

Effects of Pilates Exercise Programs in People With Chronic Low Back Pain

A Systematic Review

Antonino Patti, MSc, Antonino Bianco, PhD, Antonio Paoli, MD, Giuseppe Messina, MD, Maria Alessandra Montalto, MD, Marianna Bellafigliore, BSc, Giuseppe Battaglia, PhD, Angelo Iovane, MD and Antonio Palma, MD

Abstract: The Pilates method has recently become a fast-growing popular way of exercise recommended for healthy individuals and those engaged in rehabilitation. Several published studies have examined the effects of Pilates method in people with chronic low back pain (LBP).

The objective of this study is to describe and provide an extensive overview of the scientific literature comparing the effectiveness of the Pilates method on pain and disability in patients with chronic nonspecific LBP. The study is based on the data from the following sources: MEDLINE-NLM, MEDLINE-EBSCO, Scopus Elsevier, Cochrane, DOAJ, SciELO, and PLOS ONE.

Original articles and systematic reviews of adults with chronic nonspecific LBP that evaluated pain and/or disability were included in this study; studies in which the primary treatment was based on Pilates method exercises compared with no treatment, minimal intervention, other types of intervention, or other types of exercises.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were adopted. The literature search included 7 electronic databases and the reference list of relevant systematic reviews and original articles to July 2014. Two independent investigators conducted the literature search and performed the synthesis as follows: Study Design; Sample (n); Disability measure; Intervention; and Main results.

The searches identified a total of 128 articles. From these, 29 were considered eligible and were included in the analysis. The items were stratified as follows: Pilates method versus other kind of exercises (n = 6 trials) and Pilates method versus no treatment group or minimal intervention for short-term pain (n = 9 trials); the therapeutic effect of the Pilates method in randomized cohorts (n = 5); and analysis of reviews (n = 9).

We found that there is a dearth of studies that clearly demonstrates the efficacy of a specific Pilates exercise program over another in the treatment of chronic pain. However, the consensus in the field suggests that Pilates method is more effective than minimal physical exercise intervention in reducing pain. These conclusions need to be supported by other proper investigations.

(*Medicine* 94(4):e383)

Editor: Steven Barna.

Received: November 3, 2014; revised: November 22, 2014; accepted: November 25, 2014.

Sport and Exercise Sciences Research Unit (A Patti, AB, GM, MAM, MB, GB, AI, A Palma), University of Palermo; Posturalab (A Patti, GM), Italy; and Department of Biomedical Science (A Paoli), University of Padua, Padua, Italy. Correspondence: Antonino Patti, MSc, Via Giovanni Pascoli 6, Palermo 90144, Italy (e-mail: patti.nino@libero.it).

The authors have no funding and conflicts of interest to disclose.

Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

This is an open access article distributed under the Creative Commons Attribution License 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ISSN: 0025-7974

DOI: 10.1097/MD.0000000000000383

Abbreviations: CG = control group, CLBP = chronic low back pain, EG = experimental group, LBP = low back pain, MSCs = musculoskeletal conditions, NRPS = numerical rating pain scale, NSAID = nonsteroidal anti-inflammatory drug, VAS = visual analog scale.

INTRODUCTION

Musculoskeletal conditions (MSCs) are the most common cause of severe long-term pain and physical disability; in Europe, from 20% to 30% of adults are affected by MSCs at least once in their life.^{1,2} The burden that MSCs create has been recognized by the United Nations and World Health Organization, with their endorsement of the Bone and Joint Decade from 2000 to 2010.³ The prevalence of many of these conditions markedly increases with age and many patients also have some common lifestyle issues (obesity, smoking, and physical inactivity). With the increasing number of older people and the ongoing changes in lifestyle, the burden of MSCs and other noncommunicable diseases is predicted to increase.⁴ The Pilates method has recently become a fast-growing popular form of exercise recommended for healthy individuals and those engaged in rehabilitation. In more details, Pilates method emphasize core strengthening, posture, and coordination of breathing with movement, combining Asian and Western techniques.⁵ In 2009, Altan et al⁶ showed the effects of Pilates method in 49 women with fibromyalgia (ages 24–63 years). They demonstrated improvements in pain visual analog scale (VAS) scores. However, after an additional 12 weeks of follow-up, there were no differences between the groups. In 2001, Tuzer et al⁷ investigated if the psychological symptoms and the types of causal attributions were linked to the symptoms among women with chronic low back pain (CLBP). The authors showed that there was no difference between the groups regarding causal attributions. In this context, low back pain (LBP) is defined as pain and discomfort, localized below the costal margin and above the inferior gluteal folds, with or without leg pain. Nonspecific (common) LBP is defined as LBP not attributed to recognizable, known specific pathology. Pain cannot be attributed to pathology or neurological encroachment in about 85% of people.⁸ A role of genetic influence on liability to back pain is suggested from recent research. Hestbaek et al^{9,10} showed that LBP is usually dealt with as a specific and independent entity but the existing literature shows comorbidity to be common with LBP, suggesting that LBP may be part of a broader pattern of general health.^{9–11} Several published studies have examined the effectiveness of Pilates method in people with CLBP and reduction in pain when applying the Pilates method in treating nonspecific CLBP in adults.^{12–14} The

literature defined Pilates method as a mind–body exercise that focuses on core stability, muscle control, breathing, strength, flexibility, and posture.¹⁵ This method (and the apparatus used during therapy sessions) was developed by Joseph Pilates. Pilates method involves conscious use of trunk muscles to stabilize the pelvic–lumbar region.¹⁶ These exercises can be performed using specific equipment (equipment-based Pilates) or without specific equipment (also known as mat Pilates). In 2014, Hyun et al¹⁷ showed that Pilates mat exercise was safer than exercise on an unstable base of support, and, in particular, the Pilates mat exercise program was easier to adjust to each individual's balance ability. These exercises aim to improve static and dynamic stability, as well as posture and movements in general.¹⁵ The objective of this study sounds is to describe and provide an extensive overview of the scientific literature comparing the effectiveness of the Pilates method on pain and disability in patients with chronic nonspecific LBP.

