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# Comparing the Pilates method with no exercise or lumbar stabilization for pain and functionality in patients with chronic low back pain: systematic review and meta-analysis

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## Abstract

**Objective:** To perform a systematic review with meta-analyses that evaluates the effectiveness of the Pilates method on the pain and functionality outcome in adults with non-specific chronic low back pain.

**Data sources:** The search was performed in the following databases: Medline, Embase, AMED, Cinahl, Lilacs, Scielo, SportDiscus, ProQuest, Web of Science, PEDro, Academic Search Premier and the Cochrane Central Register of Controlled Trials from 1950 to 2011; the following keywords were used: 'Pilates', 'Pilates-based', 'back exercises', 'exercise therapy', 'low back pain', 'back pain' and 'backache.'

**Review methods:** The inclusion criteria were studies that assessed the effects of the Pilates method on patients with chronic low back pain.

**Results:** Five studies met the inclusion criteria. The total number of patients was 71 in the Pilates group and 68 in the control group. Pilates exercise did not improve functionality (standardized mean difference (SMD = –1.34; 95% confidence interval (CI) –2.80, 0.11; $P = 0.07$) or pain between Pilates and control groups (SMD = –1.99; 95% CI –4.35, 0.37; $P = 0.10$). Pilates and lumbar stabilization exercises presented no significant difference in functionality (mean difference (MD) = –0.31; 95% CI –1.02, 0.40; $P = 0.39$) or pain (MD = –0.31; 95% CI –1.02, 0.40; $P = 0.39$).

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**Conclusion:** The Pilates method did not improve functionality and pain in patients who have low back pain when compared with control and lumbar stabilization exercise groups.

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## Introduction

Low back pain represents a significant public health problem and an economic burden to employers.[1] Back pain has become one of the most common problems in industrialized societies; it can affect 80% of the people and has become the most common cause of functional limitation in individuals younger than 45 years.[2] It is the one of the most common and expensive musculoskeletal disorders in Western countries.[3] One study has suggested that the increasing use of physical therapy for patients with low back pain has contributed substantially to an increase in direct health care costs.[4]

By definition, low back pain is pain in the area between the inferior-most aspect of the scapula and gluteal folds, with or without radiation to the lower extremities.[5] A wide variety of therapeutic interventions are available for the treatment of chronic low back pain, ranging from general physical fitness or aerobic exercise to muscle strengthening, as well as various types of flexibility and stretching exercises.[6] The effectiveness of therapeutic exercise in the treatment of chronic low back pain is still debated in systematic reviews and in the adoption of therapy recomendations.[7,8]

In 2000, Van Tulder *et al.*[7] published a review about the effectiveness of exercise therapy on functional status, overall improvement, return to work, and pain intensity in patients with low back pain. Thirty-nine randomized controlled trials were included and the authors evaluated all types of exercise therapy (e.g. specific back exercises as well as abdominal, flexion, extension, static, dynamic, strengthening, stretching or aerobic exercises) and additional physical treatment (e.g. ultrasound or short-wave diathermy) for individuals with acute and chronic non-specific low back pain. The conclusions indicated no evidence to support the effectiveness of exercise for acute low back pain but that exercise may be helpful for chronic back pain.

In 2001, the Philadelphia Panel[9] examined the literature regarding nine rehabilitation programmes for low back pain (thermotherapy, therapeutic massage, therapeutic exercise, electromyographic biofeedback, mechanical traction, ultrasound, transcutaneous electrical nerve stimulation, electrical stimulation and combined rehabilitation interventions) to determine what evidence, if any, supports each of the these approaches. No evidence was observed to support the effectiveness of any of these interventions for patients with chronic low back pain. However, the authors observed evidence that acute non-specific back pain patients should continue their normal activities.

