The effects of Clinical Pilates exercises on patients with chronic low back pain: a systematic review

Aikaterini Zorba[1], Dimitrios Evangelopoulos[2]

[1] *Postgraduate Program Rehabilitation following spinal cord lesions. Spinal pain management, School of Medicine, National and Kapodistrian University of Athens, Athens, Greece*

[2] *3rd Department of Orthopaedics, School of Medicine, National and Kapodistrian University of Athens, KAT Hospital, Athens, Greece*

ABSTRACT

LBP can be characterized as a common disorder, with serious complications to a patient's life, as seen in clinical practice. The aim of the present study was to perform a systematic review of all the previous studies, in order to examine and clarify the impact of Clinical Pilates exercises on CLBP and to investigate any benefits of Pilates to CLBP patients. Eighteen randomized controlled trial articles were included. Each Pilates exercise regime was heterogenic, concerning its frequency and duration. Clinical heterogeneity was apparent in the RCT studies, a fact that was proven by the contrasting conditions, frequency, and duration of either the Pilates or the normal intervention. The study's outcomes indicate that Pilates as a therapeutic exercise method is exceeding typical intervention for pain relief up to an extent. Even though it was observed that Pilates-based regime combined with typical exercise regime can enhance pain relief process, it is should be noted that it is not the norm. Pilates exercise can be characterized as fairly more effective comparing typical physiotherapy treatment as far as disability reduction is concerned, and can provide equal advantages to minimal intervention.

Key Words: clinical Pilates, chronic low back pain, physiotherapy, systematic review.

Introduction:

Low back pain (LBP) can be characterized as a common disorder, with serious complications to a patient's life, as seen in clinical practice [1] . The prevalence of LBP is at about 60% to 70% in developed countries · the prevalence of LBP in children and adolescents is lower than in adults, however the percentages are increasing rapidly [2,3]. In Europe, 30% of the adult working population, that is 44 million people, is suffering from LBP, whereas in Greece, 44% of the adult working population has manifested LBP related to working conditions [4].

LBP as a condition can be defined as either chronic or acute, concerning the duration of the syndrome. The European guidelines for physical therapy treatment suggested a further division of the LBP syndrome into three types: specific spinal pathology, nerve root pain/ radicular pain and the third type and most commonly manifested, chronic nonspecific LBP [5] . To be diagnosed with chronic LBP (CLBP), patients should report pain in the posterior lumbar region lasting for over 12 weeks or back pain existing for 7 to 12 weeks

CORRESPONDING AUTHOR, GUARANTOR

Aikaterini Zorba, Postgraduate Student, NKUA
Email: ds.evangelopoulos@gmail.com

[6] . Nonspecific CLBP prevalence and high relapse ratios often generate disability and affect the patient's quality of life greatly [7,8].

Recently, patients suffering from CLBP have been exposed to Pilates exercise regime as a rehabilitation program (9), since Pilates is a mind-body intervention focusing on core stability and posture improvement and is widely used as an assistance in treatment of various diseases. Pilates as an exercise regime was developed in the early 20th century by Joseph Pilates. Joseph Pilates described his exercise routine as a controlled regime, emphasizing in the quality and precision of movements, resulting in improved strength and flexibility, and as a final step, improved overall health. However, there is only limited evidence in the literature supporting that the use of Pilates can decrease back pain and enhance the functionality of nonspecific CLBP patients [10,11]. Systematic reviews comparing Pilates exercises to placebo or habitual daily activities have revealed that Pilates exercises relieve pain but do not reduce disability [6,12], whereas other reviews have shown that Pilates cause no improvement to disability and/or pain [13] . However, there have been systematic reviews that proved the effectiveness of Pilates exercises in relieving pain and reducing disability, compared to placebo or habitual daily exercises [14].

