

Pilates Exercise Research: A Narrative Review

Tiffany Field*

Miller/University of Miami School of Medicine and Fielding Graduate University, USA

ISSN: 2637-7802



Abstract

This narrative review of Pilates exercise research published during 2024 suggests several positive cognitive, psychological, physical, physiological and cardiometabolic effects. Cognitive flexibility has increased, depression has decreased, and quality of life has improved. The most frequently reported physical effects of Pilates exercise have included increased balance, flexibility, muscle strength and physical fitness in general as well as decreased body weight. The most frequently addressed physiological effects have included decreased pain for low back pain, neck pain, labor pain and pain associated with dysmenorrhea and fibromyalgia. Fatigue and sleep problems were also reportedly decreased following Pilates exercises. Only a few studies were focused on cardiometabolic changes including decreased blood pressure, triglycerides, cholesterol, and pro-inflammatory cytokines. The methodological limitations of this literature include the variability in the types of Pilates exercise training, the length of sessions as well as frequency and duration of the exercise protocols. In addition, many of the studies have compared pilates exercise with inactive control groups, resulting in tenuous findings.

Keywords: Cardiometabolic; Pilates exercise; Parkinson's

Introduction

Pilates exercise is a type of mind-body exercise developed in the early 20th century by a German physical trainer Joseph pilates after whom it was named. Pilates exercise involves a combination of approximately 50 repetitive exercises to increase muscle strength and is widely practiced worldwide, especially in developed countries. It can be practiced in a supine position on a mat or on equipment called the reformer apparatus that is used to perform foot and body work in a comfortable non-weight-bearing supine position using pulleys for the exercises. This review paper is based on both mat and reformer research found in literature searches on PubMed and PsycINFO by entering the term pilates and the year 2024. The review includes 36 papers after excluding pilot studies, protocol proposals and non-English papers.


The literature from 2024 on Pilates effects can be categorized as having cognitive, psychological, physical, physiological and cardiometabolic effects (see Table 1). Cognitive flexibility has increased, depression has decreased, and quality of life has improved. The most frequently reported physical effects of pilates exercise have included increased balance, flexibility, and strength. The physiological effects include decreased pain, fatigue and sleep problems. Only a few studies focused on cardiometabolic changes including decreased blood pressure, triglycerides, cholesterol, and pro-inflammatory cytokines. The methodological limitations of this literature include the variability in the types of Pilates exercise, the length of sessions as well as frequency and duration of the training. The samples are typically small and many are exclusively female adults or individuals with different medical conditions, limiting the generalizability of the data. In addition, many of the studies have compared pilates exercise with inactive control groups rather than other exercise groups, resulting in tenuous findings. This review is accordingly divided into sections on those different positive effects followed by a discussion of methodological limitations.

Cognitive Effects

Only two studies appeared in this literature on cognitive effects (see Table 1). In one study entitled "Does reformer Pilates exercise improve cognitive function in sedentary women?", a

***Corresponding author:** Tiffany Field, Miller/University of Miami School of Medicine and Fielding Graduate University, USA

Submission:  April 23, 2025

Published:  May 07, 2025

Volume 8 - Issue 4

How to cite this article: Tiffany Field*. Pilates Exercise Research: A Narrative Review. *Adv Complement Alt Med.* 8(4). ACAM. 000695. 2025.
DOI: [10.31031/ACAM.2025.08.000695](https://doi.org/10.31031/ACAM.2025.08.000695)

Copyright@ Tiffany Field, This article is distributed under the terms of the Creative Commons Attribution 4.0 International License, which permits unrestricted use and redistribution provided that the original author and source are credited.

randomized controlled trial was conducted [1]. In this research, the reformer apparatus was used to “perform foot and body work in a comfortable non-weight-bearing supine position”. The protocol was practiced by women for 45 minutes, two times a week for six weeks (N=44 women 24-to-50 -years-old). The women who received pilates training showed improved performance on the Stroop test which measures selective attention, inhibition of cognitive interference and cognitive flexibility. The Stroop test score reflects how quickly someone can name the color of words when the word itself is a different color, for example, saying the word blue that is printed in red ink. These results are tenuous given that Pilates was compared to an inactive control group. In addition, the sample was exclusively women who were also sedentary women which limits the generalizability of the data. Further, only one test was used to assess cognitive function.

Table 1: Cognitive effects of Pilates exercise training (and first authors).

Effects	First Authors
Improved performance on the Stroop Test for selective attention	Ozeren
Improved performance on the stroop test, trail making test and montreal cognitive Assessment	Eldemir

Another research group measured cognitive function using more than one test including the stroop test, but also the trail making test and the montreal cognitive assessment [2]. In this study, pilates exercise was given to healthy adults (N=46) three times per week for six weeks. The pilates group as compared to a waitlist control group showed better performance on the montreal cognitive assessment, the trail making test and the stroop test. They also showed more functional mobility and faster walking. These physical and cognitive effects are likely related, reciprocal or bidirectional effects. This was a more valid assessment of cognitive function because of the multiple measures and the sample of active healthy adults (both males and females) as opposed to sedentary women. In addition, the pilates exercise group was compared to a waitlist control group versus an inactive control group.

