

Core Training in Low Back Disorders: Role of the Pilates Method

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Abstract

The Pilates method is a system of exercises developed by Joseph Pilates, which emphasizes recruitment and strengthening of the core muscles, flexibility, and breathing, to promote stability and control of movement. Its focus bears similarity to current evidence-based exercise programs for low back disorders. Spinal stability is a function of three interdependent systems, osseoligamentous, muscular, and neural control; exercise addresses both the muscular and neural function. The “core” typically refers to the muscular control required to maintain functional stability. Prior research has highlighted the importance of muscular strength and recruitment, with debate over the importance of individual muscles in the wider context of core control. Though developed long before the current evidence, the Pilates method is relevant in this setting and clearly relates to current evidence-based exercise interventions. Current literature supports the Pilates method as a treatment for low back disorders, but its benefit when compared with other exercise is less clear.

for low back pain. While interventional approaches have gained popularity in the treatment of low back pain, exercise and physical therapy make up the foundation for most nonpharmacologic treatments. Therapeutic exercises have several advantages over other treatments, which make them appealing for the treatment for low back pain; most are relatively inexpensive, noninvasive, have few side effects, and are beneficial for the general health of an individual.

Pilates Method

The Pilates method is a system of exercises which focuses on awareness, recruitment, and strengthening of the stabilizing muscles of the body, to promote control of movement, as well as flexibility and improved posture. Joseph Pilates (1883–1967) created his method of body conditioning in the early part of the 20th century, reportedly based on his own weaknesses as well as his experiences working with soldiers at a British internment camp during World War I (13). In its early years, the method was practiced primarily by elite athletes and dancers who often suffered injuries, as it encouraged movement throughout the rehabilitation process; exercises incorporated springs, pulleys, and gravitational advantage to provide needed assistance. It has recently gained a much wider audience because the Pilates method can be used to develop general fitness, core strength, improved function, or reduced pain.

The Pilates method, commonly referred to as just “Pilates,” is traditionally taught in a private or small group session with multiple pieces of apparatus, though there are larger group classes which focus on mat exercises. Pilates method instructors complete a training and certification program of at least 450 h of lecture self-study, and assisted teaching hours, during which they learn the extensive exercises, as well as modifications for specific injuries and conditions. The Pilates Method Alliance established a third-party certification exam for the title of PMA Certified Pilates Teacher (PMA®-CPT). This organization has established standards for Pilates method instruction, after the term “Pilates” was ruled to be generic by a U.S. federal court, allowing for unrestricted use (42).

Introduction

Low back pain is a common condition which affects most people during their lives. Recent estimates indicate that the point prevalence ranges from 1% to 58.1% (median, 15.0%) and 1 yr prevalence from 0.8% to 82.5% (median, 37.4%) (20). To further characterize this impact, the Global Burden of Disease study in 2010 demonstrated that low back pain not only had a global point prevalence of 9.4% but also was the number one cause of disability in the world (21). Despite its high prevalence, treatment of low back pain can be challenging because there are multiple potential pain generators which are often difficult to distinguish clinically. Given the vast global impact, a great deal of research has been developed to evaluate various treatments

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While created more than 100 yr ago, the Pilates method has recently gained popularity in the circles of both fitness and rehabilitation, largely because of its emphasis on principles of core strength and stability. There are several Pilates method certifications and programs that market specifically toward clients with injuries, particularly low back disorders (3). The purpose of this article is to review the current literature regarding the efficacy of the Pilates method and other core training exercise for low back disorders. To do this, we will start by reviewing basic kinesiology and biomechanics with regard to the spine, which provides a framework for the study of exercise. We will then delve into the relevant research and its limitations. Finally, we will identify areas where further research is indicated.

Spine Biomechanics

To understand how the Pilates method might improve low back pain, a brief review of kinesiology and biomechanics is helpful. Frequently, studies or texts will refer to “stability” of the spine when discussing low back pain. While there is no clear consensus definition, stability generally refers to the ability of the spine to remain in a relatively neutral position during both static and active movements, thereby preventing injury to local structures (23,43,44). Spinal stability is achieved by a complex interaction of muscles, connective tissue, and joint structures along the spine and those forming the torso wall, and can be viewed as a function of three interdependent systems—the osseoligamentous system, the musculature, and the neural control system, with one system compensating for deficits in the others if necessary (38). Injury to any of these systems can lead to abnormally large movements of spinal segments, referred to as “instability.” This in turn can cause worsening back or nerve root pain by placing excessive stress on particular structures of the spine (23). The “core” typically refers to the muscular control around the spine required to maintain functional stability (1). The concept of neuromuscular control of spinal stability is an important one, because lack of muscular strength, endurance, or control may allow inappropriate or excessive segmental motion and repeated trauma to tissues in and around the spine, triggering nociceptors and resulting in pain (Fig. 1).

