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The Use of Pilates Training in Back Pain and Musculoskeletal Disorders: A Literature Review

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Abstract:

Introduction: Pilates is a type of physical exercise invented by Joseph Pilates. They aim to have a positive effect on the body and mind. Pilates can be performed with special machines called reformers or without any additional equipment, simply on a mat. The exercises focus on strengthening the deep muscles, including the core, which can help in the treatment of patients with back pain. In addition, they have a positive effect on

maintaining correct posture and fluidity of movement. Due to the above characteristics, Pilates can be one of the pillars of therapy for back pain, musculoskeletal pain, including that associated with rheumatological diseases.
Aim of the study: The aim of this publication is to review the available literature to answer the question of whether Pilates training is a suitable intervention in back pain and musculoskeletal disorders and to compare its effects with other interventions (e.g. the Mckenzie Method or extensiona based exercises).
Material and methods: Review of the literature available on PubMed and Google Scholar database searching by the keywords: pilates, pilates and pain, pilates and back pain, pilates and spine, fibromyalgia, pilates and neck pain.
Conclusions: Pilates is a training method that can be implemented in the treatment of many ailments. These exercises have produced very good results in the treatment of back pain, neck pain, muscle and joint pain in the course of rheumatic diseases. Studies indicate that Pilates has a beneficial effect on the rehabilitation process, sometimes exceeding the effects of traditional physiotherapy. In addition to its very good therapeutic effect, Pilates is characterised by a good safety profile. Even the pregnant population can benefit from the exercises. It is likely that both mat and equipment exercises have benefits, but research on this issue is required. Given the promising results, further research should be conducted into the effects of Pilates in various pain conditions.

Key words: pilates, pilates and pain, pilates and back pain, pilates and spine, fibromyalgia, pilates and neck pain

Intorduction

Pilates is an exercise method named after its inventor Joseph Pilates. Born in Germany, Pilates lived at the turn of the 20th century. He originally called the system he invented "Contrology". It is widely recognised that Pilates is not only a type of exercise that improves physical fitness, but is also intended to have a positive impact on the psychological aspect and improve cognitive function [1, 2]. The undeniable advantage of Pilates is its versatility. It is a physical activity suitable for both children and the elderly [2]. The system of exercises developed by Pilates mainly focuses on stabilising the core muscles, which helps to maintain correct posture. There are several basic principles for the correct execution of the exercises. The role of focusing and precision over the movements performed, control of the centre of gravity when performing movements and correct, conscious use of the respiratory muscles are emphasised. Pilates is not a race - speed is of marginal importance compared to precision and fluidity of movements. The exercises are largely geared towards strengthening and stabilising the core muscles, i.e. stabilising the pelvic and back muscles [1, 2]. Pilates exercises, due to their positive effects, are used (sometimes in a modified form) in medical rehabilitation, especially in the treatment of complaints originating in the lumbosacral region [2].
Joseph Pilates developed special exercise devices. There are so-called reformers, which at first glance resemble beds. There are also devices such as the trapeze table, known as "cadillacs", which are more advanced and allow multiple exercises in different planes. In addition, there are equipment such as the tower (otherwise known as a wall unit), guillotine, several types of Pilates chairs and Pilates barrels, and many small gadgets [3]. These devices are used to generate resistance (e.g. through the use of thick springs), allowing both concentric and

eccentric muscle contraction [2]. It is also possible to perform Pilates on a mat, without reformers or other large equipment [1,2].

Methodology

Review of the literature available on PubMed and Google Scholar databases searching by the keywords: pilates, pilates and pain, pilates and back pain, pilates and spine, fibromyalgia, pilates and neck pain. When searching for publications, we focused on valuable metanalyses and studies on large research groups. We excluded case study articles and studies on unrepresentative groups with low quality evidence from the literature review.

