

- A – Research concept and design
 B – Collection and/or assembly of data
 C – Data analysis and interpretation
 D – Writing the article
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 F – Final approval of article

Effect of progressive muscle relaxation exercises versus pilates exercises on postnatal low back pain

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Abstract:

Introduction: Postpartum women are frequently affected by low back pain. This is a global health concern resulting in a variety of adverse health outcomes, including difficulties with walking, working, sleeping, and mood regulation. The aim of this study was to compare the effect of progressive muscle relaxation exercises with Pilates exercises on relieving postnatal low back pain.

Material and methods: This randomized controlled trial was implemented between February 2024 to June 2024 at Kasr El Ainy Hospital. The study included 60 women aged between 25 and 35 years complaining of postnatal low back pain, with a body mass index of no more than 30 kg/m². All participants were three months postnatal, with parity ranging from one to three. The participants were randomly divided into two equal groups of 30. Group A received progressive muscle relaxation exercises, and Group B received Pilates exercises, as three weekly sessions for four weeks. Pain pressure threshold (PPT) was assessed with a pressure algometer and functional disability and quality of life with the Oswestry disability index (ODI) for all woman in both groups (A & B), before and after treatment.

Results: Both groups showed significant within-group improvements in all measures post-treatment ($p < 0.05$). Significantly greater improvement following treatment was noted in Group B ($p < 0.05$).

Conclusions: Pilates exercises achieve better results than progressive muscle relaxation exercises in treating postnatal low back pain.

Keywords: Oswestry Disability Index, pain pressure threshold, pressure algometer, pilates-based exercises, progressive muscle relaxation

Introduction

Postpartum women frequently experience low back pain (LBP). This is a common condition worldwide, which results in a variety of adverse health outcomes, including

difficulties with walking, working, sleeping, and mood regulation. Missing work due to back pain can cause socioeconomic issues which can affect quality of life (QOL) [1]. Low back pain often arises during gestation or within three weeks post-delivery, and extends through



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the third month postpartum, resulting from ligamentous laxity and alterations in posture [2]. About one-third of postpartum women report experiencing some degree of LBP within three months of giving birth, with roughly 40% indicating a moderate to severe level of disability. While many of these experience improvement within the first three months after giving birth, a considerable proportion, between 5% and 8.5%, continue to suffer from pain for up to two years [3].

Between 80 and 90 percent of all occurrences of LBP are classed as nonspecific, which is likely the result of various biological, psychological, and social factors [2]. During pregnancy, women undergo significant changes due to the developing fetus, including alterations in abdominal length and strength, with increased relaxin levels causing joint and ligament laxity. Indeed, it has been proposed that the occurrence of LBP in pregnancy may be due to joint laxity: one study found women with the highest relaxin levels to present with the most debilitating LBP, and pregnant women with moderate to severe posterior pelvic pain demonstrated significantly greater asymmetric sacroiliac joint laxity than those who do not experience any symptoms. More pubic symphysis mobility has also been seen during pregnancy and puerperium in women with pregnancy-related lumbopelvic discomfort as compared to asymptomatic pregnant women [4].

Hormonal alterations leading to ligament laxity, structural misalignments of the lumbar spine and increased lordosis from additional weight can result in lumbopelvic instability. This instability undermines the effectiveness of the passive stability system, necessitating compensation through dynamic stability to prevent pain. Such alterations substantially impair core muscle functionality, leading to LBP [5]. The fourth trimester, generally referred to as the postpartum period, is a crucial time for the development of back pain, regardless of its stage. To help new mothers restore their strength, muscle tone, vitality, and general health, medical practitioners must take extra precautions. For women giving birth for the first time, it is probably the most important and transformative moment of their lives, and is a wonderful period in the lives of a newly-delivered mother and her child [2].

Recent advances in the management of chronic diseases have highlighted relaxation therapy as a vital component due to its multiple benefits [6]. These include minimizing stress and anxiety, diverting attention from pain, alleviating muscular tension and contraction, promoting better sleep, and diminishing sensitivity to pain and fatigue. A systematic review recently underscored the wide-ranging beneficial effects of relaxation practices for pregnant women, improving outcomes for mothers, fetuses, and newborns alike [7]. Benefits noted include fewer hospital admissions, reduced obstetric complications, lon-

ger pregnancies, fewer Caesarean deliveries and reduced complications after childbirth, as well as greater newborn weights and better neonatal behavioural outcomes [7].

