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ORIGINAL ARTICLE

Five Times Sit-to-Stand Test in people with non-specific chronic low back pain—a cross-sectional test–retest reliability study

Anıl Özüdoğru[1] · Mehmet Canlı[1] · İsmail Ceylan[1] · Şafak Kuzu[1] · Halil Alkan[2] · Başak Çiğdem Karaçay[3]

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Abstract

Purpose/aim The Five Times Sit-to-Stand Test (FTSST) is a method that evaluates lower extremity muscle strength and balance level. The aim of this study is to test the validity and reliability of the FTSST in patients with non-specific chronic low back pain (NSCLBP) whose lower extremity muscle strength and balance levels are adversely affected.

Methods The first outcome measure of the study was the FTSST, which was conducted by two different researchers. Secondary outcome measures are Biodex Balance System (BBS), Quadriceps Muscle Strength Test, Oswestry Disability Index (ODI), and Visual Analogue Scale (VAS). Intraclass Correlation Coefficient (ICC) was used for the validity and reliability of the FTSST, which was made by two different researchers, and Pearson's Correlation Analysis was used to determine its relationship with other measurements.

Results Inter-rater and test–retest reliability for the FTSST were excellent (Intraclass Correlation Coefficient = 0.99). A statistically significant correlation was found between all secondary outcome measures (BBS, quadriceps muscle strength, ODI, VAS) and FTSST ($p < 0.05$).

Conclusion In line with the findings of our study, we think that FTSST is a simple, easy, and reproducible method for evaluating lower extremity muscle strength, balance level, functional status, and pain in patients with NSCLBP.

Keywords Five times Sit-to-Stand Test · Non-specific chronic low back pain · Reliability · Validity

Introduction

Low back pain (LBP) is a widespread global condition that negatively influences the lives of the adult population [1]. LBP is stated to be one of the most common musculoskeletal disorders in the community. It is also estimated that approximately 60–80% of adults will suffer from LBP at least once in their lifetime [2]. About 10% of patients with LBP will also develop chronic low back pain (CLBP). However, approximately 85% of CLBP disorders are categorized as non-specific chronic low back pain (NSCLBP) of unknown origin [3].

Maintaining postural balance in static or dynamic conditions is essential for any functional activity. Although the exact mechanism of action is not known, it is thought that postural control is impaired in individuals with LBP due to pain, mechanical and neural factors [4–6]. In addition, it is known that individuals with LBP have insufficiency especially in hip muscles when compared to healthy individuals due to lumbopelvic imbalance [7, 8].

✉ Mehmet Canlı
canlimehmet600@gmail.com

Anıl Özüdoğru
aozudogru@hotmail.com

İsmail Ceylan
fztceylan@gmail.com

Şafak Kuzu
safak.yumusak@gmail.com

Halil Alkan
fzthalilalkan@hotmail.com

Başak Çiğdem Karaçay
basakcigdem@hotmail.com

[1] School of Physical Therapy and Rehabilitation, Ahi Evran University, Kirşehir, Turkey

[2] Faculty of Health Science, Department of Physiotherapy and Rehabilitation, Muş Alparslan University, Muş, Turkey

[3] Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Ahi Evran University, Kirşehir, Turkey

The Five Times Sit-to-Stand Test (FTSST) was originally designed as a simple, easy, rapid, and reproducible method to evaluate lower extremity muscle strength, but in the light of studies, it is now used to evaluate not only lower extremity muscle strength but also balance and mobility [9–11]. There are many studies examining the FTSST as a valid and reliable method [12–18]. However, we could not find any study examining its validity and reliability in people with NSCLBP.

In investigating individuals with NSCLBP, the objectives of this study were to (1) evaluate the inter-rater and test–retest reliability of the FTSST in NSCLBP, (2) determine FTSST performance in people with NSCLBP, and (3) determine the relationship of FTSST with different variables.

Methods

Design

This study was planned as a cross-sectional test–retest reliability study and ethical approval was received by Kırşehir Ahi Evran University Clinical Research Ethics Committee (Number: 2022–16/145). The study was carried out in accordance with the Principles of the Declaration of Helsinki. Informed consent was obtained from the participants prior to the study. Participants were randomly selected from those who refer to the physiotherapy and rehabilitation clinic of Kırşehir Training and Research Hospital. Then, all evaluations were performed by two physiotherapists who had 4 years of clinical experience in low back pain, 1 h apart. The same physiotherapists repeated the evaluations 7 days later. A flow diagram of the study is shown in Fig. 1.

Participants

Patients aged 18–65 years diagnosed with chronic (more than 6 months) non-specific low back pain by a physiatrist were included in the study. Pregnancy, previous back surgery, malignancy, and major musculoskeletal or neurologic disorders were not included in the study.