Psychological Effects

Surprisingly, only three studies appeared in this current literature on psychological effects of pilates exercise (see Table 2). They include research on depression and quality of life. In a systematic review entitled “Is Pilates effective in improving depressive disorders?”, 10 of 12 randomized controlled trials showed decreased depression, especially when Pilates exercise was compared to inactive control groups [3]. Pilates groups would be expected to be more effective than inactive control groups, which highlights the need for future research to compare Pilates with other exercise groups. In addition, the results of this systematic review need to be cautiously interpreted because of the variable types of Pilates exercise used in the different studies as well as their different duration and the different assessment scales that were used. In research on quality of life, a comparison was made on the impact of remote versus in person Pilates exercise on the

quality of life of older adults in a randomized controlled trial [4]. In this trial, “elderly adults” (60-to-70-years-old) were assigned to remote or in-person solo pilates training groups. The in-person training group was superior to the remote training group in terms of the different components of the quality-of-life scale including the physical, psychological, social relationships, autonomy, death, and dying components. This rare older adult Pilates sample may have felt more comfortable/safer being closely monitored in the in-person training.

Table 2: Psychological effects of Pilates exercise training (and first authors).

Effects	First Authors
Decreased depression	Legnani
Increased quality of life	Fraga, de Almeida

In a systematic review and meta-analysis of 11 randomized controlled trials, women were provided Pilates training [5]. On average, five of the nine components of the health-related quality of life scale were positively affected including bodily pain, physical function, social function and emotional function. More domains were affected when there were more than 48 sessions (eight domains) and fewer domains were affected when less than 48 sessions were provided (three domains). In addition, more domains were affected when Pilates training was provided on the reformer apparatus (seven domains) versus on the mat (three domains). The greater number of domains being affected by more sessions is not surprising. A possible interpretation for the greater number of domains being affected by the reformer apparatus than the mat Pilates is that the reformer apparatus has been anecdotally noted to be easier exercise because of the pulleys that can be used to “pull yourself up”. However, surprisingly, a comparison between mat Pilates and reformer Pilates within the same study has not appeared in this literature, possibly because the two types of Pilates have been compared in earlier research and the data support the anecdotal view that mat Pilates is the more difficult form. Also, this systematic review and meta-analysis exclusively included female samples which is not surprising given that Pilates is more frequently attended by women.

Physical Effects

Several physical effects have been the focus of the currently published research on pilates (see Table 3). They include improved balance, flexibility, strength, walking, body weight and fitness in general.

Balance

At least three studies on balance were found in this current Pilates exercise literature. Balance was notably improved in research that compared Pilates with physiotherapy for Parkinson’s patients (N=32 patients at stages 2 to 3) [6]. These exercises were given for 60 minutes twice a week for 12 weeks. The pilates group as compared to the physiotherapy group showed greater improvement in both static (standing still) and dynamic (moving) balance, as well as gait, reaction time and functional mobility.

These results, although limited by the small sample size, would be informative for parkinson's treatment programs. They also suggest that online Pilates could be a more cost-effective, continuous treatment for individuals with Parkinson's disease. In a group comparison between a pilates exercise group and a home exercise program, young people who had recovered from COVID-19 (N=145 who were 19-to-25-years-old) were randomly assigned to these groups [7]. The Pilates exercise group showed greater improvement on trunk balance as well as increased core muscle endurance. The pilates exercise may have been a more rigorous form of exercise and/or greater compliance may have occurred in the Pilates group due to the social involvement of the group and monitoring by the instructor. In research entitled "Influence of the Pilates method on postural balance parameters in older women" (N=14 women 60+ years-old), the Pilates protocol led to increased postural balance [8].

Table 3: Physical effects of Pilates exercise training (and first authors).

Effects	First Authors
Improved balance	Coban, Amin, Serra, Al-Nemr
Increased flexibility	Kwok
Increased muscle strength	Eseoglo, Cinha, Sivrika
Improved walking-less time and greater distance	Adamson, Eldemir, Jorge
Decreased bodyweight	Allam
Increased physical fitness	Greco, Lazarowitz

The Pilates exercise also resulted in better performance on the timed up and go test and on the short physical performance battery. These results are surprising for this extremely small sample but promising for the physical fitness of older women, who may be less apt to practice Pilates. The effects of pilates exercises on balance have also been studied in a sample of children with down syndrome (N=40 children who were 8 to 10-years-old) [9]. In this research, pilates was combined with physical therapy and compared to physical therapy alone. The children in the pilates plus physical therapy group showed greater dynamic balance and gross motor coordination following the exercise protocol. A third group of Pilates exercises alone could have had practical implications for home exercise to sustain these positive physical effects for children with Down syndrome. This is the only child study that was found in this current Pilates literature, but presumably Pilates exercises would have similar benefits for children without Down syndrome.