Back pain

Back pain is a common reason for patients presenting to general practitioner offices. Patients' complaints most commonly relate to low back pain (LBP), which is pain in the area between the lower edge of the ribs and the lower fold of the buttocks. This pain occurs throughout life in the majority of the adult population [4, 5]. As a result of the strain on the lumbar spine, the initiation of degenerative processes occurs over time. Predisposing factors in addition to the ageing process include a sedentary lifestyle, heavy physical work, obesity and pregnancy. The effect of spinal overload is also the formation of intervertebral disc protrusions and nucleus pulposus herniations. This condition can cause compression of nerve roots and the spinal cord, which will result in neurological symptoms [4]. A defect in the intervertebral disc can cause LBP. This pain is exacerbated during movement, tends to recur and may evolve into chronic pain over time [4, 6]. The pain may appear suddenly or slowly increase. LBP may be accompanied by lower limb pain and neurological symptoms such as sensory disturbances. Irritation of the sciatic nerve may result in symptoms of sciatica, i.e. pain in the lower back, buttock and posterior thigh, which may even radiate to the ankle region [6].

Low back pain

The largest number of published scientific papers investigating the effect of Pilates exercise on pain relief relate to low back pain. There have been a large number of valuable studies touching on this health problem and meta-analyses that have statistically analysed the effect of Pilates training on LBP.
A statistically significant reduction in pain sensation was shown in patients with chronic low back pain (CLBP) compared to those receiving manual therapy, passive physiotherapy, but the evidence was classified as low quality [7]. In a study that additionally assessed the effect of training on quality of life, although Pilates showed a positive effect on pain reduction (MD = -0.70, 95% CI: (-1.38, -0.03), p = 0.04) , but these exercises had little effect on improving patients' quality of life [8].
Numerous studies comparing the effectiveness of Pilates to other physical activities in the context of back pain have emerged. Investigating the effectiveness of Pilates training on a mat and with equipment such as the Cadillac, Reformer and Ladder Barrel, with the implementation of two one-hour classes per week for a period of six weeks, it was shown on the basis of Numeric Rating Scale (NRS) scores after six weeks and after six months

that both forms of Pilates were effective in alleviating LBP, indicating that Pilates with equipment was likely to be more effective [9, 10]. More strongly in favour of the use of equipment during exercise are the results obtained in a study published in 2020 on women in the first mature age. The participants were divided into two groups - one performed Pilates with the help of a large piece of equipment, the other without the use of equipment, simply on a mat. It was shown that cervical, thoracic and lumbar pain was significantly lower in the group exercising with equipment [11]. These findings suggest the need for further research to answer the question of which form of Pilates exercise is more effective in relieving spinal pain [9,10,11]. Studies on non-specific low back pain (NSLBP), have shown significant efficacy of Pilates in reducing pain sensation, comparable to the use of motor control training and the Mckenzie method [12]. Studies comparing Pilates training and other general exercise programmes (e.g. stationary cycling, stretching and strength training with equipment) showed comparable benefit in terms of pain reduction but Pilates trainees were less likely to report adverse incidents such as exacerbations of back pain (7% vs. 10%), suggesting that Pilates is a relatively safe form of exercise [13]. One published study showed that trunk exercises based on the Pilates method, resulted in a 43% reduction in pain compared to baseline, while stationary bicycle exercises reduced pain by 25%, but after a period of six months the results evened out, suggesting the same long-term effectiveness of both interventions [14]. Similar results were obtained comparing Mind body exercises (a type of training that engages the body and mind through focus and breath control e.g. Pilates, yoga) with no intervention at all and the use of other exercises (e.g. aerobic, conditioning workout) or minimal intervention. The short-term effects of Pilates were better, but long-term results were similar [15]. Pilates was also found to be more effective than extension-based exercises [16]. In a meta-analysis, Pilates had better effects in reducing chronic LBP compared to the use of minimal interventions, but did not differ from other physical activities in reducing back pain [17]. In contrast, studies agree that Pilates is more beneficial than no exercise or physiotherapy intervention at all, as the lack of exercise or rehabilitation use leads to worsening LBP symptoms [18, 19]. In a population of women with chronic back pain, implementation of an 8-week Pilates programme resulted in a statistically significant reduction in pain compared to a group doing strengthening exercises and no exercise at all [20]. Pilates may also have benefits for the child and adolescent population [21, 22]. In a study on a population of adolescents with back pain who practised Pilates twice a week for 55 minutes over a period of six weeks, better results were obtained in terms of muscle endurance and tendon flexibility compared to a control group attending only physical education classes at school [21]. Equally good results after implementing Pilates training at a frequency of once a week for 4 weeks were obtained by children playing string instruments. Adding Pilates training to therapeutic exercises resulted in a reduction in perceived back pain on the Visual Analogue Scale (VAS) before playing the string instrument ($p = 0.04$) and after playing the instrument ($p = 0.01$), with no statistically significant change in perceived pain while playing the instrument ($p = 0.24$). The control group, which was only performed therapeutic exercises, did not obtain a statistically significant change in pain sensation [22].