MATERIALS AND METHODS

The Ethics Committee of the Sport and Exercise Sciences Research Unit, University of Palermo, Palermo, Italy, approved the systematic review in November 2013. The literature search was considered in line with ethical principles for medical research involving human subjects.

Eligibility Criteria

Original articles and systematic reviews including adults with chronic nonspecific LBP that evaluated pain and/or disability; studies in which the primary treatment was based on Pilates method exercises compared with no treatment, minimal intervention, other types of intervention, or other types of exercises.

Information Sources

Publications were selected based on a literature search from 2000 to 2014. The following databases were interrogated: MEDLINE-NLM and MEDLINE-EBSCO. We also searched on Scopus Elsevier, Cochrane, DOAJ, SciELO, and PLOS ONE databases.

Search Strategy and Keywords

The standardized search strategy included the use of the terms “Pilates” and “Low Back Pain” in the title, abstract, and keyword field. Preliminary searches have shown that expanding the search to include other keywords such as “exercise,” “motor control,” “core,” or the removal of “Low” in “Back Pain” did not identify any additional studies.

Data Collection Process

All the retrieved articles were transferred into the Endnote software (Vers X6 for Windows 7, © Thomson Reuters). In the first stage, all findings were coded into 2 different categories: Reviews and Meta-analyses, and Original articles. This kind of codification was applied for each database interrogated. Afterward, we proceeded with the exclusion of all duplicates. We then proceeded with a qualitative synthesis of the full texts of the studies included. Two independent investigators conducted the literature search and performed the synthesis as follows: Study design; Sample (n); Disability measure; Intervention; and Main results. In cases of disagreement between the reviewers, a third reviewer was consulted to achieve consensus. To be

considered in this systematic review, the below points were required:

- (1) Published in the English language, as access to interpreters was not available.
- (2) Published in full so that the methodological quality of the study could be assessed alongside results. Abstracts were excluded as they contained insufficient data to enable analysis of methodological quality.¹⁸
- (3) Assessed for the effectiveness of Pilates method where the term “Pilates” was used to describe the type of prescribed exercise being investigated. Exercises described as “motor control” or “lumbar stabilization” did not suffice for Pilates method. This is because Pilates method may include other features apart from motor control and lumbar stabilization.¹⁵
- (4) Included participants with CLBP, that is, localized pain in the lumbar region of >3 months in duration. If studies only included participants with LBP of <3 months duration, they were excluded. This is because people with CLBP respond differently to treatment compared to those with acute or subacute symptoms.¹⁹ If studies included participants with acute or subacute LBP and CLBP, the study was included as findings that were still considered relevant.
- (5) Used outcome measures with appropriate psychometric qualities that evaluate pain and/or functional ability in people with CLBP (the VAS, numerical rating pain scale [NRPS], the Oswestry disability questionnaire,^{20,21} Roland-Morris disability questionnaire,²¹ Borg scale CR10,²² Quebec back pain disability scale,²³ patient-specific functional scale,²⁴ pain self-efficacy questionnaire,²⁵ and pain catastrophizing scale.^{26,27} Randomized controlled trial with outcome measures for pain and/or functional ability that did not have sufficient validity, reliability, or responsiveness were excluded to avoid not appropriate measurements of treatment effect.²⁷

RESULTS

A total of 128 records have been identified through the database search of which 67 were considered potentially relevant and respected the previously mentioned inclusion criteria. Out of these, 38 articles were removed as duplicates, and we obtained 29 eligible articles (Figure 1 and Table 1).

Original Articles

This study included 21 randomized controlled trials; 20 studies showed a reduction of LBP but it was not possible to analyze the influence of the type of exercises on the analyses because the descriptions of the exercises performed in eligible studies were very brief.

Comparison of the Pilates Method With Minimal Intervention for Pain Outcome

Nine studies^{16,30,34,37,45,46,48,53,54} evaluated the pain before and after interventions and the results were compared with control groups (CGs) both with and without interventions and also with alternative pharmaceutical interventions. The study by Rydeard et al¹⁶ administered an exercise protocol with Pilates method-based floor exercises that was initially performed as static exercises protocol; they progressed to dynamic exercises involving hip extension movements and then to exercises on the

reformer, with 12 one-hour sessions conducted in addition to a home-based program of 15 minutes, 6 days a week for 4 weeks. The individuals from the experimental group (EG) reported a significant decrease in LBP and disability, which was maintained over a 12-month follow-up period. Gladwell et al³⁰ compared the Pilates method with a CG that continued with normal activity. The study showed a significant decrease in pain ($P < 0.05$), mostly, during the postintervention period. The authors suggest that Pilates method used as a specific core stability exercise incorporating functional movements can improve nonspecific CLBP reduction in active populations. Similarly, da Fonseca et al³⁴ and Alves de Araujo et al³⁷ compared the Pilates method with no exercise. In the study of da Fonseca, the Pilates group undertook 15 sessions of Pilates, and the data were collected before and after the intervention. After intervention, the Pilates group showed a significant decrease in pain and this did not occur in the no-Pilates group. In the study of Alves de Araujo, 31 female students, with scoliosis, were divided into 2 groups: a CG = 11, which had no therapeutic intervention, and an EG = 20, which underwent Pilates-based therapy. After intervention, the Pilates group showed a significant decrease in pain ($P < 0.0001$). The study by Miyamoto et al⁴⁵ compared Pilates method treatment with giving patients an educational booklet ($n = 86$). The Pilates method was administered for 12 one-hour sessions over 6 weeks. Improvements were observed in pain (mean difference = 2.2 points, 95% confidence interval [CI] = 1.1 to 3.2),

