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Original research

Dynamic balance as measured by the Y-Balance Test is reduced in individuals with low back pain: A cross-sectional comparative study

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ABSTRACT

Objectives: To determine the effects of current LBP (cLBP) and LBP history (hxLBP) on Y-Balance Test (YBT) reach and establish relationships between YBT performance and demographic, behavioral, and disability measures.
Design: Cross-sectional comparative study.
Setting: Research laboratory.
Participants: Forty-two participants (24 males, 18 females) aged 18–50 years (30.9 ± 8.2 yr) in three groups: cLBP, hxLBP, and healthy controls.
Interventions: Three YBT trials in anterior (ANT), posterolateral (PL), and posteromedial (PM) directions.
Main outcome measures: YBT reach (relative to leg length) was measured and compared amongst groups. Pearson correlations were calculated between reach distances and pain, disability, and fear avoidance scores in the cLBP and hxLBP groups and age and activity level in all participants.
Results: For PL reach, cLBP (94.7 ± 10.6 cm) and hxLBP (94.2 ± 9.2 cm) groups demonstrated shorter distances versus controls (105.8 ± 6.6 cm). For PM reach, cLBP (100.7 ± 8.4 cm) and hxLBP (102.3 ± 7.6 cm) groups' distances were shorter versus controls (109.3 ± 6.7 cm). No significant difference was found for ANT reach (control = 66.4 ± 7.0 cm; cLBP = 66.2 ± 6.2 cm; hxLBP = 66.4 ± 3.1 cm). No significant correlations were identified.
Conclusion: YBT performance is reduced in individuals with cLBP and hxLBP in the PL and PM directions but not ANT. The YBT is useful for measuring balance deficits in these populations.

1. Introduction

Low back pain (LBP) is an almost universal experience, with 75–90% of the population affected at some point in their lifetime (Andersson, 1999). While some individuals experience LBP only once, it is often recurrent. Recurrent LBP is defined as a return of LBP with unilateral or bilateral symptoms between T12 and the mid-thigh that lasts at least 24 h with a pain intensity greater than 2 cm on a 10 cm visual analog scale (VAS) following a period of at least 30 pain-free days (Stanton, Latimer, Maher, & Hancock, 2011). Once a person has recovered from a LBP episode, he or she has a greater risk of future LBP. Approximately 50% of people have a recurrence in one year, 60% in two years and 70% in five years (Hestbaek, Leboeuf-Yde, & Manniche, 2003).

In addition to an increased risk of further LBP, people who experience LBP episodes develop postural control deficits. Postural control is the ability to maintain or return the body to a state of equilibrium or balance (Cavanaugh, Guskiewicz, & Stergiou, 2005). Compared with healthy controls, people with LBP demonstrate increased postural sway (Ruhe, Fejer, & Walker, 2011) and greater difficulty adapting to changing conditions (Mientjes & Frank, 1999). Moreover, once they lose their balance, these individuals have more difficulty recovering it (Brumagne, Cordo, & Verschueren, 2004). These deficits begin appearing within the first three months (Sung, Abraham, Plastaras, & Silfies, 2015) and can remain even after a person's LBP has resolved (Bouche, Stevens, Cambier, Caemaert, &

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Danneels, 2005; van Dieën, Koppes, & Twisk, 2010), which may contribute to the individual's increased low back re-injury risk.

Current methods used to measure balance are generally expensive and difficult to execute. Force plate instruments provide quantified balance assessment by measuring ground reaction forces, but such technology is typically expensive, the data can be complex to interpret, and the hardware can require large amounts of space. These distinctions make using such technology impractical in most clinical settings. Additionally, this technology utilizes static tests that measure center of pressure displacement to quantify balance. These tests are unable to measure the body's ability to maintain balance while performing a functional movement (Bressel, Yonker, Kras, & Heath, 2007; Sell, 2012). Thus, we need simple and inexpensive means to measure dynamic balance for clinical use.

The Star Excursion Balance Test (SEBT), which was developed by Gray (1995), is commonly used to measure dynamic balance. This test is preferred for its simplistic set up and execution, where the subject stands at the intersection of 8 tape strips successively placed on the floor at 45° angles. The subject performs a maximum reach in each of eight directions with the opposite leg: anterolateral, anterior (ANT), anteromedial, medial, posteromedial (PM), posterior, posterolateral (PL), and lateral. This way, the subject's balance is challenged in multiple predetermined directions. Because this test involves maintaining the center of mass over the base of support rather than displacing center of pressure, it evaluates a different component of balance than force plate instruments (Glave, Didier, Weatherwax, Browning, & Fiaud, 2016).

The SEBT has been used to detect balance deficits in lower extremity injuries, such as chronic ankle instability, patellofemoral pain syndrome, and anterior cruciate ligament injury (Gribble, Hertel, & Plisky, 2012). Ganesh, Chhabra, and Mrityunjay (2015) found that individuals with chronic LBP (i.e., greater than 6 months duration) demonstrated decreased reach distances in all directions except posterior. However, the study did not objectify the pain, disability, or activity levels of the LBP participants. Moreover, while age was considered, other potentially important factors such as activity level were not controlled.

