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ORIGINAL RESEARCH

Reference values and reliability for lumbopelvic strength and endurance in asymptomatic subjects

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Abstract
Background: Assessing the lumbopelvic region is useful for detecting many musculoskeletal dysfunctions and also performance deficits. Several clinical tests are used to assess this region, however, reference values and results related to method, reliability and error measurements of these tests have not been reported.
Objectives: To establish reference values and determine reliability, standard error of measurement (SEM), typical error of measurement (TEM) and minimum detectable change (MDC) of a set of clinical tests used for assessing the lumbopelvic region in subjects divided by gender, age group and physical activity levels.
Methods: An observational study was conducted. For reference values, 152 subjects performed eight clinical tests (isometric strength of hip muscles; deep abdominal function and endurance tests) used to assess the lumbopelvic region. Reliability analyses were assessed using the Intra-class Correlation Coefficient ($ICC_{2,1}$) and error measurements were calculated by using the SEM, TEM and the MDC.
Results: Reference values were established for each group and results showed significant ($p < 0.05$) differences concerning gender, age group and physical activity levels in clinical tests. All tests presented good reliability indices with an ICC higher than 0.80 for reliability; MDC values were greater than mean of SEM in all tests, confirming its usage for clinical practice assessments.

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Conclusion: Reference values are necessary in the evaluation of subjects and these results can contribute for clinical practice, providing clinical training targets. Also, evaluation of reliability and error measurements in this set of tests allows its use in clinical practice.

Introduction

Interventions concerning exercise rehabilitation have been extensively studied and results confirm that exercise plays an important role in rehabilitation.[1] Also, results of endurance and instability tests appear to be related to pain and the disability in many conditions affecting the musculoskeletal system,[2] which makes measures of function a subject of great importance for clinicians and researchers. In addition, concerning low back pain patients, there is a subgroup that despite being asymptomatic for daily life activities, report pain while performing high levels of physical activity. It is necessary to study ways to assess these patients, so clinical training targets can be established. One possible cause is impairment of movement systems' endurance, strength and power,[3] not only in the low back, but also hip and core muscles. For that reason, there is a need for an assessment composed by a set of tests compiled to optimize these patients' performance for higher levels of physical activities, and detect muscle deficits that can contribute to the symptoms.

McGill et al. stated that using healthy subjects' endurance results for low back exercises could be useful for patient evaluation and for providing clinical training targets.[4] However, conflicting results concerning test reliability have been reported[5,6] compromising clinical usage due to difficulties in identifying deficits of assessed individuals in follow-up scenarios.[7,8] Results concerning differences between subjects' performance according to gender, age, and physical activity levels are discussed[9,10] mostly in athletes,[11] but inconsistent in a non-athlete population. To the best of our knowledge, there is no evidence of reference values, reliability and error measurement values for tests compiled for lumbopelvic assessment in different groups.

Physical therapists should use reliable measures for assessing patients to assure if clinically meaningful changes have occurred during treatment period.[12] For clinical practice usage, hand held dynamometry, pressure biofeedback units (PBU) and static endurance positions are gaining considerable interest, since these are more portable, easier to perform and less expensive when compared to other options available such as isokinetic testing[13] and electromyography.[14] Several tests have been proposed to assess the lumbopelvic region[15] but to be clinically useful, must demonstrate good reliability and well-defined testing standards.[16–18]

It is crucial to consider a combination of strength, muscle activity and endurance tests which are reliable, easy to manage and affordable to be incorporated in everyday clinical practice. Therefore, the aim of the present study is to present reference values and also intra and interrater reliability, SEM, TEM and MDC of a set of tests for lumbopelvic assessment using measures of muscle strength, activity and endurance in asymptomatic subjects stratified by gender, age group and physical activity levels.

Methods

Subjects

One hundred eighty five subjects were recruited for this study from a local university setting and the community. For reference values, 152 subjects (79 men, 73 women) divided by gender, age group and physical activity levels were assessed. Sample size for reference values was calculated on the G*Power software (version 3.2.1), based on data from a pilot study, considering $\alpha = 5\%$ and 95% power, resulting in a minimum of 16 individuals per group. For reliability, 33 subjects (15 men, 18 women) were recruited. Sample size was estimated by the study of Walter et al.,[19] resulting in a minimum of 33 individuals.

This observational study was approved by the Ethical Committee of Ribeirão Preto Medical School, Universidade de São Paulo (USP), Ribeirão Preto, SP, Brazil (n° 6037/2015).

Inclusion criteria were: ability to give informed consent, ages between 18 and 65 years and ability to write and comprehend Portuguese. Subjects had to be asymptomatic without one year history of neurological or musculoskeletal diseases, back pain, injury, or surgery in the lumbar spine, hip, shoulder or knee. Women who were in their period were rescheduled to a more appropriate stage of the menstrual cycle[20] and pregnant women were excluded from the study. All subjects gave full informed consent before the experiments.

Testing procedure

Testing procedure took approximately 90 min and required a hand held dynamometer (HHD) for maximum strength measurements (*Lafayette Instrument Company*, 01165, Lafayette, IN, USA); a PBU to evaluate the activity of the transversus abdominis muscle (TrA) indirectly (*Stabilizer®*, *Chattanooga Group Inc., Hixson, TN, USA*); a stopwatch for time measurements; a goniometer for test positioning; an examination table; a wedge support with an angle of 60°; belt straps made from an inelastic material were used for better positioning of the HHD and avoiding potential

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