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From Screen Time to Spine Pain: Pilates-Based Rehabilitation for Chronic Non-Specific Low Back Pain in the Sedentary Lifestyle Era

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Abstract

Chronic nonspecific low back pain (CNSLBP) is a leading cause of disability worldwide, while prolonged sitting, excessive screen time, and physical inactivity may contribute to persistent symptoms and functional limitations. This narrative review aimed to synthesize evidence regarding Pilates-based rehabilitation for CNSLBP in the context of increasingly sedentary lifestyles. A literature review was conducted using PubMed, Google Scholar, and ScienceDirect, primarily covering publications from 2017 to 2026 and supplemented by seminal references. Eligible sources included original research articles, systematic reviews, meta-analyses, and clinical practice guidelines. Relevant publications were screened by title and abstract, assessed through full-text review, and supplemented by reference list searches. The reviewed evidence suggested that Pilates-based exercise could reduce pain intensity and disability while improving physical function, trunk muscle endurance and control, flexibility, body awareness, and health-related quality of life, particularly when compared with minimal intervention or educational advice alone. These benefits may be associated with improved trunk muscle activation, lumbopelvic motor control, breathing coordination, and confidence in movement. However, evidence regarding the superiority of Pilates over other active exercise interventions remained inconsistent, and the certainty of the available evidence varied across outcomes and comparisons. Pilates-based exercise may therefore represent a valuable component of multimodal rehabilitation incorporating ergonomic education, regular physical activity, reduced sedentary behavior, and biopsychosocial management. Further high-quality research is needed to standardize intervention protocols, determine optimal exercise frequency, intensity, and duration, and evaluate long-term functional outcomes and recurrence prevention among individuals with sedentary lifestyles.

INTRODUCTION

Low back pain (LBP) is one of the most prevalent musculoskeletal conditions and has remained the leading cause of disability worldwide for more than three decades (GBD 2021 Low Back Pain Collaborators, 2023). Globally, approximately 619 million people experienced LBP in 2020, and this number is projected to increase to 843 million by 2050, primarily because of population growth and aging (GBD 2021 Low Back Pain Collaborators, 2023). Approximately 85%–90% of LBP cases are classified as nonspecific low back pain, in which no clearly identifiable underlying pathology adequately explains the patient's symptoms (Rose-Dulcina et al., 2018). Chronic nonspecific low back pain (CNSLBP) is recognized as a

complex, multifactorial condition influenced by interacting biomechanical, physical, psychological, environmental, and behavioral factors (Rose-Dulcina et al., 2018). Although nationally representative epidemiological data on LBP in Indonesia remain limited, individual studies have reported prevalence estimates ranging from 7.6% to more than 30%, particularly among occupational groups exposed to prolonged sitting or repetitive postural loading (Andini, 2015).

The widespread adoption of digital technology has contributed to increasingly sedentary patterns of work and daily living, characterized by prolonged sitting and extended screen time (Bontrup et al., 2019). According to the 2018 Indonesian Basic Health Research survey (Riset Kesehatan Dasar, Riskesdas), 33.5% of Indonesians aged 10 years or older had insufficient levels of physical activity, highlighting a substantial public health concern related to physical inactivity (Kementerian Kesehatan Republik Indonesia, 2018). A systematic review and meta-analysis reported an association between sedentary behavior and an increased risk of LBP among adults, with prolonged sitting identified as a potential contributing factor (Mahdavi et al., 2021). Prolonged sitting may contribute to the development or persistence of CNSLBP through reduced postural variability, altered trunk muscle activity, and sustained mechanical loading of spinal structures, although these proposed mechanisms do not establish a direct causal relationship (Bontrup et al., 2019). In response to these challenges, Pilates-based exercise has gained attention as a rehabilitation approach emphasizing trunk muscle activation, lumbopelvic stabilization, postural control, coordinated breathing, and movement quality. These components may contribute to improvements in pain, physical function, and movement confidence among individuals with CNSLBP (Kloubec, 2011; Vera-Saura et al., 2024).