disability (mean difference = 2.7 points, 95% CI = 1.0 to 4.4), and global impression of recovery (mean difference = -1.5 points, 95% CI = -2.6 to -0.4) in favor of the Pilates group after intervention, but these differences were no longer statistically significant at 6 months. A study by Pappas et al⁴⁶ showed results that suggest that as the Pilates method can reduce pain and improve function for people with CLBP, in comparison to no intervention. The study enrolled 28 patients, aged 20–60 years, with CLBP divided into 2 equal groups, an exercise group and a CG. The intervention group followed a Pilates method program with fitball for 6 weeks. The intervention group showed a decrease of pain and an improvement of function, mood, balance, and flexibility. The CG showed no significant differences. In 2014, Albert Anand et al⁴⁸ published a study with the aim of evaluating the benefits of modified Pilates method for patients with chronic nonspecific LBP. The sample was randomly divided into 2 groups; the subjects of group A underwent a modified specific Pilates method with flexibility exercises and the subjects of group B underwent therapeutic exercises with flexibility exercises. The experimentation was conducted for a period of 8 weeks. Through the adoption of the Oswestry Disability Index and the VAS,^{55,56} they found that the modified Pilates method works in reducing pain, improving back-specific function, improving general health (personal car and social life), and improving flexibility in individuals with nonspecific CLBP. Results were not so remarkable on group B. Another study of particular importance