Flexibility

Flexibility has been an issue for those with chronic low back pain. In a study entitled "clinical pilates exercises for adults with chronic low back pain improve single-leg squat postural control and lumbo-pelvic -hip flexibility", adults with low back pain were given Pilates (N=40) [10]. The results are basically in the title, suggesting that there was an increase in postural control and flexibility of the hamstrings.

Muscle strength

Muscle strength has also been improved by pilates exercise. In a mat pilates exercise study, pilates was combined with electro-muscle stimulation exercises for women with fibromyalgia (N=30) [11]. The increased strength was demonstrated by increased push-up and hand grip strength, as well as strength during deep squat and sit up exercises. Another effect was a decrease in the fibromyalgia Impact questionnaire scores, suggesting a decrease in fibromyalgia symptoms. Anthropometric measurements of the abdomen, lower abdomen and hip were also decreased. Finally, scores on depression and anxiety scales were decreased. The exclusive sampling of women with fibromyalgia is not surprising given that fibromyalgia is more common in women, making this a sample of convenience. However, finding this many positive effects is surprising given the small sample size. The absence of an active control group was also a methodological limitation of this study. Increased muscle strength was also noted by another research group who compared online and face-to-face mat Pilates training for long covid patients (N=49) [12]. The pilates exercise occurred three times per week for 12 weeks. Only the face-to-face group had increased strength which included trunk isometric strength and upper limb muscle endurance strength. No changes occurred in the anthropometric or cardiometabolic markers that have been noted in other Pilates exercise studies.

The face-to-face training may have been more effective again because of greater compliance possibly related to the social involvement and monitoring by the instructor. This research would have been more valid if the patients had been randomly assigned to these groups. In a systematic review and meta-analysis entitled "Pilates dosage and rehabilitation of patients with musculoskeletal conditions", 14 studies including 13 randomized controlled trials were analyzed (N=612 patients) [13]. These data revealed an increase in muscle strength. Although the duration of Pilates training ranged from 6 to 16 weeks, the most frequent duration was eight weeks and 2 to 3 sessions per week at 50-60 minutes. The dosage data from this research can inform both the general as well as the therapeutic practice of Pilates. The data may also suggest a standard protocol for Pilates research that would make cross-study comparisons and meta-analyses more feasible.

Walking

Walking has also improved, but again in samples with medical conditions. For example, in research entitled "Evaluating the impact of seated Pilates on functional outcomes among those with mild, moderate and severe multiple sclerosis" (N=16), virtual pilates sessions were offered [14]. The Pilates training led to a shorter time completing the 25-foot walk test. The data also showed improved performance on the Up and Go measure and the Berg Balance Scale. The improved walking would likely be the most appreciated by those individuals with multiple sclerosis given that walking is one of their most compromised conditions. That Pilates could be effectively delivered virtually for this handicapped group has promising

implications for multiple sclerosis intervention programs. In other pilates exercise research on physical performance of patients with multiple sclerosis (N=30), a Pilates exercise group was compared to a waitlist control group [15].

This research revealed multiple physical fitness effects of Pilates training including walking speed and walking distance as well as greater extremity muscle strength, core endurance and power, balance, functional exercise capacity, and quality of life. Given this many positive physical effects, it is not surprising that patients with multiple sclerosis reported greater quality of life following Pilates training. In a sample of post COVID-19 syndrome patients (N=59), pilates exercise training was compared to supervised physical exercise [16]. The sessions were 60-minutes long twice per week for eight weeks. Those who received Pilates exercise training walked a greater distance on the 6-minute walk test. They also had less fatigue and better sleep quality. These physical and physiological effects are likely related, reciprocal or bidirectional.

Body weight

Body weight decreased in a study on females with irritable bowel syndrome (N=60 who were 20 to 45 years-old) [17]. Following Pilates exercises twice per week for eight weeks, body weight decreased as well as scores on the Irritable Bowel Syndrome Scale. The combined use of physical and self-report measures regarding symptoms of a medical condition contribute to the validity of these data. The decreased body weight data would likely generalize to healthy adult samples who often attend pilates exercise sessions specifically for weight control.