Nevertheless, there have been several systematic reviews in which Pilates did not show significant improvement in comparison with other forms of exercise [13–15]. The evidence of the studies is not consistent, since in another review, it was found that Pilates actually reduced disability effectively in comparison with other types of exercise [12] . The result discrepancies of these studies may be caused by the selection size of the randomized controlled trial (RCT) articles, which were comprised by low-level evidence. Furthermore, it was concluded that in some systematic reviews, meta-analyses were performed, and results were misleading, in spite of the existing clinical heterogeneity [14]. To date, conclusions made from several studies concerning pain-relief and disability treatment effects for patients suffering from LBP with Pilates exercise regime and with other types of exercise showed considerable differences [16]. There is no extensive literature on the recommendations for Pilates exercises to patients with CLBP, including various Pilates exercise regime, for instance Pilates mat exercises or Pilates equipment exercises [17]. Consequently, the aim of the present study was to perform a systematic review of all the previous studies, in order to examine and clarify the impact of Clinical Pilates exercises on CLBP and ultimately, to investigate any benefits of Pilates to CLBP patients.

Methods:

The MEDLINE/ PubMed and Google Scholar data bases were used in search of related key words, for instance "Chronic Low Back Pain (CLBP)" and "Clinical Pilates". Various relating and appropriate for our research articles were found, after our search with the keywords. Our literature research completed in January 2022 and its main focus was on recent publications, concerning the impact of Clinical Pilates exercise regime on chronic low back pain.

A systematic literature review was conducted according to the guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) database [18,19].

Study inclusion criteria:

In this review, we included only randomized controlled trials. Only double-blind studies examined in order to avoid any partial evaluations of the impact of treatment in the studies. The target population was male and female adults suffering from chronic low back pain. The articles should be written exclusively in English and the whole text should be accessible; also, we chose articles that were recently published and presented clinical results of the RCTs that were conducted.

Study exclusion criteria:

The excluded reviews were those failed in the above-mentioned criteria: they were not written in English, with no access to the whole review text, they did not perform a randomized controlled trial, the main topic was not chronic low back pain and they did not evaluate the impact of Clinical Pilates therapeutic exercise regime.

The full papers were read and any papers not meeting the inclusion/exclusion criteria were removed.

