THE ASSOCIATION BETWEEN TRUNK MUSCLE ENDURANCE AND LUMBO-PELVIC STABILITY IN ADOLESCENT LOW BACK PAIN: A CROSS SECTIONAL STUDY

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ABSTRACT: *Decreased trunk muscle endurance has been identified as a risk factor for adolescent LBP, and poor lumbo-pelvic stability has been found to be associated with LBP in the adult population. The aim of the study was to investigate the association between adolescent LBP, trunk muscle endurance and poor lumbo-pelvic stability.*

Design: A cross sectional study.

Participants: 80 adolescents in grade 8 to grade 11, aged 12 to 17 years, at three high schools in Gauteng, who agreed to participate in the study.

Method: Data was collected by means of a validated questionnaire and physical tests. The active straight leg raise test was used to record the lumbo-pelvic stabilising muscles. The Sorensen, Shirado and side-bridge tests were used to record trunk extensor, flexor and side flexor muscle endurance, respectively.

Results: The results revealed a lifetime prevalence of LBP of 82.50%, one year prevalence of 78.80% and point prevalence of 23.80%. Adolescents with LBP demonstrated decreased trunk extensor muscle endurance but increased trunk flexor muscle endurance (p=0.044), compared to non-LBP adolescents. Poor lumbo-pelvic stability was not associated with adolescent LBP, but was associated with decreased extensor trunk muscle endurance (p=0.031). Conclusion: There was an association between trunk flexor muscle endurance and adolescent LBP, and between decreased trunk extensor muscle endurance and poor lumbo-pelvic stability. No association was found between LBP and poor lumbo-pelvic stability.

KEY WORDS: *ADOLESCENT, TRUNK MUSCLE ENDURANCE, LOW BACK PAIN, LUMBO-PELVIC STABILITY, RISK FACTORS.*

INTRODUCTION

Low back pain (LBP) is a common and well-documented cause of pain and disability (Balague et al 2012, Limon et al 2004). Studies have shown a high prevalence of LBP in school aged children, despite the common perception that it is not frequently reported in this age group (Watson et al 2002). The aetiology of low back pain symptoms in adolescents is poorly understood (Watson et al 2003). It has been suggested that adolescent LBP has important consequences for the occurrence of adult LBP (Hestbaek et al 2006, Harreby et al 1995)

Possible risk factors for the occurrence of adolescent LBP include age, gender, family history, emotional status, trunk asymmetry, rapid growth, prolonged sitting, high levels of sporting activity and poor muscle endurance (Bernard et al 2008, Andersen et al 2006, Korovessis et al 2004, Kovacs et al 2003, Grimmer & Williams 2000, Feldman et al 2001, Balague et al 1999). There are conflicting reports with regards to the role of physical activity and sedentary activity as risk factor for adolescent LBP (Masiero et al 2008, Balague et al 1999).

Dysfunctional movement patterns caused by changes in strength or flexibility, poor endurance, or abnormal neural control can result in tissue damage, which could result in decreased stability of spinal structures, and increased demand placed on the already inefficient muscles, resulting in a dysfunctional degeneration cascade (Barr et al 2005). Patients with LBP often present with trunk muscle imbalances and movement dysfunction in either the local or the global muscle system (Comerford and Mottram 2001). The ability of the trunk muscles to maintain appropriate levels of activation over long periods of time may be more important than maximum strength, to protect the passive structures of the lumbar spine from injury (Evans et al, 2006). Decreased trunk muscle endurance has been identified by Andersen et al (2006) as a risk factor for adolescent

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LBP, while poor lumbo-pelvic stability has been found to be associated with LBP in the adult population (O'Sullivan et al 2002). A possible a causal relationship between LBP and decreased spinal stability was suggested by Sjolie and Ljunggren (2001). However, in a study by Jordaan (2005), no association was found between adolescent LBP and poor lumbo-pelvic stability. The aim of the current study was to investigate trunk muscle endurance and poor lumbo-pelvic stability as potential risk factors in adolescent LBP.

METHODOLOGY

This was a cross sectional study. The population chosen were adolescents of both genders in grade 8-11 (aged 12-17 years), attending a member school of the Independent Schools Association of South Africa (ISASA), in the Central Gauteng region. An ISASA school was chosen as a sample of convenience due to accessibility. At the time of the study there were 67 schools registered as ISASA member schools in the Central Gauteng region. Possible schools were narrowed down to 24 schools based on schools with both male and female students and similar sports offered. From these 24 schools that were approached only three agreed to participate in the study. Volunteers from which consent and assent was obtained were included in the study. Adolescents with a history of spinal surgery; any use of orthotic device such as brace or lumbar support; surgery, fractures or other orthopaedic procedure to pelvis or lower limbs within the last six months; adolescents with known spinal pathology (Scheurmann's disease, spondlyosis, spondylolithsesis, rheumatic disease); or with visible abnormal spinal curvature (scoliosis, kyphosis); neurological conditions which alter motor tone; and any other serious co-morbidities were excluded.