Given this understanding of spine biomechanics, it is not surprising that many studies have demonstrated associations between core muscle weakness, imbalance, and/or poor neuromuscular control and back pain. Initial studies on muscular activation demonstrated several abnormalities in patients with low back pain. Hides et al. observed a decrease in cross-sectional area of the ipsilateral lumbar multifidi muscles in patients with unilateral back pain, and hypothesized that this was likely secondary to disuse atrophy or reflex inhibition (16). Hodges and Richardson (18) identified a persistent delay in activation of the transversus abdominis in chronic low back pain patients performing movements of the upper extremity. O’Sullivan et al. (36,37) showed that in contrast to control subjects, patients with chronic low back pain due to spondylolysis or spondylolisthesis were unable to preferentially activate the internal obliques during the action of “drawing in” the abdominal wall.

More recently, Lee et al. (31) demonstrated that trunk muscle imbalance and weakness was associated with a higher frequency of low back pain. Another study demonstrated that

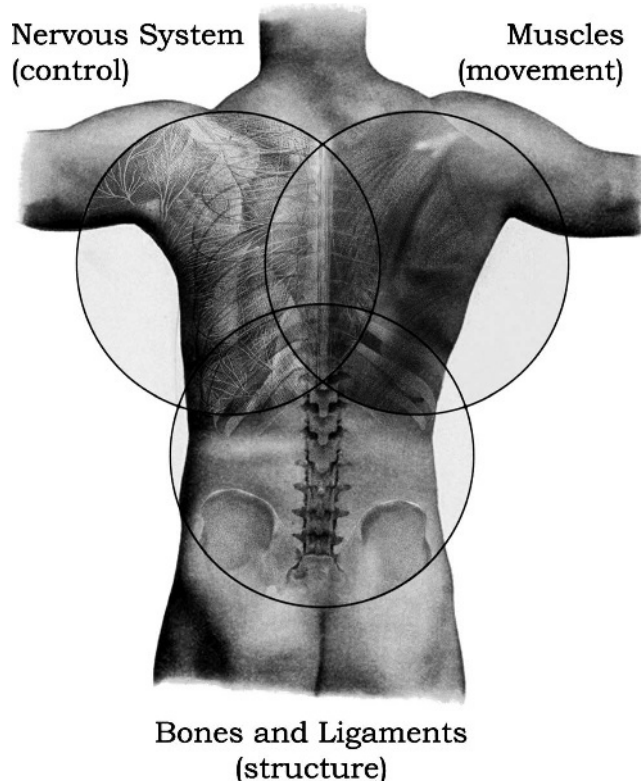


Figure 1: Systems of stability.

patients with decreased radiographic density of the multifidus and erector spinae, indicating reduced lumbar paraspinal muscle bulk, were more likely to develop CT evidence of spine osteoarthritis (6). Furthermore, subjects with less functional trunk strength, as measured by isometric and isokinetic trunk flexion and extension strength, are more likely to develop low back pain (24). In summary, these studies seem to indicate that core muscle weakness, imbalances, or poor neuromuscular control have a relationship with spine biomechanics and the development of low back pain.

Core Exercise Evidence

While the osseoligamentous system is relatively difficult to modify with conservative measures, core musculature and the neural control system can be actively modified through exercises and physical therapy. As such, exercises, particularly those focused on training the core muscles, have been proposed as a major treatment for patients with low back pain. Exercises strengthening the transversus abdominis and the multifidus muscles are of particular interest, as prior research has demonstrated that these muscles are likely primary contributors to spine stability (7,19). Despite evidence that transversus abdominis and multifidus show atrophy in patients with back pain, there are conflicting data regarding whether therapy programs focused on these specific muscles are vital to spinal stability, as well as improvement of pain. While Hodges (14,17) has suggested that the transversus abdominis is the primary spine stabilizer, Grenier and McGill (14,17) have suggested that the stability of the spine is a more complex process involving the interaction of multiple muscle groups. The difference

between these two viewpoints is important, as the transverse abdominus is isolated through “abdominal hollowing,” while an “abdominal bracing” maneuver requires activation of multiple muscles. Although the distinct patterns of activation in abdominal hollowing and bracing may seem subtly different to the untrained eye, they are in fact notably different in terms of muscle activation patterns. Body awareness and training on the part of the teacher and client are essential to properly performing these two distinct movements. Abdominal hollowing is performed by drawing the navel towards the spine, as if one was trying to squeeze into a tight pair of pants. Abdominal bracing requires activation of all layers of the abdominals as well as spine extensors (14), similar to the sensation of slowly breathing out all of the air from the lungs, until the trunk stiffens at the end of the exhalation. A key differentiating factor between the two movements is that abdominal hollowing decreases the circumference of the lower trunk, while abdominal bracing maintains lower trunk circumference. On careful examination, there is a visible difference between these two maneuvers (Fig. 2).