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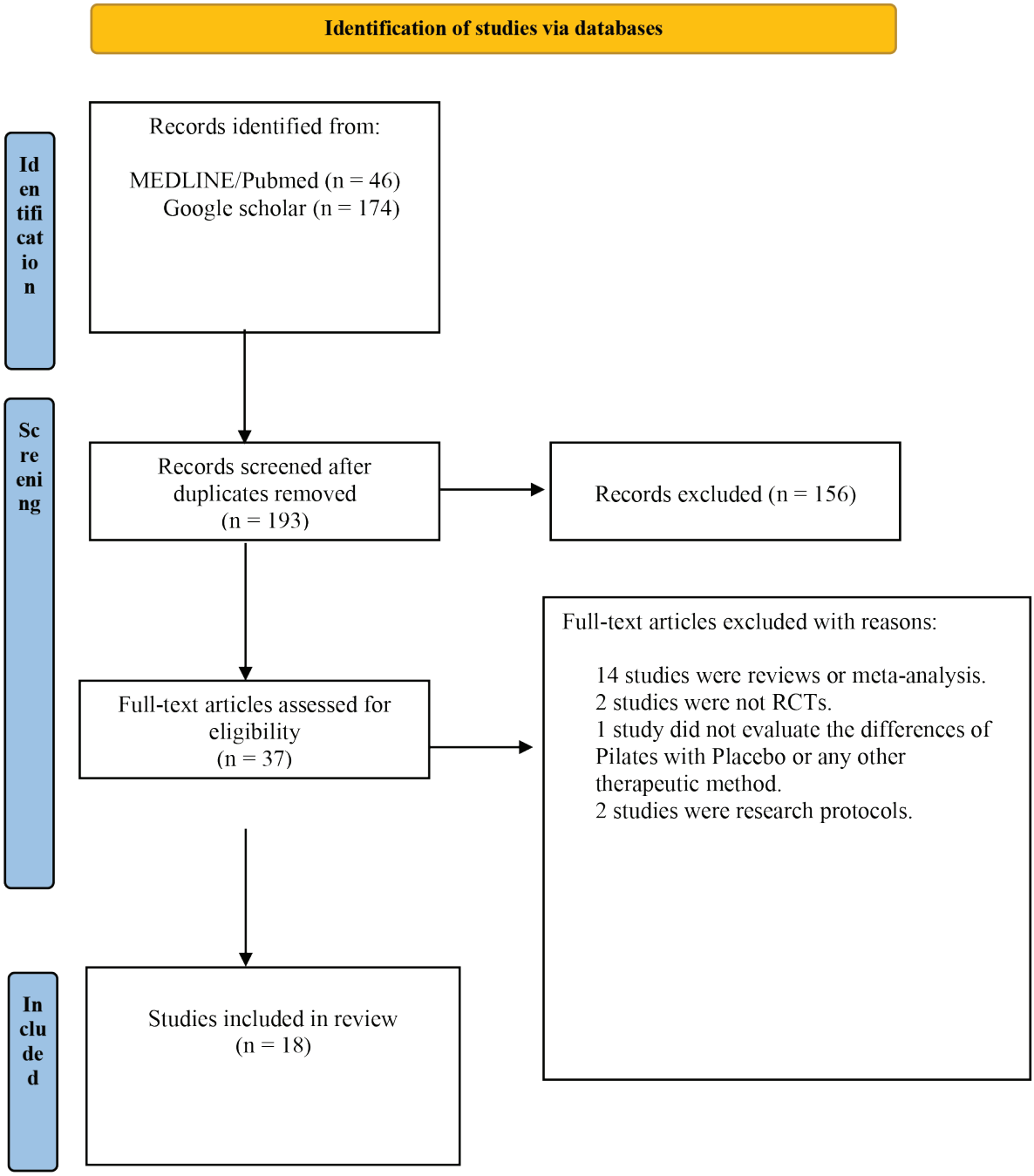
Figure 1 Flowchart



Data was extracted from the papers and entered into a table for later analysis.

Results

The initial electronic database search resulted in a total of 220 articles of these, 18 were considered for inclusion in this review (Figure 1).

The current study was consisted of 1249 subjects in total, with their age ranging from 18 to 65 years old. Each Pilates exercise regime was heterogenic, concerning its frequency (once to three times per week) and duration (thirty to sixty minutes). Clinical heterogene-

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ity was apparent in the RCT studies, a fact that was proven by the contrasting conditions, frequency, and duration of either the Pilates or the normal intervention, which consisted of home exercise training, use of Pilates equipment, administration of nonsteroidal anti-inflammatory drugs, follow-up sessions and overall evaluation of the outcomes over certain periods of time (Table 1). Each session lasted for equal amount of time, mostly for sixty minutes, involving Pilates Mat exercises and Pilates Studio equipment exercises [20–24]. In their study, Rydeard et al. performed specific rehabilitation exercise programs, influenced by the original Pilates exercise regime [25]. Seven trials performed co-interventions, comprising physiotherapy treatment, analgesic intake and home exercise training as an experimental design [22,24–28]. In their study, Gladwell et al., performed Pilates exercise regime as an additional treatment to the drug treatment [28] .

All the above-mentioned studies and their subjects presented a considerable improvement concerning pain [20,21,23–34]. Da Luz et al, Marshall et al., Natour et al. and Rydeard et al. reported a significant improvement in patients' disability [21,25,27,34]. Four of the above-mentioned studies [22,35–37] reported no significant difference among Pilates and another intervention. The study by Mostagi et al. was conducted by typical physiotherapy exercises program, for instance stationary cycling, stretching exercises, spinal mobilization exercises and trunk muscle strengthening [36]. Wajswelner et al. conducted their study using a typical exercise regime including stationary cycling, leg stretching, upper body weightlifting, resistance band exercises, and an overall floor exercise regime [37]. The study conducted by Gagnon et al. performed mat exercise regimes for lumbar stabilization operated by a team of sport trainers, physiologists, and physical therapists [22] . The studies by Gagnon et al. and Wajswelner et al. reported considerable amelioration to both the Pilates and the intervention groups ($p=0.004$ and $p<0.01$ accordingly) in their final measures, implying that Pilates exercise regime can be effective, but not equally effective to a typical exercise program [22,37] . However, the study conducted by Mostagi et al. reported no considerable improvements in either groups at the end of the trial session, even though the general exercise group reported a slight clinical but not statistical amelioration [36].