METHOD

This narrative literature review was conducted to synthesize evidence on Pilates-based rehabilitation for chronic nonspecific low back pain (CNSLBP) in the context of sedentary lifestyles. A literature search was performed using PubMed, Google Scholar, and ScienceDirect to identify relevant publications from 2017 to 2026. The search incorporated the terms "low back pain," "nonspecific low back pain," "Pilates," and "sedentary lifestyle," combined using the Boolean operators AND and OR.

Eligible publications included original research articles, randomized controlled trials, cohort and cross-sectional studies, systematic reviews, meta-analyses, and clinical practice guidelines addressing nonspecific low back pain, Pilates-based rehabilitation, sedentary behavior, or screen time. Articles published between 2017 and 2026 were considered if their full texts were available in English or Indonesian. Publications were excluded if the full text was inaccessible, the language did not meet the eligibility criteria, or the study population and outcomes were unrelated to the review objectives. Selected seminal references published before 2017 were also included to provide relevant conceptual, historical, or epidemiological context.

The titles and abstracts of retrieved publications were screened for relevance to the review objectives, followed by full-text assessment of potentially eligible articles. The reference lists of included publications were also examined to identify additional relevant studies. Findings from the selected literature were synthesized narratively, with emphasis on

the effects of Pilates-based rehabilitation on pain, disability, physical function, and other relevant clinical outcomes in individuals with CNSLBP.

RESULTS AND DISCUSSION

GLOBAL BURDEN OF LOW BACK PAIN

Low back pain carries a substantial and growing global burden: the number of cases is projected to increase from 619 million in 2020 to 843 million by 2050, driven largely by population growth and ageing (GBD 2021 Low Back Pain Collaborators, 2023). Low back pain is pain that starts below the scapulae and above the buttock cleft, with or without spread to lower extremities, including nerve root discomfort or sciatica (Bhadauria & Gurudut, 2017). Low back pain is categorized as either non-specific low back pain or specific low back pain based on the cause (Bhadauria & Gurudut, 2017). Low back pain that cannot be linked to a particular pathology (such as an infection, tumor, osteoporosis, arthritis, fracture, Cauda equina syndrome, etc.) is known as nonspecific low back pain (Bhadauria & Gurudut, 2017). A sprain (an overstretch) of a ligament or muscle, a slight issue with a disc or facet, or minor abnormalities with the lower back's structures and tissues are thought to be the source of discomfort in some situations (Bhadauria & Gurudut, 2017). Based on how long the symptoms remain, low back pain is further divided into three subtypes: acute (lasting a few weeks), sub-acute (lasting six to twelve weeks), and chronic (lasting longer than twelve weeks) low back pain (Bhadauria & Gurudut, 2017). Of all low back pain cases, 85–90% are nonspecific low back pain (Merlo et al., 2024).

A population-based musculoskeletal examination in Japan found that chronic low back pain and chronic non-specific low back pain were common in middle-aged and elderly people, which supports the view that the condition is frequent in community settings (Iizuka et al., 2017). Non-specific low back pain is varied, because of the variability between patients in pain sensitivity, physical capacity, movement control, psychosocial profile, activity level, fear-avoidance attitudes and disability pattern (Rose-Dulcina et al., 2018). This heterogeneity explains why the probability of one single passive intervention being fully effective for all individuals with non-specific low back pain is low (Rose-Dulcina et al., 2018; Zhou et al., 2024).

MECHANISMS LINKING SEDENTARY BEHAVIOR TO NON-SPECIFIC LOW BACK PAIN

Sedentary behavior is defined as any waking behavior with an energy expenditure of 1.5 metabolic equivalents or less while sitting, reclining, or lying (Tremblay et al., 2017). Activities that require little energy expenditure while a person is awake and sitting, laying, or reclining are referred to as sedentary behaviour (Guerra et al., 2023). Screen time, which implies individual or combined exposure to electronic devices with screens (such as cell phones, laptops, tablets, televisions, and video games), can be highlighted among many forms of sedentary behaviour (Guerra et al., 2023). Sedentary behaviour may contribute to low back pain by decreased water supply to the spinal disc, resulting in degenerative changes, disc herniations, decreased strength and muscular power, and hyperlordosis (Mahdavi et al., 2021).

