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# Application of Pilates-based exercises in the treatment of chronic non-specific low back pain: state of the art

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## ABSTRACT

According to the current recommendations on the management of chronic non-specific low back pain (CNLBP), the intervention in this group of patients should include a programme of exercises. Pilates is a system of exercises widely used in patients with low back pain. The practices based on this method have promoted the restoration of the function of muscles involved in lumbopelvic stabilisation, that is, transversus abdominis, multifidus, diaphragm and pelvic floor muscles. During each exercise, specific principles of this method should be followed to restore or sustain the motor control of the lumbar spine and proper body posture. The aim of this study is to present the current state of knowledge concerning the application of Pilates method in the management of CNLBP as well as to define factors (eg, duration, frequency, exercises performed on a mat or specific equipment) influencing the effectiveness of Pilates in these individuals.

## INTRODUCTION

Low back pain due to its growing prevalence is a challenge for healthcare system and a significant social problem. It has been assumed that lifetime prevalence of low back pain might be up to 84% and the prevalence of chronic non-specific low back pain (CNLBP) is 23%.[1 2] In the literature, low back pain is defined as 'pain, increased muscle tension and/or stiffness with or without referred lower limb pain and localised between the costal margin and the inferior gluteal folds'.[1 3] It has been estimated that CNLBP occurs in 85%–90% of patients.[4 5] Non-specific character of pain is diagnosed when pathologies (eg, tumour, osteoporosis, spinal canal stenosis, compression fracture, structural deformities of spine, inflammations/infectious diseases, lumbar radiculopathy, cauda equina syndrome) have not been recognised in a patient.[3 6 7] If the duration of pain exceeds 12 weeks, it is described as chronic.[4] Risk factors: female sex, middle age,[8] sedentary lifestyle as well as strenuous physical activity,[9 10] occupational overload,[6] smoking and obesity.[11] What's more, psychosocial aspect of CNLBP has been highlighted.[12–14]

The aim of this paper is to present the up-to-date state of the art on the application of Pilates-based exercises in CNLBP. The findings from systematic reviews (including studies up to 2015) and current research (up to 2018) were incorporated. What's more, based on the results of studies, the attempt of standardisation of Pilates training in this group of patients was performed.

## PILATES METHOD

The Pilates method is a concept of body and mind exercises founded by Joseph H Pilates in the early 1900s.[15] In the development of his own method Pilates drew inspiration from yoga, martial arts, Zen meditation, ballet, as well as ancient Greek and Roman exercises.[16]

The first beneficiaries of the method were patients of a hospital in a prison camp, where Pilates was involved in convalescence of patients during World War I.[16] Afterwards, in 1920s he founded a studio in the USA, where he used his concept in the recovery of injured dancers.[16] Unique for this method are the following key principles of carrying out exercises.[16–18] These principles are[16–18]:

1. Centring—activisation of core muscles, 'powerhouse': transversus abdominis, diaphragm, abdominal oblique muscles, multifidus, pelvic floor muscles, during exercise. These muscles are involved in stabilisation of the lumbopelvic complex.
2. Concentration—focusing attention on proper performance of Pilates exercises.
3. Control—exercise is performed with concentration, control of movement and posture.
4. Precision—refers to paying attention to the quality of exercise technique. The exercises are performed only with a few repetitions (to 10 times) with gradual increase of difficulty and in proper breathing rhythm.
5. Breathing—exercises are carried out in breathing rhythm, as breathing promotes activation of deep trunk muscles.
6. Flow – smoothness during exercises and flowing transition between consecutive exercises.

