Elderly, timed up and go test, 30-second chair stand test, roc analysis, multi-tasking behavior.

Introduction

One of the most important problems associated with aging is a decline in mental functions. Although some of the mental functions such as general knowledge, verbal ability, and numerical abilities decline a little with age; some of the functions such as memory, executive functions, speed of processing, and reasoning decline from earlier [1, 2]. Studies have shown that older adults with mental problems also have a higher risk of falls [3, 4]. Falls are a very common problem in the aging process that restricts activities of daily living and reduces the quality of life [5]. Especially lower extremity muscle weaknesses and sensory and postural balance problems underlie fall problems seen in older adults and limit their mobility [6]. Falls are also related to divided attention between postural control and additional tasks during activities of daily living in older adults [7, 8].

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Functional independence and safe mobility depend on the ability to perform dual-tasks in older adults and many dual-task activities are performed during daily life [9]. Therefore dual-task paradigm is important because it involves the simultaneous performance of many cognitive and motor tasks as in the activities of daily living. It has also been suggested that dual-task tests predict falls better than single-task tests [10]. Dual-task outcome measures are also used to distinguish older adults with cognitive impairment [11, 12]. Older adults are more susceptible to dual-task decrements and assessment of dual-task skills gives an idea about the individuals at risk [13].

The most commonly used test for evaluating fall risk and mobility in the clinic is the Timed Up and Go Test (TUG) [14]. It is an easy, objective, and valid test that assesses locomotive performance and mobility [15], a good indicator of future disability [16], and the TUG time was related to the past falling history [17]. Another important test used for functional assessment in the clinic is the 30-second Chair Stand Test (30-s CST) and it indicates lower limb strength that affects many functions in daily life [18-20]. In previous studies, it is seen that 30-s CST was used frequently in

predicting lower extremity strength, and became also widespread in publications that involved climbing stairs ability of the older adults, walking speed and falling risk [21], age-related declines [22], caring for the difference between those who fell and who did not fall [23] and determining the effects of physical training [24]. When the literature is examined, studies are indicating the cut-off point of TUG with and without dual-task [10, 25]. And to our knowledge, although few studies are reporting the number of repetitions in the 30-s CST Test [18], no studies are detected that reported the clinical cut-off points. On the other hand existing studies have determined the cut-off point according to the fall history. Although the importance of the dual-task paradigm in assessment and the effect of mental status on dual-task skills are known; mental status has been ignored in these studies. When we take into consideration the common cognitive decline in older adults, the present study is planned to determine the cut-off points of these two tests, which evaluate the functional mobility and muscle strength according to the mental status.

Methods

Participants

In order to examine the cut-off points of tests, older adults aged 65 years and over who were admitted to Kırıkkale High Speciality Hospital, Community Mental Health Center and who volunteered to participate in the study were included in the study.

The inclusion criteria of the study were 65 years of age or older, being voluntary, functionally independent, and taking 4 and 5 points according to Functional Ambulation Classification. The exclusion criteria of the study were cooperation problems, some orthopedic or neurological problems that prevented determination of balance and functional performance, uncontrolled hypertension, heart disease, cardiac arrhythmia, cardiovascular disease, other chronic illnesses, receiving chemotherapy and radiotherapy agents that could affect balance and functional performance, use of auxiliary equipment, to use more than 4 medicines [26] and 2 or more falls in the last 6 months.

The study was approved by the Clinical Research Ethics Committee of Kırıkkale University (Decision Date: 01/03/2016 and Decision No: 06/11) and was conducted between January 2017 and December 2017.

Procedures

Age, height, weight, body mass index (BMI), of individuals were recorded. Their cognitive status was assessed by the Mini-Mental State Examination (MMSE). The individuals were divided into two groups according to MMSE score: those with an MMSE score <24 and ≥24. Demographic and clinical assessments were made by the same physiotherapist.

Mini-Mental State Examination (MMSE)

MMSE is a commonly used test that can be easily applied within 5-10 minutes to assess the cognitive functions of older adults. The MMSE assesses five areas of cognitive function: orientation (10 points), registration (3 points), attention and calculation (5 points), recall (3 points), and language (9 points). This test consists of 11 items. Total score ranges from 0 to 30: 27-30=normal cognitive function, 24-27=mild cognitive impairment [13], and <24=severe cognitive impairment [27]. This is a test that has the Turkish version, and that is valid and reliable for older adults [28].