Physical fitness

Physical fitness in general has improved following pilates exercises. In a paper entitled "The effects of online home-based Pilates combined with diet on body composition in women affected by obesity", the women received Pilates for 60-minute sessions 3 times a week for 12 weeks [18]. This home-based pilates exercise protocol resulted in greater fat-free mass and greater appendicular-skeletal mass, suggesting improved fitness. Compliance was likely high in this sample who were presumably highly motivated to lose weight, but it's unclear how much improved diet confounded the effects of Pilates exercise in this protocol of combined diet and exercise. In another remote Pilates training, healthy women (N=40 who were 20 to 45-years-old) showed an increase in physical fitness [19]. This followed 45 minutes of training twice per week for eight weeks. These healthy women data are unique to this current literature on pilates training effects which is predominantly focused on adults with various medical conditions. This study will likely validate Pilates as an effective form of exercise for adults in general.

Physiological Effects

Pilates exercise research has been more frequently focused on pain than any other condition in this current literature (see Table 4). This is not surprising given that exercise research programs have typically been pursued by people with pain, making individuals with

pain noted as convenience samples for Pilates exercise research. Most of the pain research in this current literature is focused on low back pain, although a few other studies have focused on neck pain, labor pain, dysmenorrhea pain, and fibromyalgia pain. Other physiological effects that are reviewed here include reduced fatigue and sleep problems.

Table 4: Physiological effects of Pilates exercise training (and first authors).

Effects	First Authors
Decreased low back pain	Kwok, Correia, Nageswarr, Coelho
Decreased neck pain	Hakligi
Decreased dysmenorrhea pain	Kirthika
Decreased fibromyalgia pain	Nithuthorn
Decreased fatigue	Cinha, Saraiva
Improved sleep quality	Persaki, Xie

Low back pain

In a randomized controlled study on Pilates for low back pain, Pilates was compared to regular exercise (N=15) [10]. These exercise groups practiced two times per week for 12 weeks. Pilates led to a greater reduction in low back pain and a greater increase in endurance trunk extensors and right and left lateral muscles. These results are limited by the low power of an extremely small sample size. In another study on low back pain, mat Pilates was compared to home exercise that occurred two times per week for six weeks (N=145) [20]. The mat Pilates group had less pain intensity and less disability and greater quality of life than the home-based exercises after the six-week period. The mat Pilates exercise group may have been more compliant in practicing the Pilates exercises two times per week and more adherent to that exercise routine under the instructor's supervision. A study entitled "Effective Pilates exercise effects on pain endurance, quality of life, and disability in women with low back pain" (N=128), a Pilates group was compared to a conventional exercise group (Nageswarr et al, 2024). The Pilates group had greater pain alleviation based on a numerical pain scale. Physical measures might be used in exercise comparison studies to further inform the results favoring Pilates exercises over conventional exercise routines. Pilates exercise has been anecdotally reported as being a relatively more rigorous form of exercise, a claim that needs to be supported by objective data.

In a randomized controlled trial entitled "High-intensity and low-intensity Pilates have similar effects on pain and disability in people with chronic non-specific low back pain" (N=160 18 to 60-year-old individuals), the title gives the results [21]. This trial occurred for one hour, two times a week for six weeks. Both high and low intensity Pilates had similar scores on a numerical pain scale, on the Roland Morris Disability Questionnaire, on the Patient Specific Function Scale, on the Tampa Scale for Phobia and on isometric hip strength. The authors noted that there were less adverse effects in the low intensity Pilates group. Although greater effects might be expected for the high versus the low-intensity Pilates exercise groups, the more adverse effects in the high-

intensity group may have attenuated their expected advantage. A review and meta-analysis of 19 Pilates exercise trials suggested that Pilates exercise group performance was equivalent to the performance of the control groups and non-specific exercise groups of the 19 trials [22]. These data are difficult to interpret as they are inconsistent with the results of all the studies just reviewed.

Neck pain

Neck pain has also benefited from Pilates. For example, in a study comparing conventional treatment plus Pilates exercises versus Pilates exercises alone, the conventional treatment involved hot packs, TENS (transcutaneous electrical nerve stimulation) and therapeutic ultrasound of the cervical area [23]. The combined therapy group showed a greater reduction on the Neck Disability Index, the Neck Treatment Scale, neck pain, fear of movement, and depression. Also, that group experienced a greater increase in extension range of motion and cervical flexor endurance. It's not surprising that any study comparing two treatments versus one treatment would yield more positive effects for the two-treatment group. However, it would have been interesting to include a conventional treatment alone group to determine the comparative effects of Pilates versus conventional treatment.

Labor pain

A reduction in labor pain has been reported in at least two systematic reviews and meta-analyses on Pilates exercises. In one review of 11 studies (N=538 pregnant women), less labor pain was reported as well as shorter labor following Pilates exercises [24]. In addition, the newborns of those women who received Pilates exercises had better Apgar scores following birth. Similar data were reported in another systematic review and meta-analysis on 11 studies on Pilates exercises (N=1239 participants) [25]. A decrease in labor pain was reported as well as a decrease in overall labor duration. The reduction in labor pain in these studies may relate to the shorter labor duration or those variables may have reciprocal effects.

