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Original Article

The effect of a pilates exercise programme using fitball on people suffering from chronic low-back pain in terms of pain reduction and function imrovement

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Abstract
The aim of the present study is to examine the effect of a Pilates exercise program using Fitball on people with chronic low-back pain, in terms of pain reduction and function improvement. The study involved 28 patients, aged 20-60 years, with chronic low-back pain (continuous or at least 2 occurrences in the last 2 years), divided into 2 equal groups, an exercise group and a control group. The intervention group followed a Pilates exercise programme with Fitball for 6 weeks. The measurements for the assessment of pain and function were performed based on the visual analogue pain scale Roland Morris (Roland & Morris, 1982), the Oswestry Low-Back Pain Disability Questionnaire (OSWDQ), the Emotions Scale (EMS) questionnaire, the stork stand test, as well as the sit & reach test. The results from the variations of the two factors (Group x Time Period), with the second factor being repeated (Two-way repeated measures Anova, 2X2), regarding the measurements under examination showed some statistically significant effects deriving from the interaction of the two factors (Group x Time Period) for all measurements. For the results' analysis, a significance level of $\alpha=0.05$ was set. More specifically, all variants were examined separately in each group based on Mauchly's Test of Sphericity and Shapiro-Wilk test for the verification of sphericity and normality cases, respectively. Improvement was seen among the intervention group in reducing pain, improving function, mood, balance and flexibility. The control group showed no significant differences regarding these parameters. These results suggest that the Pilates method can reduce pain and improve function for people with chronic low-back pain, in comparison to no intervention.
Key words: exercise therapy, neuromuscular retraining, rehabilitation

Introduction

Low-back pain is one of the most common and widely studied musculoskeletal problems in the Western world and the leading cause of disability and absence from work among adult people up to 45 years old in industrialised societies (Fonseca, Magini & Freitas, 2009; Rydeard, Leger & Smith, 2006). It has been estimated that 11% to 84% of adults will have an occurrence of low-back pain at least once in their lifetime and about 40% of these patients will develop chronic low-back pain (Walker, 2000). People who will develop chronic low-back pain (7-10%), correspond to a percentage as high as 75-90% of the health cost regarding low-back pain (Twomey & Taylor, 1995).

Chronic low-back pain is a complex phenomenon which can be influenced by many factors, divided into two categories, physical and psychosocial (Manchikanti, 2000). Physical factors associated with low-back pain include muscle weakness and imbalances, repetitive movement disorders, deficient activation of the deep abdominal muscles, poor control of the trunk stabilizer muscles' function and neuromuscular dysfunction (Hodges & Richarson, 1996; O'Sullivan, Twomey & Allison, 1997). Psychosocial factors have been found to play a significant role in chronic low-back pain. Psychological aspects of low-back pain include depression, fear of moving, treatment expectations, self-perception, lack of control and other personal factors (Feuerstein & Beattie, 1995; Lackner & Carosella, 1999,).

Current documentation shows that some of the best outcome indicators regarding chronic low-back pain are of psychosocial nature. The perceived loss of control due to pain, the expected reduced performance and the fear of re-injury are thought to reduce functionality. The fear of re-injury and kinesiophobia are both considered to be accurate predictors of the functional outcome regarding low-back pain (Woby, Watson, Roach & Urmston, 2004). This verifies that inability associated with low-back pain has more to do with the perceived loss of control than the pathological situation itself (Porterfield & Rosa, 1991).