Progressive muscle relaxation (PMR) is a commonly-utilized relaxation technique characterized by its simplicity and ease of learning, which incorporates deep breathing and progressive relaxation (tense–release) of major muscle groups; it is a straightforward and easily-mastered technique that was first introduced by Jacobson in 1938 [8]. Through a combination of deep breathing with progressive tensing and release of major muscle groups, the approach promotes physical and mental relaxation, lowers the reaction to stress, decreases pain sensations, and minimizes skeletal muscular contractions, [6].

PMR exercises yield their beneficial results through a number of routes. The autonomic nervous system fires sympathetic and parasympathetic nerve fibers in response to tension and relaxation. The parasympathetic nervous system is mainly influenced by PMR, which is predominantly characterized by muscular relaxation, lowered heart rate, breathing rate, and blood pressure; furthermore, deep somatic restfulness in conjunction with parasympathetic dominance has been claimed to reduce anxiety. By lowering tissue oxygen levels, releasing endorphins, and lowering the levels of *inter alia* lactic acid, the relaxation response generally helps to lessen pain. As such, by lowering the perception of pain and reducing anxiety, PMR may enhance QOL among pregnant women [6]. In addition, it has been proposed that PMR increases endorphin release, which lowers cortisol levels in healthy human participants; this could lessen tension and pain while also promoting relaxation and well-being [9].

Pilates is a unique training system created in the early 20th century by a German named Joseph Pilates. It is an exercise that integrates mind and body, focusing on muscle control, posture, and breathing while enhancing core stability, strength, and flexibility [10]. Exercises can involve the use of specialized equipment. In modern Pilates routines, the classic principles of breathing, centering, focus, control, and precision continue to be applicable [10]. Women who want to enhance their physical and mental health frequently turn to Pilates as a type of exercise. Although there is little evidence that Pilates enhances the mental health of women, it might help with pain management, improve QOL, and increase lower limb endurance [11]. LBP sufferers were found to be more likely to highlight posture as an important component of Pilates exercises than healthy participants [12]. This shows that when performing Pilates activities, good posture is very important for people with LBP.

The transverses abdominis and multifidus are two deep, stabilizing trunk muscles that can be affected by lumbo-pelvic posture, according to recent research [13]. The Pilates method enhances the agonistic-antagonistic

relationship between these muscles, increases transversus abdominis and internal oblique muscle activity during exercise, and improves the effectiveness of transversus abdominis contractions. These benefits may reduce the incidence of mechanical or postural back pain, and activate greater postural facilitation in people with LBP whose muscles are restricted [10].

The Pilates exercise method recognizes that while in a lengthened position, muscles may be vulnerable to motor coordination problems. Injuries may occur when lengthened muscles go beyond their normal limits, leaving them unprotected by stretch reflexes or experiencing delays in activation. The increased load on these muscles can result in autogenic inhibition through the Golgi tendon reflex, which can lead to motor coordination impairments [14]. The Pilates exercise method believes that shortening affected muscles makes it easier to perform movements. Pilates exercises involve movements that cannot be executed by the reflex arc, requiring individuals to focus on performing exercises in sequences with normal breathing. This engagement of supraspinal control improves motor coordination. Therefore, the primary mechanisms of directional preference in Pilates exercises improve motor control by shortening impaired muscles and engaging supraspinal control, thereby enhancing clinical outcomes in pain and function [15].

The effects of PMR and Pilates exercises on postnatal LBP have been examined in previous studies. Their findings serve as the foundation for this present study, whose aim is to compare the impacts of PMR and Pilates exercises on postnatal LBP.

Materials and methods

Participants

A total of 70 women diagnosed with postnatal LBP were randomly selected from Kasr El Ainy University Hospital in Cairo from February 2024 to June 2024. Of these, 10 were excluded: three by choice and seven due to ineligibility. The remaining sixty postnatal women were randomly assigned to two groups using a closed envelope method (Figure 1). They were aged between 25 and 35 years, with a body mass index (BMI) of no more than 30 kg/m². All were three months postnatal. Additionally, their parity varied, ranging from one to three times. Patients previously affected by spinal, pelvic, and lower limb trauma, prior spinal surgeries (like kyphoplasty, vertebroplasty, or spinal fusion), congenital spinal deformities, spinal tumor history, ankylosing spondylitis, osteoporosis, and other spondyloarthritis were excluded from the study.