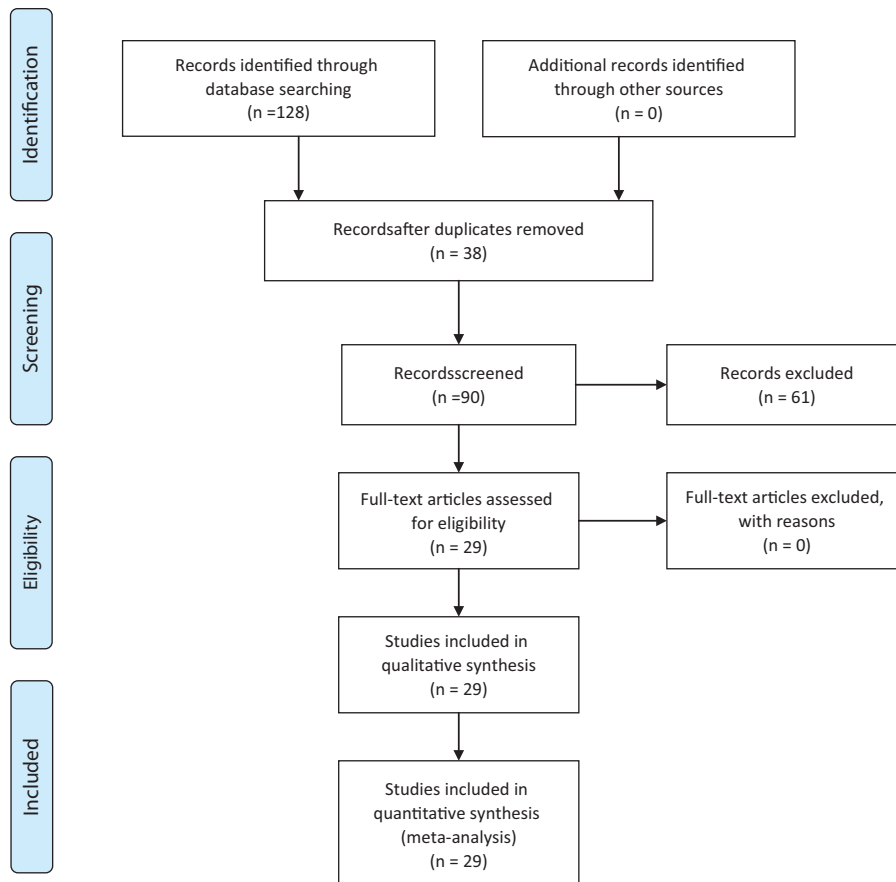


FIGURE 1. Flow of study.²⁸

TABLE 1. Overview of the Retrieved Reviews and Meta-Analyses

Study	Design	Sample (n)	Disability Measure	Intervention	Main Results
Donzelli et al ²⁹	Randomized controlled trial	53	OLBPDQ and VAS	Pilates method vs the back school method	Pain (-). A significant reduction in pain intensity and disability was observed across the entire sample.
Gladwell et al ³⁴	Randomized controlled trial	49	RMVAS	Pilates group vs the CG	Pain (-). Improvements were seen in the Pilates group postintervention period with increases ($P < 0.05$).
Rydeard et al ¹⁶	Randomized controlled trial	39	NRS-11	Pilates group vs no specific exercise group	Pain (-). The individuals in the specific exercise-training group reported a significant decrease of pain.
La Touche et al ¹²	Review	12	NA	NA	Pain (-). The results of this study showed positive effects, such as improved general function and reduction in pain, when applying the Pilates method to treat nonspecific CLBP in adults.
Lim et al ³¹	Pretest/posttest trial	59	OLBPDQ	Pilates exercises	Pain (-) Significant reduction in Oswestry disability index score ($P < 0.001$).
Sorosky et al ³²	Review	11	NA	NA	Pain (=). The authors stated that it is difficult to reach a firm conclusion regarding the efficacy of this exercise intervention for patients with CLBP.
Curnow et al ³³	Randomized controlled trial	39	OLBPDQ	Pilates group vs the CG	Pain (-). All groups experienced statistically significant reductions in frequency, intensity, and duration of LBP across the weeks of exercising but there were no significant differences between the groups.
da Fonseca et al ³⁴	Randomized controlled trial	28	VGRF	Pilates group vs the CG	Pain (-). The authors showed that improvements were seen in the Pilates group postintervention, with increased middle-support force for the left lower limb at faster walking speed and decreased pain; this did not occur in the no-Pilates group.
Lim et al ³⁵	Systematic review with meta-analysis	7	NA	NA	Pain (-). Results from this review suggest that Pilates-based exercises are superior to minimal intervention for reduction of pain in individuals with nonspecific LBP. However, the authors showed no existing evidence that can establish superiority of Pilates-based exercise on other forms of exercise to reduce pain and disability for patients with persistent nonspecific LBP.
Posadzki et al ³⁶	Systematic review	4	NA	NA	Pain (=). Although some of the authors of the reviewed studies conclude that Pilates yielded better therapeutic results than usual or standard care, the findings of this review suggest that the evidence available for its clinical effectiveness is inconclusive. This systematic review shows that the evidence base for Pilates method remains scarce and therefore larger and better designed clinical trials are needed.
Alves de Araujo et al ³⁷	Case-control study	31	Borg CR 10	Pilates group vs the CG	Pain (-). The Pilates method showed a reduction in the degree of nonstructural scoliosis, increased flexibility, and decreased pain ($P = 0.0001$).

(continued)

TABLE 1. (continued)

Study	Design	Sample (n)	Disability Measure	Intervention	Main Results
Pereira et al ³⁸	Systematic review with meta-analysis	139	NA	NA	Pain (=). The Pilates method did not improve functionality and pain in patients who have LBP when compared with control and lumbar stabilization exercise groups ($P = 0.10$).
Sullivan et al ³⁹	Review	42	NA	NA	Pain (-). The authors showed the Pilates exercise as a suitable form of exercise therapy for patients with chronic pain.
Wajswelner et al ⁴⁰	Randomized controlled trial	87	Quebec, PSFS, PSEQ	Pilates group vs no specific exercise group	Pain (-). An individualized clinical Pilates program produced beneficial effects on self-reported disability, pain, function, and health.
Gonzalvo et al ¹⁴	Systematic review with meta-analysis	19	NA	NA	Pain (-). The results of this systematic review suggest that Pilates-based therapeutic exercise is moderately superior to minimal intervention for pain relief and confers similar benefits when compared with pooled scores to another physiotherapeutic treatment.
Kucukcakir et al ⁴¹	Case-control study	100	VAS	Pilates group vs no specific exercise group	Pain (-). The results of the present study suggested that Pilates exercise program had beneficial effects on pain, functional capacity, and quality of life in patients with postmenopausal osteoporosis.
Mallin and Murphy ⁴²	Pretest/posttest trial	13	NRPS	Pilates exercises	Pain (-). The results of this pilot study suggest that Pilates has a role to play in reducing pain and disability in patients having neck pain.
Marshall et al ⁴³	Randomized controlled trial	64	PCA	Pilates group vs no specific exercise group	Pain (-). This study showed clinically meaningful improvements that were defined as >30% reduction from baseline in pain and disability scores. Pain was reduced from baseline in both the groups after training ($P < 0.05$).
Miyamoto et al ⁴⁴	Systematic review with meta-analysis	7	NA	NA	Pain (-). Pilates showed a moderate efficacy for reducing pain and disability in patients with CLBP but did not show significant difference than other types of exercise for short-term pain reduction.
Miyamoto et al ⁴⁵	Pretest/posttest trial	86	NRPS, RMMVAS	Pilates exercises vs no exercise group	Pain (-). Improvements were observed in pain, disability, and global impression of recovery in favor of the Pilates group after intervention, but these differences were no longer statistically significant at 6 months.
Pappas et al ⁴⁶	Pretest/posttest trial	28	OLBPDQ	Pilates exercises vs no exercise group	Pain (-). Improvement was seen among the intervention group in reducing pain and improving function, mood, balance, and flexibility. This study suggests that the Pilates method can reduce pain and improve function for people with CLBP.

(continued)

TABLE 1. (continued)

Study	Design	Sample (n)	Disability Measure	Intervention	Main Results
Wells et al ⁴⁷	A systematic review of systematic reviews	5	NA	NA	Pain (=). The authors suggest that there is inconclusive evidence that Pilates is effective in reducing pain and disability in people with CLBP. This conclusion relates to the insufficient number and methodological quality of available primary studies, rather than the methodological quality of reviews.
Albert Anand et al ⁴⁸	Randomized controlled trial	52	OLBPDQ, VAS	Pilates exercises vs therapeutic exercise group	Pain (-). The study concluded that the modified specific Pilates-based exercises help in reducing the pain.
Borges et al ⁴⁹	Randomized controlled trial	22	VAS	Pilates exercises	Pain (-). The authors showed significant reduction in pain intensity after the Pilates exercise protocol (paired <i>t</i> test, $P < 0.001$).
da Luz et al ⁵⁰	Randomized controlled trial	86	NRPS	Pilates mat group vs equipment-based group	Pain (=). After 12 Pilates sessions over a period of 6 weeks, no benefits were observed for pain intensity in patients with chronic nonspecific LBP.
Kim et al ⁵¹	Pretest/posttest trial	131	VAS	Pilates exercises	Pain (-). A 12-week Prop Pilates Exercise Program (PPEP) showed a significant decrease of pain.
Lee et al ⁵²	Randomized controlled trial	40	VAS	Pilates mat group vs equipment-based group	Pain (-). The authors showed significant reduction in pain intensity ($P < 0.05$), the group Pilates mat showed greater improvement in pain level and balance compared with Pilates apparatus exercises group.
Natour et al ⁵³	Randomized controlled trial	60	VAS, RMVAS	Pilate group + NSAID vs NSAID group	Pain (-). Statistical differences favoring the Pilates group were found with regard to pain ($P < 0.001$) and function ($P < 0.001$).
Notarnicola et al ⁵⁴	Randomized controlled trial	60	RMVAS, OLBPDQ	Pilates exercises vs no exercise group	Pain (-). The study showed improvements in the Pilates group with increases in physical and social functioning and general health, and decreases in disability and pain ($P < 0.05$).