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There is a wide range of options for the treatment of low-back pain. These interventions can be categorized as either active or passive, as they are related to physical and psychological factors.
An active intervention is the Pilates method initially practiced almost exclusively by athletes and dancers. However, it recently became popular in the fields of rehabilitation and exercise. Pilates exercises focus on the spine extensors and abdominal muscles, in particular the transverse abdominal muscle, and aim at strengthening the core. The aim of strengthening the core without tension in the peripheral joints is achieved through coordinated breathing and movement, stabilization of the shoulder girdle, thorax and pelvis during movement of the abdominal muscles and correct positioning of the head and neck to avoid neck strain.
Pilates instructors provide physical assistance and verbal feedback to maximize accuracy in performance and safety during exercise. The evolution of the exercises on the ground initially uses a wide support base of the trunk in the prone, lateral and supine position, while moving the ends to differentiate torque trunk muscles. As the individual develops enhanced strength and mobility, support is gradually reduced to retrain proprioceptive mechanisms, while enhancing more efficient movement patterns. This process is similar in principle to the dynamic stabilization exercises that are widely used in the treatment and prevention of low-back pain that supports the effectiveness of deep stabilizers, as well as in the reduction of muscle contraction which is counterproductive to functionality (Anderson, 2000). The proprioception is the link between the musculoskeletal and nervous system and essential for the stability of the spine. It has been shown that inhibition of deep proprioception due to pain or habit can lead people to develop compensatory motor patterns, which prolong the recovery process due to inefficient biomechanics after injury (Anderson, 2000). Additionally, the Pilates method involves closed kinetic chain exercises, which can provide the necessary compressive and decompressive forces to help regenerating the articular cartilage and reducing the degenerative risk. Thus, this method does play a role in the attenuation of predisposing factors for chronic musculoskeletal pain induced by middle vertebral instability (Segal, Hein & Basford, 2004). Purpose of this study is to examine the effect of a Pilates exercise program with Fitball on people with chronic low-back pain. In particular, the impact of Pilates on pain intensity, as well as improved functionality and mood of people with chronic low-back pain.

Material & Methods

Sample

The results were collected by 28 patients aged 20-60 years with chronic low-back pain (continuous or at least 2 episodes in the last two years). Patients were divided into 2 groups of equal number: Experimental Group (N=14) and Control Group (N=14). The evaluation of the groups was performed using the visual analogue scale Oswestry Disability Index, Roland-Morris Disability Questionnaire, Emotions Scale, as well as stork stand tests and sit & reach tests before the programme starts and after the programme's completion.

Limitations and Study Mark-Out

Patients aged 20-60 years were chosen for the initial selection of the sample. All of them suffered from chronic low-back pain (continuous for at least 6 weeks or recurring pain with at least two episodes in the last year). Individuals with low-back pain due to tumor, infection, fracture, osteoporosis, structural deformation, acute compression of nerve roots, as well as individuals suffering from comorbidities, such as clinical indications of serious illness, significant weakness of legs, pregnancy, recent abdominal surgery, neuromuscular degenerative disorders and concomitant health problems that prevent the exercise were excluded from the sample. Patients should not have been subjected to surgery on the spine, while they should also be able to move independently and perform physical activity. The programme duration was 6 weeks and the frequency was set to 3 times a week for 30 minutes. The participants were selected from patient populations of local hospitals, private clinics and private exercise areas. The doctors were given study inclusion and exclusion criteria in order to control potential participants and provided with brochures containing contact information for the study which should have been given to selected patients. Doctors were encouraged to include patients who had completed a standard course of treatment, but still suffered from symptoms of low-back pain.

Process

Intervention

The experimental group practicing Pilates attended a total of twelve lessons lasting one hour for six weeks, divided in two lessons per week. The exercise classes consisted of 7 people and the exercise programme was performed by a certified Pilates instructor.

Statistical Analysis

The statistical analysis of the questionnaires was performed using the Statistical Package for the Social Sciences, version 20.0. Additionally, following the initial study hypotheses, we proceeded to check the equality of the mean values of numerical variables for each group separately before and after the experiment (dependent samples means test), as well as for the two groups together for every specific time (independent samples means test) to verify the existence of potential differences when implementing the intervention, and between the two groups as well. The parametric t-test is used for these tests, with a significance level of $p < 0.05$, provided that the appropriate conditions occur.

a) The individuals to be studied should be independent (Paired-samples t-test was used in the event of depended individuals),

b) No sample should present extreme observations,

c) Each population should follow normal distribution and

d) Equal population variations.