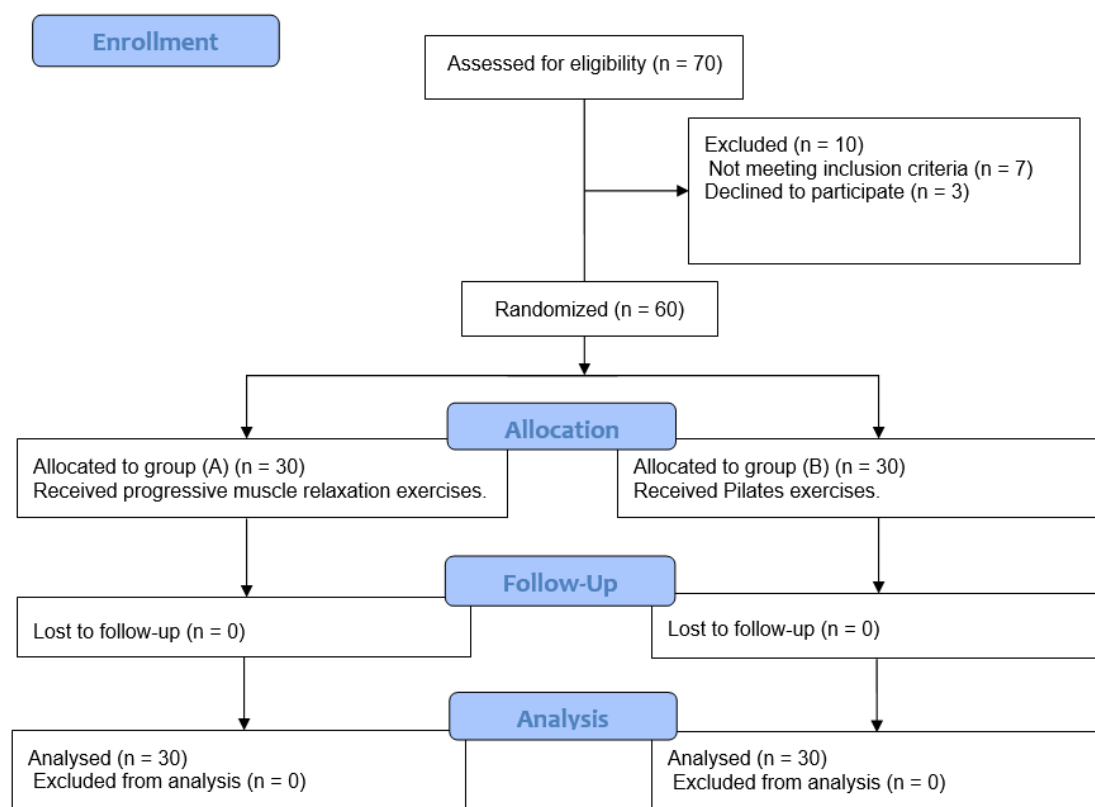


Fig. 1. Flow chart indicating numbers of participants

Ethics

Ethical approval for the study was provided by the Institutional Review Board of the Faculty of Physical Therapy at Cairo University (No: P.T.REC/012/003885). Additionally, the study was registered with ClinicalTrials.gov (protocol number: NCT06284018). The study protocol was fully outlined to each participant, who subsequently provided informed consent before taking part. This research strictly conformed to the ethical standards established in the Declaration of Helsinki for research involving human subjects.

Sample size calculation

The sample size was determined based on findings from a pilot study; these indicated a significant difference in the mean change (pre-treatment to post-treatment) in pain pressure threshold readings between the PMR exercises group (2.01 ± 0.39) and the Pilates exercises group (2.90 ± 0.24). Using an unpaired t-test, a significance level (α) of 0.05, a power of 80%, and an effect size of 0.74, it was calculated that 30 patients would be required per group. To prepare for a possible 15% dropout rate, the sample size was adjusted to 35 women per group, as analyzed using GPower 3.0.1 software (available at <http://www.psych.uni-duesseldorf.de>).

Outcome measures

Pressure Algometer

The pain pressure threshold (PPT) was determined in all participants in groups A & B before and after treatment using a hand-held Pain Test (Wagner, USA) pressure algometer with a probe size of 1.0 cm^2 . Evaluating PPT provides a valid and reliable method for assessing the subjective perception of pain. Pressure algometry, a tool used in manual therapy, quantifies PPT objectively and studies have shown predictable differences across spinal areas from the cervical to the lumbar levels. The examiner identified four primary points for assessment, located 5 cm laterally from L3 and L5 spinous processes on each side. The PA pressure force was incrementally raised at a rate of one kilogram per second. This was done by silently counting the seconds during the pressure increase. The participant was then instructed to notify the assessor when the applied pressure elicited pain at the assessment points [16].