Pain (-): reduction pain; Pain (=): no-reduction pain. Borg CR 10 = Borg scale CR10, CG = control group, CLBP = chronic low back pain; LBP = low back pain, NA = not available, NRPS = numerical rating pain scale, NRS-11 = numeric rating scale (11 point), OLBPDQ = Oswestry low back pain disability scale, PCA = pain catastrophizing scale, PSEQ = pain self-efficacy questionnaire, PSFS = patient-specific functional scale, Quebec = Quebec back pain disability scale, RMVAS = Roland-Morris visual analog scale, VAS = visual analog scale, VGRF = vertical ground reaction force.

is the experimentation of Natour et al⁵³; the authors analyzed 60 patients with nonspecific LBP. The sample was divided into 2 groups: the EG maintained medication treatment with the use of nonsteroidal anti-inflammatory drug (NSAID) and, in addition to, underwent treatment with the Pilates method, whereas the CG continued medication treatment with the use of NSAID and did not undergo any other intervention. An examiner blind to the assignment of the patients performed all evaluations at the following times: (T0) immediately prior to the study randomization (baseline); (T45) 45 days after T0; (T90) 90 days after T0 (conclusion of the Pilates method); and (T180) 90 days after the conclusion of the exercise program. Statistical differences favoring the Pilates group were found with regard to pain (VAS index, $P < 0.001$) and function (Roland-Morris questionnaire, $P < 0.001$). Statistical differences were also found between groups regarding the use of pain medication at 45, 90, and

180 days of exercise program ($P < 0.010$), with the Pilates group taking fewer NSAIDs than the CG that continued medication treatment with the use of NSAID and did not undergo any other intervention. Last, Notarnicola et al⁵⁴ showed that 5 lessons per week for a period of 6 months of Pilates method is effective for the management of CLBP ($P < 0.05$) and that the inactivity contributes to further worsening, inducing a vicious cycle in which pain and physical activity intolerance follow each other.

Comparison of the Pilates Method With Other Exercise Programs for the Pain Outcome

Within this section, 6 studies^{29,33,40,41,43,52} were included in the analysis. In these studies, the pain was evaluated before and after intervention; in addition, the results were compared

with CGs that underwent alternative exercises. In 2006, Donzelli et al²⁹ enrolled 53 patients with at least 3 months of nonspecific LBP; the subjects were entered into a Pilates therapy or a back school treatment group, but only 43 subjects completed the study. After 6 months of treatments, a significant reduction in pain intensity (VAS score) and disability (the Oswestry disability index) was observed across the entire sample but the Pilates method group showed better compliance and subjective response to treatment. Curnow et al³³ compared the effects of 3 different Pilates method regimes on chronic, mild LBP symptoms. All groups showed statistically significant reductions in frequency, intensity, and duration of LBP across the weeks of exercising but there were no significant differences between the groups relative to each other. Wajswelner et al⁴⁰ compared the efficacy of Pilates method with general exercise for CLBP. The entire sample showed significant improvements. Similar results were found at the 12 and 24 weeks follow-up in both the groups. In 2013, Kucukcakir et al⁴¹ evaluated the effects of Pilates method on pain, functional status, and quality of life in women with postmenopausal osteoporosis. Patients were randomly allocated into 2 groups (home exercise and Pilates method groups). Patients in the Pilates method group underwent a supervised Pilates method twice a week for 1 year. Patients in the home exercise group were asked to perform a home exercise program consisting of thoracic extension exercises. Patients were evaluated at baseline and after 1 year of participation in the exercise programs. All the samples showed significant improvements but were significantly greater in the Pilates exercise group compared with the home exercise group in all parameters. Similarly, Lee et al,⁵² after 8 weeks of intervention, showed a pain's decrease in both the study groups ($P < 0.05$), the Pilates mat group and the Pilates apparatus exercise group, but the Pilates mat group showed a greater decrease than the Pilates apparatus exercise group ($P < 0.05$). Finally, Marshall et al⁴³ confirmed that 8 weeks of specific Pilates method for trunk (64 patients with LBP) had reduced the disability and the pain significantly.