Timed Up and Go Test

The TUG test is a valid and reliable functional mobility evaluation that might be used in older adults to follow-up on the clinical changes in time. In the TUG test; the time (in seconds) taken by an individual to stand up from a standard armchair (approximate seat height of 46 cm, arm height 65 cm), walk a distance of 3 meters (approximately 10 feet), turn, walk back to the chair, and sit down again [15].

30-second Chair Stand Test

The 30-s CST is a reliable and valid indicator of the lower extremity force in older adults [18]. In the 30-s CST; a flat back chair is placed close to the wall. The patient is asked to sit in the chair and stand up from the chair with his/her arms crossed on his/her chest. The maximum number of correctly performed repetitions in 30-seconds is recorded [29].

Dual-Task Procedure

To evaluate single and dual-task performances, TUG and 30-s CST were performed without and with an additional cognitive task respectively. Count off twos by starting from 0 was added to these tests as an additional cognitive task. When the test had to be repeated, the person continued to count from the number she/he had left. Counting errors were ignored.

Statistical Analysis

Statistical analysis were performed using SPSS 21 (SPSS Inc., Chicago, IL, USA). The normal distribution suitability of the variables was tested by visual (histogram and probability plots) and analytical (Kolmogorov-Smirnov/Shapiro-Wilk tests) methods. To compare differences between those with an MMSE score <24 and those with an MMSE score ≥of 24, the Mann-Whitney U test was used for continuous variables.

The Receiver Operating Characteristic (ROC) analysis was used to assess the diagnostic validity of the TUG test and 30-sCST (TUG no-task, TUG with an additional cognitive task, 30-sCST no-task, 30-s CST with an additional cognitive task) for individuals. The highest combined value of sensitivity and specificity was taken to determine the optimal cut-off point for each test.

For posthoc power analysis G*Power program (version 3.0.10 Universität Düsseldorf, Düsseldorf, Germany) was used. In the posthoc power analysis, when the statistical significance of alpha was 5% and the confidence interval was taken as 95%, the power (1-β) of the study was found to be 99%. The primary outcome was determined as TUG (no-task). The effect size was found 0.73.

Results

A total of 204 older adults (aged 65 years and over) participated in this study. The demographic characteristics and clinical test scores of participants are shown in Table 1.

When the clinical test scores of both groups were examined, it was seen that there was a statistically significant difference. Also, in the effect size analysis, it was determined that the effect of mental state on TUG and 30-s CST scores was medium.

According to ROC analysis, the clinical cut-off point for TUG without an additional task in older adults with cognitive decline was determined as 10.54 sec. Scores that equal to 10.54 sec or less with 95% confidence was considered as normal for TUG no-task in older adults with cognitive decline (95% Confidence interval lower bound= 0.634 upper bound= 0.775; Area Under the curve (AUC) = 0.704; Std error= 0.036; p< 0.001). The clinical cut-off point for TUG with an additional cognitive task in the same individuals was determined as 12.21 sec (95% Confidence interval lower bound= 0.661 upper bound= 0.797; Area Under the curve (AUC) = 0.729; Std error= 0.035, p<0.001). (Figure 1-2) It is seen that the discriminant power of TUG with an additional cognitive task is high.

The sensitivity and specificity of TUG and 30-s CST with and without an additional task are shown in Table 2.

Table 1. Demoghraphic characteristics and clinical tests scores of participants

Group Statistics				
	MMSE score ≥24 (n=93) X ± SD	**MMSE score <24 (n= 111) X ± SD**	**p**	**Standardised effect size Cohen D**
Age	69.36±4.97	71.53±6.47	0.020*	0.37
BMI	28.49±4.25	29.26±5.31	0.405	0.15
TUG (no-task)	10.20±2.81	14.07±6.87	<0.0001*	0.71
TUG (cognitive additional task)	11.51±3.76	16.88± 8.56	<0.0001*	0.78
30 s CST (no-task)	11.05±3.21	8.55±3.45	<0.0001*	0.74
30 s CST (cognitive additional task)	9.19±3.39	7.18±3.44	<0.0001*	0.58

BMI: Body Mass Index; TUG: Timed Up and Go Test; 30 s CST: 30 - second Chair Stand Test; MMSE: Mini Mental State Examination; *:p<0.05 (Mann-Whitney U test); X: Mean; SD: Standard Deviation.