Data collection included a questionnaire and physical testing. The questionnaire was used to obtain information on LBP and the characteristics and behaviour of pain. The questionnaire had been validated previously and permission was granted to use it (Jordaan, 2005). The physical tests measured trunk muscle endurance and lumbo-pelvic stability. All measurements were taken by the principal author and intra-rater reliability was established prior to the study.

Back extensor endurance was recorded using the Sorensen test (Arab et al 2007, Evans et al 2006, Demoulin et al 2004). The participant was positioned in prone with the upper edge of the iliac crests aligned with the edge of the table and the pelvis, knees and ankles fixed to the table via three straps. The participant was asked to hold the upper body in a horizontal position in line with the lower body with the arms folded across the chest for as long as possible. The test was stopped after 240 seconds if the participant was still holding the position.

Abdominal endurance was recorded using the Shirado test (Bernard et al 2008, Ito et al 1996). The participant was positioned in supine, arms crossed over their chests and hips and knees flexed to 90°. The test begins when the participant lifts their upper body from the examination table. The position was held for as long as possible, or until the position could no longer be maintained, the test is stopped after 240 seconds (Evans et al 2006).

Trunk lateral flexor endurance was recorded using the side bridge endurance test (Evans et al 2006, McGill et al 1999). The participant lay on their side with the legs extended, resting on their forearm with the elbow flexed to 90°. The top foot was placed in front of the lower foot for support. The participant was instructed to lift the hip off the bed, support themselves on their one elbow and their feet, and maintain a straight line with the whole body throughout the test. The uninvolved arm was held across the chest with the hand placed on the opposite shoulder. The position was held for as long as possible.

The active straight leg raise (ASLR) test was used to measure the functional control of the lumbo-pelvic stabilising muscles (Mens et al 2001). The participant was instructed to lift one leg 20cm above the bed, keeping the leg straight. The participant was then asked to rate the difficulty of the movement according to the following scale: not difficult at all, minimally difficult, somewhat difficult, fairly difficult, very difficult, unable to do (Mens et al 2001). This was repeated on the other leg. The measurement was also quantified by the readings on three pressure biofeedback units, which were used to measure control of the rotatory component of the pelvis (Jordaan 2005). Two pressure biofeedback units were positioned beneath the posterior superior iliac spines on each side just lateral to the midline, to monitor coronal rotation of the pelvis. One pressure biofeedback unit was placed beneath the leg at the ankle of the resting leg to monitor an increase in pressure when the other leg was lifted in the ASLR test. Each was inflated to a baseline pressure of 40mmHg. A change of pressure more than 16mmHg was considered poor, a change of between 9 and 15mmHg was considered moderate and a change in pressure of 8mmHG or less was considered good performance (Jordaan 2005). This measurement was described by Jordaan (2005) and has been used in other studies on adolescent low back pain (Fanucchi et al 2009).

During all testing procedures, participants were instructed to stop if they experienced any pain. No participants reported pain during any of the testing.

RESULTS

Prevalence of LBP

The lifetime prevalence of adolescent LBP in this group was 82.50% (n=66), one-year prevalence was 78.80% (n=63), and point prevalence was 23.80% (n=19).

The association between trunk muscle endurance and adolescent LBP

Adolescents with a history of LBP (n=66) showed higher levels of trunk flexor endurance than non-LBP subjects (n=14) (p=0.044). The results are presented in **Figure 1**.

Although adolescents with a history of LBP showed weaker extensor trunk muscle endurance than those without LBP, no direct association was found (p=0.304). The results are presented in **Figure 2**.

No association was found between LBP and side flexor muscle endurance.

The association between lumbo-pelvic stability and adolescent LBP

No association was found between LBP and participants' perception of the ease of lifting the right and left ASLR (p=0.275 and p= 0.373 respectively). The results are presented in **Figure 3**.

No association was found between LBP and either the right or the left pressure change, as measured at the PSIS (p=0.287 and p= 0.719 respectively). The results are presented in **Figure 4**.

The association between trunk muscle endurance and lumbo-pelvic stability.