One of the sedentary behaviours that is most commonly measured in studies involving children and adolescents is screen time (Guerra et al., 2023). A screen time of three hours or

more per day is the cutoff point frequently associated to an elevated risk of nonspecific low back pain in teenagers, where the use of smartphones, tablets, and televisions shows a more consistent relationship compared to computers (Guerra et al., 2023). Prolonged static posture during the use of digital devices is suspected to be the primary cause of lower back pain (Guerra et al., 2023). Sitting for extended periods of time can cause muscle fatigue, discomfort, and even lower back pain (Bontrup et al., 2019). This statement is in accordance with the research that states workers with chronic low back pain exhibit more static sitting behavior, characterized by fewer small movements, fewer position changes, and longer durations of stable sitting compared to the group without pain (Bontrup et al., 2019). Changing sitting positions periodically is believed to be able to reduce the mechanical load on the spine, maintain the nutrition of intervertebral disks, and reduce muscle fatigue during work (Bontrup et al., 2019). Dynamic sitting does not occur naturally, therefore it must be encouraged by education, ergonomic techniques, or technology that reminds workers to change positions on a regular basis (Bontrup et al., 2019).

In adults, the evidence linking screen-based and sedentary behaviour to low back pain is growing, although it remains less consistent than in adolescents. A systematic review and meta-analysis of longitudinal studies found that a sedentary time of at least three hours per day was associated with worse low back pain-related disability, even though sedentary duration was not consistently associated with the onset of low back pain (Alzahrani et al., 2022). Data from a birth cohort of young adults similarly showed that prolonged computer use was associated with a higher prevalence of neck pain, while using mobile devices for seven or more hours per day was associated with a higher prevalence of low back pain (Blumenberg et al., 2021). Taken together, these findings suggest that in the sedentary lifestyle era, prolonged screen time and device use may act less as a direct trigger of low back pain and more as a factor that sustains symptoms and amplifies disability, reinforcing the rationale for interventions that target screen time modification and postural variation alongside active rehabilitation.

PILATES AS A REHABILITATION EXERCISE

In the last two decades, Pilates has been increasingly practiced for rehabilitation (Kloubec, 2011). Basically, Pilates is made up of around 50 simple repeating movements which promote muscle tension, though there are small variances (Kloubec, 2011). The exercises are designed to improve muscle strength and endurance, as well as flexibility, posture, and balance (Kloubec, 2011). They are relatively easy to start and to maintain and are in line with the guidelines set forth by the U.S. Surgeon General and the American College of Sports Medicine (Kloubec, 2011). The implementation of Pilates as a rehabilitation exercise specifically for chronic non-specific low back pain is defined as a comprehensive mind-body intervention that integrates physical conditioning with mental focus (Eliks et al., 2019). Originally developed by Joseph Pilates in the early 1900s, it has evolved into a structured therapeutic tool used to restore the function of the lumbopelvic stabilizing muscles (Eliks et al., 2019). Rehabilitative Pilates is built upon several principles that ensure the quality and safety of movement. The first is centring, it means focuses on activating the "powerhouse" the core muscles including the transversus abdominis, multifidus, diaphragm, and pelvic floor to provide a stable base for the lumbopelvic complex (Eliks et al., 2019; Patti et al., 2016). The second is concentration and control, patients must focus attention on the proper performance of every movement, ensuring

that exercises are executed with full mental engagement and postural control rather than reflexively (Eliks et al., 2019; Patti et al., 2016). The third is precision, means emphasizes the quality of technique over the quantity of repetitions. Exercises are typically limited to 10 repetitions, with difficulty increased gradually as the patient gains mastery (Eliks et al., 2019). Fourth is breathing, workouts are synced with a certain rhythm of breathing, which contributes to the activation of deep trunk muscles and assists in preserving a neutral spine during movement (Eliks et al., 2019; Huang & Park, 2023). The last is flow, motions are done with fluidity, featuring flowing transitions between different workout positions (Eliks et al., 2019).