Scoliosis

Scoliosis is a defect of the spine that manifests as curvature and deformity of the spine. In the course of scoliosis, spinal canal stenosis and progressive degeneration can occur, among other things, which manifests as pain and

neurological symptoms [23].

Studies have emerged on the potential benefits of Pilates in the treatment of scoliosis. One of the parameters assessed was the reduction of associated pain. It was shown that the use of Pilates training reduced the level of pain experienced, which was assessed using pain scales such as the Visual Analogue Scale (VAS). In addition, patients showed improvements in performance and well-being [24].

Neck pain and headaches

Neck pain is a common health problem in the age of smartphone use. As a result of prolonged, multi-hour use of these devices, ‘’text neck‘’ syndrome can develop [25]. Due to the socially increasing problem of ‘’text neck‘’ and chronic neck pain of different aetiology, many studies and meta-analyses have been conducted in recent years on chronic neck pain and the use of different exercise techniques to alleviate it. In 2023. the results of a meta-analysis of the effects of different types of exercise on chronic neck pain were published. It showed that, in the context of pain relief, the short-term effects of Pilates exercise did not show greater efficacy than other forms of exercise or the use of pharmacological pain treatment (SMD = 9.29, 95% CI -25.84 to 7.26), while the medium-term effects in the context of Pilates exercise were found to be more effective than pharmacological pain treatment (SMD = 3.11, 95% CI 2.05 to 0.17). This means that in order to benefit from Pilates exercise in relieving neck pain, training should be performed over a longer period of time [26]. A study evaluating the impact of implementing a 6-week Pilates exercise programme in 13 patients with chronic neck pain, where outcomes were assessed using scales and tests such as The Neck Disability Index (NDI), Patient Specific Functional Scale (PSFS), Numerical Rating Pain Scale (NRPS), and Abdominal Drawing in Test (ADIT), was published. Study participants were assessed a total of three times-before the start of the programme and at six and 12 weeks after the start of the programme. There was a statistically significant improvement in NDI at both 6 and 12 weeks ($p < 0.01$), with an average decrease of 4.24 points at 6 weeks and 6.85 points at 12 weeks, and an improvement in PSFS scale scores ($p <0.01$), with an average of 2.4 points at 6 weeks and 3.6 points at 12 weeks. A statistically significant ($p <0.01$) improvement in NRPS was only achieved after 12 weeks, with an average decrease of 2.6 points. The ADIT test assessing the function of the abdominal muscles (a large proportion of patients with chronic neck pain have weakened muscles), did not show satisfactory results, as after 12 weeks only two participants managed to obtain a normal score indicating good function of the musculus transversus abdominis. The results of the above study were satisfactory and indicate a positive effect of a 6-week Pilates programme on neck pain [27]. In a study on a population of people complaining of recurrent, moderate neck pain and declaring a minimum of four hours per day of smartphone use, the impact of three types of training was assessed. Participants were divided into three groups: an isometric training group (this was the control group), a stabilisation training group and a Contrology (Pilates) group. The results were based on a comparison before and 4 weeks after the training intervention of parameters such as Craniovertebral Angle (CVA), NPRS scale and NDI. After 4 weeks, improvements in CVA were noted in all groups, but the differences between groups were statistically insignificant ($p=0.6$). In the NPRS pain score, statistically significant improvement was noted in all groups after 4 weeks (neck stabilisation training: $t(48)=11.58$, $p<0.001$, Contrology (Pilates) training: $t(48)=15.71$, $p<0.001$, isometric neck training: $t(48)=7.87$, $p<0.001$). Differences

