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# Reliability of Corrective Exercise Specialist Raters Assessing Movement System Impairment Approach Items in Transient Low Back Pain Developers During Prolonged Standing

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**ABSTRACT**

**Aims:** The purpose of this study was to examine the inter- and intra-rater reliability of corrective exercise specialist raters assessing movement and postural impairments of transient Low Back Pain (LBP) developers during Prolonged Standing Protocol (PSP) which called Pain Developers (PDs).

**Method and Materials:** Twenty-four subjects developing transient LBP during prolonged standing (9males, 15females) between 17-85 years of age, were examined by 2 corrective exercise specialists. In order to control the effect of repeated testing on intra-rater reliability, both raters assessed the subjects at the same time. To assess inter-rater reliability, one of the raters assessed the subjects one week later. Examination findings were recorded independently, without discussion. Inter- and intra-rater reliability were indexed by the percent of agreement and kappa coefficient.

**Findings:** Overall, the kappa values for intra- and inter-rater reliability of the items ranged from 0.12 - 0.86 and 62.5 - 1.00, respectively.

**Conclusion:** The results of the present study indicate these clinical test items as a reliable tool for corrective exercise specialists. They can reliably utilize these test items for identification of movement and alignment impairments that need to be modified in order to prevent the onset of LBP in in healthy-back PDs.

**Keywords**: Low Back Pain, Movement System Impairment Approach, Reliability, Corrective Exercise Specialist Raters

## Introduction

The main goal of corrective exercise specialists is to identify the movement dysfunctions and musculoskeletal imbalances that predispose the human body to pain. Their primary focus is on types of movement and musculoskeletal impairments that are mainly caused by repetitive movements, sustained postures, sedentary living, and overuse. Based on the kinesiopathologic model, corrective exercise specialists attempt to prevent musculoskeletal disorders and injuries by modifying these impairments [1]. One of the most common musculoskeletal disorders in modern society is Low Back Pain (LBP) with a lifetime prevalence of up to 80%; 90% of which accounted for the non-specific type [2]. Hence due to the huge prevalence rate, enormous treatment costs, and complexity of treatment, have turned LBP into a major health concern [3]. Therefore, prevention of this prevailing musculoskeletal pain can be of great value both for physicians and the government.

Contrary to expectations, prevention has been largely ignored in LBP. Clinical care and research have mainly focused on the treatment of those currently experiencing an episode of LBP [4-7]. The first reason for this negligence might be the difficulty of identifying individuals more susceptible to LBP. In this regard, the study of Nelson Wang et al. in 2014 [8], which introduces prolonged standing protocol as a valid tool for identifying LBP susceptible individuals, is a turning point that has paved the way for further studies on LBP prevention. Their study confirms transient LBP development during prolonged standing, as a positive predictive factor for future clinical LBP. Transient LBP by definition is a type of pain that exists solely during the exposure time and dissipates quickly once the standing ceases. Based on the result of their study, developing transient LBP during prolonged standing identifies significantly 3 times more exposure to clinical LBP during the next 2 years. Hence, it is a valid test for diagnosing susceptibility to LBP [9].

Based on the kinesiopathologic model, Observing and comparing movement, postural and neuromuscular characteristics of Pain Developers (PDs) and Nom-Pain Developers (NPDs) during prolonged standing, might provide corrective exercise specialists with valuable clues about the impairments that increase the risk of LBP incidence in healthy back individuals [3-13]. Sahrmann suggests the Movement System Impairment (MSI) model based on this paradigm [14, 15]. In this model, she introduces a standardized physical examination format for the assessment of these impairments.

MSI examination format includes a set of clinical movement and postural tests in two parts assessing: 1) provocation tests (symptoms behavior) and, 2) judgment of alignment and movement (signs) [16, 17]. In provocation tests, the patient performs a movement through his preferred strategy and reports symptoms [3]. The rater evaluates these items based on either producing or alleviating symptoms in a specific direction [17, 18]. Since the population of the recent study were asymptomatic PDs, did not include these items.