The training in Pilates is characterized by a strong effect in the activation of the core muscle groups, improving the stability of numerous parts of the body and improving the mobility of the lumbar joints (Huang & Park, 2023). Patients with chronic low back pain show a weakness of the internal oblique, transverse abdominis, rectus abdominis, multifidus, and iliopsoas muscles (Huang & Park, 2023). As these muscles weaken, lumbar stability and mobility of the lumbar spine are decreased (Huang & Park, 2023). Pilates training awakens these muscles and improves the strength and stability of the lumbar region (Huang & Park, 2023). Furthermore, it can increase the range of motion of the lumbar spine through stretch-based posture and breathing control and decrease pain and dysfunction in patients with persistent low back pain (Huang & Park, 2023).

EFFECTIVENESS OF PILATES-BASED REHABILITATION

Effectiveness of Pilates on Pain Intensity

The efficacy of Pilates-based rehabilitation on pain intensity for non-specific low back pain has been well documented across subacute and chronic phases, consistently showing significant reductions in pain relative to minimal interventions or general exercise programs (Asik & Sahbaz, 2025; Valenza et al., 2017). Systematic reviews and meta-analyses have confirmed a considerable improvement in pain intensity following Pilates in patients with persistent low back pain (Huang & Park, 2023). Meta-analyses demonstrate that Pilates leads to considerable improvement in pain scores. The weighted mean difference was -29.38 for the Visual Analog Scale (VAS) and -2.12 for the Pain Numerical Rating Scale (NRS) (Huang & Park, 2023). These changes are clinically relevant, as they are over the limits for minimal clinical relevance (17–18 units for VAS and 2 units for NRS) (Huang & Park, 2023). Valenza et al. (2017) found substantial improvements in pain following an 8-week Pilates program in comparison to a control group, who were given informational leaflets only. Likewise, Patti et al. (2016) found a higher reduction in pain perception in the Pilates group compared to the control group that engaged just in a social program. There is evidence that Pilates may significantly alleviate pain in the short term (Huang & Park, 2023). Although the effects tend to decline in the medium term (6 months after training), the patients impairment levels continue to exhibit clinically meaningful improvement (Huang & Park, 2023). In the subacute phase (4–12 weeks), a supervised Pilates program resulted in a higher reduction in pain intensity compared to a home exercise program (Asik & Sahbaz, 2025). Pilates is regarded an excellent early intervention technique to prevent pain from becoming chronic (Asik & Sahbaz, 2025). Most significant pain alleviation is observed immediately post-intervention and benefits are frequently maintained in the medium term (6 months) although the magnitude of relief may somewhat diminish over time (Huang & Park, 2023).

Effectiveness of Pilates on Disability and Function

Recent studies have shown that Pilates is helpful for reducing disability and physical function in patients with non-specific persistent low back pain. Oswestry disability index (ODI) is used to assess the severity to which back discomfort impacts daily activities. Valenza et al. (2017) reported that the Pilates program of 8 weeks decreased the score of ODI with an average of 16.35 points, which was surpassing the lowest important change of 10 points. The Pilates group demonstrated considerable functional improvement compared to the control group and the conventional exercise group, and the effects were maintained at the 8-week follow-up (Marotta et al., 2025). The change of the ODI score is related to the reactivation of the stabilizing muscles such transversus abdominis and multifidus (Bhadauria & Gurudut, 2017).

Another tool for measuring disability is the Roland-Morris Disability Questionnaire (RMDQ). The meta-analysis suggests that Pilates is better than minimal intervention to reduce short term impairment with a combined average difference of 5.2 points (Miyamoto et al., 2013). Both mat Pilates and Pilates with equipment (such as reformers) are beneficial in decreasing RMDQ scores, however the use of equipment provides faster and better effects in lowering impairment (Cruz-Díaz et al., 2017). Participants reported decreased difficulty in doing normal actions such as walking, bending, sitting and standing (Asik & Sahbaz, 2025; Valenza et al., 2017). Even in studies where the difference between Pilates and home exercise was not “clinically relevant” for handicap, the Pilates group demonstrated a substantial overall favorable benefit compared to the home-based group (Tottoli et al., 2024).

