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Immediate effects of Pilates based therapeutic exercise on postural control of young individuals with non-specific low back pain: A randomized controlled trial

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ABSTRACT

Objectives: Low back pain affects the person's ability to keep balance, especially in challenging conditions. The purpose of this study was to determine the immediate effects of Pilates exercises on postural sway and dynamic balance of young individuals with non-specific low back pain.
Design: Controlled laboratory design.
Settings and main outcome measures: Forty-six participants with non-specific low back pain were randomized to a Pilates (n = 23, 10 males; age: 21.8 ± 3.2 years) and a control group (n = 23, 9 males; age: 22.8 ± 3.6 years). Postural sway was assessed with a force platform and dynamic balance with the Star Excursion Balance Test, before and after the intervention or rest period. To assess postural sway, participants stood still on an unstable surface set on the force plate for 90s, with eyes closed.
Intervention: The intervention lasted 20 min and consisted on four Pilates exercises: single leg stretch (level 1), pelvic press (level 1), swimming (level 1) and kneeling opposite arm and leg reach.
Results: At baseline, no differences were found between groups. The Pilates group improved in all the postural sway values (area of CoP: 11.5 ± 3.4 to 9.7 ± 2.7 cm^2, $p = 0.002$ and CoP velocity: 2.8 ± 0.6 to 2.3 ± 0.5 cm/s, $p < 0.001$) and in the Star Excursion Balance Test. Control group only improved in CoP velocity, however, this improvement was significantly inferior compared to the Pilates group.
Conclusions: Pilates exercises immediately improved postural sway and dynamic balance in young adults with non-specific low back pain.

1. Introduction

Non-specific low back pain (NSLBP) is one of the most common health problems and is the leading cause of disability in young adults.[1] During school age, the overall risk of low back pain is similar to adults, with prevalence rates as high as 70% to 80% by the age of 20 years old.[2] Despite these high prevalence rates, NSLBP in young adults is poorly understood because most the NSLBP research has focused on the working aged population. Although the causes and consequences of NSLBP are still under discussion, changes in movement patterns and spine stability deficits seem to be important factors.[3,4] Additionally, several studies have demonstrated that the deep muscles of the trunk, especially the multifidus and transversus abdominis, present late activation, weakness, and diminished resistance during episodes of low back pain.[3,5] Dysfunction of the gluteus maximus and changes of the hip extensor recruitment pattern have also been reported in low back pain conditions.[6] Together, these changes seem to predispose to instability and reduced postural control. Indeed, in comparison to healthy individuals, those with NSLBP showed increased center of pressure (CoP) displacement and velocity, especially with eyes closed and on unstable surfaces.[7–9] Several studies have described possible underlying mechanisms that may result in changes in postural control; however, no specific conclusions were reported. Body balance can be altered by reduced afferent feedback, inadequate motor control or insufficiencies in the strength and mechanical instability of the back, hip, knee, and ankle.[10,11] The selection of postural control strategies is predetermined in patients with HSLBP because of long-term neuromuscular adaptations.[10] Body-stiffening strategy is one of the most commonly used postural strategies in patients with NSLBP in anticipation of any pain.[12] These patients tend to use the ankles more, with an increased feed-

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forward preparation of ankle stiffness and use fewer hip and back strategies for destabilizing perturbations aimed to achieve balance recovery.[8,11] Interestingly, younger adults tend to be more affected by NSLBP than older adults.[13] These postural control deficits begin appearing within the first three months of the onset of low back pain[14] and can remain even after a person's NSLBP has resolved,[15] which may contribute to the individual's increased low back re-injury risk.

Therapeutic exercise interventions, such as Pilates exercises, that address the underlying motor control impairments responsible for these altered movement patterns and reduced postural control seem to contribute to the reduction of the probability, duration, and/or severity of recurrent episodes of pain.[16,17]

Pilates is a mind-body exercise approach that can be considered a complementary and Alternative Medicine therapy.[17] It focuses on improving static and dynamic stability, strength, core stability, flexibility, muscle control, posture, and breathing.[17,18] Per opposition to other forms of exercise, such as hydrotherapy and walking programmes, Pilates aims to improve coordination and control of the core muscles of the trunk muscles, which contribute to the optimal lumbar-pelvic stabilization needed for the balance requirements of daily activities and function.[19,20]

A recent quality evaluation and summary of systematic reviews based on randomized controlled trials showed that five systematic reviews for chronic low back pain concluded that there was pain-relief and functional improvement of the intervention in the short term, but two systematic reviews were inconclusive about the effectiveness of Pilates exercise.[21] There was also evidence of improved flexibility and dynamic balance, and of enhanced muscular endurance in healthy people in the short term[21] and improved balance and reduced number of falls in older adults.[20] Despite some controversy about the effectiveness of Pilates exercise, it has been increasingly indicated for NSLBP due to their focus on the activation of the deep stabilizer muscles.[22] These exercises seem to assist in the reactivation of these muscles, hence improving support to the lumbar spine, reducing pain and disability,[22,23] and improving postural control.[24–26]