In 2005, another Cochrane review[8] was published that attempted to identify specific characteristics of therapeutic exercise programmes, which decreased pain and improved function in adults with non-specific chronic low back pain. The authors included 43 randomized controlled trials and concluded that exercise therapy, which consisted of individually designed programmes, including supervised stretching or strengthening, may improve pain (5.4 points (95% confidence interval (CI) 1.3, 9.5)) and small improvement in function (5.5 points (95% CI 0.5, 10.5)) in chronic non-specific low back pain.

In 2007, Chou and Huffman[10] published a review with the aim of evaluating the benefits of non-pharmacological therapies for acute and chronic low back pain. The conclusion was that cognitive behavioural therapy, exercise, spinal manipulation and interdisciplinary rehabilitation are therapies with moderate efficacy for either chronic or subacute low back pain. Specifically for acute low back pain, superficial heat was the only therapy with acceptable efficacy.

More recently, in 2011, van Middelkoop *et al.*[11] performed a systematic review to determine the effectiveness of physical therapy and rehabilitation interventions for chronic low back pain. Moderate evidence was found for multidisciplinary treatment to reduce pain intensity and disability in the short term compared with non-treatment/waiting list controls. Exercise therapy compared to the usual care improved post-treatment pain intensity and disability, and long-term functioning. In the short-term, behavioural treatment was found to be effective in reducing pain intensity compared with non-treatment/waiting list controls.

General conditioning programmes to improve the strength and endurance of spinal musculature have been shown to reduce pain intensity ($P = 0.002$) and disability ($P = 0.023$), therefore the programmes seem to be useful in the treatment of non-specific chronic low back pain.[12] Among them, the Pilates method is one increasingly common exercise regimen suggested for patients with low back pain.[13] Based on methods developed by Joseph Pilates (1880–1967), this programme consists of movement routines, facilitated by the use of special equipment, that are designed to enhance flexibility, strength and coordination.[14]

Some systematic reviews have been carried out assessing the effects of the Pilates method on chronic low back pain patients.[15–17] The first was an unpublished dissertation in 2007 in which the authors included four randomized controlled trials and one case series. The conclusion was that there is limited evidence to support the efficacy of Pilates in the management of low back pain when compared to no treatment. The objective of the second systematic review was similar; the authors in 2008 included two randomized controlled trials and one quasi-randomized trial and the results showed positive effects in favour of Pilates. Both reviews, however, were found to have bias (selective report within studies and assessment of risk of bias), and neither performed meta-analyses to demonstrate the magnitude of the effects. The third review was published 2011 with the same topic and meta-analysis. Because of differences in the risk of bias assessment and the inclusion of studies with serious flaws (for instance, quasi-randomized trial, no concealed allocation and without intention-to-treat analysis) the conclusion that Pilates is superior to minimal intervention for pain relief should be interpreted with caution.[17] In order to evaluate more rigorously the effectiveness of the Pilates method on pain and functionality outcomes in adults with non-specific chronic low back pain was carried out this study with meta-analyses.

## Method

The search strategy was formulated by two of the authors, assisted by a specialist librarian. Disagreements were solved by a third person with experience in search strategies. The following databases were used: Medline (1950–December 2011); Embase (1980–December 2011); AMED (Allied and Complementary Medicine) (1985–December 2011); Cinahl (Cumulative Index to Nursing and Allied Health Literature) (1982–December 2011); Lilacs (Latin American and Caribbean Health Science Literature Database) (1982–December 2011); Scielo (Scientific Electronic Library Online) (1998–December 2011); SportDiscus (1975–December 2011); ProQuest (1980–December 2011); Web of Science; PEDro; Academic Search Premier and the Cochrane Controlled Trials Register Library (Issue 02, 2011). The following keywords were used: Pilates, Pilates-based, back exercises, exercise therapy, low back pain, back pain and backache.

After concluding the preliminary search findings, each of the articles was examined for actual relevance to the topic, as well as for further references of interest which were not revealed in the original search. Low back pain experts were also consulted for information about additional trials, which might not have appeared in the databases. The search was not restricted to any specific language.