The results of the mean muscle endurance and the average pelvic rotation control during ASLR are presented in **Figure 5**. There was a statistically significant association between the ASLR test and trunk extensor muscle (p=0.031). Those adolescents with better performance of the ASLR test had better endurance of the trunk extensor muscles. Those participants with a good muscle control during ASLR (pressure change on the biofeedback less than 9mmHg) had better endurance scores for all four endurance tests.

DISCUSSION

The life-time and year prevalence of LBP among adolescents found in this study are higher than those recorded in other studies in which life-time prevalence has been recorded between 26% to 69.30% (Jordaan 2005, Kovacs et al 2003, Fairbank et al 1984) and one-year prevalence between 50% and 57% (Jordaan 2005, Sjolie & Ljunggren 2004). Point prevalence of adolescent LBP in this study is similar to that reported in other studies which have documented point prevalence between 13% and 23.90% (Masiero et al 2008, Watson et al 2002, Lebouef-Yde & Kyvik 1993). The results of this study indicate that adolescent LBP could be a common complaint of South African adolescents. The concern is that an association has been reported between adolescent and adult LBP (Hestbaek et al 2006, Harreby et al 1995) and intervention programmes may thus need to be instituted to prevent LBP to become recurrent or chronic in nature.

The mean value for trunk flexor muscle endurance in participants with a history of LBP was higher than in individuals with no history of LBP (p=0.04). Although the results of this study are contrary to those reported by Salminen et al (1992), they are similar to those reported by Bernard et al (2008) and Perry et al (2009). Perry et al (2009) suggest that the LBP is a result of the flexor dominance and that the dominant flexion or compressive loading forces of the trunk flexor muscles can exert increased pressure on the lumbar spine. It cannot be determined from this study if the changes seen in trunk muscle flexor endurance are the cause or effect of LBP. It could be that the flexor muscle endurance is increased due to compensatory mechanisms of the global muscles in an effort to improve spinal stability or it could be the cause of LBP as suggested by Perry et al (2009). Conversely, trunk extensor muscle

