Effect of Core Stability Exercises on Balance and Trunk Muscles Endurance in Healthy Adult Subjects

Thesis
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Abstract

Background: Core stability exercises are nowadays used to improve torso muscles’ performance in a way that protects the spine from damage. Abdominal muscle endurance, torso balance, and dynamic balance are important for trunk stability, appropriate posture, and proper body movement. The purpose of this study was to examine the effect of core stability exercises on trunk muscle endurance and dynamic balance in healthy adult individuals.

Methods: Thirty five male and female college students participated in the study. The participants were randomly assigned to two groups; experimental (group A) and control (group B). Group A consisted of 20 participants (10 male and 10 female) with mean±SD age 20.7±2.4 years, weight 66.5±12.1 kg, and height 166.7±7.8 cm. Group B consisted of 15 participants (6 male and 9 female) with mean±SD age 20.3±0.61 years, weight 68.57±12.2 kg, and height 164.28 ±7.59 cm. Isokinetic endurance parameters (total work and work fatigue) and dynamic balance parameters (antero-posterior (AP), medio-lateral (ML) and overall (O) stability indices (SI)) were collected using the Biodex Isokinetic and Biodex Balance systems respectively before and after a 6-week period during which group A performed a core stability exercise program.

Findings: Considering the endurance parameters, the 2x2 Mixed Design MANOVAs revealed that there were significant differences between both groups for the total extension and flexion works only in the "post" test (p<0.01), with no significant differences inbetween for all the tested variables in the "pre" test (p>0.01). Moreover, they revealed significant differences between the "pre" and "post" tests for the total extension and flexion works in group A and the total flexion work only in group B (p<0.01) with no significant differences inbetween for the work fatigue at either of the tested groups (p>0.01). The Mann-Whitney tests revealed that there were significant differences between both groups for the APSI, MLSI and OSI in the "post" test (p<0.01), with no significant differences inbetween for all the tested variables in the "pre" test (p>0.01). The Wilcoxon Signed Rank tests revealed significant differences between the "pre" and "post" tests for the APSI, MLSI and OSI in group A and the MLSI and OSI only in group B (P<0.01).

Conclusion: It may be concluded that core stability exercises are effective in improving trunk muscle endurance and dynamic balance.

Keywords: Core stability, isokinetic, balance, trunk muscle endurance.
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<tr>
<td>1-RM</td>
<td>One repetition maximum</td>
</tr>
<tr>
<td>AP</td>
<td>Antero-posterior</td>
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<td>APSI</td>
<td>Anterior/posterior stability index</td>
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<td>BBS</td>
<td>Biodex balance system</td>
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<tr>
<td>BSS</td>
<td>Biodex stability system</td>
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<tr>
<td>COG</td>
<td>Center of gravity</td>
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<td>CS</td>
<td>Core stability</td>
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<td>DLS</td>
<td>Dynamic limits of stability</td>
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<td>EMG</td>
<td>Electromyography</td>
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<td>IAP</td>
<td>Intra-abdominal pressure</td>
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<td>LBP</td>
<td>Low back pain</td>
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<td>LBD</td>
<td>Low back dysfunction</td>
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<td>LBT</td>
<td>Low back trouble</td>
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<tr>
<td>MANOVA</td>
<td>Multivariate Analysis of Variance</td>
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<tr>
<td>MF</td>
<td>Median frequency</td>
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<td>ML</td>
<td>Medio-lateral</td>
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<td>MLSI</td>
<td>Medial/lateral stability index</td>
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<tr>
<td>MVIC</td>
<td>Maximum voluntary isometric contraction</td>
</tr>
<tr>
<td>N</td>
<td>Newton</td>
</tr>
<tr>
<td>OSI</td>
<td>Overall stability index</td>
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<tr>
<td>PBU</td>
<td>Pressure biofeedback unit</td>
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<td>PF</td>
<td>Pelvic floor</td>
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<tr>
<td>Abbreviation</td>
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<tr>
<td>RA</td>
<td>Rectus abdominis</td>
</tr>
<tr>
<td>ROM</td>
<td>Range of motion</td>
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<tr>
<td>SD</td>
<td>Standard deviation</td>
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<td>SEBT</td>
<td>Star excursion balance test</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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<tr>
<td>TA</td>
<td>Transversus abdominis</td>
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<tr>
<td>VAS</td>
<td>Visual analogue Scale</td>
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<tr>
<td>VGRFV</td>
<td>Vertical ground reaction force vector</td>
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INTRODUCTION
CHAPTER I
INTRODUCTION