in NDI were significant in each group after 4 weeks (Neck stabilisation training: $t(48)=15.65$, $p<0.001$, Contrology training: $t(48)=16.11$, $p<0.001$, Neck isometric training: $t(48)=7.96$, $p<0.001$). The above results suggest a beneficial effect of Stabilisation and Contrology training in the reduction of pain and function in the ''text neck syndrome'' [25].

Another subject the researchers addressed was cervicogenic headache and the possible benefits of Pilates for this condition. An experiment was conducted in which the research group was instructed to perform Cervical Mobilization (CM) and additionally Clinical Pilates Exercises (CPE), while the control group had only CM introduced. The frequency of the administered interventions was 3 times a week for 6 weeks. Both the use of CM and CM+ CPE effectively reduced the frequency and intensity of headaches and the number of pain medications used. In both groups, there was a reduction in muscle stiffness and improved blood flow through the internal carotid and vertebral arteries (differences in flow rates between the study and control groups were considered statistically insignificant), and there was a reduction in pain medications taken. The implementation of CPE provided additional headache reduction as assessed by the Visual Analog Scale (VAS) and influenced a greater reduction in muscle stiffness. The results suggest that adding CPE to CM carries additional benefits [28]. In 2018, the results of a randomized control trial were published, where they tested whether Pilates is helpful in the treatment of chronic mechanical neck pain. The study group had Pilates exercises implemented at the rate of two classes per week for 12 weeks, while the control group was prescribed analgesic treatment for pain. Patients in the Pilates exercise group reported less pain compared to the control group, and scored an improvement in NDI index compared to the control group. The differences between the groups were statistically significant ($P<0.001$). Very satisfying was the reduction in pain medication use achieved in the Pilates training group. The results of the study support the high efficacy and safety of Pilates in chronic neck pain and suggest the advisability of supporting oneself with this training [29].

Shoulder Rim and Upper Limbs.

A study has been published in which researchers wanted to see if Pilates could help with upper limb dysfunction in women after breast cancer treatment. A group of women trained Pilates on a mat using a resistance band at a frequency of 3 times a week for 8 weeks. It turned out that Pilates caused a reduction in pain both during movements and at rest [30]. In a group of patients suffering from chronic shoulder pain, a study was conducted where participants were divided into a Clinical Pilates training group and a group performing conventional exercises. The Pilates training group had a statistically significant greater reduction in pain as assessed by the VAS scale relative to the control group, which had no significant improvement in relation to pain [31].

Fibromyalgia

Fibromyalgia is a rheumatic disease associated with chronic muscle and joint pain and soreness at typical tender points such as the cartilage-bone junctions of the second rib or the upper lateral quadrant of the buttock. Symptoms are accompanied by a feeling of general fatigue, often a feeling of stiffness, mental disturbances and cognitive dysfunction. The aetiology of the disease is not completely known. Mainly women from the 3rd to 5th decade of life are affected. In order to make a diagnosis, it is necessary to exclude other diseases that may cause

such conditions [32]. A study was conducted on 50 women diagnosed with fibromyalgia to assess whether Pilates training would affect their pain, overall condition and quality of life. They were divided into two groups, one group of which had a Pilates exercise program implemented at 1 hour, 3 times a week for a period of 12 weeks, while the other group performed relaxation and stretching exercises for the same amount of time. The effectiveness of the intervention was measured using the VAS pain scale and the Fibromyalgia Impact Questionnaire (FIQ). It was shown that the Pilates exercise group scored a significant reduction in pain and improvement in the FIQ after 12 weeks ($P < 0.001$), but with no improvement at week 24. The control group reported no statistically significant improvement at either week 12 or 24 [33].
In a study comparing the effects of mat Pilates exercises with aquatic aerobic exercises, women were divided into two groups-one group practiced mat Pilates and the other aquatic aerobic exercises at a frequency of twice a week for 12 weeks. Both interventions were effective in improving pain among women with fibromyalgia after 12 weeks, with aquatic aerobic exercises producing a better pain-relieving effect [34].