Assessment of the Possible/Potential Therapeutic Effect of the Pilates Method on CLBP in Randomized Cohorts

Five studies^{31,42,49–51} were analyzed within this section. The pain was evaluated before and after intervention, using scale measures for pain that were validated for the measurement and the comparison. In 2008, after 1-year period of Pilates method intervention on 59 patients, Lim et al³¹ suggested that the Pilates method has beneficial effect in reducing symptom of LBP. The authors found a clinically significant reduction in Oswestry disability index score ($P < 0.001$) and there was also an association between improvement in pain reduction and frequency of attendance ($r = 0.314$, $P = 0.028$). Similarly, Mallin and Murphy⁴² showed significant differences using the NRPS⁵⁷ after 12 weeks of intervention ($P < 0.01$). However, after 6 weeks, the modifications were not confirmed ($P > 0.05$). In 2014, Borges et al⁴⁹ studied a sample of 22 patients diagnosed with myelopathy/tropical spastic paraparesis caused by human T-lymphotropic virus type 1. LBP is the most common type of pain in these patients. Therefore, the Pilates method induced significant reduction in pain intensity ($P < 0.001$) and in almost all domains of the SF-36.⁵⁸ Da Luz et al⁵⁰ analyzed 86 subjects that were randomly allocated to 1 of the 2 groups: a Pilates mat group ($n = 43$) and an equipment-based Pilates group ($n = 43$); in this case, no benefits were observed for pain

intensity in patients with chronic nonspecific LBP. In 2014, Kim et al⁵¹ showed a significant decrease of pain index (VAS) after 12-week of Prop Pilates Exercise Program.

Analysis of Reviews

Nine studies^{12,14,32,35,36,38,39,44,47} were analyzed within this section. A close examination of reviews was conducted to critically evaluate and summarize the results of all published systematic reviews (with and without meta-analysis) that have investigated the effectiveness of Pilates method exercise in reducing pain and disability in people with CLBP. La Touche et al¹² suggested that Pilates method reduces pain and disability, whereas Lim et al³⁵ reported that Pilates method reduces pain when compared with minimal treatments, but not disability. In contrast, Pereira et al³⁸ in 2012 concluded that Pilates method is ineffective in reducing pain and disability, and Posadzki et al³⁶ in 2011 suggested that evidence was inconclusive. The above-mentioned studies adopted similar outcome measures for pain. On the contrary, Lim et al,³⁵ Aladro-Gonzalvo et al,¹⁴ and Pereira et al,³⁸ adopted different outcome measures for pain. In addition, La Touche et al,¹² Lim et al,³⁵ and Pereira et al³⁸ investigated people with nonspecific LBP. Interestingly, Posadzki et al³⁶ included an additional primary study that included participants with LBP related to disc pathology in the lumbar spine.

In line with Posadzki et al,³⁶ in 2013 Wells et al⁴⁷ highlighted the insufficient number of studies and the poor methodological quality of available evidences; so, accordingly, they concluded that there was inconclusive evidence that Pilates method is effective in reducing pain and disability in people with CLBP. Moreover, Miyamoto et al⁴⁴ and Sullivan et al³⁹ asserted that Pilates method was better than a minimal intervention for reducing pain and disability in patients with CLBP but Pilates method was not better than other types of exercise for short-term pain reduction. However, the authors suggest that Pilates method can be recommended for the reduction of pain and disability, but no definitive conclusion can be made regarding the analyzed outcomes in the medium term.

DISCUSSION

The Pilates method, using functional exercises, improves the muscular strength and endurance.⁵⁹ While practicing, the level of these exercises increases week after week and consequently determines one important postural control improvement.¹⁶ In 2009, Curnow et al³³ showed that the Pilates method improves load transfer through the pelvis. Previously, in 2005, Gagnon et al⁶⁰ concluded that there is no significant difference between Pilates method and other exercises for lumbar stabilization. In 2013, Pereira et al³⁸ confirmed Gagnon conclusions but, in addition, in this case the authors stated that the principles of the Pilates method are similar compared with other generic lumbar exercises. Our systematic review explores the clinical effectiveness of Pilates method in patients with LPB through a critical review of the literature. Nevertheless, this review indicates that there is heterogeneity at various levels including methodology, physical examination, population, the intervention itself, and the outcome measures. The interesting outcome is that all the included articles focused on functional disability and pain. All of the studies opted to begin sessions with basic exercises, but the duration or frequency of sessions were significantly different. However, our systematic search shows evidence that Pilates method-based exercises are more effective than no treatment or minimal physical exercise

interventions in the management of chronic nonspecific LBP. Our results, pointed out that the effects of the Pilates method are only proven for patients with chronic nonspecific LBP in the short term and it is still not possible to make inferences regarding the effects of treatment over time. Of interest, a recent study by Natour et al³³ showed that the group of participants that were practicing Pilates method resulted statistically different compared with the CG regarding the use of pain medication at 45, 90 (conclusion of the Pilates method), and 180 days, 90 days after the conclusion of the exercise program ($P < 0.01$).

In conclusion, the level of “physical exercise,”³⁰ the frequency, and the intensity/workload of Pilates protocols applied resulted vague and often undefined. Moreover, there is not homogeneity in terms of control and intervention group or intervention therapy in many studies analysed.^{16,29,30} Table 1 clearly shows that there is a dearth of well-designed studies that clearly demonstrates the efficacy of a specific exercise program over another in the treatment of chronic pain. However, the consensus in the field suggests that Pilates method is more effective than minimal physical exercise intervention in reducing pain and disability in the short-term period. In other words, there is agreement that exercise “helps” in the treatment of chronic pain, but it is still not clear exactly which factors or particular kind of exercises may be responsible of such improvements. Further studies should be carried out in order to better understand the short-term and long-term effects of Pilates programs on LBP reduction.

ACKNOWLEDGMENT

The authors would like to thank the Posturalab Scientific Committee for their support. We are grateful to Sensor Medica Sas for their contribute.