According to the recommendations proposed by the Cochrane Collaboration Handbook[18] only randomized controlled trials, published or not, that assessed the effects of the Pilates method (mat and apparatus) on patients with chronic low back pain, were included in this review. Clinical trials that were not randomized or quasi-random were excluded. Participants in the included randomized controlled trials were between 18 and 65 years old, and had been treated with the Pilates method for chronic low back pain (persistent pain for at least 12 weeks not attributable to any specific disease) and/or recurrent low back pain (with at least two incidences per year). Low back pain was defined as pain below the scapulas and above the cleft of the buttocks, with or without radiation to the lower extremities.[5] The outcome measures considered were pain and functional status. This systematic review followed the recommendations of the PRISMA statement.[19]

The criteria adopted for assessing the risk of bias followed the recommendations of the Cochrane Back Review Group.[20] These criteria are based on 12 topics, which were created to assess the specific methodological quality of back pain studies (randomization, allocation concealed, groups similar at baseline, patient, care provider and outcome assessor blinded, co-interventions avoided or similar, compliance acceptable in all groups, drop-out rate described, timing of the outcome assessment similar and intention-to-treat analysis, reports of the study free of suggestion of selective outcome reporting). The risk of bias for each of the studies was evaluated by two independent authors and each assigned a score according to the criteria. When there was disagreement between the two a third, experienced reviewer was convened to rule on the decision.

Pertinent information missing from any of the studies, which would have negatively affected its score, was obtained by contacting the lead author of the study. If none of the authors could be contacted or if the information was no longer available, the specific question on the bias risk form was marked 'don't know'.

The descriptive results were presented in tables. Meta-analysis was performed in order to compare pain and functionality outcomes between either a Pilates and a control group or a Pilates and a lumbar stabilization exercise group. The standardized mean difference (SMD) with 95% confidence intervals was calculated because the outcomes were measured using different instruments. For comparison between Pilates and lumbar stabilization exercises, the mean difference (MD) was used because the instruments were identical. For all analysis, a fixed-effects model was used if the results were homogeneous ($P > 0.10$), and a random-effects model was used if heterogeneity was present ($P \leq 0.10$). To examine the sensitivity effect of each study on the overall results, analyses were also performed removing the studies one by one from the model. These analyses were performed using Review Manager 5.1 software.[21] The kappa coefficient was used to assess the agreement among judges for quality of randomized controlled trials (SPSS 15.0; SPSS Inc., Chicago, IL, USA).

## Results

Searches from databases identified 1133 articles. Of these, 51 full texts were retrieved. Six randomized controlled trials were ultimately included for the review. A diagram of the search strategy is presented in Figure 1. For one study (O'Brien *et al.*)[22] the citation referred to an abstract, so it was necessary to contact the authors to assess the complete data. The most common biases that compromised the quality of the studies were: inadequate randomization process, lack of allocation concealment and lack of intention-to-treat analysis. The quality of the studies ranged from 6/12 to 9/12 (Table 1). The agreement between reviewers regarding the assessment of the risk of bias of studies was considered high (kappa = 0.81).

Rydeard *et al.*[12] compared the effects of Pilates intervention on functionality and pain. The Pilates group ($n = 18$) received training in specific exercises, which were carried out with a