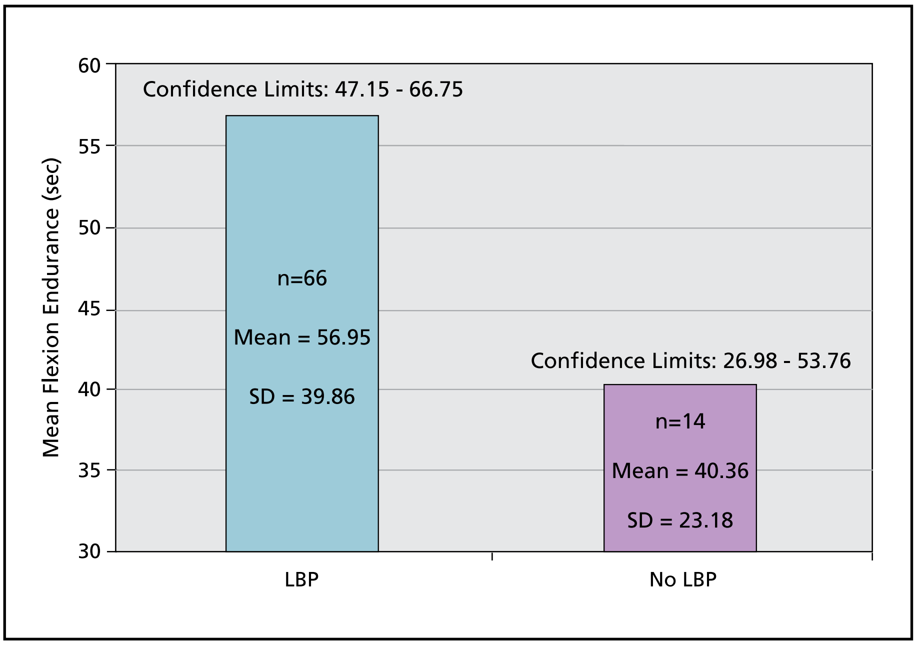

Figure 1: Mean values for trunk flexor muscle endurance

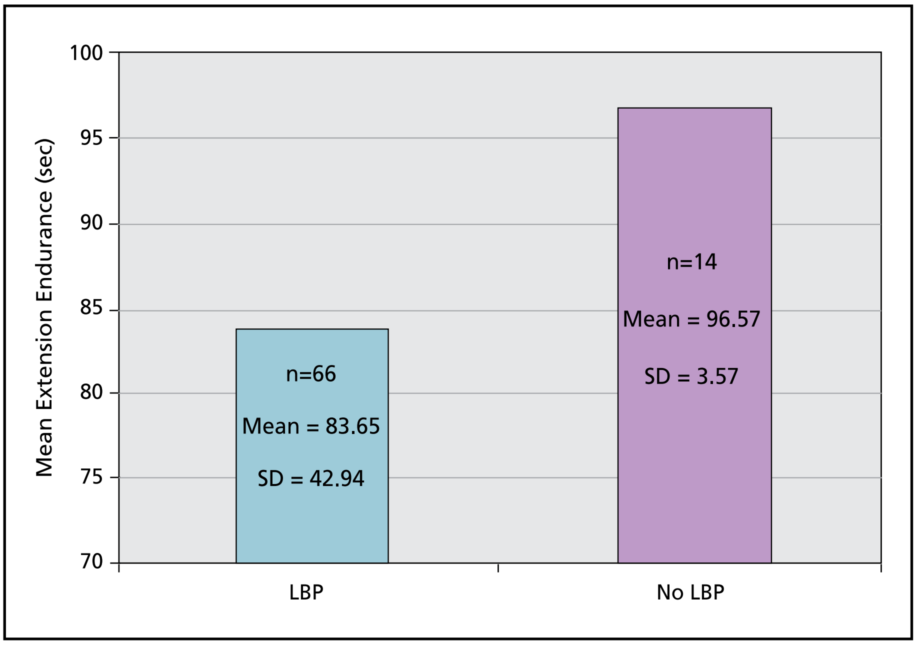

Figure 2: Mean values for trunk extensor muscle endurance

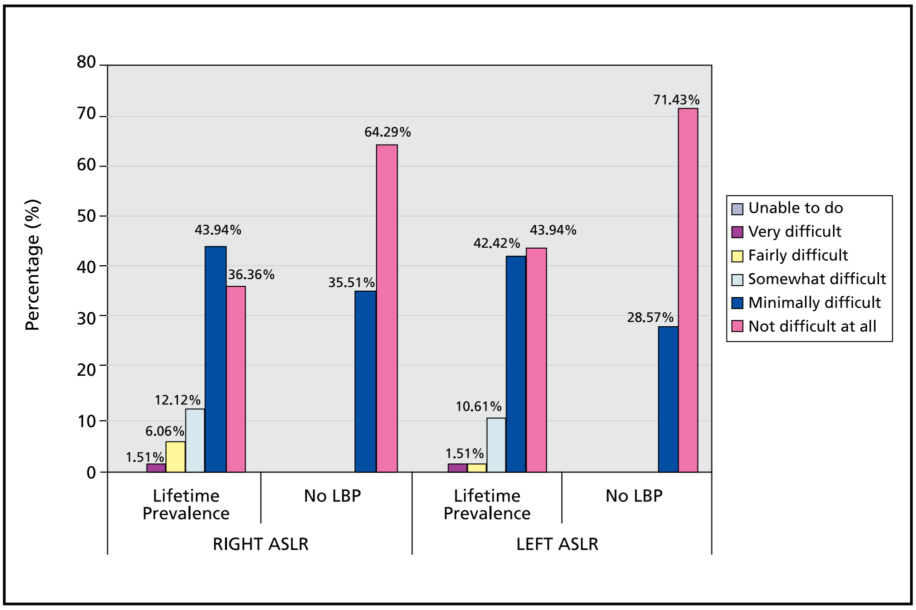

Figure 3: Subjects perception of ASLR

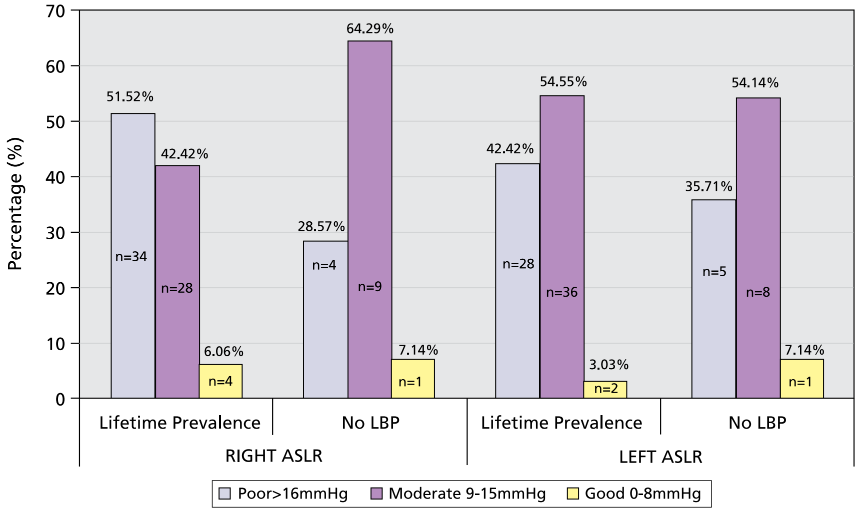

Figure 4: Pressure change at PSIS on side of ASLR test

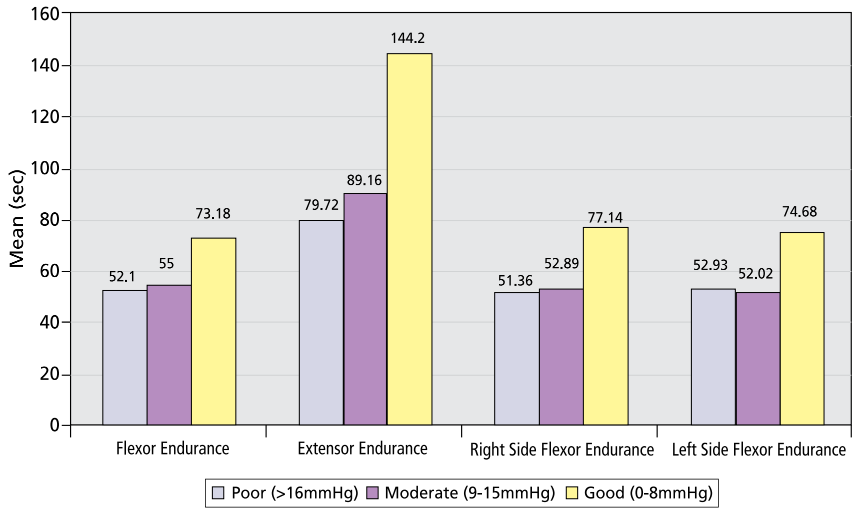

Figure 5: Mean muscle endurance and ASLR

endurance was decreased in those adolescents with a history of LBP, although the result was not statistically significant. These results are similar to other studies in which decreased trunk extensor muscle endurance was recorded in adolescents with LBP (Bernard et al 2008, Andersen et al 2006, Sjolie and Ljunggren 2001, Salminen et al 1995). Another study shows both deficits and excesses of back muscle performance related to LBP (Perry et al 2009). The results of this study indicate that in adolescents with LBP the rehabilitation programme should perhaps address trunk muscle endurance.

The results of the current study suggest that poor lumbo-pelvic stability is not associated with adolescent LBP. The majority of adolescents within the study, whether they presented with LBP or not, demonstrated poor lumbo-pelvic stability when assessed with the ASLR test via pressure biofeedback as well as by perceived difficulty during the ASLR test. These results are similar to those reported by Jordaan (2005), but in contrast with other studies that report an association between adult LBP and poor lumbo-pelvic stability (Comerford and Mottram 2001). The ASLR test, as described by O'Sullivan et al (2002), is a measure of lumbo-pelvic stability and measures the control of the deep stabilising muscles, by monitoring the rotation of the pelvis. A poor result indicates decreased stabilisation due to weakness of the local stability muscles. This may result in increased or uncontrolled segmental