Core stability (CS) is being studied extensively since the early 1980s (Hibbs et al., 2008). It was reserved mainly for individuals with low back pain (Check, 1999; McGill, 2001; Saal, 1990). Low load training of the abdominal and trunk muscles (stability exercises) is often the treatment of choice to these patients (Norris, 1995; Richardson & Jull, 1995). The objective of such exercises is to enhance the function of the critical torso muscles in a way that spares the spine from damage. However, core stability exercises are now commonly performed by healthy individuals and athletes to improve performance.

Panjabi (2003) proposed that spinal stability is dependent on the interaction between the passive, active and neural control systems. The passive system is composed of the vertebrae, facet articulations, intervertebral discs, spinal ligaments, joint capsules and the passive mechanical properties of the muscles. The active system consists of the muscles and tendons surrounding the spinal column. The neural system includes various force and motion transducers which are located in the ligaments, tendons, muscles, and neural control centers. All three systems interact with each other to provide sufficient stability to the spine to face challenges from spinal posture and static and dynamic loads. Gross instability occurs when either of these systems is disturbed.

Of the active system that provides spinal stabilization is the core musculature. The core musculature can be generally defined as the 29 pairs of muscles that support the lumbo-pelvic-hip complex. Bergmark (1989) first classified the core musculature as either "local" or "global" based on the varying characteristics of them. Slow-twitch fibers primarily make up the local muscle system. These muscles are short in length and
are suited for controlling the intersegmental motion and responding to changes in posture and extrinsic loads. Local muscles include the transversus abdominis, multifidi, internal obliques, deep transversospinal, and pelvic floor muscles (Hides et al., 1996). On the other hand, fast twitch fibers comprise the global muscle system. These muscles are long and possess large lever arms, allowing them to produce large amounts of torque and gross movement. Global muscles include the erector spinae, external obliques, rectus abdominis and quadratus lumborum muscles (McGill, 2001). The core muscles stabilize the spine, pelvis, and kinetic chain during functional movement (Fredericson & Moore, 2005).

Through its ability to contract, the core musculature provides core stability and creates a foundation for the naturally present unstable spine which buckles under compressive loading of only 90 N (Crisco & Panjabi, 1992). This is in addition to allowing for the transfer of forces between the body segments during dynamic movements (Briggs et al., 2004; Faries & Greenwood, 2007; Stanford, 2002).

Core stability is comprised of components such as core strength, endurance, power, balance, as well as coordination of the spinal, abdominal, and hip musculatures (Liemohn et al., 2005; Cowley & Swensen, 2008). Cholewicki and McGill demonstrated that sufficient stability of the lumbar spine is achieved in most persons with very modest levels of coactivation of the paraspinal and abdominal wall muscles. So, maintaining stability when performing tasks of daily living is not achieved by sufficient muscle strength but rather by sufficient endurance (McGill, 2001). So, strength gains should not be overemphasized at the expense of endurance (McGill, 1999) especially that muscle endurance was suggested to be more important than muscle strength for providing spinal stability (Leman, 2006).
Muscle endurance can be defined as the ability of a group of muscles to execute repeated contractions over a given time that is sufficient enough to cause muscle fatigue (Baechle & Earle, 2002). Poor trunk muscle endurance was shown to be highly correlated with the occurrence of low back pain (McGill et al., 2003). This poor endurance is associated with delayed hip extensors (gluteus maximus) and abductors (gluteus medius) firing (Beckman & Buchanan, 1955). Strong abdominals were concluded not to protect against back problems but endurable muscles reduce the risk of back troubles (Luoto et al., 1995).