Flexibility is usually measured with the modified Schober test or finger-to-floor test (Bhadauria & Gurudut, 2017). Pilates uses a combination of static and dynamic stretching that activates the Golgi tendon organ. This inhibits the activity of alpha motor neurons, allowing the sarcomeres to elongate and safely increasing the flexibility of the trunk and lower limb muscles (Valenza et al., 2017). The Pilates program consistently reports improvements in bending ability and lumbar spine range of motion compared to no exercise (Bhadauria & Gurudut, 2017).

Patients with chronic pain often fear moving because they are worried about getting injured again, this called kinesiophobia. Pilates is effective in reducing the level of kinesiophobia (measured by the Tampa Scale of Kinesiophobia or TSK) through the enhancement of body awareness (Cruz-Díaz et al., 2017). Through an emphasis on the precision and control of movement, Pilates allows patients to become aware of what their body is capable of, which could increase their confidence to participate in physical activity and decrease their avoidance of movement (Cruz-Díaz et al., 2017; Marotta et al., 2025).

Effectiveness of Pilates on Quality of Life

Improvements in Quality of Life were significant and clinically relevant, especially in physical function and general health areas (Tottoli et al., 2024). Pilates training has been proven to improve kinesiophobia (fear of movement) and improve the patient’s general perception of recovery (Huang & Park, 2023; Tottoli et al., 2024). As high as 88% of the participants in the Pilates program had a very satisfied perception of recovery shortly after the end of the intervention (Tottoli et al., 2024). The social interaction in the supervised group sessions might explain these good psychological outcomes as well (Tottoli et al., 2024).

COMPARATIVE ANALYSIS OF PILATES WITH OTHER REHABILITATION EXERCISES

Pilates versus Conventional Exercise

Pilates was usually more beneficial than basic therapies, compared with other standard exercise interventions for chronic non-specific low back pain however the benefit of Pilates over other active exercise interventions was frequently small and variable. The McKenzie method is an exercise designed to correct posture and target specific spinal movements depending on the initial examination. A study showed that men with chronic low back pain experienced significant pain reduction after both Pilates and McKenzie training, and there was no significant difference in pain reduction between the two (Hasanpour-Dehkordi et al. 2017). Pilates may have a medium effect size (ES 0.65) in favour of Pilates compared to direction specific exercises for pain, however this was based on very poor certainty evidence (Wong et al., 2023). Pilates has shown a clear advantage in improving general health indexes, including physical symptoms, anxiety, and social dysfunction, compared to the McKenzie method (Hasanpour-Dehkordi et al., 2017).

General exercise often involves stationary cycling, floor movements, and stretching (Hasanpour-Dehkordi et al., 2017). Research by Ashtiani and Askari (2020) found no significant difference between modified Pilates and general exercise regarding lumbopelvic motor control, trunk muscular endurance, and functional disability. Some reviews suggest a slight advantage for Pilates, one meta-analysis reported it was more effective than general exercise for pain reduction (ES 0.44), though supported by low certainty evidence (Wong et al., 2023). Conversely, other systematic reviews concluded Pilates is not better than other exercises for short-term pain intensity (Miyamoto et al., 2013).

Dynamic strengthening targets mobility and the strength of global spinal muscles such as the rectus abdominis (Miyamoto et al., 2013). In comparisons, Pilates has shown a larger reduction in impairment (measured by the Oswestry Disability Index) than dynamic strengthening. This could be because dynamic strengthening can exacerbate symptoms at times due to the load placed on the spine (Ashtiani & Askari, 2020). Pilates is good, however lumbar stabilization (targeting deep muscles like the multifidus) has been proven to be more helpful than Pilates and dynamic strengthening in decreasing pain and increasing core strength (Bhadauria & Gurudut, 2017).