Discussion

The aim of this study was to review high-quality RCT studies and present update evidence on the effects of Pilates on patients suffering from nonspecific CLBP. In two high-quality RCT articles comparing the effects of Pilates over various exercise regimes on patients suffering from CLBP, the Pilates exercise regime was included in a typical equipment training session. In their study, Wajswelner et al. concluded that a Pilates influenced training session, lasting for 12 to 14 hours, showed no statistical advantage over a typical therapeutic exercise for patients suffering from CLBP [37]. This conclusion was also proved by the study of Pereira et al, thus suggesting that Pilates exercise regime and lumbar stabilization exercises provide equal effects on patients' functional enhancement and pain relief [13]. Marshall et al. investigated a longer Pilates exercise session (up to 24 hours) and concluded to the fact that Pilates did show statistical advantage for functional enhancement and pain relief for patients suffering from CLBP compared to exercises with stationary cycling. Pilates-influenced exercise routine and typical therapeutic exercise routine showed related outcomes to the study by Wajswelner et al., possibly due to the fact that both regimes focused on trunk exercises, particularly in extension, rotation and flexion. Marshall et al. argued that both exercise groups, either Pilates-influenced exercise regime or stationary cycling regime had equal psychological effects on patients with CLBP, indicating that the psychological factor cannot be considered as a cause for statistical discrepancies on functional enhancement and pain relief [34].

The post-trial follow up periods of each study differed, likewise the results of the longer periods differed· Miyamoto et al. observed that any group discrepancies were not statistically significant after the period of time of six months, while in contrast, Wajswelner et al. observed that any amelioration in the final outcomes of the studies was still valid at 24 weeks [33,37].

Another considerable conclusion of this specific study was that any significant progress to a patient's condition with Pilates exercise compared to typical

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TABLE 1.

Description of included studies

Study	Year	Population	Intervention	Time period	Results
Bhadauria et al. (Comparative effectiveness of lumbar stabilization, dynamic strengthening, and Pilates on chronic low back pain: randomized clinical trial)	2017	44 patients were assigned into three groups (n=12). Group A was about Lumbar stabilization, Group B about Dynamic strengthening and Group C did Pilates exercises.	All three groups performed different exercise regimes. Group A completed 16 lumbar stabilization exercises. Group B completed 14 exercises for core strengthening; Group C: focus on activating the powerhouse	3 weeks	A reduction of pain, an improvement in the range of motion and core strength was shown in all three groups. In spite of that, lumbar stabilization was the most effective form of exercise for patients suffering from CLBP.
Borges et al. (Pilates exercises improve low back pain and quality of life in patients with HTLV-1 virus: A randomized crossover clinical trial)	2014	22 patients were infected by HTLV-1. 11 patients was divided into group A (Pilates-control), treated with Pilates exercises. The second group, Control-Pilates group, consisted of the rest 11 patients.	Group A did Pilates exercises immediately, whereas the Control-Pilates group did not change their lifestyles for 15 weeks, up to the point when they started the Pilates program. The groups exchanged their activities after 30 sessions. The Pilates exercise regime consisted of 60′ sessions, twice a week. It was taught by trained personnel.	30 weeks	An important decline in pain intensity, together with an amelioration in almost of the domains of the SF-36 after treatment with Pilates exercises was documented.
Cruz-Diaz et al. Comparative effects of 12 weeks of equipment based and mat Pilates in patients with Chronic Low Back Pain on pain, function and transversus abdominis activation. A randomized controlled trial	2017	98 patients Were divided in the Mat Pilates Group (n=34), Equipment-based Pilates Group (n=34) and control group (n=30)	The Pilates group exercised twice a week of approximately 50 min, together with physical therapy treatment sessions. The Control group did only physical therapy treatment sessions.	12 weeks	The Pilates regime was proven effective in ameliorating pain, disability, core activation and kinesiophobia. The equipment-based Pilates exercises showed better and faster results, contrary to Pilates Mat exercises.
da Fonseca et al. (Laboratory Gait Analysis in Patients With Low Back Pain Before and After a Pilates Intervention)	2009	17 patients (Low-Back Group) were divided into either the Pilates group (n=8) or a no-Pilates group (n=9).	The Pilates group did an exercise program with 15 sessions in total, 2 sessions per week for 1 hour and no-Pilates continue usual physical activity but no treatment apart from medications.	7-8 weeks	The weight-acceptance rate and push-off rate were quite declined in the right lower limb for the low-back group rather than of the Pilates group. The Pilates group showed improvement after the intervention in the increased middle support force for the left lower limb at a faster walking pace. The low-back group did not show the same improvement.