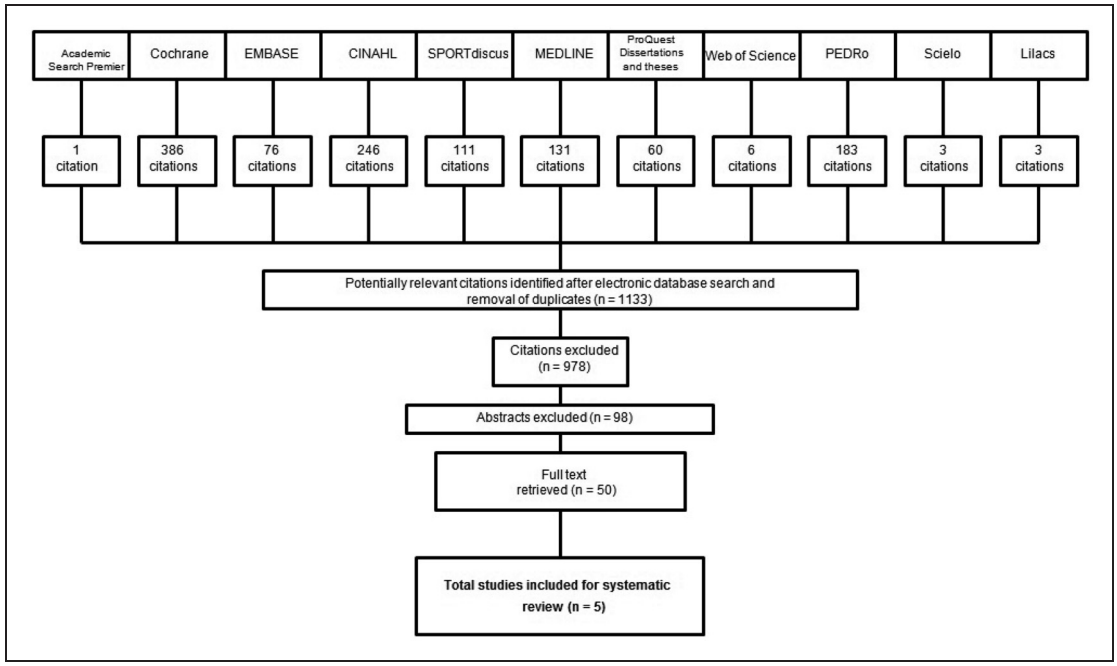


**Figure 1.** Diagram of search strategy.

**Table 1.** Score of the risk of bias assessment

| Author, year | Scores |
|---|---|
| Anderson, 2005 | 7/12 |
| Gladwell, 2006 | 7/12 |
| Gagnon, 2005 | 6/12 |
| O'Brien, 2003 | 9/12 |
| Rydeard, 2006 | 9/12 |

specialized exercise apparatus at the clinic, and with no specialized equipment at home. The control group ($n = 21$) received no specific exercise training and continued with their normal health care consultations as they thought necessary. The pain was measured by a 101-point numeric rating scale and functionality was measured by the Roland–Morris Questionnaire. The authors concluded that the Pilates group decreased their low back pain and disability; these results were maintained over a 12-month follow-up period.

O'Brien *et al.*[22] compared the effects of Pilates ($n = 9$), lumbar stabilization exercises ($n = 10$) and no exercise ($n = 9$) on patients with low back pain. Pain was measured by visual analogue scale (VAS) and functionality was measured using the Roland–Morris Questionnaire. The results did not present any statistical improvement on functionality; however, pain was reduced in both intervention groups compared to the control group.

Gladwell *et al.*[13] compared a Pilates group ($n = 20$) to a control group ($n = 14$). The Pilates exercises were performed at both the clinic and at home without supervision. The control group continued with their normal activities and pain relief strategies. The pain was measured by Roland–Morris Pain Rating Visual Analogue Scale and functionality was measured by the Oswestry Disability Questionnaire. In the Pilates group low back pain decreased, but no changes in functionality were observed; no changes were observed in either variable in the control group.