Test of Welch was used in cases where the latter condition is not met, whereas in cases where the second and/or third conditions had not been met, corrective attempts with appropriate transformation were performed (eg Box-Cox, log, root and others). If the problem had still not been settled, then the initially desired control was implemented using non-parametric statistical tests (Mann-Whitney or Wilcoxon for dependent samples).

Validity and Reliability

The statistical test for the reliability of the three questionnaires was conducted by calculating the reliability coefficient Cronbach's Alpha. The values resulted from all questionnaires (EMS(Negative), EMS(Positive), ODI and RDQ) were (0,829, 0,862, 0,930 and 0,965) and (0,945, 0,948, 0,949 and 0,968) before and after intervention, respectively. Therefore, the hypothesis of reliability cannot be rejected for any of them.

Results

Table 2. Results from the variance analysis of the two factors (Group on specific time) with the second factor being repeated (Two-way repeated measures Anova, 2X2) for the set of the sample variables.

	Independence points (df)	**Statistical value (F)**	**Crucial Value p value**
ODI			
Group	1	22.454	<0.001*
Specific time	1	7.463	<0.011*
Group x Specific time	1	8.996	<0.006*
RDQ			
Group	1	1.063	<0.312
Specific time	1	23.309	<0.001*
Group x Specific time	1	59.832	<0.001*
EMS (Negative)			
Group	1	17.413	<0.001*
Specific time	1	7.089	<0.013*
Group x Specific time	1	43.712	<0.001*
EMS (Positive)			
Group	1	22.623	<0.001*
Specific time	1	18.984	<0.001*
Group x Specific time	1	41.507	<0.001*
Stork Stand (sec)			
Group	1	3.043	<0.093
Specific time	1	55.131	<0.001*
Group x Specific time	1	48.505	<0.001*
Sit and Reach(cm)			
Group	1	32.583	<0.001*
Specific time	1	332.874	<0.001*
Group x Specific time	1	234.550	<0.001*

Table 3. Statistical measures (mean and standard deviation) of initial-final measurement for each group separately regarding the overall measurements.

	Before intervention	After intervention
ODI		
Intervention Group (n=14)	2.46±1.04	1.39±0.27
Control Group (n=14)	3.11±1.09	3.16±0.65
RDQ		
Intervention Group (n=14)	3.55±1.14	1.57±0.42
Control Group (n=14)	2.59±0.86	3.05±0.52
EMS (Negative)		
Intervention Group (n=14)	2.41±0.54	1.45±0.37
Control Group (n=14)	2.45±0.74	2.86±0.4
EMS (Positive)		
Intervention Group (n=14)	2.25±0.78	3.87±0.5
Control Group (n=14)	2.41±0.71	2.1±0.27
Stork Stand(cm)		
Intervention Group (n=14)	24.14±8.05	42.00±12.80
Control Group (n=14)	38.00±5.14	38.57±6.19
Sit and Reach (cm)		
Intervention Group (n=14)	28.07±4.03	37.07±4.07
Control Group (n=14)	23.29±4.05	24.07±4.57

Owestry Disability Index

Regarding the ODI measurement, the variance analysis of the two factors (Group on specific time) with the second factor being repeated (Two-way repeated measures Anova, 2X2) showed a statistically significant interaction between the two factors [$F_{(1,26)}$=8.996, p=0.006]. The improvement of the intervention group after the program was rapid, in comparison to the control group which remained stable. More specifically, the intervention group showed a significant difference before and after the intervention with a percentage variation -43%, while the control group did not show any significant change.

Roland Morris Disability Questionairre

Regarding the RDQ measurement, the variance analysis of the two factors (Group on specific time) with the second factor being repeated (Two-way repeated measures Anova, 2X2) showed that the statistically significant interaction between the two factors cannot be rejected [F(1,26)=59.832, p<0.001]. The intervention group showed greater initial measurements compared to the control group, however, after the programme's implementation the values started to decline remarkably, whereas the values for the control group were increased, intensifying the problem. More specifically, both groups showed a significant difference before and after the intervention with rates of change between -56% and 18% for the intervention and control group, respectively.