In Pilates, emphasis is especially placed on alignment of body posture, which means adequate adjustment of the head, shoulder and pelvic girdle in neutral position with maintaining spine curvatures as well as axial position of the lower limbs and symmetrical weight-bearing of the feet in standing position.[19] Pilates sessions are run individually or in groups. Most frequently the exercises are performed on a mat, but special equipment (Reformer, Cadillac, Wunda Chair, Ladder Barrel) can be used as well.[16 20]

## THE REVIEWS ON EFFECTIVENESS OF PILATES IN CNLBP

The effectiveness of the Pilates method in patients with CNLBP was analysed meticulously in reviews, systematic reviews (including Cochrane Database of Systematic Reviews) and meta-analyses. The three newest are from the years 2005–2015.

A systematic review by Wells *et al* was prepared on the basis of 14 randomised controlled trials (RCT) selected from 152 studies from the years 2005–2014.[21] In incorporated studies the Pilates method was compared with minimal intervention (usual care), massage and other forms of exercise, such as cycling, McKenzie method, traditional lumbar stabilisation exercise and mixed form of treatment package—stretching, strengthening and stabilisation.[21] Pilates programmes were delivered one to three times per week, for 4–15 weeks, and the duration of each session was 30–60 min. Mats or specialised Pilates exercise equipment were used.[21] The evaluation of the therapeutic programmes was carried out after 4–15 weeks following their termination (defined as a short period). In one study, the follow-up was performed after 24 weeks. For outcome measures, such tools as visual analogue scale (VAS) and numeric rating scale (NRS) for pain intensity, the Roland Morris Disability Questionnaire (RMDQ) and Oswestry Disability Index (ODI), and the Quebec Score and the Miami Back Index for functional capacity or disability were used.[21] The results suggest that Pilates exercise offers greater improvements in pain intensity and functional ability compared with usual care and physical activity—minimal interventions in the short term, but in comparison to a massage or other forms of exercise, the Pilates method provides equivalent outcomes.[21] The authors indicate the need of further research on optimal Pilates exercise programme designs and on defining subgroups of patients with CNLBP who may likely benefit from Pilates.[21]

The Cochrane Systematic Review included 10 RCTs from 2006 to 2014 that compared Pilates to minimal intervention (six trials), that is, education, non-steroidal anti-inflammatory drugs, following daily activities and no intervention, or other types of exercises (four studies) (McKenzie, general exercise, stationary cycling).[22] Pilates programmes lasted from 10 to 90 days with a various number of sessions—from 6 to 30; approximately 1-hour sessions were performed from one to four times per week. Outcome measures were recorded in short-term (up to 3 months) and intermediate-term follow-ups (up to 6 months). Based on the low to moderate-quality evidence it was found that Pilates is more effective than minimal intervention as regards pain reduction (VAS), disability (ODI, RMDQ) and function outcomes (Patient-Specific Functional Scale), and global impression of recovery (Global Perceived Effect Scale) in short term, and regarding pain relief and disability outcomes in intermediate term.[22] In this review, no conclusive evidence was found that Pilates is superior to other forms of exercise.[22] No adverse effects were found, or they were minor.

The latest systematic review by Lin *et al* is based on eight RCTs selected from 40 studies up to the year 2015.[23] The Pilates method was compared with minimal intervention or other forms of exercise. It was found that Pilates compared with no or little intervention, usual healthcare applied in 4–12 week programmes can be effective in pain reduction (VAS) and functional improvement (RMDQ); the improvement in two out of five trials reached minimal clinically important differences.[23] This improvement was observed in 12 or 24-week follow-ups. However, no minimal clinically important differences in pain relief or functional ability were achieved in 6–8 week Pilates programmes and other forms of exercise (stationary cycling or general exercises).[23]

## THE STANDARDISATION OF PILATES TRAINING IN CNLBP

In the aforementioned reviews, factors influencing the effectiveness of the Pilates method, such as duration, frequency and conditions of a session (on a mat or with specialised equipment), were pointed out. It is crucial to create relevant and homogenous standards on Pilates training and to determine subgroups of patients with CNLBP who are likely to benefit from this method.