Anderson[23] compared an active intervention (Pilates group, $n = 10$) with a passive intervention

**Table 2.** Description of interventions in the included studies

| Author, year | Description | Frequency | Duration |
|---|---|---|---|
| Rydeard *et al.*, 2006 | I = Pilates (mat Pilates, Pilates reformer, at clinic and home); | 3×/week – clinic | 1 hour – clinic |
| | C = No systematic exercise. Treatment from health care professionals as needed | 6×/week – home | 15 min – home |
| | | | 4 weeks |
| O'Brien *et al.*, 2006 | I = Pilates (reformer, mat Pilates) | 2×/week | 1 hour |
| | I = Lumbar stabilization exercise | 8 sessions | 4 weeks |
| | C = No exercise, normal daily activity | | |
| Gladwell *et al.*, 2006 | I = Pilates (modified Pilates techniques) | 3×/week | 1 hour – clinic |
| | C = No exercise, normal daily activities and pain relief | | 1 hour (2 sessions) – home |
| | | | 6 weeks |
| Anderson, 2005 | I = Pilates (Allegro Pilates, Pilates reformer); | 2×/week | 50 min |
| | C = Massage, massage therapist, gluteal folds to head | | 6 weeks |
| Gagnon, 2005 | I = Pilates (mat Pilates, Stott Pilates); | 1.5×/week | 30–45 min |
| | I = lumbar stabilization exercise | | 7.3 weeks |

I, Intervention; C, Control.

(therapeutic massage, $n = 11$) among subjects with low back pain. The SF-36 pain subscale was used to measure pain. Functionality was measured using the Miami Back Index and Oswestry Disability Questionnaire, but only the results from the Oswestry Disability Questionnaire were considered so that a clearer comparison between studies could be made. No significant differences between groups for either Oswestry Questionnaire or the SF-36 pain subscale were found following the intervention.

Gagnon[24] compared the effects of Pilates ($n = 6$) and lumbar stabilization exercises ($n = 6$) among patients with low back pain. Pain was measuring using visual analogue scale and the functionality was determined by the Oswestry Disability Questionnaire. No significant differences in any of the outcome measures were observed between groups. The results of all included randomized controlled trials are summarized in Tables 2 and 3.

Figure 2 shows the meta-analysis of Pilates exercise group compared to control group for functionality outcomes. For this meta-analysis four studies were included.[12,13,22,23] The total number of subjects in the intervention group was 64, while 63 subjects were in the control group. This analysis indicated a non-significant improvement in functionality for Pilates group (SMD = –1.34; 95% CI –2.80, 0.11; $P = 0.07$).

Figure 3 shops the meta-analysis results for pain outcome. Four studies were included in this analysis.[12,13,22,23] The intervention group (Pilates) consisted of 65 subjects and the control group of 62 subjects. No significant differences in pain were found between the Pilates and the control group (SMD = –1.99; 95% CI –4.35, 0.37; $P = 0.10$).

The comparison between Pilates and lumbar stabilization exercises involved 15 patients in the Pilates group and 16 patients in the lumbar stabilization exercises group.[22,24] The results

