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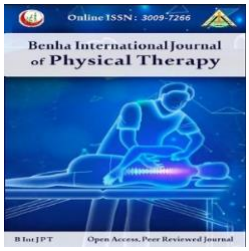

Original research

Reliability Of Flexion Rotation Trunk Endurance Test In Patients With Chronic Non-Specific Low Back Pain

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Abstract

Background: Non-specific low back pain is a prevalent condition often associated with impaired core muscle function; particularly diminished endurance of trunk muscles essential for spinal stability. Effective assessment tools are vital for treatment and rehabilitation. **Purpose:** To evaluate the intra-rater and inter-rater reliability of the Flexion Rotation Trunk Endurance Test in assessing oblique abdominal muscle endurance in chronic non-specific low back patients and to determine the impact of pain distribution on test outcomes. **Methods**: This cross-sectional study involved 51 patients diagnosed with chronic non-specific low back (24 males, 27 females; aged 20–45 years). Participants underwent two sessions of the Endurance Test, separated by two days, with two trials per rater in each session. Pain intensity and functional impairment were also evaluated. Reliability analyses included Cronbach's alpha, Intraclass Correlation Coefficients, and F-tests. **Results:** The Flexion Rotation Trunk Endurance demonstrated excellent intra-rater reliability (Cronbach's alpha: 0.884–0.906; ICCs: 0.792–0.828, $p < 0.001$) and inter-rater reliability (Cronbach's alpha: 0.918–0.954; ICCs: 0.849–0.912, $p < 0.001$). Pain distribution was observed 45.1% bilateral, 23.5% right-sided, and 31.4% left-sided, with no significant difference ($\chi^2 = 3.647$, $p = 0.161$). **Conclusion:** The Flexion Rotation Trunk Endurance Test is a reliable and practical tool for assessing core endurance in patients with chronic non-specific low back pain, whether the pain is on the right or left side or bilateral. Its simplicity and reliability make it ideal for clinical and research use.

Keywords: Chronic non-specific low back pain (CNSLBP) and Flexion Rotation Trunk Endurance Test (FRT).

Introduction

Low back pain (LBP) is the most prevalent health condition globally, significantly contributing to disability, healthcare expenditure, and work absenteeism.[1,2] Most LBP cases are categorized as nonspecific, meaning the exact source of nociceptive pain remains unidentified.[2, 3, 4] Chronic low back pain refers to pain that sustains for a duration exceeding three months and often results in functional impairments and reduced quality of life.[5, 6] A critical factor in managing LBP is understanding the role of trunk muscle endurance, as Previous studies indicated that inadequate endurance in the abdominal and lumbar musculature predisposes individuals to recurrent pain and functional limitations.[7, 8, 9] Furthermore,

the endurance of rotator trunk muscles is crucial for maintaining spinal stability and enhancing functional performance.[10,11,12,13] .Clinical assessments of trunk muscle endurance commonly involve tests such as the Sorensen test (targeting spinal extensors) or the side bridge test (lateral flexors).[14,15,16,17] However, rotational trunk endurance has received less attention despite evidence that twisting movements can contribute to LBP onset or exacerbation[18, 19].

The Flexion Rotation Trunk Endurance Test (FRT) has emerged as a clinical tool designed to assess the endurance capacity of the oblique abdominal muscles responsible for rotation by combining both flexion and rotation movements. While its reliability was well established in healthy individuals[20], Its reliability properties in individuals with chronic nonspecific low back pain (CNSLBP) remain underexplored.

Therefore, the current study aimed to examine inter and intra-rater reliability of endurance test in patients with CNSLBP. Additionally, this research investigated the potential influence of pain distribution (bilateral or unilateral (right or left side)) on FRT outcomes. Establishing the reliability of the FRT in a clinical LBP population, and determining whether pain location affects test performance, may offer clinicians an efficient method to evaluate trunk rotational endurance and guide evidence-based rehabilitation strategies.

Methods

This cross-sectional study involved two raters with varying levels of clinical experience. All participants underwent a retest two days after the initial assessment to evaluate intra-rater reliability. Conducting two separate trials per rater is adequate for accurately evaluating core muscle endurance[21].