REFERENCES

1. Woolf AD, Zeidler H, Haglund U, et al. Musculoskeletal pain in Europe: its impact and a comparison of population and medical perceptions of treatment in eight European countries. *Ann Rheum Dis.* 2004;63:342–347.
2. Picavet HS, Hazes JM. Prevalence of self reported musculoskeletal diseases is high. *Ann Rheum Dis.* 2003;62:644–650.
3. WHO Scientific Group on the Burden of Musculoskeletal Conditions at the Start of the New Millennium. The burden of musculoskeletal conditions at the start of the new millennium. *World Health Organ Tech Rep Ser.* 2003;919:i-x1–218.
4. Hanson M, Gluckman P, Nutbeam D, et al. Priority actions for the non-communicable disease crisis. *Lancet.* 2011;378:566–567.
5. Busch AJ, Webber SC, Brachaniec M, et al. Exercise therapy for fibromyalgia. *Curr Pain Headache Rep.* 2011;15:358–367.
6. Altan L, Korkmaz N, Bingol U, et al. Effect of pilates training on people with fibromyalgia syndrome: a pilot study. *Arch Phys Med Rehabil.* 2009;90:1983–1988.
7. Tuzer V, Bulut SD, Bastug B, et al. Causal attributions and alexithymia in female patients with fibromyalgia or chronic low back pain. *Nordic J Psychiatry.* 2011;65:138–144.
8. Burton AK, Balague F, Cardon G, et al. Chapter 2. European guidelines for prevention in low back pain: November 2004. *Eur Spine J.* 2006;15:S136–S168.
9. Hestbaek L, Iachine IA, Leboeuf-Yde C, et al. Heredity of low back pain in a young population: a classical twin study. *Twin Res.* 2004;7:16–26.
10. Hestbaek L, Leboeuf-Yde C, Kyvik KO, et al. Comorbidity with low back pain: a cross-sectional population-based survey of 12- to 22-year-olds. *Spine.* 2004;29:1483–1491.
11. MacGregor AJ, Andrew T, Sambrook PN, et al. Structural, psychological, and genetic influences on low back and neck pain: a study of adult female twins. *Arthritis Rheum.* 2004;51:160–167.
12. La Touche R, Escalante K, Linares MT. Treating non-specific chronic low back pain through the Pilates method. *J Bodyw Mov Ther.* 2008;12:364–370.
13. da Luz MA Jr, Costa LO, Fuhro FF, et al. Effectiveness of mat Pilates or equipment-based Pilates in patients with chronic non-specific low back pain: a protocol of a randomised controlled trial. *BMC Musculoskelet Disorders.* 2013;14:16.
14. Aladro-Gonzalvo AR, Araya-Vargas GA, Machado-Diaz M, et al. Pilates-based exercise for persistent, non-specific low back pain and associated functional disability: a meta-analysis with meta-regression. *J Bodyw Mov Ther.* 2013;17:125–136.
15. Wells C, Kolt GS, Bialocerkowski A. Defining Pilates exercise: a systematic review. *Complement Ther Med.* 2012;20:253–262.
16. Rydeard R, Leger A, Smith D. Pilates-based therapeutic exercise: effect on subjects with nonspecific chronic low back pain and functional disability: a randomized controlled trial. *J Orthop Sports Phys Ther.* 2006;36:472–484.
17. Hyun J, Hwangbo K, Lee CW. The effects of pilates mat exercise on the balance ability of elderly females. *J Phys Ther Sci.* 2014;26:291–293.
18. Hopewell S, Clarke M, Moher D, et al. CONSORT for reporting randomised trials in journal and conference abstracts. *Lancet.* 2008;371:281–283.
19. Hayden JA, van Tulder MW, Malmivaara A, et al. Exercise therapy for treatment of non-specific low back pain. *Cochrane Database Syst Rev.* 2005;3:CD000335.
20. Fairbank JC, Couper J, Davies JB, et al. The Oswestry low back pain disability questionnaire. *Physiotherapy.* 1980;66:271–273.
21. Roland M, Fairbank J. The Roland-Morris disability questionnaire and the Oswestry disability questionnaire. *Spine.* 2000;25:3115–3124.
22. McGorry RW, Lin JH, Dempsey PG, et al. Accuracy of the Borg CR10 scale for estimating grip forces associated with hand tool tasks. *J Occup Environ Hyg.* 2010;7:298–306.
23. Schoppink LE, van Tulder MW, Koes BW. Reliability and validity of the Dutch adaptation of the Quebec back pain disability scale. *Phys Ther.* 1996;76:268–275.
24. Westaway MD, Stratford PW, Binkley JM. The patient-specific functional scale: validation of its use in persons with neck dysfunction. *J Orthop Sports Phys Ther.* 1998;27:331–338.
25. Tonkin L. The pain self-efficacy questionnaire. *Aust J Physiother.* 2008;54:77.
26. Osman A, Barrios FX, Kopper BA, et al. Factor structure, reliability, and validity of the pain catastrophizing scale. *J Behav Med.* 1997;20:589–605.
27. Chapman JR, Norvell DC, Hermsmeyer JT, et al. Evaluating common outcomes for measuring treatment success for chronic low back pain. *Spine.* 2011;36 (suppl 21):S54–S68.
28. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 2009;6:e1000097.
29. Donzelli S, Di Domenica F, Cova AM, et al. Two different techniques in the rehabilitation treatment of low back pain: a randomized controlled trial. *Eur Medicophys.* 2006;42:205–210.