Oswestry Disability Index (ODI)

Functional disability and QOL were assessed in both groups (A & B), before and after treatment, using ODI. QOL was evaluated by ten questions examining how LBP affected daily activities of each participant in both groups, both pre- and post-study. The Punjabi version of the ODI (ODI-P) provides a validated and reliable measure of disability due to LBP, making it appropriate for application in both research and clinical contexts [17].

The ODI evaluates functional impairment based on ten factors, including pain intensity, personal care ability, lifting capacity, work performance, sitting, standing, sleep quality, sexual function, social engagement, and travel capability. Each question was rated on a scale from 0 to 5, with the total possible score being 50. To obtain a percentage, this score was then multiplied by 2. Based on the scoring, disability was stratified into:

- 0–4: Non-disabled
- 5–14: Mildly disabled
- 15–24: Moderately disabled
- 25–34: Severely disabled
- 35–50: Completely disabled [18].

Interventions

Group (A) included thirty postnatal women who underwent progressive muscle relaxation exercises three times per week for four weeks. Similarly, Group (B) also comprised thirty postnatal women who participated in Pilates exercises with the same frequency and duration. Each exercise intervention was performed three sessions a week under the supervision of the physical therapist at the outpatient clinic of El Kasr El-Einy University Hospital, Cairo University.

Progressive muscle relaxation (PMR) exercises

All women in group A performed PMR exercises three times a week for four weeks, as three sets with five repetitions for each muscle group. The patient was instructed to be in a comfortable supine position in a quiet place, inhale slowly and deeply while firmly contracting the muscle group to the maximum without causing strain. This tension was maintained for five seconds, and then the patient exhaled while relaxing the muscles. She then maintained this relaxation for 10 seconds before proceeding to the next muscle group.

The following muscle groups were exercised:

- Hands and arms (for both left and right - one hand at a time, with a tight fist, the forearm was brought up to the shoulder and the upper arm was tightened).
- Forehead (the eyebrows were raised as high as possible).
- Eyes and cheek (the eyes were squeezed tightly with a tight smile).
- Mouth and jaw (the mouth was opened wide and held).
- Neck (head was pulled back slowly and held).
- Shoulder (the shoulders were raised to the ears then the blades were pushed back and the chest forward and held).
- Stomach (chest and abdomen were fully expanded).
- Leg (the thighs were tightened by pushing out of the chair, then pulling the toes up towards her shin, tightening the calf muscle).
- Toes (the toes were curled downwards and held)

Pilates exercises

The women in group B received this treatment three times a week, with each session lasting half an hour, for a total of four weeks. All participants were given an introductory session on Pilates-based exercises and trained in activating their core muscles before the first session of the treatment program. This involves isometrically contracting the transversus abdominis, pelvic floor, and multifidus muscles during exhalation in diaphragmatic breathing. Each exercise was repeated between five and ten times and each contraction was held for 10 seconds.

Pilates exercises included:

Pelvic Curl (the patient was asked to assume a supine position with bent knees, take a deep breath in to prepare, exhale, raise the pelvis and spine, take a breath in, hold, breathe out and lower the trunk gradually).

Single-leg lift (from supine position with knees bent, she was asked to breathe out and lift one leg upward, forming a 90-degree angle between the thigh and the surface, breathe in and return the leg to the starting position, then proceed to the opposite leg).

Chest lift (from supine position, with knees flexed, the patient was asked to lift the head, upper trunk, and shoulder blades off the surface; she inhaled deeply, pulled the abdominals in further while maintaining the lift of the trunk, hold; she exhaled, while lowering the head and chest back to the starting position).

Supine spine twist (from lying on the back with the legs elevated to a tabletop position, the patient was asked to exhale, slightly tilt the pelvis backwards; she inhaled, rotated the spine and pelvis, brought the legs towards one side; she then exhaled and returned to the center; she inhaled again, rotating the spine and pelvis to lower the legs to the opposite side; finally she exhaled and returned to the center).

Basic back extension (from lying face down, placing the forehead on a small cushion, she was instructed to inhale

and lift the head and upper back gently off the plinth, starting from the top and moving sequentially downward; this position was held for a few breath cycles, and then the patient exhaled and lowered herself back to the starting position).