With the evidence supporting the importance of muscle endurance for improving core stability, it is important to emphasize on improving core muscle endurance to improve health and reduce the risk of injury. In the clinical settings, the standard method of measuring core strength and endurance is through the use of isokinetic dynamometers (Delitto et al., 1991; Hislop & Perrine, 1967; Karatas et al., 2002; Keller et al., 2001; Rothstein et al., 1987). Isokientic sagittal lumbar performance measurement has been developed recently to measure trunk muscle endurance by determining the decline in the work performance on repeated reciprocal dynamic contractions (work fatigue) (Sahin et al., 2011).

Aside of testing trunk muscles endurance, assessing the balance remains an integral component of core stability. Balance, or postural control, can be described as either dynamic or static. Static balance is the attempt to maintain the base of support while minimizing the movements of the body segments and center of mass. Dynamic balance involves maintaining a stable base of support while completing a specific movement, while there is a changing base of support (Gribble, 2003; Hertel et al., 2000). Dynamic balance is required for activities of daily
living and is necessary for complex weight-shift activities in standing (Donahoe et al., 1994; Kinzey et al., 1998).

The core functions to maintain postural alignment and dynamic postural equilibrium during functional activities. This helps avoid serious distortion patterns (Clark et al., 2000). The core, when working efficiently, provides the neuromuscular control to maintain dynamic balance (Akuthota & Nadler, 2004). A poorly developed core contributes to poor posture because the core musculature is not able to generate a variety of movements of the trunk in many planes of motion and the force is transferred through a straight line (Brittenham & Brittenham, 1997). Assessing dynamic balance aids in assessing joint instability more effectively than static testing (Guskiewicz, 2003) because static testing does not take into account the shift in the center of gravity (Gribble, 2003). Therefore, dynamic balance testing using the Biodex balance system has been proposed.

Despite the wide use of core stability exercises, there is few studies that examined the effect of core stability exercises on trunk muscle endurance (Sung, 2003; Tse et al., 2005) and dynamic balance (Swaney & Hess, 2003) in healthy adult individuals. Most of the studies were designed to examine the effect of core training on muscle strength at the expense of muscle endurance. Moreover, most of the previously conducted studies examined the effect of core stability exercises on balance in athletes. So, the purposes of this study were to investigate the effect of core stability exercises on dynamic balance and trunk muscle endurance in healthy adult individuals.
Statement of the problem:

- Would the beginners' core stability exercise program affect the work fatigue and total work of the trunk extensors and flexors?
- Would the beginners' core stability exercise program affect the antero-posterior, medio-lateral, and overall stability indices?

Purposes of the study:

The purposes of this study were:

- To investigate the effect of the beginners' core stability exercise program on the work fatigue and total work of the trunk extensors and flexors.
- To investigate the effect of the beginners' core stability exercise program on the antero-posterior, medio-lateral, and overall stability indices.

Significance of study:

Examining the effect of the beginners' core stability exercise program on trunk muscle endurance and dynamic balance may help physical therapists in designing rehabilitation programs that aim to improve these aspects especially in those who have endurance and balance problems.

Delimitations:

This study was delimited to the following:

- Healthy non athletic college students.
- Assessing trunk muscle endurance through measuring the work fatigue and total work of the trunk extensors and flexors using the
Biodex isokientic system before and after the core stability exercise program.

- Measuring the dynamic balance using the Biodex balance system before and after the core stability exercise program.

**Basic assumptions:**

It was assumed that:

All participants performed to the best of their abilities

**Hypotheses:**

The null hypotheses of this study were:

**H₀:** There would be no significant effect of the beginners' core stability exercise program on the work fatigue and total work of the trunk extensors and flexors.

**H₀:** There would be no significant effect of the beginners' core stability exercise program on the antero-posterior, medio-lateral, and overall stability indices.
LITERATURE REVIEW