Regardless of the different views on muscular sources of spinal stability, multiple studies and reviews have evaluated core strengthening exercises for low back pain, and most have found benefit in terms of pain and disability (4,28,46). Most guidelines recommend at least some level of exercise as part of the treatment for low back pain (10). However, the Pilates method is unique when compared to more traditional exercises because of its strong emphasis on core strengthening, lumbopelvic stability, and encouragement of functional movement patterns (13).

The Pilates method appears to have a relationship to exercise concepts already in use. Pilates method instructors typically use anatomical cues as described above to train clients to properly activate muscles during exercises. The ideas of “drawing in,” “hollowing,” and “lengthening” are

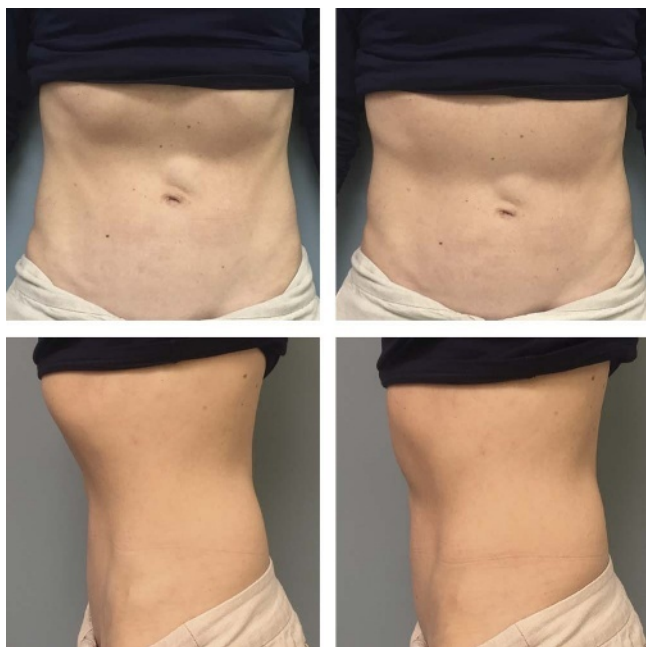


Figure 2: Abdominal hollowing versus bracing.

often used to encourage activation of deeper layers of abdominal muscles, knowing that these muscles do not typically act in isolation during functional movement. When a client is challenged to perform an exercise, they also will activate other supporting muscles. Herrington and Davies studied the ability to activate the transversus abdominus in asymptomatic individuals trained in either the Pilates method or abdominal curls. They found that the Pilates method trained group performed significantly better than the abdominal curl and control groups on an test of abdominal hollowing (Transversus Abdominis Isolation test) and a test of the ability to maintain spinal position with limb load (the Lumbo-Pelvic Stability test), both measured by a pressure biofeedback unit (15). This is consistent with the idea that exercise type influences recruitment patterns of abdominal muscles. These studies indicate that the Pilates method, which incorporates elements of abdominal hollowing, bracing, and emphasizes lumbopelvic control, may improve spinal stability and be of benefit to patients with low back pain.

Pilates and Low Back Disorders

As with much of the current spine literature, research on the Pilates method and its effect on low back pain is limited in several ways. For one, low back pain is not a diagnosis, but rather a symptom, associated with a wide variety of distinct clinical entities such as spondylosis, spondylolisthesis, facet arthropathy, muscle strain, lumbar radiculopathy, and discogenic pain. Distinguishing these entities clinically is very challenging, due to significant overlap in symptomatology; in addition, many radiographic abnormalities are present even in asymptomatic patients. As such, most studies use “non-specific low back pain” as a diagnosis, despite the fact that this represents a heterogenous mix of various disorders.

Additionally, researching this exercise regimen presents a challenge, as there is no clear standard control group. Studies which use “usual care” as the control may find significantly different results compared to studies which utilize alternative exercises as their control. Research on the Pilates method is further compounded by the fact that there are many different styles of Pilates method exercises, whether they be traditional, mat-based, equipment-based, derivatives or hybrid exercises such as “Yogalates.” Classical Pilates training follows a specific workout structure and order of exercises, though the instructor may select specific combinations of exercises and a particular strategy for progression based on the client’s needs and individual weaknesses.