Wells *et al* carried out a survey study (using Delphi technique) among 30 Australian physiotherapists and Pilates instructors.[24 25] Respondents agreed that indications for Pilates in people with CNLBP include primarily maladaptive movement patterns and lack of body awareness, and then poor breathing pattern, fear avoidance behaviour, pain, poor postural control, psychosocial factors associated with pain, reduced lumbar spine mobility and weak stabilising muscles of the lumbar spine.[24] Within potential benefits there are: improvement in functional ability and confidence with movement, exercise and activities; increased activity of stabilising muscles of the lumbar spine; promotion of body awareness; and control of posture and movement patterns.[24] Contraindications comprise unstable fractures, with caution required in unstable spondylolisthesis and radiculopathy.[24] Potential risks can include: increase in low back pain, aggravating pathology, excessive muscle tension or even self-injury during exercises.[24]

Furthermore, it was suggested that Pilates exercises in patients with CNLBP should be performed during supervised sessions with a duration of 30–60 min and a frequency of two sessions per week.[25] Nevertheless, this intervention should last from 3 to 6 months.[25] A similar recommendation was provided by Lin *et al*. According to those authors, Pilates exercises should be administered more than two to three times a week, with a session lasting minimum 60 min, within at least 20 sessions (20 hours).[23]

Valenza *et al* evaluated the effectiveness of an 8-week Pilates programme in patients with CNLBP.[26] Pilates exercises were performed in the intervention group two times a week within 45 min sessions, carried out on a mat with the supervision of an instructor.[26] The level of difficulty (basic, intermediate, advanced) was individually adopted to a participant. The individuals in the control group continued their daily activity and obtained an educational leaflet with information about postural care, physical activity, lifting weights, and so on.[26] The outcome measures were pain intensity (VAS), lumbar mobility (modified Schober test), flexibility (finger-to-floor test), balance (single-limb stance test) and disability (RMDQ, ODI). The evaluation was performed after the intervention.[26] The improvement was observed in the experimental group in a majority of the assessed aspects. Although the 8-week programme was effective in the management of patients with CNLBP, the authors presented limitations of their study, such as lack of patient's satisfaction evaluation and follow-up of long-term effects of the Pilates method in CNLBP.[26]

In the research by Miyamoto *et al*, the evaluation of different doses of Pilates-based exercises in 296 patients with CNLBP was performed.[27] The study involved the comparison of providing education booklet with the application of different frequencies (once, twice and three times per week) of individual supervised 1-hour Pilates sessions with delivering merely educational booklet in a 6-week treatment programme in patients with CNLBP.[27] The results revealed small to moderate short-term improvement in pain and disability in all groups with Pilates sessions with the comparison to participants given only advice.[27] The analysis of the different

frequencies of Pilates-based exercises showed that application of two sessions per week seems to be better than once a week and provided clinically important improvements.[27] What's more, the three sessions per week did not influence on beneficial effect in decreasing pain and disability.[27]

### Which subgroup of individuals with low back pain may be prone to benefit from Pilates exercises?

Stolze *et al* attempted to determine a preliminary clinical prediction rule for identifying a subgroup of patients with low back pain likely to benefit from Pilates-based exercises.[28] The study was performed in a group of 96 patients treated with an 8-week Pilates exercise programme (with the use of Reformer) with two sessions per week.[28] The inclusion criteria included: low back pain without signs consistent with nerve root compression, modified ODI score of minimum 20% (from moderate disability) and no previous spinal fusion surgery.[28] Based on the results of the study, variables such as the total trunk flexion range of motion (ROM) of 70° or less, duration of current symptoms of 6 months or less, no leg symptoms in the last week, body mass index of 25 $kg/m^2$ or more, and left or right hip average rotation ROM of 25° or more should be included in the clinical prediction rule for classifying individuals with CNLBP who can benefit most from Pilates-based exercise.[28] It should be noted that this research was carried out in a group with a majority of women (81% of participants) and the authors pointed out that this result should be verified in further RCTs.[28]

### Pilates mat versus equipment-based exercises

In some research studies, a comparison of the effectiveness of the mat and equipment-based Pilates exercises was performed.