In the second part of examination format, which was the part of interest in this study, the raters observe alignment and movement patterns, and judge based on specific criteria mentioned in standardized forms used for recording the findings. Results of assessing these clinical tests may provide valuable information about the impaired patterns that need to be modified for preventing the onset of pain [3].

Although the reliability of MSI classification has been previously reported [16-22], these studies: 1) were devoted to patients suffering from LBP and 2) have assessed the reliability of physiotherapist raters. However, to the best of the authors' knowledge, there is no study devoted to: 1) PDs population during prolonged standing, who are although pain-free, but 3times more susceptible to LBP, and 2) assessing the reliability of corrective exercise specialist raters. Thus, the purpose of this study was to assess intra- and inter- rater reliability of corrective exercise specialist assessing MSI classification test items in transient LBP developers during prolonged standing.

## Method and Materials

An inter- and intra-rater reliability study was conducted. In this regard, two corrective exercise specialists blinded to the patients and to each other, rated the test performances as either yes or no to each movement and also postural error listed in the assessment form. The study was approved by the Ethics committee of the University of Tehran.

The sample size requirement for comparing two kappa coefficients was calculated using Donner's method [23]. By selecting the level of significance as alpha = 0.01 and power [beta] = 0.80 for testing hypothesis Ho: k1 > 0.6 versus hypothesis H1: k1 < 0.6, based on Sim & Wright's sample size calculation table, the required sample size would be 21 cases for good strength of agreement (k index > 0.60) [18]. The sample size was set as N = 24 to cater for a potential dropout rate of 10%.

In this study, 24 volunteers (9 males, 15 female) between 17-85 years of age[16], who had previously undergone the standing protocols as a part of a larger study, and had therefore already been identified as pain developers (PDs), were recruited for this study. The background and the aims of the study were explained and all patients signed written informed consent.

Patients were excluded if they had no lifetime history of LBP that resulted in: 1) seeking some type of health intervention, 2) three or more consecutive days of missed work or school, or 3) three or more days of altered activities of daily living [24, 25].

Other exclusion criteria were pregnancy, severe kyphosis or scoliosis, history of spinal surgery, cancer, inability to stand and walk without an assistive device, and dizziness disorders during 12 months before participation in this study [16].

In order to examine inter-rater reliability, subjects were assessed by two corrective exercise specialists simultaneously in a single session. To avoid the effect of repeated testing for each subject, only one of the raters implemented the tests, and the other rater merely observed the testing process. Both raters assessed all alignment and movement-related items (signs). Table2 represents the sign items in the process of physical examination. The subject assumed an alignment or performed a movement and the raters made a judgment based on visual assessment. A standardized clinical examination form was used to record findings. During the examination, each of the raters recorded the examination findings on a separate data form. Each rater was blinded to the judgment made by the other rater. On average, each testing session took approximately 20 minutes.

In the first test session, both raters tested all subjects. Because previous investigators have suggested that using a repeated testing (test-retest) design, my result in poor reliability for item, both raters assessed the subjects at the same time. Therefore, the effect of repeated testing as a source of inter-tester reliability was controlled. On the second test session, one week later, only raters 'A' assessed the subjects [16]. The same subject and rater testing order were used for the second test occasion.

Each of the raters administered all the items in the same order to every patient. The raters were not allowed to communicate with each other during the process of testing each patient. They were also not allowed to discuss previously tested subjects during the study.

The collected data were analyzed by SPSS 19.0. Rates of inter- and intra-rater agreement were analyzed by calculating the percentage of agreement, kappa Coefficient (CI 95%). McHugh values [26] were used to interpret reliability scores. A kappa coefficient of 1.0 indicated full agreement beyond chance. Values greater than 0.90 interpreted as almost perfect, values between 0.80 – 0.90 considered as strong, values between 0.60 – 0.79 considered as moderate, values between 0.40 – 0.59 considered as weak and values < 0.40 considered as minimal [30]. Based on this rating, an acceptable kappa value for both inter- and intra-rater reliability was considered above 0.6 and any kappa below 0.60 interpreted as inadequate agreement between or within the raters.