While relatively understudied, there is some evidence to suggest that Pilates leads to physical changes which may be helpful in the treatment of low back pain (Table 1). As stated earlier, Pilates has been shown to improve use of the transverse abdominus, which has been found to be dysfunctional in patients with low back pain. Other studies have demonstrated that hamstring inflexibility can be a predictor for low back pain (5), and Pilates has been demonstrated in multiple studies to be effective for improving hamstring flexibility (25,41). Furthermore, several studies have demonstrated by radiographic and functional tests that Pilates improves rectus abdominus strength, lumbopelvic stability, and abdominal endurance while eliminating asymmetries of the oblique muscles and transverse abdominus

Table 1.
Physical changes in Pilates.

Physical Changes With Pilates
Increased rectus abdominis strength (12)
Elimination of muscular asymmetries in transversus abdominis and obliques (12)
Improved isolation of transversus abdominis (15)
Improved spinal stability with limb loading (15,41)
Improved hamstring flexibility (25,41)
Improved abdominal muscular endurance (25)

(12,25,41). Studies thus far have produced conflicting results on whether Pilates significantly improves posture or balance (25,45). Put together, these studies indicate that Pilates training affects multiple biomechanical factors which should improve spinal mechanics and potentially reduce pain.

Despite the relative scarcity of primary literature on Pilates and low back pain, there has been a surge of systematic reviews within the last several years. Over the past 10 yr, more than 10 systematic reviews have been published on the topic. Initial reviews found conflicting evidence which was difficult to interpret. As reported in Wells' systematic review of systematic reviews, an initial review by La Touche et al. (29) in 2008 found that Pilates reduced pain and disability, while a separate review by Pereira et al. 2012 found Pilates ineffective for improving pain and disability (29,40,48). Other findings also were conflicting, with Lim et al. (32) finding that Pilates reduced pain but not disability when compared to minimal intervention, while Aladro-Gonzalvo et al. (2) found that Pilates reduced disability compared with other physiotherapeutic treatments (2,32,48). A recent systematic review by Lin et al. (33) found Pilates effective in promoting a statistically significant improvement in pain relief

and functional ability compared to usual or routine health care, but similar exercises to Pilates showed the same findings when performed at a comparable volume and intensity. Ultimately, Wells' review of these systematic reviews found that the evidence available in 2013 was unable to clearly delineate whether Pilates was effective for reducing pain or disability. This was due to the small number and poor methodological quality of primary studies and varying methodological quality of reviews (48).

Fortunately, a number of systematic reviews have been completed since Wells' review of systematic reviews in 2013, and their findings have been much more consistent. Late in 2013, Miyamoto et al. (35) published a systematic review and meta-analysis which found that Pilates was at least moderately superior to minimal intervention for reducing pain and disability. Similarly, Patti et al. and Yamato et al. (39,50) found that despite the lack of high-quality evidence, there was a general consensus in the literature that Pilates was more effective than minimal interventions for pain and disability. Wells et al. (49) found similar findings to these other reviews, although noted that the effects may not sustain over the course of 24 wk. Based on these multiple reviews, the general sense from current literature is that Pilates is an effective treatment for reducing low back pain and disability (Table 2).

The efficacy of Pilates when compared with other exercise techniques is much less clear. Of the systematic reviews, only Yamato's recent Cochrane review found any clear improvement with Pilates when compared to other exercises. Other reviews by Wells et al., Patti et al., and Pereira et al. (39,40,49) did not find any clear evidence that Pilates was more efficacious than other forms of exercise. While some studies did demonstrate better short-term pain and disability (34), better satisfaction (11), and improved quality of life (27), current evidence does not clearly distinguish Pilates as a superior treatment when compared to other exercises. Although there are reasons to believe that Pilates may be

Table 2.
Systematic reviews on Pilates for low back pain.