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da Luz et al. Effectiveness of Mat Pilates or Equipment-Based Pilates Exercises in Patients With Chronic Nonspecific Low Back Pain: A Randomized Controlled Trial	2014	86 patients with LBP were randomly assigned into two groups: a Pilates Mat group (n=43) and a Pilates equipment-based group (n=43).	The sessions lasted 1 hour and were administered twice a week Both groups completed their sessions twice a week for 1 hour.	6 weeks	After a course of time of six months, an important difference in the disability and kinesiophobia of the patients allocated in the Pilates equipment-based group was noted (p<0,01). No other difference was noted in the findings.
Franco et al. (Is Interferential Current Before Pilates Exercises More Effective Than Placebo in Patients with Chronic Nonspecific Low Back Pain? A Randomized Controlled Trial)	2017	148 patients with CLBP were randomly assigned into two groups: active IFC + Pilates and placebo IFC+ Pilates	Each group was treated for 30′ with active or placebo IFC for 2 weeks; afterwards, 40′ of Pilates exercise was added to their routine for 4 weeks. The treatment had a duration of 18 sessions	6 weeks	As far as pain pressure, disability and pain threshold are concerned, no significant differences were observed in both groups. However, an important difference was observed between baseline and a 6-month-follow up in the analysis of the intragroup for all findings except pain pressure and pain threshold in the place IFC+ Pilates group.
Gagnon (Efficacy of Pilates Exercises as Therapeutic Intervention in Treating Patients with Low Back Pain)	2005	12 patients who were introduced for physical therapy with LBP were randomly divided into two groups: the traditional lumbar stabilization exercise group (Group A) (n=6) and the Pilates exercise group (Group B) (n=6).	Group A completed traditional lumbar stabilization exercises for 30-45′, whereas group B completed a Pilates Mat regime for 30-45′.	The duration was 6.6 weeks for Group A and 7.3 for Group B.	The Pilates group showed improvement in measures of pain, function and core strengthening; equal measures showed the lumbar stabilization group.
Gladwell et al. (Does a Program of Pilates Improve Chronic Non-Specific Low Back Pain?)	2006	49 patients suffering from CLBP were assigned in two groups, the Control group (n=24) or the Pilates group (n=25).	The Control group did not change their lifestyles or the pain relief routine. The Pilates group completed six one-hour sessions per week.	6 weeks	The Pilates group showed an improvement in general health levels (p<0.05), sports functioning (p<0.05), proprioception (p<0.05), flexibility (p<0.05) and lower pain levels (p<0.05). The Control group did not show any improvement.
Marshall et al. (Pilates Exercise or Stationary Cycling for Chronic Nonspecific Low Back Pain: Does it Matter?)	2013	64 patients suffering with LBP were randomly divided into two groups, the Pilates group or the Stationary Cycling group.	The Pilates group completed three supervised sessions for 50-60′ per week, whereas the Stationary Cycling group completed three supervised sessions for 50-60′.	8 weeks	The Pilates group showed improvement in disability after 8 weeks (d=0.62, p=0.018). After training, pain was significantly lower in both groups (p=0.05), however, it was lower for the Pilates group (p=0.05).