Statistical analysis

Results are presented as the mean $\pm$ standard deviation. For comparing normally-distributed variables between the two groups, the unpaired t-test was utilized [19]. The Analysis of Covariance (ANCOVA) was used for comparing values before and after treatment, with adjusting for the initial measurements [20]. Differences in data before and after treatment within each group were analyzed through the paired t-test [21]. For non-normally distributed data, the Mann-Whitney test was applied to compare between groups [22] while the Wilcoxon Signed Rank test was used for analyzing differences within groups at baseline and after treatment [23]. Data analysis was conducted using Statistical Package for Social Sciences (SPSS) software, version 19 for Windows [24]. A p-value of 0.05 or less was deemed statistically significant.

Results

No statistically significant differences were observed between the two groups with regard to their general demographic or anthropometric characteristics ($p > 0.05$; Table 1).

Table 2 presents the intragroup and intergroup comparisons of the pre- and post-treatment ODI values. A statistically significant difference was found between groups A and B post-treatment, with group B showing a more significant decrease in ODI scores.

The intergroup and intragroup comparisons of pre- and post-treatment PPT values are shown in Table 3. A statistically significant difference between groups A and B post-treatment, with group B exhibiting a more significant increase in PPT scores.

Tab. 1. Demographic features (general characteristics) of the two studied groups

	Group A	Group B	t value	p value
Age [yrs]	28.70 $\pm$ 2.56	28.73 $\pm$ 2.66	-0.049	0.961 (NS)
Weight [kg]	69.57 $\pm$ 6.27	68.93 $\pm$ 6.10	0.397	0.693 (NS)
Height [cm]	158.43 $\pm$ 5.03	158.93 $\pm$ 6.14	-0.345	0.731 (NS)
BMI [kg/m ²]	27.69 $\pm$ 1.28	27.35 $\pm$ 1.35	0.992	0.325 (NS)

Data are expressed as mean $\pm$ SD; BMI- body mass index, NS- Not significant ($p > 0.05$), p- probability; SD- standard deviation; t value- paired t test.

Tab. 2. Inter- and intragroup comparisons of ODI, measured at pre and post-treatment

ODI	Group A	Group B	Z# value	P value
Pre-treatment	35.97 ± 2.80	35.80 ± 2.78	-0.223	0.824 (NS)
Post-treatment	18.17 ± 2.78	8.93 ± 2.41	-6.667	0.001 (S)
Difference between means	17.80	26.87		
% change	49.49 ↓↓	75.06 ↓↓		
Z## value	-4.815	-4.800		
p value	0.001 (S)	0.001 (S)		

Data are expressed as mean ± SD; NS- not significant ($p > 0.05$), ODI- Oswestry Disability Index, S- significant ($p \leq 0.05$), Z# value- Mann-Whitney test, Z## value- Wilcoxon Signed Rank Test.

Tab. 3. Inter- and intragroup comparisons between mean PPT values measured at pre- and post-treatment

PPT	Group A	Group B	F value	P value
Pre-treatment	3.54 ± 0.37	3.67 ± 0.43	1.361	0.248 (NS)
Post-treatment	5.26 ± 0.52	6.50 ± 0.56	75.444	0.001 (S)
Mean difference	1.72	2.83		
% change	48.59 ↑↑	77.11 ↑↑		
t value	-16.760	-25.294		
p value	0.001 (S)	0.001 (S)		

Data are expressed as mean ± SD; F value- ANCOVA test; NS- not significant ($p > 0.05$), PPT- pain pressure threshold, S- significant ($p \leq 0.05$); t value- paired t test.

Discussion

Postnatal low back pain (LBP) refers to pain and discomfort situated between the lower rib margin and the upper boundary of the buttocks, which begins shortly after childbirth and is exacerbated by physical activity but alleviated by rest. During the postnatal period, many women experience sacroiliac joint pain in addition to postural backache. This the pain is aggravated by long periods of sitting, and further exacerbated by lifting the baby [25].