Raters

Two independent physiotherapists participated in this study to evaluate the reliability of endurance test. Rater 1(primary investigator) has six years of experience in musculoskeletal assessment and rehabilitation, while rater 2 (research assistant) has nine years of expertise in the same field. Both raters were provided with instructions on the testing protocol and engaged in practice sessions with sample participants. To reduce bias, each rater remained blind to the other rater's scores during the testing phase.

Subjects

This reliability study was conducted at the Physiotherapy Department of Nile Specialized Hospital, located in Aswan, Egypt. The study involved 51 adults (24 males and 27 females) aged 20 to 45 years, all diagnosed with chronic nonspecific low back pain (CNSLBP). To be eligible, participants were required to have a Visual Analog Scale (VAS) pain score below 8 cm, and an Oswestry Disability Index (ODI) score below 60% at the time of evaluation. Inclusion criteria encompassed individuals who complained of CNSLBP more than three months and had a BMI of less than 29.9 kg/m² and more than 18,5 kg/m.

Exclusion criteria eliminated those with a history of lumbar spine surgery, structural spinal deformities (e.g., scoliosis), significant neurological deficits, osteoporosis, pregnancy, or any cardiovascular conditions that would contraindicate participation in physical endurance testing. Additionally, participants with diagnosed disc prolapse, spondylolisthesis, fractures, tumors, infections, or rheumatologic diseases were excluded to ensure the specificity of the NSLBP diagnosis. All participants provided written informed consent for their approval before joining the study[14,23].

Each participant attended two separate testing sessions, labeled Session 1 and Session 2, conducted two days apart to assess both intra-rater and inter-rater reliability of endurance test, the VAS (to measure pain intensity), ODI (to assess functional disability), height and weight measurements used to determine BMI .

During each session, Participants lay in a supine position on a semi-rigid mat (head and back were kept in contact with the floor) with their feet flat on the floor and knees bent at a standardized 90-degree angle, measured with a goniometer (fig. 1). The arms were extended along the sides of the trunk, and hands rested on the thighs. An experimenter stabilized the participant's knees to prevent movement of the lower limbs during the test (fig.2) .

Participants performed as many trunk flexion and rotation movements as possible within a 90-second timeframe, alternating twisting to the right and left sides. Each correct repetition required the hands to touch the experimenter’s fifth knuckle during ascent and the head to contact the mat during descent (Fig.2). In Session 1, participants completed 10 practice repetitions to familiarize

themselves with the test.16 Following the practice, each participant performed two trials of the FRT for each rater, separated by a 30-minute rest interval to minimize fatigue. Intra-rater reliability was evaluated by having the same examiner administer the FRT in both sessions, while inter-rater reliability was assessed by a second-rater during Session 1 and Session 2. Additionally, participants reported whether their pain was unilateral right or left, or bilateral, allowing for analysis of pain distribution's impact on test performance. All procedures were standardized to ensure consistency and accuracy in test administration and scoring (fig. 3).

Figure(1): Standard goniometer.

Figure(2): Flexion rotation test viewed from both the lateral (A) and posterior (B). initial position (A1 and B1) and FRT (A2 and B2).

Figure (3): Standardize the position of the experimenter's fist during the FRT, both before and after placing the thumb behind the participant's knees.

Statistical Analysis

The data analysis was conducted using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as means and standard deviations for numerical variables, while percentages were used for categorical variables. The reliability of the endurance test was assessed using the Intraclass Correlation Coefficient (ICC) which evaluated inter-rater reliability between different raters and intra-rater reliability across repeated measurements by the same rater. Cronbach's alpha was used to assess the internal consistency of the test, ensuring the reliability of its scoring method. Statistical significance was determined at a *p*-value threshold of less than 0.05.

Results

A total of 51 individuals diagnosed with CNSLBP participated in this study, with a mean age 34.27 Table 1. The gender distribution included 27 females (52.9%) and 24 males (47.1%). Regarding pain distribution, 23 patients (45.1%) reported bilateral pain, while 28 patients (54.9%) experienced unilateral pain—12 right-sided (23.5%) and 16 left-sided (31.4%). The Chi-square test indicated no significant difference in gender distribution ($\chi^2 = 0.176$, $p = 0.674$), and pain location distribution ($\chi^2 = 3.647$, $p = 0.161$) (Table 2).