Dysmenorrhea pain

In a study on reducing dysmenorrhea pain, Pilates was compared to an exercise gym ball protocol (N=30) [26]. After 12 weeks of these protocols, the Pilates group had a lower visual analogue pain score and a lower score on the Menstrual Pain Scale. Again, objective physical measurements of the two types of exercise in this study would have further informed the underlying mechanisms for the differences in these exercises that may have contributed to the differential effects. The Pilates exercises that typically involve abdominal muscles may have been more effective for reducing dysmenorrhea pain than the exercise gym ball that typically stretches back muscles and/or the Pilates exercises versus the exercise gym ball may have placed less stress and discomfort on the back leading to greater relaxation resulting in lower pain.

Fibromyalgia pain

In a systematic review and meta-analysis on fibromyalgia pain (N=6 studies and 265 participants), the Pilates exercise groups

had lower pain scale scores and better scores on the Fibromyalgia Impact Questionnaire [27]. A review on Pilates exercise groups versus 6 other forms of non-specific exercise has questionable validity by virtue of the small sample size and variety of the comparison exercise groups. Further, it's not surprising that the Pilates group had lower scores given that most of the triggers for fibromyalgia pain are in the back region, and Pilates exercises have been significantly effective for back pain, as has already been noted in this review.

Fatigue

Fatigue has been reduced by Pilates exercises in one study already described. In that research on face-to-face mat Pilates exercises, both physical and mental fatigue were decreased [12]. In a randomized controlled trial, Pilates mat exercises reduced fatigue in survivors of head and neck cancer (N=30) [28]. This protocol was 60 minutes two times per week for 12 weeks. Body image was also improved as was quality of life. It is not surprising that quality of life would be improved along with reduced fatigue, but it's not clear how improved body image would be related to reduced fatigue. Improved body image is unique to this study. If weight control is an incentive for participating in Pilates exercises, improved body image would follow from reduced weight. Although body weight was decreased following Pilates exercises in at least one study in this literature [17] and physical fitness in another study [18], neither of those studies assessed body image. This highlights the reality of researchers arbitrarily selecting variables that sometimes do not seem related.

Sleep quality

Sleep quality has been significantly improved by Pilates exercises which may relate to reduced fatigue, although those two variables did not appear together in the same study in this literature. In research entitled "The effect of Pilates on sleep quality, aerobic capacity and anaerobic power in pre-menopausal women" (N=40 exercise participants and 13 controls), the Pilates exercises were offered for 60 minutes three times a week for 16 weeks [29]. The Pilates exercise group had lower Athens Insomnia Scale scores, lower Epworth Sleepiness scores, and lower Autonomic Arousal index. They also had greater fitness, muscle strength, flexibility, balance and abdominal muscle endurance but as self-reported on the 36-item short form of the Health Survey. Unfortunately, these results were all based on self-report and the groups had very unequal sample sizes, raising the question of reliability of the data. In a systematic review and meta-analysis assessing the optimal exercise intervention for sleep quality (N=27 studies, 2142 participants), Pilates exercise, yoga and qigong were noted to increase sleep quality [30]. Pilates exercise was superior to the other forms of exercise based on a 95% improvement rate on sleep quality. This review and meta-analysis is unique for its comparison of the three different forms of exercise. It would have been interesting to compare the groups on other variables to inform the result of the Pilates exercise leading to better sleep quality. It could simply relate to Pilates exercise participants being younger

than those of yoga and qigong as younger adults typically have better sleep quality. Or, it could relate to Pilates exercise being more rigorous than yoga or qigong.

Cardiometabolic Effects

Pilates exercises have been noted to have cardiometabolic effects (see Table 5). They included improved cardiorespiratory responses and decreased blood pressure, triglycerides and pro-inflammatory cytokines.

Table 5: Cardiometabolic effects of Pilates exercise training (and first authors).

Effects	First Authors
Decreased heart rate	Guttekin
Decreased blood pressure	Gonzalez-Leves, Woramontiri, Batista
Decreased TNF-alpha	Woramontiri
Decreased triglycerides, cholesterol and glycated hemoglobin	Batista

Cardiorespiratory responses

In research entitled “Cardiorespiratory responses: Pilates compared to different walking speeds in healthy adults” (N=31), the average heart rate following Pilates exercise was similar to the average heart rate following walking at 4.8 km/hour [31]. Oxygen and energy consumption for Pilates exercise were similar to those measures following a slower rate of walking at 3.2 km/hour. Pilates exercise did not enhance cardiorespiratory function and fitness, but it increased flexibility, core strength and posture. It’s not clear from this report how Pilates exercise compared with walking on these physical measures of flexibility, core strength and posture.