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Miyamoto et al. (Different doses of Pilates-based exercise therapy for chronic low back pain: a randomised controlled trial with economic evaluation)	2018	296 patients received advice about their condition and were randomly divided into four groups (n=74). The first group was the Booklet Group (BG), the Pilates Group 1, exercised one a week, (PG1), the Pilates Group 2, exercised twice a week, (PG2) and the Pilates Group 3, exercised three times a week, (PG3).	All patients exercised individually, with ground exercises, for one hour. PG1 patients completed six treatment sessions, once a week. PG2 patients completed 12 treatment sessions, twice a week and PG3 patients completed 18 treatment sessions, three times a week.	6 weeks	All Pilates groups improved relating to pain, in contrast to the BG group. Among the Pilates groups, PG2 improved in a significant way concerning pain and disability, compared with PG1.
Miyamoto 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)	2013	86 patients suffering from non-specific CLBP received an educational booklet about low back pain and were randomly divided into two groups. The Pilates group (n=43) was assigned to complete 12 sessions over six weeks, the non Pilates group did not follow any exercise regime.	The Pilates group completed two Pilates Mat sessions for 60'every week. The No Pilates group received the educational booklet and physiotherapy advice twice per week.	6 weeks	The Pilates group showed improvement in terms of pain, disability and general recovery, contrary to the No Pilates group. However, the improvement was only statistically important for a six-month period.
Mostagi et al. (Pilates versus general exercise effectiveness on pain and functionality in non-specific chronic low back pain subjects)	2015	22 patients were divided into two groups. The Pilates group (n=11) and the General exercise group (n=11).	Both groups exercised twice a week, for 60', in a private session.	8 weeks	Functionality was improved for the General exercise group during the study (p=0.02 at the end of the study and p=0.04 at the follow up). Also, flexibility was improved for the General exercise group at follow up (p=0.01). The Pilates group showed no significant improvement during the study.

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Natour et al. (Pilates improves pain, function and quality of life in patients with chronic low back pain: a randomized controlled trial)	2015	60 patients suffering from non-specific CLBP were randomly divided into two groups. The Experimental group continued their medication treatment with NSAIDs and Pilates sessions. The Control group continued their medication treatment with NSAIDs, with no Pilates exercising.	Both groups completed Pilates sessions for 50′ twice per week. The patients were adviced to use 50mg of sodium diclofenac every 8 hours when needed.	13 weeks	Pain was significantly improved for the Pilates group (p=0.001), functionality (p=0.001), vitality (p=0.029) and general quality of life (p=0.046). Also, the Pilates group took fewer medication than the Control group (p=0.010).
Quinn et al. (Do patients with chronic low back pain benefit from attending Pilates classes after completing conventional physiotherapy treatment?)	2011	29 patients suffering with CLBP who had completed physiotherapy treatment sessions and had core instability and residual pain. The patients were divided into two groups, the Pilates group and No Pilates group.	The Pilates group completed supervised mat sessions for 60′ once a week and five home exercise sessions for 15′per week. The No Pilates group did not complete any exercise sessions or treatment.	8 weeks	The Pilates group showed a statistical improvement in pain (p=0.047) compared to the No Pilates group. However, this improvement cannot be characterized as clinically significant. There was not an important difference in disability in both groups at follow up (p=0.301). Lumbopelvic control improvement was shown in the Pilates group.
Rajpal et al. (A Study on Efficacy of Pilates & Pilates & Mckenzie Exercises in Postural Low Back Pain- A Rehabilitative Protocol)	2008	40 female patients with postural CLBP were divided into two groups; the Pilates group (n=17) and the McKenzie group (n=15).	The Pilates group completed daily home exercise regime (ten repetitions with 10′′ hold) for over four weeks. The McKenzie group completed daily postural correction exercise regime (fifteen-twenty repetitions, three times a day).	4 weeks	No significant improvement was shown in both groups. The Pilates group did not show any important improvement during the 0-15 days period (0.805); however, during the 15-30 days period, the Pilates group improved (p=0.001). The McKenzie group showed no important improvement during the 0-15 days period (0.452); yet, during the 15-30 days period, the McKenzie group improved significantly (p=0.001). Therefore, both groups improved as a whole, but the Pilates group showed greater improvement than the McKenzie group.