Table 2. Sensitivity and Specificity of TUG and 30 s CST

Tests	**AUC**	**%95 CI**	**Cut-off Point**	**Sensitivity (%)**	**Specificity (%)**
TUG (no-task)	0.704	0.634-0.775	10.54	66.7	60.2
TUG (cognitive additional task)	0.729	0.661-0.797	12.21	67.6	64.5
30 s CST (no-task)	0.701	0.630-0.772	10.5	72.1	51.6
30 s CST (cognitive additional task)	0.667	0.593-0.741	8.5	67.6	51.6

TUG: Timed Up and Go Test, 30 s CST: 30 second Chair Stand Test; AUC: Area Under Curve (ROC Analysis)

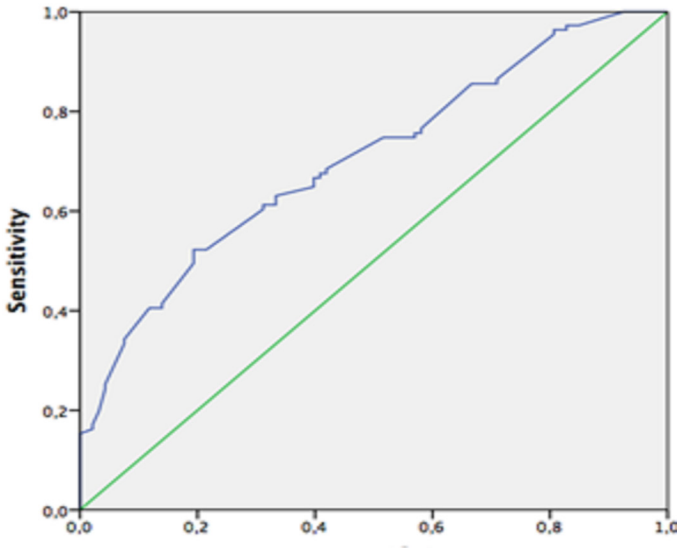

Figure 1. ROC-curve for TUG (no-task)

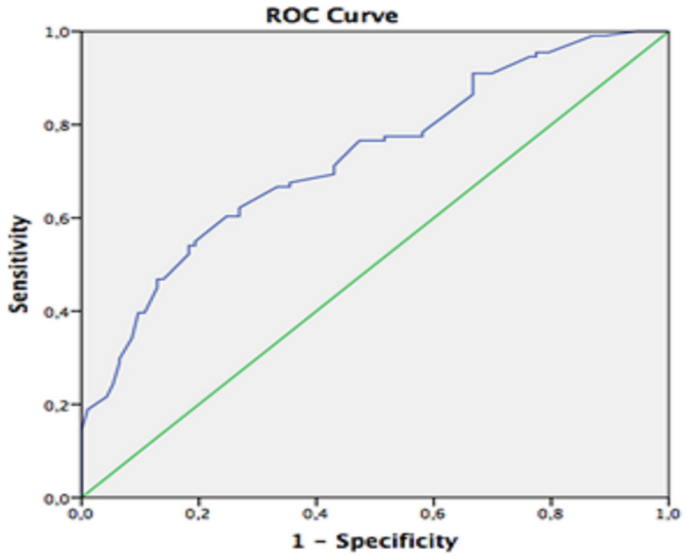

Figure 2. ROC-curve for TUG(with the cognitive task)

According to ROC analysis, the clinical cut-off point for 30-s CST without an additional task in older adults with cognitive declinewas determined as 10.5 stands and 10.5 stands or less with 95% confidence was considered as no-task for 30-s CST normal in older adults with cognitive decline (95% Confidence interval lower bound= 0.630 upper bound= 0.772; Area Under the curve (AUC) = 0.701; Std error= 0.036; p<0.001). The clinical cut-off point for 30-s CST with an additional cognitive task in the same individuals was determined as 8.5 stands (95% Confidence interval lower bound= 0.593 upper bound= 0.741; Area Under the curve (AUC) = 0.667; Std error= 0.038, p<0.001) (Figure 3-4).