Measures

Participants' age, height, gender body weight, and body mass index were recorded. Then, the clinical evaluations were performed.

FTSST test

The participants were asked to stand up and sit down as quickly as they could, without any support, while sitting in a supported chair. The time they repeated this movement 5 times was measured with a cronometer and the result was recorded in seconds [19].

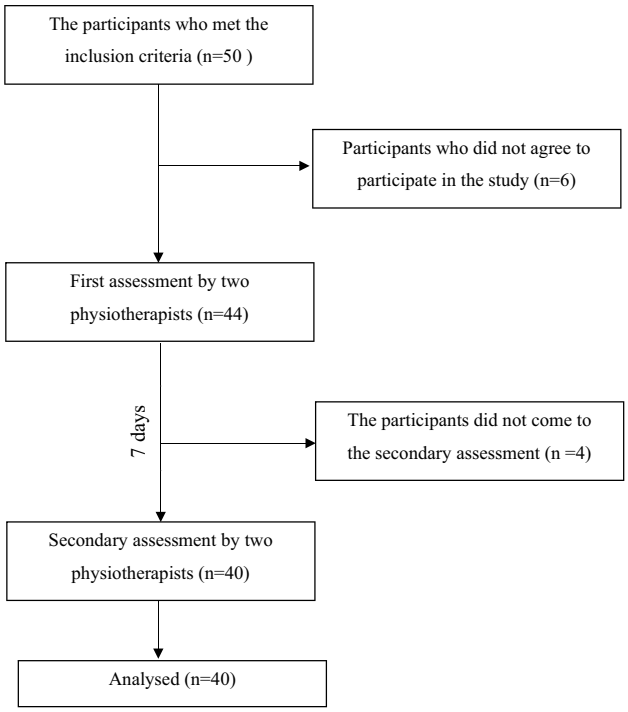

Fig. 1 Flow diagram of the study

Balance

Balance evaluation of the participants was performed with Biodex Balance Systems (Biodex Medical Systems, Shirley, NY, 11,967–0702, USA) device. The patients tried to remain in balance for 20 s on the device whose platform stability was adjusted. This process was repeated three times, with rest periods of 10 s [20].

Oswestry Disability Index

It was developed by Fairbank to identify functional disability [21]. Turkish validity and reliability were determined by Yakut et al. In the index, activities in daily life are evaluated from different perspectives [22]. High score indicates the highest level of functional disability in terms of low back pain. In the evaluation, the total score obtained by the patient was divided by the maximum possible score, and this number was multiplied by 100 and the obtained number was calculated as a percentage [21].

Muscle strength

Muscle strength was evaluated by measuring isometric quadriceps muscle strength with a baseline brand hydraulic

push–pull dynamometer. Participants sat on the edge of a flat bed with their hips and knees flexed 90º, feet free, without support. The dynamometer was placed perpendicular to the leg so that it was 1–2 cm above the level of the malleolus. While the person measuring kept the dynamometer steady, the person being measured applied maximum force against the device [23].

Pain

It is a scale consisting of a single line of 10 cm and evaluating the severity of pain. Patients were asked to mark the severity of their pain at rest on a 10-cm line. Starting point for patients on the scale: no pain, end point; expressed as unbearable pain. During the calculation, the distance between the marked point and the starting point was measured in cm [24, 25].

Statistical analysis

Statistical analyses were performed using IBM Statistical Package for the Social Science software version 24. Visual (histograms and probability plots) and analytical methods (Shapiro Wilk's test) were used to determine whether or not the numerical variables were normally distributed. The descriptive analyses were presented using means and standard deviations for the numerical variables. In order to determine inter-rater (ICC) and test–retest (ICC) reliability of the FTSST, intraclass correlation coefficients (ICC) were used. ICC is classified as excellent (0.80–1.0) and good (0.60–0.80) [26]. The relationship with other tests was evaluated with the Pearson correlation test to determine the concurrent validity of the FTSST. The level of correlation was evaluated as low correlation between 0.05 and 0.4, moderate correlation between 0.4 and 0.7, and high correlation between 0.7 and 1.0 according to the correlation coefficient [27]. The minimal detectable change (MDC) was calculated based on the standard error of measurement (SEM) conforming to the formula $MDC95 = 1.96*SEM*\sqrt{2}$. SEM was calculated to ensure the accuracy of the evaluation method with the formula $SEM = SD*\sqrt{(1\text{-}ICC)}$. Statistically significant level was accepted as $p < 0.05$. Standard error of measurement (SEM) and the minimal detectable change (MDC) were calculated (by using the formula $MDC95 = 1.96*SEM*\sqrt{2}$. SEM was calculated to ensure the accuracy of the evaluation method with the formula $SEM = SD*\sqrt{(1\text{-}ICC)}$).