Blood pressure

Decreases have been noted in both systolic and diastolic blood pressure following Pilates exercise. In a systematic review and meta-analysis entitled “The efficacy of Pilates method in patients with hypertension”, four randomized controlled trials and seven comparative studies were included [32]. The authors concluded that across the Pilates exercise studies, systolic and diastolic blood pressure were routinely reduced.

Triglycerides and pro-inflammatory cytokines

Decreases in systolic and diastolic blood pressure have been accompanied by other cardiometabolic changes such as cholesterol and pro-inflammatory cytokines following Pilates exercise. In a study entitled “Effect of mat Pilates training on blood pressure, inflammatory and oxidative profiles in hypertensive individuals” (N=34 who were 60 to 75-years-old), Pilates exercise was given for 60-minutes three times a week for 12 weeks [33]. The decreases in systolic and diastolic blood pressure were accompanied by a decrease in the pro-inflammatory cytokine TNF-alpha (a marker of stress). These decreases highlight the stress-reducing effects of Pilates exercise. In research entitled “The influence of mat Pilates training on cardiometabolic risk factors (N=44 women with various medical conditions), the Pilates training was given

three times a week for 12 weeks [34]. Decreases were noted in blood pressure, triglycerides (stored in fat cells), cholesterol and glycated hemoglobin (average blood sugar) following the mat Pilates training. These cardiometabolic fitness data complement the physical exercise data that are more frequently reported for Pilates exercise. However, they are derived from samples of adults with hypertension and other medical conditions which limits their generalizability and highlights the need for future research on these objective measures of cardiometabolic fitness in healthy samples.

Methodological Limitations of this Literature

Several methodological limitations can be noted for this current literature on Pilates exercise effects. They include the variety of Pilates exercise training, the infrequent use of active control groups, the small samples, the almost exclusive focus on Pilates exercise in samples with medical conditions, the variety of measures, and the absence of research on potential underlying biological mechanisms for the positive effects. The variety of Pilates exercise training protocols in terms of the type of Pilates (reformer or mat), the length of the sessions, and the frequency and duration of sessions has limited the number of systematic reviews and meta-analyses in this literature. Some of the Pilates exercise groups also received other modalities, for example, electro-muscle stimulation or conventional treatment, thereby confounding the effects of Pilates exercise training. Active exercise comparison groups were often missing except for walking in a couple studies and yoga and qigong in a systematic review and meta-analysis [35-37].

Most of the samples were small, for example a sample as small as 15 participants. This possibly related to the costliness of these intensive interventions (frequently 60 minutes long for 5 to 6 times a week for six months). Surprisingly, Pilates training has become a widely adopted exercise despite the typically frequent sessions required for the effectiveness of this practice. Except for a few studies, most of the samples were young females which also limits the generalizability of the data. In addition, most of the samples had medical conditions, for example, cancer, fibromyalgia, irritable bowel syndrome, Parkinson’s, multiple sclerosis, low back pain and long COVID. Surprisingly, only a couple of healthy samples without medical conditions appeared in this literature. Having a variety of measures has limited the possibility of systematic reviews and meta-analyses. The variety of measures is also a positive feature of this literature. Physical fitness variables were the primary measures in the older research on Pilates exercise. The current literature has included physiological measures, for example, sleep and cardiometabolic measures, blood pressure, cholesterol and proinflammatory cytokines. The physiological fitness and cardiometabolic fitness data complement the physical fitness data.

As a reviewer of this paper suggested, although Pilates exercise may be used to increase balance, flexibility, muscle strength and physical fitness with decreased body weight, it may not reverse the aging process with the activation of the anti-aging gene Sirtuin 1. Sirtuin 1 is critical for the prevention of obesity, diabetes and neurodegenerative disease. Unfortunately, potential underlying biological mechanisms for the positive effects of Pilates exercise

were not addressed in this literature. Although respiratory function and proinflammatory cytokines were measured in a few studies, these were not considered potential underlying biological mechanisms for the positive effects of Pilates exercise. These methodological limitations have limited this literature. However, they have also suggested the need for further research on comparisons between active forms of exercise in healthy samples that might prevent the medical conditions that have been sampled in this literature. The data on other forms of fitness, for example, the physiological and cardiometabolic fitness have complemented the older data on physical fitness which might encourage more males and older adults as well as children and adolescents to engage in Pilates exercise.

Conclusion

Pilates exercise research published during 2024 has highlighted its positive effects including cognitive, psychological, physical, physiological, and cardiometabolic effects. Examples of the cognitive effects are improved cognitive flexibility and quality of life as well as decreased depression. Physical effects of Pilates exercise include improved balance, flexibility, muscle strength and decreased body weight. Physiological effects include decreased low back pain, neck pain, labor pain and pain related to dysmenorrhea and fibromyalgia. Fatigue also decreased and sleep quality improved. Cardiometabolic changes included decreased blood pressure, triglycerides, cholesterol and pro-inflammatory cytokines. Several methodological limitations of this literature were mentioned including the variable types of Pilates exercises, the length as well as the frequency and duration of the sessions. In addition, many of the findings are tenuous given that Pilates has typically been compared with inactive control groups.