**Table 3.** Mean and standard deviation data to each randomized controlled trial pre and post intervention

| | Pain | | | | Function | | | |
|---|---|---|---|---|---|---|---|---|
| Author, year | Pilates | Lumbar stabilization exercise | Control | *P*-value | Pilates | Lumbar stabilization exercise | Control | *P*-value |
| Rydeard *et al*., 2006 | NRS-101 | N/A | NRS-101 | | RMQ | N/A | RMQ | |
| | Pre = 23.0 (3.9) | | Pre = 30.4 (4.2) | <0.001* | Pre = 3.1 (0.6) | | Pre = 4.2 (0.8) | 0.02* |
| | Post = 18.3 (3.2) | | Post = 33.9 (3.5) | | Post = 2.0 (0.3) | | Post = 3.2 (0.4) | |
| O'Brien *et al*., 2006 | VAS | VAS | VAS | | RMQ | RMQ | RMQ | |
| | Pre = 6.1 (0.6) | Pre = 5.5 (0.6) | Pre = 4.9 (0.6) | <0.001* | Pre = 10.7 (1.9) | Pre = 9.5 (1.8) | Pre = 7.0 (1.9) | 0.02* |
| | Post = 1.7 (0.8) | Post = 1.8 (0.6) | Post = 5.2 (0.7) | | Post = 3.7 (1.5) | Post = 4.2 (1.5) | Post = 6.2 (1.5) | |
| Gladwell et al,. 2006 | RMVAS | N/A | RMVAS | | ODQ | N/A | ODQ | |
| | Pre = 2.7 (0.9) | | Pre = 2.4 (0.9) | >0.05* | Pre = 19.7 (9.8) | | Pre = 24.1 (13.4) | >0.05 |
| | Post = 2.2 (0.9) | | Post = 2.4 (0.8) | | Post = 18.1 (11.2) | | Post = 18.1 (13.0) | |
| Anderson, 2005 | SF-36 Pain | N/A | SF-36 Pain | | ODQ | N/A | ODQ | |
| | Pre = 7.3 (1.7) | | Pre = 6.3 (2.5) | 0.22 | Pre = 16.7 (4.2) | | Pre = 18.5 (5.9) | 0.34 |
| | Post = 8 (1.2) | | Post = 6.2 (2.5) | | Post = 13.9 (5.7) | | Post = 17.9 (7.2) | |
| Gagnon, 2005 | VAS | VAS | N/A | | ODQ | ODQ | N/A | |
| | Pre = 2.0 (1.7) | Pre = 3.8 (2.5) | | 0.30 | Pre = 15.8 (3.7) | Pre = 17.1 (6.1) | | 0.80 |
| | Post = 0.9 (1.7) | Post = 1.5 (1.7) | | | Post = 7.0 (5.9) | Post = 9.2 (7.5) | | |

VAS, visual analogue scale; NRS-101, 101-point numerical rating scale; RMQ, Roland–Morris Questionnaire; ODQ, Oswestry Disability Questionnaire; RMVAS, Roland–Morris Pain Rating Visual Analogue Scale; N/A, not available;
*Significant difference between groups.