Intra-rater Reliability

The intra-rater reliability analysis was conducted for both measurements of the test values between sessions one and two. The findings demonstrated very good to excellent internal consistency, with Cronbach's alpha (α) value of 0.884 for the first rater and 0.906 for the second rater, suggesting that the measurements of both raters between sessions are highly reliable and

consistently assess the endurance of the oblique abdominal muscles (Table 3). The ICC values for both raters were strong and significant (r =0.792, p <0.001 *, r =0.828, p <0.001 * respectively) revealing a strong correlation between measures of the successive sessions (Table 4).

Table 1. Descriptive statistics for the mean values of the demographics.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age	51	21	45	34.27	7.275
Weight	51	50	98	73.41	11.538
Height	51	153	189	169.18	7.957
BMI	51	19.10	29.70	25.537	3.41

Table 2. The frequency and percent of sex distribution in the study group.

Variable	Description	Frequency	%	X2	p-value	Sig
Gender	**Male**	24	47.1	0.176	0.674	NS
	Female	27	52.9			
Location of pain	**Bilateral**	23	45.1	3.647	0.161	NS
	Unilateral Rt	12	23.5			
	Unilateral Lt	16	31.4			

Table 3. Cronbach's alpha for intra-rater reliability.

	Reliability Statistics		
	Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
Intra-rater reliability of Rater 1	0.884	0.899	2
Intra-rater reliability of Rater 2	0.906	0.906	2

Table 4. ICC measures for intra-rater reliability.

Intraclass Correlation Coefficient								
		Intraclass Correlation	**95% Confidence Interval**		**F Test with True Value 0**			
			Lower Bound	**Upper Bound**	**Value**	**df1**	**df2**	**Sig**
First rater	**Single Measures**	0.792	0.662	0.876	8.625	50	50	**<0.001**
	Average Measures	0.884	0.797	0.934	8.625	50	50	**<0.001**
Second rater	**Single Measures**	0.828	0.716	0.898	10.600	50	50	**<0.001**
	Average Measures	0.906	0.835	0.946	10.600	50	50	**<0.001**

Inter-rater Reliability

The inter-rater reliability analysis was performed for the test measurements obtained by both raters during Sessions 1 and 2. The results demonstrated excellent internal consistency, with Cronbach's alpha (α) = 0. 918 for the first session and Cronbach's alpha (α) = 0.954 for the second session, suggesting that the measurements of both raters in each session were highly reliable and consistently measure the endurance of the oblique abdominal muscles (Table 5). The ICC for the measurements of both raters was strong and significant (r =0.849, p <0.001 *, r =0.912, p <0.001 * respectively) revealing a strong correlation between both raters of the successive sessions (Table 6).

Table 5. Cronbach's alpha for inter-rater reliability.

	Reliability Statistics		
	Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
Inter-rater reliability of Rater 1	0.918	0.931	2
Inter-rater reliability of Rater 2	0.954	0.954	2

Table 6. ICC measures for inter-rater reliability.

Intraclass Correlation Coefficient								
		Intraclass Correlation	**95% Confidence Interval**		**F Test with True Value 0**			
			Lower Bound	**Upper Bound**	**Value**	**df1**	**df2**	**Sig**
First session	**Single Measures**	0.849	0.750	0.911	12.247	50	50	**<0.001**
	Average Measures	0.918	0.857	0.953	12.247	50	50	**<0.001**
Second session	**Single Measures**	0.912	0.851	0.949	21.724	50	50	**<0.001**
	Average Measures	0.954	0.919	0.974	21.724	50	50	**<0.001**

Discussion

This study aimed to evaluate the reliability (intra-rater and inter-rater) of the endurance test (FRT) assessing oblique abdominal muscle endurance in individuals with CNSLBP and to explore the potential influence of pain location on test outcomes.