**Table 1)** Characteristics of studied sample

| | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|
| Age (Yrs) | 18 | 70 | 41.29 | 17.75 |
| Height (m) | 1.57 | 1.78 | 1.63 | 0.05 |
| Weight (kg) | 49 | 75 | 61.63 | 6.35 |
| BMI (Kg/m$^2$) | 19 | 29 | 23.23 | 2.73 |

**Table 2)** Alignment and movement items (signs): intra- rater Kappa values, and percentages of agreement

| POSITION | TEST | IMPAIRMENT | kappa | % of Agreement | Intra-rater Reliability |
|---|---|---|---|---|---|
| Standing | Alignment | Thoracic: Hyper Kyphosis | 0.86 | 96 | strong |
| | | Swayed back | 0.82 | 92 | strong |
| | | Lumbar: Hyper-Lordotic | 0.80 | 92 | strong |
| | | Lumbar: Flat | 0.83 | 96 | strong |
| | | Asymmetric Lumbar | 0.86 | 96 | strong |
| | Forward bending | Lumbar Spine Flexion>25 degrees | 0.74 | 87.5 | moderate |
| | | Lumbar spine extended | 0.78 | 96 | moderate |
| | | Spine faster> hips | 0.12 | 62.5 | minimal |
| | | Hip flexion<70 degrees | 0.83 | 92 | strong |
| | Return Forward bending | Mostly leads with back | 0.50 | 62.5 | weak |
| | | Hip sway | 0.74 | 87.5 | moderate |
| | Single-Leg stance | Lateral trunk flexion, hip adduction, pelvic/trunk rotation | 0.74 | 87.5 | moderate |
| | Side bending | Asymmetry | 0.70 | 92 | moderate |
| | Rotation to sides | Asymmetry | 066 | 96 | moderate |
| Supine | Double knee to chest | Lumbar flexion, Sacrum off table | 0.75 | 87.5 | moderate |
| | Hip flexor length | Pelvis anterior tilt | 0.80 | 92 | strong |
| | | Pelvis lateral tilt/Rotation | 0.83 | 92 | strong |
| | Straight leg raise | < 80 degrees with back flat | 0.74 | 87.5 | moderate |
| | Hip abduction lateral rotation | Lumbopelvic Rotation | 0.75 | 87.5 | moderate |
| | Unilateral hip and knee flexion | Lumbar flexion | 0.75 | 87.5 | moderate |
| Side lying | Hip abduction/ lateral rotation from flexion | Lumbopelvic rotation | | 83 | moderate |
| | Hip abduction | Lateral pelvic tilt | 0.75 | 87.5 | moderate |
| | Hip adduction | Lateral pelvic tilt | 0.75 | 87.5 | moderate |
| Prone | Knee flexion | Pelvic anterior tilt | 0.75 | 87.5 | moderate |
| | | Pelvic rotation | 0.70 | 87.5 | moderate |
| | Hip medial rotation | Pelvic rotation | 0.60 | 80 | moderate |
| | Hip lateral rotation | Pelvic rotation | 0.60 | 80 | moderate |
| | Hip extension with flexed knee | Lumbar extension | 0.70 | 87.5 | moderate |
| | Hip extension with extended knee | Lumbar extension | 0.70 | 87.5 | moderate |
| Quadruped | Rocking backward | Lumbar flexion | 0.86 | 96 | strong |
| | Rocking forward | Lumbar extension | 1 | 100 | full agreement |
| | Shoulder flexion | Lumbar rotation | 0.75 | 87.5 | moderate |
| Sitting | Knee extension | Lumbar flexion | 0.70 | 87.5 | moderate |
| | | Lumbar rotation | 0.50 | 62.5 | moderate |