30. Gladwell V, Head S, Haggart M, et al. Does a program of pilates improve chronic non-specific low back pain? *J Sport Rehabil.* 2006;15:338–350.
31. Lim CWE, Chen YC, Lim HWW, et al. A retrospective evaluation of isotonic strengthening with clinical pilates exercises on patients with chronic low back pain. *Physiother Singapore.* 2008;11:5–12.
32. Sorosky S, Stulp S, Akuthota V. Yoga and pilates in the management of low back pain. *Curr Rev Musculoskelet Med.* 2008;1:39–47.
33. Curnow D, Cobbin D, Wyndham J, Boris Choy ST. Altered motor control, posture and the Pilates method of exercise prescription. *J Bodyw Mov Ther.* 2009;13 (1):104–111.
34. da Fonseca JL, Magini M, de Freitas TH. Laboratory gait analysis in patients with low back pain before and after a pilates intervention. *J Sport Rehabil.* 2009;18:269–282.
35. Lim EC, Poh RL, Low AY, et al. Effects of Pilates-based exercises on pain and disability in individuals with persistent nonspecific low back pain: a systematic review with meta-analysis. *J Orthop Sports Phys Ther.* 2011;41:70–80.
36. Posadzki P, Lizis P, Hagner-Derengowska M. Pilates for low back pain: a systematic review. *Complement Ther Clin Pract.* 2011;17:85–89.
37. Alves de Araujo ME, Bezerra da Silva E, Bragade Mello D, et al. The effectiveness of the Pilates method: reducing the degree of non-structural scoliosis, and improving flexibility and pain in female college students. *J Bodyw Mov Ther.* 2012;16:191–198.
38. Pereira LM, Obara K, Dias JM, et al. 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. *Clin Rehabil.* 2012;26:10–20.
39. Sullivan AB, Scheman J, Venesy D, et al. The role of exercise and types of exercise in the rehabilitation of chronic pain: Specific or nonspecific benefits. *Curr Pain Headache Rep.* 2012;16:153–161.
40. Wajswelner H, Metcalf B, Bennell K. Clinical pilates versus general exercise for chronic low back pain: randomized trial. *Med Sci Sports Exerc.* 2012;44:1197–1205.
41. Kucukcakir N, Altan L, Korkmaz N. Effects of Pilates exercises on pain, functional status and quality of life in women with postmenopausal osteoporosis. *J Bodyw Mov Ther.* 2013;17:204–211.
42. Mallin G, Murphy S. The effectiveness of a 6-week Pilates programme on outcome measures in a population of chronic neck pain patients: a pilot study. *J Bodyw Mov Ther.* 2013;17:376–384.
43. Marshall PW, Kennedy S, Brooks C, et al. Pilates exercise or stationary cycling for chronic nonspecific low back pain: does it matter? A randomized controlled trial with 6-month follow-up. *Spine.* 2013;38:E952–959.
44. Miyamoto GC, Costa LO, Cabral CM. Efficacy of the Pilates method for pain and disability in patients with chronic nonspecific low back pain: a systematic review with meta-analysis. *Braz J Phys Ther.* 2013;17:517–532.
45. Miyamoto GC, Costa LO, Galvanin T, et al. Efficacy of the addition of modified Pilates exercises to a minimal intervention in patients with chronic low back pain: a randomized controlled trial. *Phys Ther.* 2013;93:310–320.
46. Pappas E, Panou H, Souglis A. The effect of a pilates exercise programme using fitball on people suffering from chronic low-back pain in terms of pain reduction and function improvement. *J Phys Edu Sport.* 2013;13:606–611.
47. Wells C, Kolt GS, Marshall P, et al. The effectiveness of pilates exercise in people with chronic low back pain: a systematic review. *PLoS One.* 2014;9:e100402.
48. Albert Anand U, Mariet Caroline P, Arun B, et al. A study to analyse the efficacy of modified pilates based exercises and therapeutic exercises in individuals with chronic non specific low back pain: a randomized controlled trial. *Int J Physiother Res.* 2014;2 (3):525–529.
49. Borges J, Baptista AF, Santana N, et al. Pilates exercises improve low back pain and quality of life in patients with HTLV-1 virus: a randomized crossover clinical trial. *J Bodyw Mov Ther.* 2014;18:68–74.
50. da Luz MA Jr, Costa LO, Fuhro FF, et al. Effectiveness of mat Pilates or equipment-based Pilates exercises in patients with chronic nonspecific low back pain: a randomized controlled trial. *Phys Ther.* 2014;94:623–631.
51. Kim HJ, Nam SN, Bae UR, et al. The effect of 12 weeks Prop Pilates Exercise Program (PPEP) on body stability and pain for fruit farmers with MSDs. *Technol Health Care.* 2014.
52. Lee CW, Hyun J, Kim SG. Influence of pilates mat and apparatus exercises on pain and balance of businesswomen with chronic low back pain. *J Phys Ther Sci.* 2014;26:475–477.
53. Natour J, Cazotti LD, Ribeiro LH, et al. Pilates improves pain, function and quality of life in patients with chronic low back pain: a randomized controlled trial. *Clin Rehabil.* 2014.
54. Notarnicola A, Fischetti F, Maccagnano G, et al. Daily pilates exercise or inactivity for patients with low back pain: a clinical prospective observational study. *Eur J Phys Rehabil Med.* 2014;50:59–66.
55. Hawksley H. Pain assessment using a visual analogue scale. *Prof Nurse.* 2000;15:593–597.
56. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. *Pain.* 1983;17:45–56.
57. Bijur PE, Latimer CT, Gallagher EJ. Validation of a verbally administered numerical rating scale of acute pain for use in the emergency department. *Acad Emerg Med.* 2003;10:390–392.
58. Reed PJ, Moore DD. SF-36 as a predictor of health states. *Value Health.* 2000;3:202–207.
59. Kung J, Chiappelli F, Cajulis OO, et al. From systematic reviews to clinical recommendations for evidence-based health care: validation of Revised Assessment of Multiple Systematic Reviews (R-AMSTAR) for grading of clinical relevance. *Open Dent J.* 2010;4:84–91.
60. Gagnon L. Efficacy of Pilates Exercises as Therapeutic Intervention in Treating Patients With Low Back Pain [dissertation]. Knoxville, TN: University of Tennessee; 2005; 119.