Systematic Review	Efficacy vs Minimal Intervention	Efficacy vs Other Exercises
H.T. Lin 2016	Pilates with significant improvement in pain and function compared with routine care.	Other exercises similar in pain relief and functional ability.
T.P. Yamato 2015	Pilates is more effective than minimal intervention for pain and disability.	Pilates is slightly better than other exercises for functional improvements at intermediate follow up.
C. Wells 2014	Greater improvements in pain and function in short term than usual care or physical activity.	Equivalent improvements to massage and other exercises.
A. Patti 2015	Pilates more effective than minimal physical exercise in reducing pain.	No clear evidence that Pilates is more effective than other exercise programs for chronic pain.
G.C. Miyamoto 2013	Pilates better than minimal intervention for reducing pain and disability.	Pilates not better than other exercises for short-term pain reduction.
C. Wells 2013	Inconclusive evidence that Pilates reduce pain and disability.	
L.M. Pereira 2012	Pilates did not improve functionality compared with control.	Pilates no better than lumbar stabilization exercises in function.
E.C. Lim 2011	Pilates superior to minimal intervention for pain.	No evidence of superiority of Pilates for pain and disability when compared with other exercises.

helpful in certain patients with poor neuromuscular control and weak core stabilizers, identifying the patients who would benefit most from Pilates remains a challenge.

While the primary focus of this review has been to evaluate how effective Pilates is at reducing low back pain, we would be remiss if we failed to take a more holistic approach and mention other potential benefits of Pilates training which might factor into clinical decision-making. Studies have demonstrated that Pilates can help reduce the frequency of falls (22) and improve health-related quality of life in women (26). Furthermore, one study found that patients tended to be more satisfied with Pilates than a “back school,” and were more likely to perform exercises on a regular basis. There is an increasingly prevalent belief among physicians that “exercise is medicine,” and physical activity should be incorporated into daily life to maintain benefits. Pilates method typifies this idea, with its emphasis on consistency and translation into functional movement. Although evidence has not clearly shown that Pilates is superior to other exercises at reducing low back pain, Pilates may have other positive health benefits which may be equally, if not more important.

Future Research

Despite the recent expansion of Pilates research, many questions about its efficacy remain unanswered. As mentioned earlier, there are multiple differing types of Pilates training, including mat-based, equipment-based, and hybrid or Pilates-inspired exercise. Although a study by Curnow in 2009 found no significant difference in back pain between 3 different Pilates exercise regimens, only 39 patients were enrolled in the study, and the exercise regimens only differed by a few exercises (8). More recently, studies have focused on whether mat-based or equipment-based Pilates is superior, with conflicting results (9,30).

As with any exercise therapy, duration and frequency likely play a role in efficacy. However, there is no clear evidence as to how long or frequent Pilates training should last. Current recommendations are based on a Delphi survey of Australian physical therapists, who recommended 30- to 60-min sessions twice weekly for 3 to 6 months. Wells et al. (47) is currently completing a study to further our knowledge on this, but more research is needed. A recent study recommended that based on the evidence, Pilates training should have an exercise frequency greater than two or three times a week, with each session lasting at least 1 h, for a minimum cumulative training of 20 h (33). Another important study is currently ongoing to evaluate the cost-effectiveness of Pilates as a treatment for low back pain. Given the high cost of health care in the United States, further understanding of this issue can help practitioners understand whether Pilates training for patients with low back pain is an appropriate use of health care dollars.

There are several ways in which future research can help enrich our understanding of the Pilates method. First, comparative biomechanics studies would be useful to help identify which exercises from the Pilates method appear to have the greatest effect on the core and lumbar spine mechanics. This in turn can help researchers identify which key exercises provide the greatest gains for patients, while also helping further our understanding of why certain Pilates mat-based

or equipment-based exercises might yield greater benefits. Because prior studies have used a variety of control methods, a larger study with several treatment arms comparing multiple exercise and therapeutic regimens to the Pilates method would be very useful to help delineate which types of exercises are most efficacious. In addition, a specific approach to Pilates training should be clearly defined for the purposes of research, whether it was to follow the classical Pilates method order and selection of exercises, or customize a program based on a client's needs, both frequently used strategies in Pilates training. With the rapidly changing economics in health care, further evaluation of the cost effectiveness of the Pilates method when compared with other interventions is vital to ensure its availability to patients with limited resources. Finally, more studies are needed to establish the optimal frequency and duration of Pilates training as a treatment. Once this is better defined, future studies will have the opportunity to be more consistent in their regimens, and study results will be more easily interpreted.

Conclusions

The Pilates method is a system of exercises focusing on core stability and control, which appears to be one of several effective conservative treatments for low back pain. Anatomic and biomechanical studies have provided a plausible explanation for its effectiveness, but research is limited both by suboptimal methods of defining both Pilates exercise and low back pain itself. As of this writing, Pilates has not been shown to be significantly better overall than other exercises, though it does result in clear benefits and physical changes. Continued research into this field may help provide us with a better understanding of Pilates' role in health care.

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