Minimal therapies typically involve offering patients an instructional leaflet or recommendations to remain active (Miyamoto et al., 2013). Pilates is always better than advice or booklets in decreasing pain and disability immediately after the intervention (Miyamoto et al., 2013). As there is no solid evidence for one type of exercise over another, clinicians are recommended to work with patients to select an intervention that is based on the individual's goals, preferences, and clinician skill sets (Wong et al., 2023).

Pilates versus Core Stabilization Exercise

The comparison between Pilates and Core Stabilization Exercise (CSE) or lumbar stabilization, reveals two different but successful techniques to the management of chronic non-specific low back pain. Both involve the deep musculature of the trunk, although research shows variances in their processes and clinical results. Core stabilization exercise (CSE) or lumbar stabilization, is a method for improving the neuromuscular control, strength and

endurance of the muscles responsible for maintaining spine and trunk stability (Bhadauria & Gurudut, 2017; Smrcina et al., 2022). It notably uses the "drawing-in maneuver" for co-activation of the transversus abdominis and multifidus muscles in a feedforward pattern to provide a sturdy base for the spine (Bhadauria & Gurudut, 2017; Smrcina et al., 2022). The purpose of Pilates is to maintain a 'neutral spine' and stable pelvis by activating the 'powerhouse' (transversus abdominis, pelvic floor and obliques) (Bhadauria & Gurudut, 2017). It emphasizes controlled breathing, isometric contractions, and the detachment of the extremities from the trunk to preserve control during functional motions (Bhadauria & Gurudut, 2017). A randomized clinical trial comparing these two interventions found that while both are beneficial, lumbar stabilization (CSE) proved superior to Pilates in several key areas: after 10 sessions, the lumbar stabilization group showed a significantly greater reduction in pain (Visual Analog Scale) compared to the Pilates group (Bhadauria & Gurudut, 2017), the stabilization group achieved significantly better scores on the Modified Oswestry Disability Questionnaire (MODQ) than the Pilates group (Bhadauria & Gurudut, 2017; Smrcina et al., 2022), lumbar stabilization led to more significant improvements in core muscle strength (measured by pressure biofeedback) and lumbar range of motion (flexion and extension) compared to Pilates (Bhadauria & Gurudut, 2017).

Systematic reviews reinforce that while Pilates is a valid therapeutic tool that improves general health and flexibility, there is no strong evidence that it is superior to CSE for pain relief or functional improvement) (Bhadauria & Gurudut, 2017; Smrcina et al., 2022). In fact, most high-quality evidence supports CSE as a more favorable or at least equivalent method for treating the symptoms of non-specific low back pain (Smrcina et al., 2022). Some researchers suggest that while the two are comparable, stabilization exercises address the specific muscles primarily affected by LBP (multifidus) more effectively than the broader abdominal focus of Pilates (Bhadauria & Gurudut, 2017).

Supervised versus Home-Based Pilates

Supervised Pilates programs are often more helpful for people who have subacute and chronic low back pain than independent home-based exercise programs (Asik & Sahbaz, 2025; Tottoli et al., 2024). A supervised 8-week Pilates intervention showed greater decreases in pain intensity and functional handicap throughout the subacute phase compared to a home exercise group, with ongoing benefits at 3-month follow-up (Asik & Sahbaz, 2025). Similarly, individuals suffering from chronic low back pain performed supervised mat Pilates and showed considerably less pain and disability than patients conducting home exercises immediately after a 6-week program (Tottoli et al., 2024).

Though statistical advantage was seen in several trials, the therapeutic importance of these differences remains a topic of dispute (Tottoli et al., 2024). Supervised Pilates is often numerically better. One chronic low back pain trial commented that the differences in pain and disability between supervised Pilates and home-based exercise were statistically significant but did not meet the established thresholds for minimal clinical importance (Tottoli et al., 2024).