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Rydeard et al. (Pilates-Based Therapeutic Exercise: Effect on Subjects With Nonspecific Chronic Low Back Pain and Functional Disability: A Randomized Controlled Trial)	2006	39 physically active patients with CLBP were randomly divided into two groups. The Intervention group (n=21) completed Pilates sessions, while the Control group (n=18) received the traditional treatment, that is a consultation with healthcare specialists and doctors.	The Intervention group completed Pilates sessions for 60′ three times a week and home exercise regime for 15′, in total 13 hours of exercise. The Control group did not exercise.	4 weeks	Functional disability (p=0.023) and average pain intensity (p=0.002) were lowered significantly in the Intervention group than in the Control group. The ameliorated disability levels in the Intervention group were sustained for up to 12 months, together with treatment intervention.
Wajswelner et al. (Clinical Pilates versus General Exercise for Chronic Low Back Pain: Randomized Trial)	2012	87 patients with LBP suffering for over 3 months were divided into either the Pilates group (n=44) or the General exercise group (n=43).	The patients exercised at the clinic for 60′ twice a week for 6 weeks total, together with home exercise for 60′ once a week. The total exercise regime was 12-14 hours.	6 weeks	From the 87 patients, the 96% completed the 6-week intervention and the 60% completed the 24-week follow up. There was no significant difference at six weeks, for both groups. Also, no significant difference was shown at the 12-week and 24-week follow ups.
Yang et al. (Pilates-based core exercise improves health-related quality of life in people living with chronic low back pain: A pilot study)	2021	39 physically active patients suffering from non-specific CLBP were divided into two groups: the Control group (n=20) and the Experimental group (n=19).	The Control group completed Pilates sessions for 60′ twice a weak. The Control group was given advice and information regarding LBP, specifically about posture, stretching exercises and lifestyle adjustment. Also, they had access to medical consultations and traditional medical care, involving injections and physiotherapy treatment sessions, but no Pilates sessions.	8 weeks	The Experimental group showed an improvement in the quality of life, relating to health, rather than the Control group. The trends regarding pain showed a preceding pain reduction for the Experimental group, lasting until the end of the study, over the Control group.

treatment and physical activity is not possible at 24 weeks. This finding was based on research evidence by one high quality RCT investigating the extending effect of Pilates exercise [23]. However, in the specific RCT, the participants ended their Pilates training regime at 6 weeks, thus it is unknown if an extended lasting effect may have been found if the groups concluded their regime for more than 6 weeks, as recommended [38].

The findings of systematic reviews are parallel to those of another review concluding that a statistically considerable decrease in pain was achieved by Pilates exercise regime compared to no Pilates exercise regime [15]. This specific review analyses that the improvement caused by Pilates can only be considered as short term but clinically substantial. As far as functional ca-

pability is concerned, the findings of the two reviews are in contrast with other systematic reviews, since these reviews showed a statistically considerable amelioration in functionality in the short term [12,13,15]. This discrepancy may be because meta-analyses of some reviews, together with variable grouping of comparing treatments, was not in the appropriate manner [38]. However, the measure range of functional recovery in RCTs in the current study is not statistically considerable [39,40].