EMS (Negative)

Regarding the Ems (Negative) measurement, the variance analysis of the two factors (Group on specific time) with the second factor being repeated (Two-way repeated measures Anova, 2X2) showed a statistically significant interaction between the two factors [$F_{(1,26)}$=43.712, p<0.001]. Improvement of the intervention group after the program was quite high, compared to the control group whose problem was intensified. More specifically, both groups showed significant difference before and after the intervention with rates of change between -40% and 17% for the intervention and control group, respectively.

EMS (Positive)

Regarding the Ems (Positive) measurement, the variance analysis of the two factors (Group on specific time) with the second factor being repeated (Two-way repeated measures Anova, 2X2) showed a statistically significant interaction between the two factors [$F_{(1,26)}$=41.507, p<0.001]. Improvement of the intervention group after the program was rapid, unlike the control group whose problem was intensified. More, specifically, the intervention group showed a significant difference before and after the intervention with a percentage change of 72%, while the control group showed no significant change.

Stork Stand test

Regarding the Stork Stand measurement, the variance analysis of the two factors (Group on specific time) with the second factor being repeated (Two-way repeated measures Anova, 2X2) showed that the statistically significant interaction between the two factors cannot be rejected [$F_{(1,26)}$=48.505, p<0.001]. Although the intervention group showed initially smaller measurements than the control group, after the programme implementation its values were remarkably improved, whereas the control group remained stagnant. More, specifically, the intervention group showed a significant difference before and after the intervention with a percentage change of 74%, while the control group showed no significant change.

Sit and Reach test

Regarding the Sit and Reach measurement, the variance analysis of the two factors (Group on specific time) with the second factor being repeated (Two-way repeated measures Anova, 2X2) showed a statistically significant interaction between the two factors [$F_{(1,26)}$=234.55, $p<0.001$]. Although the intervention group initially showed higher values, its improvement after intervention was significantly higher than the one of the control group. More specifically, both groups showed significant difference before and after the intervention with rates of change 32% and 3% for the intervention and control group, respectively.

Discusion

The results of this survey show that a Pilates exercise program using Fitball can help reduce pain for individuals with chronic low back pain compared to those who received no intervention. Moreover, Pilates exercises using Fitball can improve functionality, mood, balance and flexibility in people with chronic low-back pain.

In this survey, the intervention group showed a rapid reduction of pain symptoms compared to the control group which remained stable. These results comply with the findings of Rydeard et al. (2006). These researchers suggest that a therapy based on Pilates exercises focused on the activation of neuromuscular mechanisms, was effective in treating a group of individuals with chronic low-back pain. An intervention of 4 weeks was more effective than standard treatment in reducing pain intensity and functional disability levels. These changes were maintained over 12 months.