motion and poor dynamic stability. In the current study the pressure biofeedback apparatus was put under the PSIS's, monitoring the rotation of the pelvis (Jull 1993), and thus the global muscle balance (Jull et al 1993). The deep muscle function was not monitored. Poor lumbo-pelvic stability does not appear to be a dysfunction specific to adolescents with LBP. While this method for measuring lumbo-pelvic stability is used clinically, it has yet to undergo rigourous validity testing. Further studies are required to provide construct validity. In this study, the findings from the pressure biofeedback as described by Jull et al (1993) were similar to that of the perceived difficulty as described by Mens et al (2001), providing an element of concurrent validity.

No previous studies, in adults or adolescents, have been found to compare the results of this study in which lumbo-pelvic stability and trunk muscle endurance have been investigated. In both these the integrity of the global muscles stabilising system was assessed. The results of this study indicate that those adolescents with a good control during the ASLR had better muscle endurance for all the trunk muscles and those adolescents with poor control during the ASLR had decreased muscle endurance with lower mean scores. This was only statistically significant for extensor muscle endurance.

CONCLUSION

Lumbo-pelvic stability, as measured with rotation of the pelvis in the ASLR test and perceived difficulty of the ASLR test, showed no association with adolescent LBP. Trunk muscle endurance showed a stronger association. Adolescents with LBP presented with increased trunk flexor muscle endurance and decreased trunk extensor muscle endurance. Those adolescents with better lumbo-pelvic global stability had better trunk muscle endurance results. This was only statistically significant for extensor trunk muscle endurance (p=0.031).

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