References

- Özeren A, Uluğ N, Şahan N, Karahan ZC (2024) Does reformer pilates exercise improve cognitive functions in sedentary women? A randomized controlled study. *J Bodyw Mov Ther* 40: 1899-1905.
- Eldemir K, Gunduz AG, Eldemir S, Saygili F, Ozkul C, et al. (2024) Effects of pilates-based telerehabilitation on physical performance and quality of life in patients with multiple sclerosis. *Disabil Rehabil* 46(9): 1807-1814.
- Legnani F, Tassi L, Surace T, Capuzzi E, Caldiroli A, et al. (2025) Is pilates effective in improving depressive disorders? A comprehensive overview. *Int Clin Psychopharmacol* 40(2): 53-61.
- Fraga BS, Pires VJ, Brito GR, Krause RB, Faganello MP, et al. (2024) Remote and in-person pilates impact on the quality of life of older adults: A controlled and randomized clinical trial. *J Bodyw Mov Ther* 40: 1440-1445.
- Almeida PPD, Oliveira RGD, Almeida LIMD, Oliveira LCD (2024) Effects of pilates exercises on health-related quality of life in postmenopausal women: a systematic review and meta-analysis. *Qual Life Res* 33(8): 2067-2079.
- Coban F, Kaygisiz BB, Selcuk F (2025) Motor learning-based clinical pilates training for the parkinson's disease rehabilitation @ parkinsonpilates: A parallel group, randomised controlled trial with 3-month follow-up. *Complement Ther Med* 90: 103161.
- Amin WM, Ali OI, Malik S, Draj SAI, Masoud FAM, et al. (2024) Effects of pilates exercises on core stability after recovery from COVID-19: A randomized controlled trial. *J Multidiscip Healthc* 17: 753-763.
- Serra ACS, Orlando JB, Scheicher ME (2024) Influence of the pilates method on postural balance parameters in older women: An exploratory single-arm trial. *J Bodyw Mov Ther* 37: 11-17.
- Nemr AA, Reffat S (2024) Effect of pilates exercises on balance and gross motor coordination in children with down syndrome. *Acta Neurol Belg* 124(5): 1499-1505.
- Kwok BC, Soh REC, Smith HE, Kong PW (2025) Clinical pilates exercises for adults with chronic low back pain improve single-leg squat postural control and lumbopelvic-hip flexibility. *Gait Posture* 119: 127-134.
- Eseoğlu I, Yılmaz AK, Anil B, Korkmaz E, Akdemir E, et al. (2024) Effects of electro-muscle stimulation exercise combined with mat pilates on pain, anxiety, and strength in sedentary females with fibromyalgia: A single-blind randomized controlled trial. *J Pers Med* 14(7): 697.
- Cunha ACR, Silva JC, Garcês CP, Sisconeto TM, Nascimento JLR, et al. (2024) Online and face-to-face mat pilates training for long COVID-19 patients: A randomized controlled trial on health outcomes. *Int J Environ Res Public Health* 21(10): 1385.
- Sivrika AP, Kypraios G, Lamnissos D, Georgoudis G, Stasinopoulos D (2024) Pilates dosage in rehabilitation of patients with musculoskeletal conditions: A scoping review. *Sports Health*.
- Adamson B, Lindsay KG, Almasri L, Duffy MK, Kirkpatrick S, et al. (2024) Evaluating the impact of seated pilates on functional outcomes among those with mild, moderate, and severe multiple sclerosis impairment: A pilot feasibility trial. *Adapt Phys Activ Q* 42(1): 19-47.
- Eldemir K, Eldemir S, Ozkul C, Irkeç C, Gunduz AG (2025) The effects of online pilates training on cognitive functions and dual task performance in people with multiple sclerosis: A randomized controlled study. *Mult Scler Relat Disord* 97: 106393.
- Jorge MSG, Nepomuceno P, Schneider RH, Wibelinger LM (2025) Eight weeks of pilates method improves physical fitness and sleep quality of individuals with post-COVID-19 syndrome: A randomized clinical trial blinded. *J Bodyw Mov Ther* 41: 238-245.
- Allam DMM, Ghaffar HAA, Elshamy AM, Safa MA, Ahmad AM (2024) Effect of pilates exercises on symptoms of irritable bowel syndrome in women: A randomized controlled trial. *Arch Physiother* 14: 170-181.
- Greco F, Tarsitano MG, Cosco LF, Quinzi F, Folino K, et al. (2024) The effects of online home-based pilates combined with diet on body composition in women affected by obesity: A preliminary study. *Nutrients* 16(6): 902.
- Zanzuri CL, Hadas D, Hutzler Y, Goral A, Tsuk S (2024) Remote pilates training is effective in improving physical fitness in healthy women: A randomized controlled study. *Healthcare (Basel)* 12(7):724.
- Bulhões LCC, Gomes SRA, Silva VDD, Rodolfo JIDA, Macedo LB, et al. (2024) Effects of a mat pilates-based exercise program for low back pain in helicopter pilots of the Brazilian Air Force: Randomized controlled trial. *J Bodyw Mov Ther* 39: 544-549.
- Coelho ACS, Dourado JF, Lima POP (2025) High-intensity and low-intensity Pilates have similar effects on pain and disability in people with chronic non-specific low back pain: A randomised trial. *J Physiother* 71(2): 100-107.
- Patti A, Thornton JS, Giustino V, Drid P, Paoli A, et al. (2024) Effectiveness of pilates exercise on low back pain: A systematic review with meta-analysis. *Disabil Rehabil* 46(16): 3535-3548.
- Haklıgil GV, Oksüz S, Angın E (2024) The effects of conventional treatment in addition to pilates on biopsychosocial status in chronic neck pain: A randomized clinical trial. *J Back Musculoskelet Rehabil* 37(6): 1715-1727.
- Li Y, Lu H, Zhang L, Ren Y, Dai X, et al. (2025) Pilates exercise in pregnancy: A systematic review and meta-analysis. *BMC Sports Sci Med Rehabil* 17(1): 20.
- Haseli A, Eghdampour F, Zarei H, Karimian Z, Rasool D (2024) Optimizing labor duration with pilates: Evidence from a systematic review and meta-