**Table 3)** alignment and movement Items (signs): inter rater Kappa values, and percentages of agreement

| POSITION | TEST | IMPAIRMENT | kappa | % of Agreement | Intra-rater Reliability |
|---|---|---|---|---|---|
| Standing | Alignment | Thoracic: Hyper Kyphosis | 1 | 100 | full agreement |
| | | Swayed back | 1 | 100 | full agreement |
| | | Lumbar: Hyper-Lordotic | 1 | 100 | full agreement |
| | | Lumbar: Flat | 1 | 100 | full agreement |
| | | Asymmetric Lumbar | 1 | 100 | full agreement |
| | Forward bending | Lumbar Spine Flexion>25 degrees | 1 | 100 | full agreement |
| | | Lumbar spine extended | 0.78 | 100 | full agreement |
| | | Spine faster> hips | 0.61 | 69.2 | moderate |
| | | Hip flexion<70 degrees | 0.81 | 92 | Strong |
| | Return Forward bending | Mostly leads with back | 0.68 | 71 | moderate |
| | | Hip sway | 0.73 | 87.5 | moderate |
| | Single-Leg stance | Lateral trunk flexion, hip adduction, pelvic/trunk rotation | 0.72 | 71 | moderate |
| | Side bending | Asymmetry | 0.80 | 92 | Strong |
| | Rotation to sides | Asymmetry | 0.86 | 96 | Strong |
| Supine | Double knee to chest | Lumbar flexion, Sacrum off table | 1 | 100 | full agreement |
| | Hip flexor length | Pelvis anterior tilt | 0.80 | 92 | Strong |
| | | Pelvis lateral tilt/Rotation | 0.71 | 92 | Strong |
| | Straight leg raise | < 80 degrees with back flat | 1 | 100 | full agreement |
| | Hip abduction lateral rotation | Lumbopelvic Rotation | 083 | 92 | Strong |
| | Unilateral hip and knee flexion | Lumbar flexion | 0.75 | 87.5 | moderate |
| Side lying | Hip abduction/ lateral rotation from flexion | Lumbopelvic rotation | 1 | 100 | full agreement |
| | Hip abduction | Lateral pelvic tilt | 0.83 | 92 | Strong |
| | Hip adduction | Lateral pelvic tilt | 0.92 | 96 | Strong |
| Prone | Knee flexion | Pelvic anterior tilt | 0.92 | 96 | Strong |
| | | Pelvic rotation | 0.73 | 87.5 | Moderate |
| | Hip medial rotation | Pelvic rotation | 0.75 | 87.5 | Moderate |
| | Hip lateral rotation | Pelvic rotation | 0.75 | 87.5 | Moderate |
| | Hip extension with flexed knee | Pelvic rotation | 0.91 | 96 | Strong |
| | Hip extension with extended knee | Lumbar extension | 0.73 | 87.5 | Moderate |
| Quadruped | Rocking backward | Lumbar flexion | 0.87 | 96 | Strong |
| | Rocking forward | Lumbar extension | 0.83 | 92 | Strong |
| | Shoulder flexion | Lumbar rotation | 0.88 | 87.5 | Moderate |
| Sitting | Knee extension | Lumbar flexion | 0.88 | 96 | Strong |
| | | Lumbar rotation | 0.73 | 87.5 | Moderate |