One of the most constant benefits of supervised Pilates over home-based programs is a striking and clinically relevant improvement in health-related quality of life (Asik & Sahbaz, 2025; Tottoli et al., 2024). Supervised participants in separate research reported a higher perception of recovery and a higher quality-of-life score (Asik & Sahbaz, 2025; Tottoli et al.,

2024). This increased well-being may be due to the social interaction possible in small group supervised sessions, which is not possible in home-based regimens (Tottoli et al., 2024).

Supervised interventions' efficacy depends significantly on direct instruction and expertise from a licensed instructor (Asik & Sahbaz, 2025; Tottoli et al., 2024). Supervision leads to improved adherence rates, more consistent performance of exercises and use of right techniques such as core stabilization and neuromuscular re-education (Asik & Sahbaz, 2025; Tottoli et al., 2024). In contrast, home-based programs frequently do not have the personalized adjustments and immediate feedback that can potentially increase their effectiveness overall (Asik & Sahbaz, 2025).

Mat Pilates versus Equipment-Based Pilates

Recent research have revealed that when comparing Mat Pilates to Equipment-Based Pilates for individuals with chronic low back pain, both modalities are helpful, but differ in the pace of progress and the amount of sensory feedback. Mat Pilates involves a series of exercises (such as the Hundred, Roll-up, and Single-leg stretch) performed on a mat on the floor and uses mainly body weight for resistance (Cruz-Díaz et al., 2017). Equipment-Based (Apparatus) Pilates Uses modality utilizes specific equipment, most notably the Reformer which is a multi-pulley system and enables for intensity modulation via an adjustable spring system (Cruz-Díaz et al., 2017). Both mat Pilates and Equipment-Based (Apparatus) Pilates adhere to the same fundamental values of centering, focus, control, accuracy, breath, and flow and usually have a format of warm-up, primary training and cool-down (Cruz-Díaz et al., 2017).

Both methods have been proven to be significantly successful in enhancing transversus abdominis (TrA) activation, reducing pain, decreasing disability and reducing kinesiophobia, as evidenced by a randomized controlled trial explicitly comparing the two (Cruz-Díaz et al., 2017). But their clinical results differ significantly. Equipment-based Pilates produced faster and more substantial gains than Mat Pilates (Cruz-Díaz et al., 2017). After 12 weeks of intervention, significant changes favoring the equipment group were found, particularly concerning the activation of the transversus abdominis and the decrease in pain and impairment. The equipment group improved more than the mat group in terms of ratio of TrA activation (51.81% at 12 weeks vs. 41.87% at 12 weeks) (Cruz-Díaz et al., 2017). The Reformer provides bigger impulses to the sensory system and gives constant feedback regarding the condition of lumbopelvic stability (Cruz-Díaz et al., 2017). The feedback and proprioceptive stimulation offered by the equipment allow patients to grasp and incorporate Pilates concepts much faster than mat Pilates, where the patient must rely solely on internal awareness (Cruz-Díaz et al., 2017).

Other sources verify the fact that mat Pilates alone is still a very effective rehabilitation therapy. Studies using Matwork programs (8-week durations) consistently indicate significant reductions in peak pain intensity, subjective impairment (measured via the Oswestry Disability Index and Roland-Morris Disability Questionnaire), and pain catastrophizing (Marotta et al., 2025; Merlo et al., 2024). In fact, one study showed that at follow-up mat Pilates had a higher protective index (in terms of the Flexion Relaxation Ratio) compared to traditional workouts (Marotta et al., 2025). To summarize, although mat Pilates might be a potent and easily accessible intervention to decrease chronic low back pain symptoms (Merlo et al., 2024),

equipment Pilates may be more appealing in clinical settings where a quicker recovery and improved neuromuscular feedback are prioritized (Cruz-Díaz et al., 2017).

