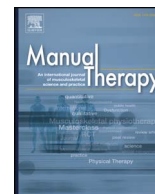




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Technical and measurement report

## Test-retest reliability of sit-to-stand and stand-to-sit analysis in people with and without chronic non-specific low back pain

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## ABSTRACT

**Background:** Sit-to-stand (STD) and stand-to-sit (SIT) analysis can provide information on functional independence in daily activities in patients with low back pain (LBP). However, in order for measurements to be clinically useful, data on psychometric properties should be available.

**Objectives:** The main purpose was to investigate intra-rater reliability of STD and SIT tasks in participants with and without chronic non-specific LBP (CNLBP). The second purpose was to detect any differences in lumbar spine and hips sagittal plane kinematics and coordination between asymptomatic individuals and CNLBP patients during STD and SIT.

**Design:** Cross-sectional study.

**Method:** Twenty-three CNLBP patients and 23 demographically-matched controls were recruited. Ten markers were placed on specific anatomical landmarks. Participants were asked to perform STD and SIT at a preferred speed. Peak flexion angles, mean angular velocities, lumbar to hip movement ratios, and relative phase angles were measured. The procedure was repeated after 2 h and 6–8 days. Differences between two groups were analyzed using independent *t*-test. Intraclass correlation coefficient (ICC 3,k), standard error of measurement (SEM), and limits of agreement (LOAs) were also estimated.

**Results:** The ICC values showed moderate to excellent intra-rater reliability, with relatively low SEM values ( $\leq 10.17^\circ$ ). The 95% LOAs demonstrated that there were no differences between the measured parameters. Furthermore, CNLBP patients had limited sagittal plane angles, smaller angular velocities, and lumbar-hip discoordination compared to asymptomatic participants.

**Conclusions:** The results indicated moderate to excellent test-retest reliability of STD and SIT analysis. Moreover, CNLBP patients had altered kinematics during STD and its reverse.

### 1. Introduction

In clinical settings, various methods have been introduced for the measurement of spine kinematics, ranging from simple tapes to computer application devices (e.g., motion analysis systems). Motion analysis systems are noninvasive, allow to repeat the examination more times within a short period of time, and provide detailed quantitative and 3-dimensional (3D) data (Cimolin et al., 2013). Lumbar spine kinematics obtained using the motion analysis systems may be of value in generating functional diagnoses, assessing the mechanisms of therapies, and establishing specific rehabilitation programmes in low back pain (LBP) patients.

Patients with LBP often report difficulties during daily activities, such as sit-to-stand (STD) (Andersson et al., 2010) and stand-to-sit (SIT) (Shum et al., 2005). STD consists of transferring the center of mass from a low position centered within a base of support to a high position over a shallow base of support (Tung et al., 2010). In addition, the center of mass moves in the opposite direction of STD during SIT. Previous studies indicated that LBP patients usually perform STD task with limited lumbar sagittal plane angles and smaller angular velocities (Shum et al., 2005; Christe et al., 2016). However, the magnitude of movements out of the sagittal plane during STD and its reverse is very small and can be neglected in both people with and without LBP (Shum et al., 2005).

In order for measurements to be clinically useful, data on

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**Table 1**  
Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
1- CNLBP (LBP persisting for more than 3 months in the absence of an underlying pathology)	1- Obvious deformity of the spine, pelvis, and lower extremities
2- Aged between 18 and 40 years	2- Pregnancy
3- Ability to perform STD and SIT movements without an aid	3- Rheumatological or neurological diseases
	4- Presence of infection, tumors or radicular symptoms
	5- Spinal fractures
	6- Back surgery
	7- Any recent trauma to the musculoskeletal system such as bony, muscular, ligamentous, and soft tissue structures in the lower extremities and trunk that might interfere with STD and SIT movements



**Fig. 1.** Musculoskeletal biomechanics laboratory in which the measurement procedures were performed. Six cameras were set up and angled in a manner to decrease hidden spots that might obscure data collection. In addition, a visual target (white A4 paper with a black circle drawn upon it) was used to standardize head posture.

psychometric properties such as reliability should be available in the population for which the measurements are intended to be used (de Vet et al., 2006; McDermott et al., 2010; Kottner et al., 2011). Since low reliability in clinical research may lead to underestimation or failure to detect significant effect sizes (McGinley et al., 2009), researchers have to strive for good reliability. Therefore, the main purpose of this study was to determine the reproducibility (within- and between-day intrarater reliability) of STD and SIT analysis in participants with and without chronic non-specific LBP (CNLBP) using a marker-based motion capture system. In addition, the second purpose was to determine any differences in lumbar spine and hips sagittal plane kinematics and lumbar-hip coordination between asymptomatic individuals and patients with CNLBP. In this investigation, STD and SIT movements were defined according to Shum et al.'s (2005) study. Shum et al. (2005) divided each movement into 2 phases: flexion and extension. The flexion phase begins with initiation of the movement and terminates when maximum flexion of the lumbar spine is achieved. The extension phase starts just after the flexion phase and continues until the end of the movement (Shum et al., 2005). It was hypothesized that the test-retest reliability of STD and SIT analysis is reliable within and between days in people with and without CNLBP.

## 2. Methods

### 2.1. Study design

A cross-sectional observational study was conducted between September 2016 and April 2017 (~32 weeks) in Tehran, Iran. The level of evidence of this investigation was level 2b. In writing the manuscript, we tried to follow the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and Guidelines for Reporting Reliability and Agreement Studies (GRRAS) checklists items to improve the quality of paper (von Elm et al., 2007; Kottner et al., 2011).

### 2.2. Ethics

Approval for the study was obtained from the Ethics Committee at Iran University of Medical Sciences (IUMS) (REC Reference: IR.IUMS.REC.1395.9211342207). All participants received a verbal and written description of the study. A written informed consent was obtained from all volunteers and all procedures were performed according to the Declaration of Helsinki. The participants were given confidence that their personal information were kept confidential (confidentiality principle). None of the volunteers received monetary rewards or compensation for their time and participation to this study.

### 2.3. Recruitment

The population of the current investigation was a convenience sample, recruited by purposive and snowball sampling. Flyers were also distributed within the local community.

### 2.4. Study population

The sample size of this study was calculated based on a pilot study (8 participants with CNLBP) using the 'sampicc' command in Stata statistical software (Shoukri et al., 2004). One of the main variables of this study was relative phase angle. The ICC value of between-day intrarater reliability for measuring mean relative phase angle between the right hip and lumbar spine during STD was 0.71. The null hypothesis was selected to be 0.40, with the power set at 80%, type I error fixed at 5%, and three repetitions were conducted for each measurement. The results indicated that a minimum of 19 participants was needed. To allow for 20% attrition, this sample size was increased to 23 participants. Therefore, 23 participants with CNLBP and 23 asymptomatic participants were included based on eligibility criteria.

In the current study, asymptomatic participants were defined as those without history of LBP requiring medical attention during the last

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