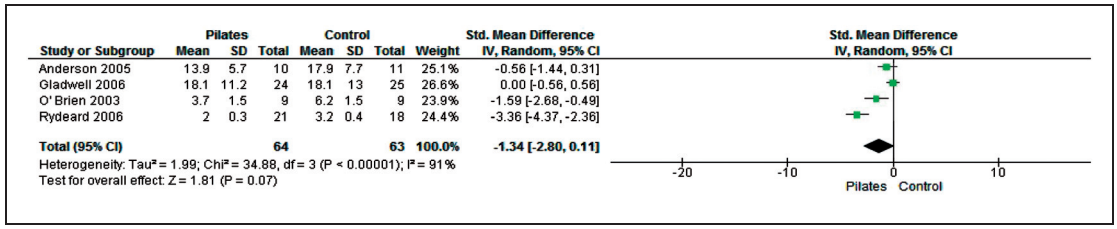


**Figure 2.** Meta-analyses of Pilates compared to the control group to functionality outcome.

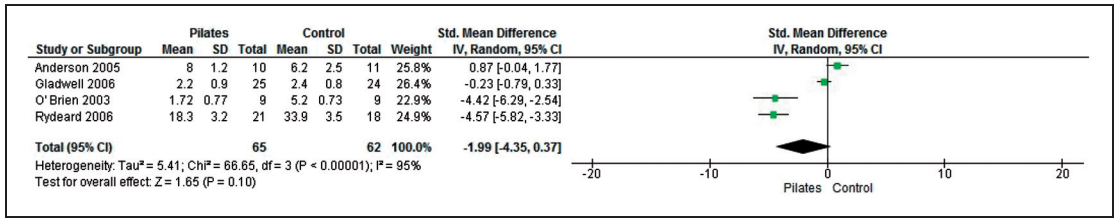


**Figure 3.** Meta-analyses of Pilates compared to control group for pain outcome.

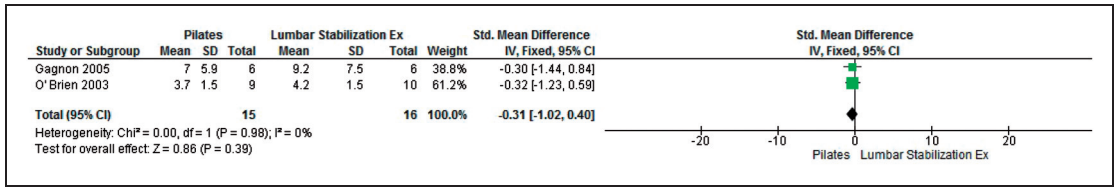


**Figure 4.** Meta-analyses of Pilates and lumbar stabilization exercise for functionality outcome.

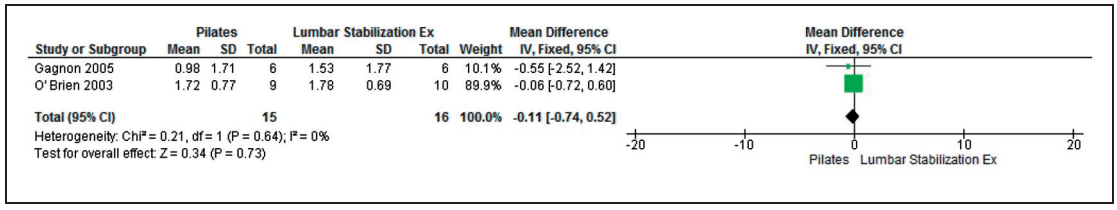


**Figure 5.** Meta-analyses of Pilates and lumbar stabilization exercise for pain outcome.

presented no significant differences between intervention techniques regarding functionality (SMD = –0.31; 95% CI –1.02, 0.40; $P = 0.39$) and pain (MD = –0.31; 95% CI –1.02, 0.40; $P = 0.39$) (Figures 4 and 5).

## Discussion

The Pilates method is based on the use of functional exercises for improving muscular strength and endurance. The objective of the Pilates method is to train these muscles submaximally to improve strength.[24] This method has been recognized for its therapeutic benefits, however, little scientific evidence proves or disapproves its use in the treatment of musculoskeletal disorders, including low back pain.[25] The exercises are gradually increased in complexity to help the patient develop stabilization strategies during movement, which may be important for the

retention of improvements made during treatment and transferring these gains to everyday movement and functional activies.[12] In order to explain the biomechanics of Pilates exercise on subjects with low back pain, Curnow *et al.*[26] evaluated load transfer through the pelvis and concluded that Pilates promotes greater efficiency. Gagnon[24] evaluated core stability and concluded that there is no difference between Pilates and traditional lumbar stabilization exercises for this outcome. Other outcomes, however, such as muscular activity from lumbar extensors and abdominis muscles during Pilates exercises were evaluated only on subjects without low back pain.[27] It is important that these outcomes be re-examined in subjects who have low back pain to clarify the exact functioning of these exercise regimens and facilitate their proper recommendation.

This systematic review did not find evidence that Pilates was superior to lumbar stabilization exercises for pain relief or functional improvement. Lumbar stabilization exercises include principles similar those of Pilates, such as retraining, strengthening and promoting the use of local muscular groups to stabilize the spine, in order to promote better control.[9] In the first phase of Pilates, which is focused on rehabilitation, the objective is to recruit deep stabilizer muscles (i.e. transverses abdominis, internal and external abdominal obliquus and multifidus muscles) at a submaximal effort, while disassociating the extremities from the trunk and pelvis, so that the deep stabilizers work efficiently to maintain control.[28] This suggests that lumbar stabilization exercises are as good as Pilates.