A potential limitation of the SEBT is the extended amount of time for its administration, which could produce subject fatigue and decreased motivation (Hertel, Braham, Hale, & Olmsted-Kramer, 2006). In order to enhance testing efficiency and participant motivation, as well as reduce required testing time and the potential fatigue affect, Hertel et al. (2006) identified redundancy among the eight directions and recommended reducing the test direction number. In response, Plisky, Gorman, Butler, Kiesel, Underwood, and Elkins (2009) adapted the SEBT to incorporate only the ANT, PM, and PL testing directions, resulting in the commercially identified Y-Balance Test (YBT) Kit. These directions were chosen because the sum of the reach distances in the three YBT directions were able to predict lower extremity injury risk in high school basketball players (Plisky, Rauh, Kaminski, & Underwood, 2006). Other studies (Coughlan, Fullam, Delahunt, Gissane, & Caulfield, 2012; Fullam, Caulfield, Coughlan, & Delahunt, 2014) found that PL and PM reach distances were similar during the YBT using the Kit versus the SEBT testing on the floor. However, the ANT reach distance was smaller using the YBT Kit. This difference was attributed to greater hip flexion during the YBT (Fullam et al., 2014). Moreover, the YBT demonstrates good to excellent intra-rater (.85–.91) and inter-rater (.99–1.00) reliability (Plisky et al., 2009).

While the SEBT is able to detect dynamic balance deficits in a chronic LBP population (Ganesh et al., 2015), it is not known whether pain or activity levels influence test outcomes. Additionally, the relationships between test outcomes and fear-avoidance beliefs or disability are unknown. Finally, this test's ability to detect dynamic balance deficits in people with a LBP history who are currently pain-free (hxLBP) is undetermined. This information may help clinicians better understand the role of diminished balance in LBP pathology and provide a simple test to detect these changes and monitor treatment progression in these individuals. The purpose of this study was to examine whether there are differences in YBT scores among participants with current LBP (cLBP), hxLBP, and no history of LBP (control). An additional purpose was to investigate the relationship among YBT scores and activity level and age in all three groups and YBT scores and pain, disability, as well as fear of movement measurements for the cLBP and hxLBP groups.

2. Methods

2.1. Study design and setting

A one factor between-subjects design was used to examine differences in YBT scores among three groups: cLBP, hxLBP, and control. The study was completed in a university research laboratory.

2.2. Participants

Each group consisted of 8 males and 6 females. The hxLBP group included participants with a history of one or more recurrent LBP episodes over the previous 18 months. These participants experienced one or more of the following: (a) a severity requiring medical or allied health intervention; and/or (b) a severity impairing the subject's ability to perform normal activities of daily living. At the time of testing, participants were in a period of remission from their LBP symptoms (Macdonald, Moseley, & Hodges, 2010). Criteria for inclusion in the cLBP group were defined by the same parameters as those described for the hxLBP group, except cLBP participants were required to report that such a profile was accompanied by present pain that was ≥2/10 cm on a VAS or an average of ≥3/10 cm over the past week, versus a lack of present symptoms required of the hxLBP group. Moreover, these cLBP participants were excluded if they experience radicular low back or leg pain or neurological signs. Participants in the control group were free of LBP in the previous two years. Exclusion criteria for all groups were: (a) history of hip, knee, or ankle pain in the previous two years; (b) history of lower extremity or lumbar spine surgery; (c) pregnancy by self-report; (d) rheumatologic or neurological

Table 1
Demographic data (mean ± SD).

Group	Current LBP	History LBP	Control	*P*
Age (years)	30.4 ± 9.6	32.1 ± 8.3	30.2 ± 7.3	.802[a]
Height (cm)	173.1 ± 8.1	175.9 ± 9.9	174.0 ± 10.6	.739[a]
BPAQ (scale 0–15)	7.8 ± 1.3	7.7 ± 1.4	8.1 ± 1.3	.702[a]
Current pain (cm)	3.0 ± 1.4	NA	NA	
Average pain (cm)	4.0 ± 1.2	NA	NA	
Pain medication usage (%)				
None	21.4	85.7	NA	
Occasional (Few times a month)	64.3	14.3	NA	
Frequent (Few times a week)	14.3	.0	NA	
RMDQ (scale 0–24)	5.6 ± 3.9	1.2 ± 1.4	NA	.001[b]
FABQ (scale 0–66)	20.8 ± 8.6	14.9 ± 10.7	NA	.208[b]

LBP = low back pain; BPAQ = Baecke Physical Activity Questionnaire; RMDQ = Roland Morris Disability Questionnaire; FABQ = Fear Avoidance Beliefs Questionnaire.
[a] =1 × 3 ANOVA.
[b] =independent t-test.