The findings of this study demonstrated that the FRT exhibits excellent intra-rater and inter-rater reliability in assessing oblique abdominal muscle endurance among individuals with CNSLBP. Both raters showed strong internal consistency, as evidenced by high Cronbach's alpha and ICC values, along with statistically significant F-test results, further confirming the test's reliability and consistency. These findings establish the FRT as a stable, repeatable, and reliable tool for assessing oblique abdominal muscle endurance in individuals with CNSLBP.

These findings are consistent with previous research on the FRT in healthy individuals, which conducted four trials with a one-week interval between each, reporting high ICC values for measuring oblique abdominal endurance. This emphasizes the test's reliability and validity in both clinical and research applications[20] Notably, the FRT's reliability extends to individuals with CNSLBP as well, further supporting its utility in trunk endurance assessments.

Similarly, excellent reliability for isometric lumbar (chest raised in a prone position) and abdominal (legs raised at 90° in a supine position) endurance tests in office worker were assessed in patients with nonspecific subacute low back pain,

reinforcing the consistency of such evaluations in trunk endurance assessments[22]. Furthermore, the significance of reliable muscle endurance assessments was highlighted, showing moderate reliability for the modified Biering-Sorensen test in individuals with chronic low back pain[23].

This high level of reliability also aligns with previous research. For instance, The Biering-Sorensen test showed high reliability in patients with NSLBP[14] Similarly, excellent reliability was demonstrated for core endurance tests, such as the Abdominal Static Endurance Test and the Modified Biering-Sorensen Test[24] Additionally, high inter- and intra-rater reliability for isometric trunk endurance tests were reported, supporting their application in both clinical and athletic populations[16] .These findings reinforce the FRT as a reliable and practical tool for evaluating oblique abdominal muscle endurance, regardless of the rater's level of expertise.

A previous study investigating the reliability of lateral trunk flexion tests specifically, the number of repetitions required to reliably determine core muscle endurance, and it also compared the performance of the right and left trunk muscles during these tests in individuals with CNSLBP and without LBP[21].

Building on that work, our current study aimed to investigate the potential influence of pain distribution (whether bilateral or unilateral on the right or left side) on FRT outcomes. The analysis revealed that pain location did not influence FRT outcomes, as no significant differences were found between patients with bilateral pain and those with unilateral pain, whether on the right or left side. This indicates that the FRT reliably assesses overall trunk endurance without being affected by pain distribution.

These results differ from those found in a study on lateral trunk flexion tests, which reported that both those with CNSLBP and those without LBP were more likely to achieve the highest score on the left side (92% and 76%) than on the right side (72% and 76%). Since most participants (94%) were right-handed, the left trunk muscles were frequently more engaged in stabilizing the torso, potentially explaining the higher initial maximal scores in left trunk flexion among individuals with CNSLBP and those without LBP.[21] This difference may arise from the unique characteristics of each test and the specific muscle groups they assess.

The FRT has demonstrated reliability in measuring trunk rotator endurance, underscoring its importance in clinical and rehabilitative settings. This study's findings can aid physical therapists by offering an evidence-based method to assess rotator muscle endurance in patients with CNSLBP through a quick and simple procedure that requires minimal, low-cost equipment.

Limitations

Although the two-day gap between sessions shorter interval minimized changes in daily activity, it may not have allowed sufficient recovery or adequately reduced the learning effect. A longer interval could address these concerns but might also increase external variability and the risk of participant dropouts. Future research should explore the optimal interval to balance these factors effectively.

Conclusion

This study confirmed the FRT as a reliable tool for assessing oblique abdominal muscle endurance in patients with CNSLBP, whether the pain is on the right or left side or bilateral. These findings highlight the FRT's practicality, stability, and relevance in both clinical and research settings. Its strong reliability ensures consistent assessments across clinicians with varying levels of experience, making it valuable for tracking patient progress and guiding evidence-based rehabilitation. The FRT helps clinicians identify trunk muscle weaknesses, prescribe targeted exercises,

and enhance spinal stability and functional outcomes.

Acknowledgement

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Ethical approval

The study adhered to ethical guidelines and was approved under reference number 012/004568 by the Faculty of Physical Therapy, Cairo University. Before participation, all individuals provided written informed consent, and their confidentiality and rights were fully protected throughout the research process.

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