- analysis of randomized controlled trials. *BMC Pregnancy Childbirth* 24(1): 573.
26. Kirthika SV, Sudhakar S, Kumar GM, Ramachandran S, Deepthi Rnv, et al. (2024) Comparing pilates and gym ball exercises for primary dysmenorrhea management: An empirical study. *Cureus* 16(4): e59184.
27. Nithuthorn C, Chaipichit N, Jeeraaumponwat T, Maiprasert M, Dilokthornsakul P (2024) Effect of pilates on pain and health-related quality of life in fibromyalgia patients: A systematic review and meta-analysis. *J Clin Med* 13(23): 7447.
28. Saraiva PSDS, Boing L, Fausto DY, Lima AG, Lyra VB, et al. (2025) Effects of mat pilates on quality of life, fatigue and body image in head and neck cancer survivors: a randomized clinical trial. *Disabil Rehabil* 47(6): 1553-1560.
29. Persaki DG, Nieri A, Apostolidis NG, Konstantinou E, Myrianthefs P (2024) The effect of pilates on quality of sleep, aerobic capacity and anaerobic power in premenopausal women. *Sleep Sci* 17(1): e75-e81.
30. Xie W, Lu D, Liu S, Li J, Li R (2024) The optimal exercise intervention for sleep quality in adults: A systematic review and network meta-analysis. *Prev Med* 183: 107955.
31. Gultekin SC, Kahraman BO, Kahraman T (2024) Cardiorespiratory responses: Pilates compared to different walking speeds in healthy adults. *Ir J Med Sci* 193(1): 139-147.
32. Devesa DG, Varela S, Gómez JCD, Pérez CA (2024) The efficacy of pilates method in patients with hypertension: Systematic review and meta-analysis. *J Hum Hypertens* 38(3): 200-211.
33. Woramontri C, Chaunchaiyakul R, Yang AL, Lin YY, Masodsai K (2024) Effect of mat pilates training on blood pressure, inflammatory, and oxidative profiles in hypertensive elderly. *Sports (Basel)* 12(5):120.
34. Batista JP, Amaral AL, Mariano IM, Gonçalves LF, Tavares JB, et al. (2025) The influence of mat pilates training on cardiometabolic risk factors in postmenopausal women with single or multiple cardiometabolic diseases. *Int J Environ Res Public Health* 22(1): 56.
35. Martins IJ (2016) Anti-aging genes improve appetite regulation and reverse cell senescence and apoptosis in global populations. *Advances in Aging Research* 5: 9-26.
36. Martins IJ (2017) Single gene inactivation with implications to diabetes and multiple organ dysfunction syndrome. *J Clin Epigenetics* 3(3): 24.
37. Tottoli CR, Ben ÂJ, Silva END, Bosmans JE, Tulder MV, et al. (2024) Effectiveness of pilates compared with home-based exercises in individuals with chronic non-specific low back pain: Randomised controlled trial. *Clin Rehabil* 38(11): 1495-1505.