CLINICAL IMPLICATIONS IN MEDICAL REHABILITATION

The application of Pilates research in medical rehabilitation for the management of chronic non-specific low back pain shifts from holistic efficacy to a formal clinical methodology that promotes active, patient-centered treatment (George et al., 2021; Zhou et al., 2024). Global clinical practice recommendations state that Pilates is mainly advised for chronic and subacute phases of low back pain as a high-grade recommendation for adults and older individuals to enhance function and prevent long-term mobility handicap (George et al., 2021; World Health Organization, 2023). This makes it especially suitable for patients with lumbopelvic motor control impairments or those who prefer mind-body therapies over typical resistance training (George et al., 2021).

The program should be delivered as a supervised and structured intervention, not a stand-alone education method, achieving a total volume of at least 20 hours to ensure correct technique and adherence (George et al., 2021; World Health Organization, 2023). The main therapeutic aims are activation of the "powerhouse" known as the deep trunk muscles (transversus abdominis, multifidus) to restore the neuromuscular coordination and decrease the functional limits (George et al., 2021). Standardized assessment tools like the Oswestry Disability Index (ODI) or Roland-Morris Disability Questionnaire (RMDQ) are used to monitor progress, alongside clinical measures of the patient's ability to dissociate movements of the extremities while keeping a neutral spine (George et al., 2021; Tuninetti et al., 2025; World Health Organization, 2023).

While Pilates is effective, its application is limited by the low to very low certainty of current evidence, and its clinical superiority over other forms of active exercise is often small or inconsistent (World Health Organization, 2023). Therefore, Pilates should be integrated within a multimodal rehabilitation strategy that includes ergonomic education, physical activity promotion, screen time modification, self-management, and a biopsychosocial approach in addressing non-specific low back pain in the sedentary lifestyle era (Asik & Sahbaz, 2025; Tottoli et al., 2024).

CONCLUSION

Pilates-based rehabilitation represents a potentially beneficial therapeutic exercise approach for individuals with chronic nonspecific low back pain (CNSLBP), particularly in the context of sedentary lifestyles characterized by prolonged sitting, extended screen time, and insufficient physical activity. These behaviors may be associated with reduced postural variability, altered trunk muscle function, and persistent mechanical loading of spinal structures. However, direct causal relationships between sedentary behavior and specific structural abnormalities, such as intervertebral disc degeneration, disc herniation, or lumbar hyperlordosis, have not been consistently established. Current evidence suggests that Pilates-based exercise may reduce pain intensity and disability while improving physical function, trunk muscle control, body awareness, and health-related quality of life. These potential benefits may be supported by the integration of breathing, centering, concentration, control, precision, flow, and postural alignment into structured exercise programs. Although Pilates

generally demonstrates greater benefits than minimal intervention or educational advice alone, its superiority over other active exercise interventions has not been consistently established. Therefore, Pilates may be incorporated into individualized, multimodal rehabilitation programs that include ergonomic education, physical activity promotion, strategies to reduce prolonged sedentary behavior, progressive exercise prescription, self-management support, and biopsychosocial care. Further high-quality research is needed to standardize Pilates intervention protocols, determine optimal exercise frequency, intensity, and duration, and evaluate long-term outcomes, including pain recurrence, disability reduction, and functional recovery among individuals with CNSLBP who engage in prolonged sedentary activities.

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AUTHOR CONTRIBUTION

Nonidha Tiendie: Conceptualization, literature search, screening and selection of articles, writing – original draft, writing – review & editing, correspondence.

Abdul Hakim Pranata: Literature search, screening and selection of articles, data extraction, writing – review & editing.

Badzlina Sulistyo Putri Pratondo: Literature search, writing – review & editing, supervision.

All authors have read and agreed to the published version of the manuscript.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The authors state that generative artificial intelligence (AI) was used in the preparation of this manuscript. The authors acknowledge the use of generative AI to help improve language clarity and improve the grammatical structure of manuscripts. The use is carried out in compliance with applicable ethical guidelines regarding the use and disclosure of generative AI in scientific research. Each author has made substantial intellectual contributions to this work. The entire content of the manuscript has been carefully reviewed to ensure its accuracy, and the author is solely responsible for the integrity and final content of the manuscript.

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