Lee *et al* compared the influence of Pilates mat and Pilates apparatus exercises on pain intensity (VAS) and balance (balance performance monitor) in a group of 40 businesswomen with CNLBP.[29] The intervention was carried out during 8 weeks with 50 min sessions with a frequency of three sessions per week. Significant improvement in balance (posturographic parameters) and pain reduction was noted in both groups. However, greater improvement was found in favour of Pilates mat exercises.[29] Due to the authors, this result may indicate that exercises using body weight to strengthen stabilising muscles are more suitable than exercises with apparatuses in this group of patients.[29]

Contrary findings were obtained by da Luz *et al* who compared the effectiveness of Pilates mat and equipment-based Pilates exercises (with the use of Reformer, Cadillac, Ladder Barrel, Step Chair) in a group of 86 individuals with CNLBP.[30] The 6-week programme included individual, 1-hour sessions performed twice a week and supervised by a Pilates-experienced physical therapist.[30] The outcome measures were: pain intensity (NRS), disability (RMDQ), global perceived effect (Global Perceived Effect Scale), patient's specific disability (Patient-Specific Functional Scale) and kinesiophobia (Tampa Scale for Kinesiophobia).[30] The assessment was recorded after 6-week intervention and 6 months. A significant difference was noted in both groups after a 6-week programme in all evaluated aspects. After 6 months, a significant difference was found in disability, specific disability and kinesiophobia in favour of equipment-based Pilates exercises.[30]

In the study by Cruz-Diaz *et al*, the influence of Pilates mat exercises and equipment-based Pilates exercises (with Reformer) on pain (VAS), disability (RMDQ), kinesiophobia (the Tampa Scale of Kinesiophobia) and activation of transversus abdominis (expressed as a change in muscle thickness and assessed by real-time ultrasound examination) was assessed.[31] The trial involved 98 patients with CNLBP allocated to three groups: Pilates mat exercises, Pilates apparatus or the control group.[31] The programme was conducted in groups of four participants during 12 weeks with 50 min sessions (twice a week).[31] The evaluation was carried out during intervention (6 weeks after baseline) and after 12 weeks.[31] Significant improvement was found in both groups for all outcome measures after 6 and 12 weeks.[31] However, in the comparison between groups, the superiority of equipment-based Pilates was noted.[31]

In both studies,[30 31] it was suggested that the finding may be an effect of the use of apparatus in exercises that provides larger stimuli to the sensory system, resulting in larger feedback, which facilitates proper performance due to better stabilisation. According to da Luz *et al*, this result may also be caused by a placebo effect inherent for the application of equipment.[30]

### Pilates versus other methods used in CNLBP

Recently, three trials have been released, comparing the effectiveness of Pilates to another methods widely used in the management of CNLBP.[32 33]

Hasanpour-Dehkordi *et al* compared the influence of Pilates and McKenzie methods on pain intensity (McGill Questionnaire) and general health (General Health Questionnaire-28) in a group of 36 men at the age of 40–55 years.[32] The participants were allocated to groups managed by the Pilates method, the McKenzie method or the control one.[32] The intervention within the Pilates programme lasted 6 weeks with 18 sessions (three sessions per week), while in the McKenzie group it was 20 days (1-hour sessions with extension and flexion-type exercises).[32] Significant improvement in pain relief was observed in both experimental groups, with no superiority of any method. However, there was a significant difference in general health in favour of Pilates.[32] Additionally, the authors concluded that Pilates might be the low-cost and safe management of CNLBP.[32]