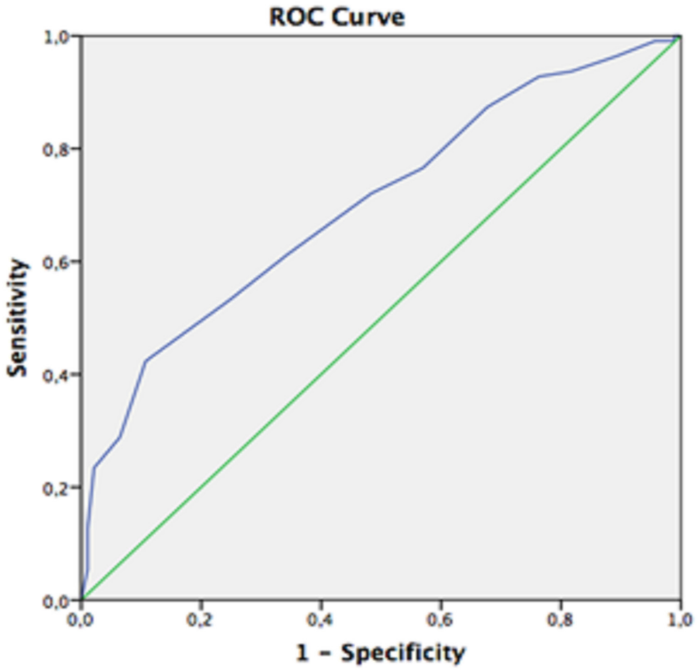

Figure 3. ROC-curve for 30-s CST (no-task)

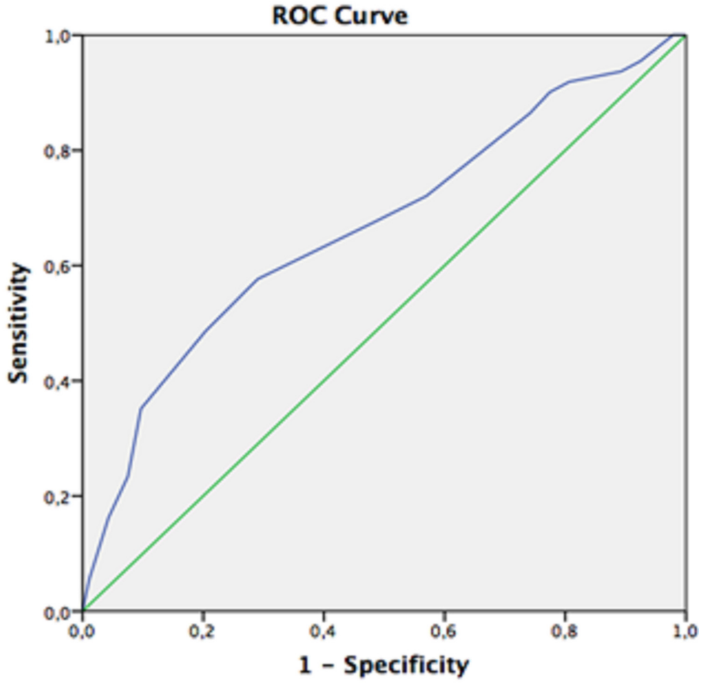

Figure 4. ROC-curve for 30-s CST (with the cognitive task)

Discussion

This study demonstrates that the performances of TUG and 30-s CST performed with additional cognitive task deteriorated in the older adults with mental declines. Therefore, the effects of mental declines should be taken into account when interpreting the results of clinical functional mobility assessments such as TUG and 30-s CST in older adults.

Many studies have been performed to determine their normal values in different age groups. In particular, there are studies on the cut-off points of the TUG test made by no-task and dual-task activities in older adults. In a study conducted in older women aged 65-85 years living in the community by Bischoff et al. [30], the cut-off point of the TUG test was determined as 12 sec. Tang et al. [10] investigated the cut-off point of the TUG test without and with an additional cognitive and motor task in 28 non-frail and 37 prefrail individuals over 50 years old. The cut-off point for the TUG test without an additional task and with an additional cognitive task in prefrail individuals was determined as 7.7 sec (sensitivity 68%) and 14.3 sec (sensitivity 29%), respectively. In a study performed in older adults with a history of falls by Shumway-cook et al. [25], the cut-off points for the TUG test without an additional task and with an additional cognitive task were determined as 13.5 sec and 15 sec, respectively.