The systematic relaxation of the major muscle groups in PMR can lower the stress response, and reduce skeletal muscle tension and pain perception [6]. Pilates is a popular approach for the management of LBP, with the primary goal of enhancing static and dynamic stability, posture, and overall movement pattern [26]. This study aimed to compare the effect of PMR and Pilates exercises on postnatal LBP. Our findings indicate that Pilates yielded significantly more favourable PPT and ODI values than PMR, with a greater decrease in ODI and a more

significant increase in PPT. Rhoads [27] reports that progressive muscle relaxation leads to neurotransmitter release, including serotonin, dopamine, noradrenaline, acetylcholine, GABA, and endorphins, often referred to as “feel good” hormones due to their role in inducing feelings of contentment and well-being. Additionally, relaxation techniques can diminish pain or the perception of pain and tension, foster a positive mental status, decrease anxiety before an event, and reduce stress-related anxiety. These practices also enhance parasympathetic activities, which support rest and repair, reduce the cardiac index, lower blood pressure, and improve physical activity performance.

PMR training has been found to increase blood flow and improve cellular metabolism: training can support the elimination of nociceptive receptors, which are responsible for causing pain. Patients consequently experience a decrease in perceived pain [28]. Our findings corroborate those of Lamadah et al. [29], who demonstrated that PMR can alleviate LBP and enhance QOL during pregnancy, and should be recommended as an alternative to pharmacological pain management for expectant mothers. Our results also agree with Yu, et al. [30], who found that PMR reduced pain intensity, improved back pain-related functional impairment, and decreased somatization and depressive symptoms. Additionally, Dhyani et al. [31] report that the utilization of PMR as a therapeutic approach was linked to diminished pain perception, reduced stress levels, and enhanced overall well-being among individuals with chronic LBP. Moreover, Akmeşe et al. [6] note that music-accompanied PMR is beneficial for enhancing pain management and QOL in pregnant women experiencing LBP.

Pilates concentrates on deep core muscle activation, spinal stabilization exercises, and body postural controls: these factors improve the strength and endurance of deep muscle groups, the interaction between them and the entire muscle, joint compression, pelvic inclination, postural control, and spine stability; all of these help to keep the spine neutral and upright in the pelvis and reduce the perceived force of the lumbar spine on stimuli sent by nociceptors, which in turn relieves pain. This suggests that Pilates may be of value in relieving low back pain [32]. Our findings are consistent with those of Kanase and Patil [33], who found Pilates treatment to achieve superior results over traditional training in terms of back pain relief, abdominal muscle strengthening, and QOL enhancement. In addition, Askari et al. [34] found that modified Pilates exercises provided greater improvements in muscle tolerance, lumbopelvic motion control, and pain and disability reduction compared to general exercises; as such, people with nonspecific chronic LBP can benefit from Pilates activities as part of their rehabilitation.

Oktaviani [35] found Pilates to be a safe, practical, and effective way to reduce pain during pregnancy, and hence a useful substitute exercise for suppressing pain during the third trimester of gestation. Also, Valenza et al. [36] found that Pilates exercises for eight weeks proved efficacious in recovering disability, reducing pain perception, enhancing flexibility, and improving balance in chronic non-specific LBP. Conversely, Bhadauria and Gurudut [37] examined the usefulness of lumbar stabilization, dynamic strengthening, and Pilates in managing chronic LBP. The findings indicated that lumbar stabilization is more effective than Pilates on improving pain levels and functional outcomes for individuals with chronic LBP. The authors attribute this to the shorter duration of the Pilates group intervention compared to other studies: the effectiveness of the Pilates program was determined after only a six-week regimen. Compared to groups who performed dynamic strengthening and lumbar stabilization exercises, the patients in the Pilates group experienced symptoms for a longer period of time.

The present randomized controlled trial highlights the significance of Pilates exercises and PMR exercises for physical therapy treatment for postnatal LBP. Our findings demonstrate that a four-week program of PMR exercises and a four-week program of Pilates exercises can both improve PPT and QOL in this population, although Pilates exercises achieve better results than PMR exercises. These findings underscore the importance of taking a multimodal physical therapy approach, PMR and Pilates exercises, to address the multifaceted impairments associated with postnatal LBP.

Although this is the first study to compare the effect of PMR and Pilates exercises on postnatal LBP, some limitations should be recognized. The study population consisted of postnatal women with LBP, and so results may not be fully applicable to other populations. Also, the length of the intervention was limited to four weeks, and a longer-term follow-up is needed. Furthermore, the study did not track participants' adherence to the exercise regimens after it was over. Building on these findings will require longer studies in more varied populations.

Conclusions

Pilates exercises achieve better results than PMR exercises in treating postnatal LBP, indicated by increasing the value of PPT and decreasing that of ODI.

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Conflicts of interest

The authors declare no conflict of interest

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