Juvenile idiopathic arthritis

Juvenil idiopathic arthritis (JIA) is an autoimmune rheumatologic disease. The diagnosis of JIA can be made in patients under the age of 16. There are different types of JIA, such as Oligoarticular, Polyarticular without Rheumatoid Factor (RF), Polyarticular with RF, Systemic Onset, Psoriatic, Enthesitis Related Arthritis. Common features of all types include symptoms such as arthritis, muscle atrophy, morning stiffness, subcutaneous nodules, and uveitis. The knee joints are most often affected by the inflammatory process. Skin symptoms such as salmon-pink rash may also occur [35].
A meta-analysis published in 2016 included studies regarding the effect of exercise on the course of JIA. The results of one study showed that Pilates training resulted in a reduction in pain on the VAS scale and exercise was well tolerated by patients [36]. A study on the effects of Pilates on Polyarticular Juvenile Idiopathic Arthritis was published in 2022. Children in the study group had Pilates classes implemented 3 times a week for 3 months in addition to physiotherapy, while the control group used only physiotherapy. Children practicing Pilates achieved a statistically significant reduction in perceived pain as measured by the VAS scale compared to the control group [37].

Pregnancy and childbirth

Pain relief during pregnancy and childbirth is a difficult issue as a rule for the registration restrictions of painkillers for pregnant women. Therefore, it is important to look for non-pharmacological methods to relieve pain. A meta-analysis published in 2023. meta-analysis evaluated the effect of Pilates training on pain occurring during pregnancy and childbirth. In the studies, there was no statistically significant difference in pain reduction during pregnancy between the group of women who practiced Pilates and the group who did no exercise (SMD: -0.55, $Z=0.61$, $p=0.54$), while Pilates training had a beneficial effect on labour pain relief [38]. A study on a study group of more than 50 pregnant women who practiced Pilates for 8 weeks showed satisfactory results, as pregnant women practicing Pilates reported less pain intensity on the VAS scale compared to the control group during cervical dilation compared to the control group ($p < 0.001$) [39].

Summary and Conclusion

In most of the work presented, the implementation of Pilates training was beneficial and provided pain relief. The high effectiveness and safety of the intervention suggests that these exercises can be offered to people struggling with spinal pain, neck pain, and musculoskeletal pain. Very good results have been obtained for groups of patients with rheumatologic diseases such as fibromyalgia and juvenile idiopathic arthritis, raising hopes that the training will improve their overall functioning.
The work on pain in pregnant women is also positive, but further research is still needed to confirm its effectiveness and, most importantly, its safety.
Looking for methods of non-pharmacological pain relief is an important area of research. Pilates seems to be a good direction in developing rehabilitation programs for all age groups.
Areas that require further research include comparing the effectiveness of Pilates using large equipment and Pilates performed on a mat with possible support from small exercise equipment such as resistance bands. Attending reformer-equipped and Cadillacs Pilates studios can be financially challenging for trainees, and residents of small urban centres may also not have access to such places. Another aspect, is the long-term effectiveness of Pilates training. Most studies focus on the short term use of Pilates training, usually a few weeks, which is not a long time. Conducting a study with the implementation of training for a period of several years with regular follow-ups would answer whether Pilates has additional benefits in the long term.

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Author's contribution:

Conceptualization: Anita Ptak, Michał Szyc
Methodology: Michał Szyc, Anita Ptak
Software: Michał Szyc
Check: Anita Ptak
Formal analysis: Michał Szyc, Anita Ptak
Investigation: Michał Szyc, Anita Ptak
Resources: Michał Szyc, Anita Ptak
Writing- rough preparation: Anita Ptak, Michał Szyc
Writing- review and editing : Anita Ptak, Michał Szyc

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