**Table 4)** Comparison of Kappa coefficients

| POSITION | TEST | IMPAIRMENT | Current study | Van Dillen Et al. [16] | Lomajouki [23] |
|---|---|---|---|---|---|
| Standing | Alignment | Thoracic: Hyper Kyphosis | strong | partial | - |
| | | Swayed back | strong | partial | - |
| | | Lumbar: Hyper-Lordotic | strong | partial | - |
| | | Lumbar: Flat | strong | partial | - |
| | | Asymmetric Lumbar | strong | weak | - |
| | Forward bending | Lumbar Spine Flexion>25 degrees | moderate | weak | - |
| | | Lumbar spine extended | moderate | weak | - |
| | | Spine faster> hips | minimal | - | - |
| | Return Forward bending | Hip flexion<70 degrees | strong | partial | - |
| | | Mostly leads with back | weak | partial | - |
| | | Hip sway | moderate | weak | - |
| | Single-Leg stance | Lateral trunk flexion, hip adduction, pelvic/trunk rotation | moderate | - | - |
| | Side bending | Asymmetry | moderate | weak | - |
| | Rotation to sides | Asymmetry | moderate | - | - |
| Supine | Double knee to chest | Lumbar flexion, Sacrum off table | moderate | - | - |
| | Hip flexor length | Pelvis anterior tilt | strong | - | - |
| | | Pelvis lateral tilt/Rotation | strong | - | - |
| | Straight leg raise | < 80 degrees with back flat | moderate | - | - |
| | Hip abduction lateral rotation | Lumbopelvic Rotation | moderate | partial | weak |
| | Unilateral hip and knee flexion | Lumbar flexion | moderate | - | - |
| Side lying | Hip abduction/ lateral rotation from flexion | Lumbopelvic rotation | moderate | - | - |
| | Hip abduction | Lateral pelvic tilt | moderate | - | - |
| | Hip adduction | Lateral pelvic tilt | moderate | - | - |
| Prone | Knee flexion | Pelvic anterior tilt | moderate | perfect | - |
| | | Pelvic rotation | moderate | partial | - |
| | Hip medial rot | Pelvic rotation | moderate | partial | good |
| | Hip lateral rot | Pelvic rotation | moderate | partial | good |
| | Hip extension with flexed knee | Lumbar extension | moderate | - | good |
| | Hip extension with extended knee | Lumbar extension | moderate | - | - |
| Quadruped | Rocking backward | Lumbar flexion | strong | good | good |
| | Rocking forward | Lumbar extension | full agreement | - | good |
| | Shoulder flexion | Lumbar rotation | moderate | weak | - |
| Sitting | Knee extension | Lumbar flexion | moderate | partial | good |
| | | Lumbar rotation | moderate | partial | good |

## Findings

Subjects' characteristics are shown in Table 1. The percentages of agreement and the kappa values for alignment and movement (signs) items are provided in Tables 2 and 3 for intra- and inter-rater assessment, respectively. The intra-rater percentages of agreement ranged from 62.5 to 100. The intra-rater kappa values ranged from 0.12 to 1.00. Of the total of 34 items, two items had perfect, ten items had strong, twenty items had moderate, and one item had weak intra-rater reliability (Table 2).

The inter-rater percentages of agreement ranged from 69.2 to 100 and kappa values for the sign items ranged from 0.61 to 1.00. Of the total of 34 items, eleven items had perfect, thirteen items had strong, ten items had moderate, and one item had weak inter-rater reliability (Table 3). Comparison of Kappa coefficients has been shown in Table 4.

## Discussion

The goal of the present study was to assess the intra- and inter-rater reliability of corrective exercise specialists, using the MSI approach's lumbar alignment and movement clinical test items, for assessing individuals susceptible to LBP. The current study is one of the only two studies devoted to assessing the reliability of MSI approach test items related to lumbar region. These two studies are different from some aspects. The current study was devoted to a healthy back population susceptible to LBP, assessed by corrective exercise specialist raters, while in the other one conducted by Van Dillen et al. (1998), the raters were physical therapists assessing the patients suffering from LBP. Study of Van Dillen et al [16] includes items related to assessment of both signs (movement and alignment) and symptoms (pain provocation) while the items related to symptoms were excluded from the current study due to the back healthy participants.