In the study by Kofotolis *et al*, the influence of Pilates and trunk strengthening exercise programme on functional disability (RMDQ) and health-related quality of life (the Short-Form 36 Health Survey) was evaluated in a group of women with CNLBP.[33] The 8-week intervention (with three sessions per week) included 101 participants divided into three groups: with Pilates training, with trunk strengthening exercises, and control.[33] The evaluation was performed in the course of treatment, directly after the programme and in a 3-month follow-up.[33] It was found that Pilates exercise programme improved health-related quality of life and functionality more than trunk strengthening exercises at every stage of assessment.[33]

Mazloum *et al* compared the effectiveness of selective Pilates and extension-based exercises on pain (VAS), lumbar spine curvature (flexible ruler), the ROM of lumbar flexion (modified Schober test) and physical disability (ODI) in rehabilitation programme of patients with CNLBP.[34] Participants were allocated in three groups: with Pilates exercises (16 individuals), extension-based exercises (15 individuals) and controls (16 individuals).[34] The duration of intervention was 6 weeks (three sessions per week); the evaluation was performed at baseline, after intervention and with 1-month follow-up.[34] The findings revealed significant improvement in both experimental groups in lumbar flexion ROM, decrease of pain and disability at the end of treatment and follow-up; however, the improvement was greater in group with Pilates—after the intervention in

## Main messages

1. Pilates-based exercises can be proposed as a therapeutic option in patients with CNLBP.
2. It has been recommended that a sessions should last about 60 minutes, with a frequency of two and three times a week, and be supervised by qualified instructors.
3. The selection of exercises during Pilates-based sessions should be tailored to patients with CNLBP.

## Current research questions

1. Which exercises from a wide range of Pilates method would be the most accurate for individuals with chronic non-specific low back pain (CNLBP) and how should they be performed (on a mat or an equipment)?
2. How long should an intervention with Pilates-based exercises last to provide the long-term effect on patients with CNLBP?
3. What kind of objective outcome measures should be chosen to assess the effectiveness of Pilates exercises?

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all above-mentioned variabilities and in decrease of pain and increase of ROM of lumbar flexion at follow-up.[34] Due to conclusions of authors, the superiority of Pilates in exercises may be the result of activation of deep stabilising muscles and restoration of lumbopelvic rhythm.[34]

## CONCLUSION

The results of the previous studies can suggest a beneficial influence of the application of Pilates-based exercises on patients with CNLBP, especially if no other modalities are used. Due to the comparative effectiveness of Pilates and other methods, it can be proposed as a therapeutic option in this group.

In numerous studies including reviews, a positive effect of Pilates such as reducing pain and improving functional outcomes was observed at short term (up to 3 months). Nonetheless, it should be noticed that the methodology of the previous studies was heterogeneous regarding a wide assortment of Pilates exercises. What's more, a majority of trials were carried out in relatively small groups (up to 50 participants) with a dominance of females at an average age of 40–50 years.

According to the abovementioned reviews, it has been recommended that sessions supervised by qualified instructors should last about 60 min, with a frequency of two to three times a week. Additionally, the exercises should be individually selected for each participant. The positive effects of Pilates were observed after a period from 68 weeks to 3–6 months. However, due to ambiguous results of previous research, it is not possible to determine the superiority of mat or equipment-based Pilates in patients with CNLBP.

The fact that there have been no studies with long-term follow-up results in the lack of a consensus on the duration of pain and function improvement. Further RCTs need to be performed in large homogenous groups of patients, with at least 24-month follow-up.

## Self assessment questions

1. In the diagnosis process of CNLBP disorders such as tumour and spinal canal stenosis, compression fracture lumbar radiculopathy should be excluded.
2. Risk factors for CNLBP are male sex, age over 70 years and adequate physical activity.
3. During Pilates exercises the activation of deep stabilising muscles of lumbar spine and maintaining body alignment is optional.
4. The beneficial effects of Pilates in patients with CNLBP were observed up to 3 months, especially in reducing pain and improvement of function.
5. It has been observed that the 90 min Pilates sessions should be performed every day in subjects with CNLBP.


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## Answers

1. True
2. False
3. False
4. True
5. False