When the literature is examined, it is seen that the cut-off point for the TUG test with dual-task is usually investigated in individuals with and without a history of falls. Unlike these studies, we determined the clinical cut-off points for TUG without and with an additional cognitive task in older adults according to cognitive decline and we determined the values as 10.54 sec (sensitivity 66.7%, specificity 60.2%) and 12.21 sec (sensitivity 67.6%, specificity 64.5%), respectively. It is seen that the cut-off points of TUG in older adults with a history of falls are similar to those in older adults with cognitive decline. We think that it is important to take these values into account in interpreting these commonly used test when the cognitive status is considered to be related to falls. For this reason, it is recommended that older adults with cognitive decline should also be examined in terms of the risk of falls.

The 30-s CST has been developed by modifying the repetitive sit-up test (5 or 10 times) to evaluate a larger portion of the older population. Lower extremity weakness is proposed as a risk factor for the inadequacy and decline of infrequently used functions in everyday life such as walking, standing up, stepping, and lower body dressing. It is more advantageous for older adults to record the number of standing up and sitting down within 30-seconds instead of measuring the time required for standing up and sitting down five times that some older adults have difficulty completing them [18]. It has been suggested that it is a more preferable test especially for patients with moderate dementia [31, 32]. Although it is a commonly used test, there are no many articles on its cut-off points. In a study of Jones et al. [18] using the 30-s CST in older adults, they showed that the mean 30-s CST score was 14 stands in those between 60 and 69 years, 12.9 stands in those between 70 and 79 years, and 11.9 stands in those between 80 and 89 years, respectively. In our study, we have found that the clinical cut-off points for 30-s CST without an additional task and with an additional cognitive task in older adults with cognitive decline were determined as 10.5 sec and 8.5 sec, respectively. When the

examination is made with appropriate cut-off points of 30-s CST without an additional task, its success rate in determining older adults with and without cognitive decline is 70% (AUC=0.701).

In the dual-tasking paradigm, when an older adult performs two tasks simultaneously, performance decreases, and they exhibit slower response times, reduced accuracy, slower walking speed, shorter stride length [33, 34]. Some researchers state that; during a dual-task activity, the priority is given to postural control for safety (posture first strategy) [35], while others have suggested that priority is given to cognitive function in the older adults and some neurological diseases such as Parkinson's disease [36, 37]. Regardless of the strategy used, dual-task performance is the allocation of existing cognitive capacity between tasks, and when the capacity is exceeded, dual-task performance decline occurs [38]. In this study, there is a group whose cognitive functions have declined. In our previous study, we obtained similar results in two different clinical tests in the older adults with mild cognitive impairment (39). Therefore, this group will have more difficulty in the dual-task activity. In this study, we would like to draw attention to this and emphasize that mental state should not be forgotten during the evaluations.

Since dual-task is common in activities of daily living, we believe that applying the test during the dual-task activity will yield beneficial results in the decision-making process. According to our findings, we also recommend clinicians examine the older adults who are above our TUG cut-off scores and below the 30-s CST cut-off scores in terms of cognitive decline using appropriate tests. We think that our study creates a different perspective in this direction.

Limitations

The most important limitation of our study is that the accuracy of the additional task given was not assessed. We think that it should be taken into account in future studies. The present study is a cross-sectional, and therefore, retrospective study conducted to measure the skills with these tests in the older adults who already have/do not have cognitive decline. There is a need for prospective studies that will be conducted to predict the future risks of older adults who do not have cognitive decline for the time being. Determination of cut-off scores at different cognitive levels will contribute to the literature.

Conclusion

The most commonly used test for evaluating functional mobility and fall risk and lower limb strength in the clinic is the TUG test and the 30-s CST, respectively. Our results are important to reveal the cut-off points of TUG and 30-s CST with and without an additional cognitive task in older adults with mental decline.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
The study was approved by the Non-Invasive Clinical Research Ethics Committee of Kırıkkale University. (Decision Date: 01/03/2016 and Decision No: 06/11).

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