Results

The characteristics of the demographic variables of the patients with NSCLBP included in the study are given in Table 1.

Table 1 Demographic characteristics of patients with non-specific chronic low back pain included in the study

		(*n* = 40)			
		Mean	SD	Min	Max
Age (years)		55.9	8.2	33	67
Height (cm)		163.8	6.1	150	176
Weight (kg)		72.9	14.9	49	120
BMI (kg/m^2)		27.4	6.3	17.1	41.5
		n		(%)	
Gender	Male	17		42.5	
	Female	23		57.5	

SD, standard deviation; *BMI*, body mass index

The values of the variables (Mean, SD, Min–Max) of the patients with NSCLBP included in the study are given in Table 2.

When the test–retest (ICC), inter-rater (ICC) reliability of the patients with NSCLBP included in the study was examined.

The test–retest result of the first evaluator, the ICC value, was found to be 0.99, and this result showed us that FTSST was a perfect match in terms of test–retest in patients with NSCLBP.

When we look at the compatibility (inter-rater) between the first and second raters, the result of the ICC value was found to be 0.99. Thus, it was observed that the inter-rater agreement was also excellent (Table 3).

In order to determine the concordance validity of the FTSST test in patients with NSCLBP, the correlation results of Biodex Stability System, ODI, VAS, and quadriceps muscle strength, which are frequently used in the clinic, are examined in Table 4. According to this table:

There was a positive, high statistical correlation between FTSST and all Biodex Stability System sub-parameters ($p < 0.05$).

A positive and high statistical correlation was found between FTSST, ODI percentage, and VAS ($p < 0.05$).

There was a statistically significant negative correlation between FTSST and quadriceps muscle strength (right, left) ($p < 0.05$).

Discussion

This research showed that the FTSST demonstrated excellent test–retest and interobserver reliability in NSCLBP. In patients with NSCLBP, FTSST was significantly correlated with measures of strength, balance, pain, and functional capacity supporting validity for the measure.

The validity and reliability of the FTSST test has been investigated in many different conditions and groups such

Table 2 Values of the variables of the patients with non-specific chronic low back pain included in the study (Mean, SD, Min–Max)

		(*n* = 40)		Min	Max
		Mean	SD		
Biodex Stability System	Dynamic stability (AP)	2.4	1.4	0.4	6.1
	Dynamic stability (ML)	1.6	0.8	0.2	3.9
	Dynamic stability (overall)	3.4	1.9	0.9	7.6
	Static stability (AP)	1.9	1.3	0.2	5.0
	Static stability (ML)	1.3	0.8	0.4	3.8
	Static stability (Overall)	2.8	1.8	0.7	7.0
ODI		42.6	30.8	3.0	90.0
VAS		4.6	2.6	1.0	9.0
Quadriceps Muscle Strength	Left	9.1	3.6	4.0	15.0
	Right	10.5	3.9	4.0	17.5
FTSST (1)	Test	14.5	4.9	6.8	23.3
	Retest	14.8	4.9	6.1	22.9
FTSST (2)	Test	14.7	4.7	6.3	22.4
	Retest	14.9	4.8	6.4	22.5

1: first assessor, 2: second assessor

SD standard deviation, *TSST* five times sit-to-stand test, *VAS* visual analog scale, *AP* anteroposterior *ML* Mediolateral, *ODI* Oswestry Disability Index

as intensive care patients [12], balance disorders [13], pelvic girdle pain due to pregnancy [14], total hip arthroplasty [15], older adults [16], Parkinson's disease [17], and chronic stroke patients [18] before and it has been shown to be a valid and reliable method. Few different reliability studies have been investigated in NSCLBP, and we also examined the inter-rater reliability in this study. In our study, we found that the FTSST had excellent test–retest reliability in patients with NSCLBP, in line with the literature. The results showed that the FTSST is a usable tool in NSCLBP.