It should be mentioned that study of van Dillen et al. [16], was conducted as a preliminary study for investigating validation of the MSI model for classifying patients with LBP, in which the items related to assessment of signs, included only 25 alignment and movement tests. These items have developed since then and Sahrmann[3] introducing this approach in her book, Diagnosis and Treatment of Movement Impairment Syndromes, mentions to almost 34 alignment and movement (signs) test items for lumbar region assessment. Our study considered the latter one as the base and reference for movement and alignment test items of the lumbar region.

Overall, the corrective exercise specialist examiners, demonstrated an almost high percentage of agreement (mainly>75%) and moderate to strong (k<0.6) inter-rater and intra-rater reliability in administering the majority of the alignment and movement testing items: Two of 35 items had perfect, ten of 35 items had strong, twenty of 35 items had moderate, and only one item had weak intra-rater reliability.

The best intra- rater reliability was shown in tests related to assessing: alignment, hamstring length in forward bending, hip flexor length, and lumbar extension in quadruped rocking forward test [k = 0.92–0.96]. The two poorest tests were: assessing how fast spine and hip move in relation to each other in forward bending and return, with respectively minimal (k = 0.12) and weak (k = 0.50) intra-rater reliability.

In the study of Van Dillen et al. [16], similar to our results, the physical therapist examiners demonstrated acceptable, not excellent, reliability in administering the majority of the clinical examination items. This can be mainly explained by the nature of judgment in these items which are mainly visual and tactile. Their results show excellent reliability for 2 of 25 items, good reliability

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for 3 of 25 items and fair reliability of 13 items. Kappa values below 0.40 for seven items including: asymmetry of the lumbar region, regularity of lumbar curve assessed with flexible ruler, asymmetry in side bending, and asymmetry in lumbar region while arm lifting in a quadruped position, indicated poor reliability of these items.

Physical therapists examiners in study of Van Dillen et al.[16], were not as likely to agree on items related to alignment and movement (k > 0.00 and % agreement > 67%)as they were for items related to the symptoms elicited (k > 0.89 and % agreement > 98%). Also in their study, intra-rater reliability of the spinal alignment was slightly lower (k = 0.27–0.58) than items related to active movements (k = 0.49–0.66). However, in the current study Alignment test items were of the greatest kappa values with inter and intra-rater values evaluated as strong (k = 0.82-0.86) and perfect (k =1), respectively.

Unlike the current study, the great discrepancy between kappa values (less than 0.7 for most items) and percentages of agreement (more than 75% for most items) in study of Van Dillen et al. [16], demonstrates the skewness of raters' results distribution in their study.

Study of Luomajoki et al.[23] on assessing the reliability of Movement Control tests in the lumbar spine, has eight tests in common with the recent study, including: sitting knee extension, crook lying hip abduction (called hip abduction lateral rotation in the MSI model), prone knee-bent hip extension, single-leg stance, prone knee-bent hip rotation, rocking 4-point kneeling flexion (called rocking forward in the MSI model), rocking 4-point kneeling extension (called rocking backward in the MSI model) and waiters bow (calked forward bending in the MSI model). In general, the results of the two studies are similar with Inter- and intra-rater reliability of the majority of the items rated good (k > 0.6).

## Conclusion

This study demonstrates that movement impairment tests of the lumbar region, except items assessing the speed of hip and lumbar movement in forward bending and return, have a good to moderate inter-and intra- rater reliability for corrective exercise specialist raters (k > 0.6). Based on these results, corrective exercise specialists, can reliably utilize these items, for identification of the impairments that need to be modified in individuals susceptible to LBP before the onset of pain. It's also advisable that the same rater carry out all the necessary assessments of each specific client, due to higher inter-rater reliability for almost all test items.

Future studies should investigate whether it is possible to utilize movement system impairment model for classification of the LBP susceptible subjects.


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## Authors' contribution

Authors contributed equally in preparing this article . All authors helped in all sections of the study, they read the final draft of the manuscript.

## Conflict of interest

The authors declared no conflict of interest.

## Ethical Permission

Ethical approval was obtained from the Research Ethics Committee of the Tehran University. (IR.UT.SPORT.REC.1400.039)


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