Previous studies reported an improvement in static postural control with a Pilates based intervention of 6, 8 or 14 weeks.[24,25,27] However, to our best knowledge, no study has been conducted evaluating the immediate effects of Pilates exercise on the postural control of individuals with NSLBP. It is important to know whether the immediate effects of an exercise session are a decrease or increase in postural control, as an acute decrease in balance could be an issue since individuals with NSLBP have already lower postural control compared to individuals without NSLBP.[28] Additionally, although younger adults tend to be more affected by NSLBP than older adults,[13] few studies have been conducted so far in this age group, despite the high prevalence rates of low back pain. Thus, the aim of this study was to evaluate the immediate effects of Pilates based therapeutic exercises session on postural sway, dynamic balance and pain in young adults with NSLBP. We hypothesise that a single session acutely increases postural control and dynamic balance and decreases pain.

2. Methods

2.1. Participants

The present study was a single blind randomized controlled trial. All participants signed an informed consent form before the beginning of the study, which was approved by the Ethics Committee of the Faculty of Sport of the University of Porto, Portugal (reference CEFADE 20.2014) and conducted in accordance with the Declaration of Helsinki, good clinical practices, and applicable laws and regulations.

Fifty-two young university students with NSLBP (31 females and 21 males) volunteered to participate in this study. Inclusion criteria were: 18 years of age and older, history of non-specific low back pain lasting at least 12 weeks.[29] Exclusion criteria: history of vestibular disorders, neurological, respiratory disease or spine surgery; structural spinal problems; medication or condition affecting balance; and regular practice of Pilates or any specific exercise program in the last 6 months.

Recruitment occurred through verbal advertisement, research posts and email. Participants were not paid for participation. After the initial screening, 6 participants were excluded by not complying with the study criteria. The 46 participants were randomly divided into two groups (block randomization, 1:1): Pilates group (n = 23, 13 females and 10 males) or control group (n = 23, 14 females and 9 males). Allocation concealment was achieved by using numbered sheets (1-corresponding to the Pilates group; 2–control group), inside sealed, opaque envelopes picked up by the participants before baseline data collection. The outcomes assessors were blinded to group allocation.

Power calculation was previously computed using the software G*Power version 3.1. This computation was based on data from a pilot study enrolling 10 participants with the same inclusion/exclusion criteria in which the effect size in the total CoP displacement was 0.8. Then, based on a beta error of 20% (power = 0.80), an alpha error of 5%, an allocation ratio of 1:1, a total sample size of 42 participants was required. A target of 46 participants was identified to accommodate a potential dropout rate of 10%.

2.2. Measurements

2.2.1. Body composition, physical activity, pain and disability

At baseline, body composition, physical activity and disability were assessed. Height and weight measurements were attained using a scale and stadiometer (Seca 285, Seca, Birmingham, United Kingdom). Body mass index was calculated from the ratio of weight (kg) to squared height (m^2). Daily physical activity was assessed with the short-form of the International Physical Activity Questionnaire. The Oswestry Disability Index version 2 (ODI V2.0) was used to quantify disability for low back pain.

Pain intensity was assessed at baseline and immediately after the session using the visual analogue scale (VAS, 0–10 cm). Regarding pain, a 30% change in VAS from baseline to after the session may be considered a clinically meaningful improvement when assessing pain in individual with low back pain.[30,31]

2.2.2. Postural control

The participants reported to the laboratory once and were assessed before and after performing a Pilates exercise session lasting 20 min or a 20-min control period.

The postural control was evaluated using a dynamic postural-control task, the Star Excursion Balance Test (SEBT), and the assessment of postural sway using a force platform. The order of the assessments (postural sway/SEBT or SEBT/postural sway) was randomized for each participant. Both assessments were performed with bare feet.

The SEBT is a simple, reliable and valid method of dynamic performance.[32] This test has proved to detect measure reach deficits in individuals with chronic low back pain.[33] First, SEBT was demonstrated and participants practiced (6 trials). The participants stood on the non-dominant leg in the centre of a grid, with the extremity of the heel at the starting line, as a guide for maintaining foot position. While maintaining single-leg stance, the participant was asked to reach with the free limb in the anterior, posteromedial, and posterolateral directions in relation to the bearing foot. The trial was discarded and repeated if the participant failed to maintain unilateral stance, lifted or moved the bearing foot, touched down with the reaching foot, or failed to return the reaching foot to the starting position.[32] Each participant performed 3 assessment trials. The value taken for analysis was the greatest trial for each reach direction. The overall performance of the test was obtained by summing the greatest reach distance from each direction to obtain the composite reach distance. Since the heel was aligned with middle of the grid, the foot length was subtracted in the anterior reach distance. In this way, the foot position did not need to be