It is worth mentioned that not all RCTs included in the current study are consisted to the effectiveness of Pilates exercise regime in comparison with typical treatment and exercise routine (24,28,30). The contrasting results may be clarified by the variable methodological quality of the RCTs of the study. Moreover, any contrasting result may occur on the grounds that the sample sizes were small or there were co-interventions within the RCTs. Four of the RCTs that did not present statistically considerable data were underpowered with small sample sizes, thus any treatment alterations may have not been as easily detectable [24,32,34].

Additionally, any alteration in the outcome of the RCTs may be attributed to the fact that the groups completed altered Pilates exercise regimes, for instance exercise sessions that happened more than once a week, often using specialized Pilates equipment, thus producing RCTs with statistically substantial results [16,25,26,29]. Therefore, it is advisable to perform equal Pilates exercise regimes of the RCTs that produced statistically considerable results as a way to maximize the treatment outcome.

Since the present data is limited, it is challenging to conclude on the short-term effectiveness of Pilates exercise on people suffering from CLBP comparing to other forms of exercise. This is based on the fact that statistically considerable advancements in pain and disability have been reported in one high quality RCT [34], not in other high quality RCTs [37. However, it is commonly believed among high quality RCTs that pain and functional ability in patients with CLBP will be improved with Pilates exercise or other types of exercise at 24 weeks [34,37].

Therefore, Pilates exercise is unclear whether it can provide higher advancements in pain and functional ability when compared to other forms of exercise, at best in a long-term period. The findings of this review are equal to those of past systematic reviews, since that advancements in pain and functional ability from Pilates exercise regime in contrast with other types of exercise have not been characterized as statistically critical [12,13,15]. However, in the current review, it is agreed that there could have been alterations in the short term.

There has been a statistically critical alteration in the outcome when Pilates exercise was contrasted with a definitely dissimilar exercise, that is cycling [34]. However, no discrepancy was observed when Pilates exercise was in contrast with lumbar stabilization exercises [22,35–37]. We propose that any future reviews should examine the relative effectiveness of Pilates exercise over other forms of exercise.

This review consisted of only high-quality RCTs and therefore, few articles comparing the effects of Pilates exercise and other types of exercise on patients with CLBP were included· likewise, few articles comparing the effectiveness of Pilates Mat exercise regime over Pilates equipment regime were included. Several limitations were noted throughout this review. The first limitation was that even though the selection criteria of this review were equivalent to several studies, the results might have a bias as a consequence of the discrepancies in the ability to participate in each original RCT. The second limitation involved the publication bias since we reviewed studies only with English keywords at two databases. Another limitation that was encountered was that since this review pinpointed on the effects of Pilates exercise on specific health conditions and health enhancement, further information about the quality and quantity of Pilates Mat exercise and Pilates Equipment exercises was not described.

Conclusion

In the current study, we conducted a systematic review of clinical trials that used Pilates as a rehabilitation method for treatment of patients suffering from CLBP. The majority of these clinical trials concluded that Pilates can be an effective method towards achieving a reduction in pain and disability. The outcomes of the current study indicate that Pilates as a therapeutic exercise method is exceeding typical intervention for pain relief up to an extent. Even though it was ob-

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served that Pilates-based regime combined with typical exercise regime can enhance pain relief process, it is should be noted that it is not the norm. Pilates exercise can be characterized as fairly more effective comparing typical physiotherapy treatment as far as disability reduction is concerned, and can provide equal advantages to minimal intervention. The low methodological quality of the studies that were reviewed, as well as the diversity of the physiotherapy treatments demonstrated an estimate bias of the effectiveness towards disability and pain. Therefore, it is advisable to consider Pilates as a rehabilitation program for patients with CLBP, even though its ideal application is not clear at present. Any future studies investigating the topic of the therapeutic effect of Pilates should conduct placebo-controlled trials, with larger sample sizes, with intervention protocols capable of being comparable and make provisions for longer follow-up terms in order for any outcome to be considerable.

Abbreviations

LBP, low back pain; CLBP, chronic low back pain

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