De Sousa et al. in their study comparing patients with LBP and healthy people, they emphasized that people with LBP had lower extremity muscle strength [28]. Lord et al. concluded that the most important predictor of FTSST performance is muscle strength in their study on 669 elderly people aged between 75 and 93. [29] In our study, we found that quadriceps muscle strength, which evaluates lower extremity muscle strength, and FTSST had a high level of statistically significant correlation. LBP due to loss of strength in the hip muscles has been reported to be a factor associated with the presence of lumbopelvic imbalance [7, 8]. The lower extremity muscles, especially

Table 3 Inter-rater (ICC) and test–retest (ICC) reliability of the FTSST

n = 40	Difference (Mean ± SD)	Inter-rater ($ICC_{1,2}$) (95% CI)	Test–retest ($ICC_{1,1}$) (95% CI)	SEM	MDC_{95}
FTSST	0.27 ± 0.5	0.99 (0.99–0.99)	0.99 (0.98–0.99)	0.05	0.13

SD standard deviation, *FTSST* five times sit-to-stand test, *ICC* intraclass correlation coefficient, *SEM* standard error of measurement, MDC_{95} minimum detectable change at the 95% confidence interval

Table 4 The relationship between the five times sit-to-stand test and other tests

			FTSST
Biodex Stability Index	Dynamic stability (AP)	r	0.877
		p	**0.000***
	Dynamic stability (ML)	r	0.848
		p	**0.000***
	Dynamic stability (Overall)	r	0.887
		p	**0.000***
	Static stability (AP)	r	0.902
		p	**0.000***
	Static stability (ML)	r	0.851
		p	**0.000***
	Static stability (Overall)	r	0.905
		p	**0.000***
ODI		r	0.941
		p	**0.000***
VAS		r	0.937
		p	**0.000***
Q muscle strength	Left	r	−0.925
		p	**0.000***
	Right	r	−0.902
		p	**0.000***

ODI Oswestry Disability Index, *FTSST* five times sit-to-stand test, *VAS* visual analog scale

* p<0.001

the hip muscles, play an important role in lumbar spine stability. Strength and coordinate activation of the lower extremity muscles can help transfer forces between the lower extremities and the lumbopelvic region by contributing to the coordination between the hip and trunk [30]. In addition, the high correlation between muscle strength and FTSST in the results may be due to the fact that the quadriceps muscle is an antigravity muscle and is associated with the standing up activity in the FTSST test.

Berenshteyn et al. in their study, in which they compared the static standing balance of individuals with CLBP and healthy individuals, stated that the balance was impaired in individuals with CLBP [31]. Although the sit-stand test was developed as a functional measure of lower extremity muscle strength, our current results, in conjunction with previous findings [9], show that the FTSST actually assesses balance ability as well. Tiwari et al. stated in a study they conducted in older adults that the strongest predictors of FTSST performance were dynamic balance and lower extremity muscle strength [10]. In another study, Shamay et al. stated that the FTSST showed a strong correlation with the Berg Balance Scale in hemiparetic patients [11]. Our results show that the FTSST provides information on balance performance in individuals with NSCLBP. The balance system uses information from three main sensory (visual, vestibular, and proprioceptive) sources to elicit muscle reactions that maintain balance. Damaged proprioceptive structures may lead to balance problems in individuals with NSCLBP [32].

When the literature is examined, it has been stated that those with high muscle strength in patients with lumbar spinal stenosis have a higher quality of life than those with low muscle strength[33]. When the results of our study are examined, there is a statistically high level of correlation between the FTSST, which evaluates muscle strength, and the Oswestry scale, which evaluates the quality of life in individuals with LBP. LBP affects many daily living activities such as walking, sitting, standing, dressing, and quality of life. Sitting and standing movement is important for an independent life in patients with NSCLBP and is a prerequisite for walking in daily life [34]. The relationship between the FTSST test and functional status in patients with NSCLBP may be due to sitting and standing movements increase the load on the lumbar region and increase pain.

Keller et al. investigated the predictors of isokinetic back muscle strength in patients with LBP. According to the results of the study, they concluded that one of the strongest predictors of isokinetic back muscle strength is pain [35]. In another study, Estlander et al. reported that pain intensity and trunk muscle strength were related in patients with LBP [36]. In our study, we found a statistically significant correlation between pain level and FTSST, which is consistent with the literature.

Study limitation

This study has some limitations. Lower extremity muscle strength and balance performance change with age-related physiological changes. In this study, it should be known that FTSST is a valid and reliable method in patients with NSCLBP whose mean age is 55.9 ± 8.2. Therefore, we think that FTSST performance should be examined according to age groups in patients with NSCLBP. Another limitation would be to compare the FTSST results according to the severity of low back pain and this would require more participants.

Conclusion

In conclusion, the FTSST test in patients with NSCLBP is a valid, reliable, understandable, and easy method that can be used by clinicians and researchers. In addition, FTSST may be an alternative, easy, short-term, and understandable method for evaluating lower extremity muscle strength, balance level, pain intensity, and functional loss in patients with NSCLBP.

Declarations

Ethics approval Ethical approval was received by Kırşehir Ahi Evran University Clinical Research Ethics Committee (Number: 2022–16/145).

Conflict of interest The authors declare no competing interests.

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