Macedo *et al.*[29] evaluated the effectiveness of motor control exercises (training in the preactivation of the deep trunk muscles, with progression toward more complex static, dynamic, and functional tasks integrating the activation of deep and global trunk muscles) compared to minimal intervention (general practitioner care or education) for persistent low back pain and the conclusion was that motor control exercise is more effective than minimal intervention for pain (weighted mean difference = –14.3 points; 95% CI –20.4, –8.1) in three months or less. The authors pointed out benefits when all-time points were added to pain therapy and also for disability in long-term follow-up (more than 12 months) (weighted MD = –14.4 points; 95% CI –23.1, –5.7), for pain outcome. Furthermore, it was showed that motor control exercise is no more effective than manual therapy or other forms of exercise.

In the literature, there are other studies that address the role of Pilates in low back pain, beyond those already included in this review. Sorosky *et al.*[25] conducted a review of literature that explored yoga and Pilates in the management of low back pain. The authors suggested that studies should assess longer follow-up for outcome measures to determine the effects of these interventions. Although the authors concluded that both methods seem to be useful therapies for treating patients with low back pain, it was suggested that health professionals should have a basic understanding of exercise regimens to consider the recommendation of these regimens.

Maher[30] divided the treatment of low back pain into three groups: effective physical treatments, ineffective treatments and treatments of unknown value. The Pilates method has been included in treatment of the unknown value group and it was concluded that this technique should not be considered as a treatment of low back pain and needs to be studied more.

Pilates has been applied in various populations and musculoskeletal disorders. Low back pain is one of the most studied. However, the lack of definition regarding the time and frequency of the application required for each approach is a limiting factor for use of this technique, mainly in special populations (i.e. athletes, woman who are recovering from breast cancer treatments, pregnancy and low back pain). One reason for this lack is the different methodologies and protocols and the small sample sizes in the published studies.

While this study was being carried out, La Touche *et al.*[16] published a similar study on the effectiveness of the Pilates method on pain and

functionality outcome for low back pain. However, the authors utilized only three studies, including a quasi-random trial in which the items of the assessment of risk of bias were not clearly described. These methodological issues compromised internal validity. The authors also did not perform a meta-analysis, which is important for determining the usefulness of a particular intervention, as well as for planning research related to the same clinical question.

Pain and disability were assessed by Lim *et al.*[17] in individuals with persistent non-specific low back pain who were treated with Pilates exercises compared to minimal or other interventions in a systematic review. The authors included seven studies, while in this review five were included. This can be explained by the differences in the assessment of the risk of bias. The Cochrane Back Review Group (CBRG) recommends that the studies have at least 6 out 12 CBRG criteria.[20] Then, the trials must be rated as having a 'low risk of bias' and no serious flaws. For this reason the studies of Donzelli *et al.*[31] and Quinn[32] were not included in this present review.

The study of Donzelli *et al.*[31] was considered quasi-random, and when the risk of bias was assessed, only four items were scored: outcome assessor blinded, drop-out rated described and acceptable, co-interventions avoided and timing of the outcome assessment similar in all groups. Quinn[32] scored only five items: knowledge of the allocated interventions adequately prevented during the study, drop-out rate described and acceptable, groups similar at baseline, co-interventions avoided or similar and timing of the outcome assessment similar in all groups. The studies had neither concealed treatment allocation, intention-to-treat analysis nor a blinded outcome assessor, causing potential problems for a systematic review. Furthermore, the assessment of the risk of bias in the Lim *et al.*[17] study was not clearly described. The results were also different. In this review no significant improvement in functionality and pain for the Pilates group compared to the control group was found. Lim *et al.*[17] found significant results in favour of Pilates for pain relief when compared to minimal intervention (SMD = –2.72; 95% CI –5.33, –0.11; $P = 0.04$). However, the presence of the two trials with high risk of bias compromises the quality of the Lim *et al.*[17] study and its results. This systematic review did not conclude that Pilates improves functionality and pain on patients who have low back pain.

## Clinical messages

- There is no evidence that the Pilates method improves pain or functionality of patients with low back pain.
- It is recommended that the Pilates method should be carefully considered for patients with low back pain.

## Note

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