Similar results were shown by MacIntyre, (2006) who focused on stabilizing the lumbar spine with Pilates exercises. In this study, the intervention group followed a 12-week Pilates programme, whereas the control group followed a physical therapy programme. The evaluation was initially performed for 3 to 12 weeks using the Visual Analog Scale for pain and Roland Morris Disability Questionnaire, the results of which were compared. Researchers observed significantly greater improvements in pain and functional disability in the Pilates group compared to the control group, suggesting that it may be an effective treatment for people suffering from chronic low-back pain. Additionally, Foncseca et al. (2009), conducted a survey for the pain impact on the vertical ground reaction force, VGRF, for patients with low-back pain and the effect of Pilates on the patients' gait. Results indicate that patients with low-back pain use strategies to reduce the amount of pressure imposed on their body. Pilates can improve the discharge of weight in gait and reduce pain compared to no intervention (van Tulder, Malmivaara & Esmail, 2000). Similarly, O Brien et al. (2006) conducted research to compare the effectiveness of Pilates and physiotherapy on the reduction of pain and the improvement of efficacy for patients suffering from chronic low-back pain. The intervention lasted for 8 sessions with a frequency of 2 times a week. The Pilates session lasted for one hour, involving ground exercises, while equipment and physiotherapy session lasted 30 minutes. Results showed that the two methods were equally effective for the treatment of pain and improvement of functionality. Similar results to improve the functionality were mentioned by Gladwell et al. (2006) who conducted research among individuals with chronic low-back pain. The intervention lasted for 6 weeks and the functional assessment was performed using the Owestry Disability Index questionnaire. The Pilates method was used as a special stabilizing exercise of the trunk, in combination to functionally active methods, while there was a significant improvement in the control group as well. The researchers reported that the Pilates method used in this study is likely to be beneficial for low-back pain, as it uses functional exercise for the strengthening and endurance of the core muscles, as well as improve motor control of the trunk and limbs. At the same time, it is also mentioned that Pilates is a kind of exercise that covers biological, psychological and educational aspects, including treatment strategies, which are important factors in the alleviation of low-back pain. In this study, the intervention group made a significant difference in improving suppleness after exercising with Pilates. Similar results were observed by Araujo et al. (2012) in a study conducted over female college students with scoliosis, who attended Pilates sessions. Also, Segal et al. (2004) used Pilates for healthy individuals. The sessions lasted for 6 months and were performed once a week with a significant improvement in values. In this study, individuals who attended Pilates sessions showed greater ability to maintain balance, in comparison to those of the control group, also presenting greater proprioceptive ability. Similarly, Gladwell et al. (2006) reported that exercising with Pilates improves postural balance in individuals with chronic low-back pain. In addition, positive effects on dynamic balance in healthy individuals after 10 Pilates sessions were observed by Johnson et. al. (2006), claiming that the method is a useful tool for clinicians and instructors planning to apply this to patients and customers who want to improve their dynamic balance.

The Pilates method improves proprioceptive stimulation which is necessary for the improvement of kinetic exercises using the muscles of the core body (abdominal transverse, oblique abdominal and multifunctional), and through repetition of correct movements for the achievement of the kinetic model leads to better kinetics performance and less chance of injury (Anderson et al., 2000).

The results of this study regarding the assessment of the responses of patients with chronic low-back pain in conditions of positive and negative emotions using the Emotions Scale (EMS) questionnaire, showed significant improvement, after the intervention, for the subjects who participated in the Pilates programme compared to the subjects of the control group. Respectively, positive results were generated from a study conducted regarding the effects of the Pilates method on psychological factors. More specifically, a study conducted by Cruz-Ferreira et al. (2011) among women who participated in a Pilates programme lasting six months, showed significant improvement in life satisfaction, as well as in the three dimensions of physical self-perception, total physical self-perception and the perception of the state of health compared to women in the control group.

A study about the effect of group exercise programmes on college students regarding self-regulation, self-efficacy, mood, anxiety and sleep quality showed that the group participated in a Pilates program presented improvement in all the above parameters. Additionally, improved quality of sleep was caused by four variables: fatigue, negative mood, relaxation and perception of stress. The authors reported that they used different vocabulary and gave emphasis on different aspects of consciousness. In the Pilates group, they used a terminology to focus on the core, concentration, control, precision, flow and breath to create awareness, as well as connect mind and body (Caldwell, Harrison, Adams & Greeson, 2010). In conclusion, this study applied an intrusive exercise Pilates programme using Fitball, which improved the functionality and reduced pain for people suffering from chronic low-back pain. This study is important because it gives significant information about the importance of the Pilates method using Fitball in the treatment of chronic low-back pain. Through intervention, patients experience improvement in the areas of everyday life functions, pain alleviation, reaction to psychological factors such as negative and positive emotions, balance and flexibility. Given the results of this study, health professionals can integrate this programme into a comprehensive rehabilitation programme, improving parameters such as strength and trunk stability, proprioception and flexibility, so that they have the best possible development in patients' conditions.

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