

The effect of Pilates exercise training for scoliosis on improving spinal deformity and quality of life

Meta-analysis of randomized controlled trials

Yanyun Gou, MPT, PhD, Huangwei Lei, PhD, Yi Zeng, OTD, Jing Tao, PhD, Weicheng Kong, Undergraduate, Jingsong Wu, PhD*

Abstract

Background: It remains unclear if Pilates is conducive to reducing spinal deformity and improving patients' quality of life (QOL) with scoliosis. The aim of this study was to systematically review the published evidence to determine whether Pilates exercise training is an efficacious therapy for scoliosis.

Methods: Searches was conducted in Medline, Embase, PubMed, Scopus, CINAHL, Physiotherapy Evidence Database (PEDro), Cochrane library, Baidu Scholar, and Green Medical to identify randomized studies that tested the effect of Pilates exercise training on Cobb angle, pain level, trunk range of motion (ROM), angle of trunk rotation, and QOL in idiopathic scoliosis. Separate meta-analyses were performed on the endpoints of these outcome measures. The PEDro scale was used to assess the methodological quality of the included studies.

Results: This review included 10 randomized controlled trials (n=359). PEDro scores ranged from 3 to 10, with the mean score across all articles being 5.3/10 and judged to be of fair quality. The results indicated that Pilates exercises was effective in reducing Cobb angle (standardized mean difference [SMD]= 1.23, 95% confidence interval [CI]= 0.11–2.35), angle of trunk rotation (SMD= 1.37, 95% CI= 1.01–1.73), and pain level (SMD= 2.78, 95% CI= 1.55–4.01), as well as improving trunk ROM (SMD= 1.23, 95% CI= 0.45–2.00), and QOL (SMD= 3.05, 95% CI= 2.59–3.51) in patients with scoliosis.

Conclusion: Pilates exercise training may reduce the Cobb angle and trunk rotation, relieve pain, increase trunk ROM, and improve QOL for patients with scoliosis. Due to the poor quality of the evidence, however, these results should be interpreted with caution.

Abbreviations: ATR = angle of trunk rotation, CI = confidence interval, PEDro = Physiotherapy Evidence Database, QOL = quality of life, RCT = randomized control trials, ROM = range of motion, SMD = standardized mean difference.

Keywords: meta-analysis, Pilates exercises training, scoliosis

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

College of Rehabilitation Medicine, Fujian University of Traditional Chinese Medicine, Fuzhou, Fujian, China.

* Correspondence: Jingsong Wu, College of Rehabilitation Medicine, Fujian University of Traditional Chinese Medicine, No.1 Qiuyang Road, Minhou Shangjie, Fuzhou, Fujian 350122, China (e-mail: jingsongwu01@163.com).

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1. Introduction

Scoliosis is defined as a “three-dimensional torsional deformity of the spine and trunk”, and 80% of cases are idiopathic scoliosis.^[1,2] Idiopathic scoliosis implies an unknown etiology or is not associated with a specific syndromic, congenital, or neuromuscular disease.^[3] The diagnosis of scoliosis is based on a standing anteroposterior radiograph with a Cobb angle greater than 10°.^[4] The worldwide prevalence of scoliosis in the general population has been reported to be 0.93% to 12%.^[1] It is a progressive disease that affects spinal alignment, trunk mobility, and symmetry,^[5] reducing the quality of life (QOL). It may cause respiratory problems.^[6] Severe cases of scoliosis have been shown to cause psychological disturbances.^[7] Significant efforts have been made to improve corrective interventions. The Society of Scoliosis Orthopedic Rehabilitation and Treatment was founded in 2004 to respond to corrective interventions.^[8] Surgery is the standard management for severe curvatures. At the same time, conservative treatment is commonly recommended for those with mild-to-moderate curvatures.^[5] Exercises are often recommended for patients with curvature angles between 10° and 30°. Pilates exercise training has been reported to improve flexibility and overall physical health by emphasizing strength, posture, and coordination of movements associated with respiration.^[6] Tang et al^[9] demonstrated that Pilates exercise training is an effective physical technique for improving pain and Cobb angle for scoliosis. Suzanne et al^[10] reported that Pilates exercise training is a whole-body approach to scoliosis that is symptom management was successful. Pilates exercise training

has been reported to be effective in improving scoliosis by correcting poor posture, strengthening the muscles necessary for postural correction, and maintaining body balance.^[11] However, other authors claim that general physiotherapy, including Pilates, is ineffective for scoliosis.^[12] Therefore, a comprehensive systematic review and meta-analysis was conducted to examine the benefits of Pilates exercise training for scoliosis on a range of outcomes, including Cobb angle, angle of trunk rotation (ATR), pain level, trunk range of motion (ROM), and QOL to inform better whether Pilates exercise training justifies the inclusion of the intervention.

2. Methods

2.1. Protocol and registration

This study was registered using the International Prospective Register of Systematic Reviews PROSPERO on October 22, 2020, with the corresponding reference number CRD42002167617 (http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42002167617).

2.2. Literature search

The search was conducted using Medline (1967–December 2020), Embase (1967–December 2020), PubMed (1967–December 2020), Cochrane (1960–December 2020), China National Knowledge Infrastructure (1967–December 2020), Wanfang degree and conference papers database (1967–December 2020), and Chinese Science and Technology Periodical Database (1967–December 2020). The search is for articles published in any language. The PubMed search strategy consists of the following keywords and their combinations: (exercise) OR (exercise therapy) AND (spinal disease) OR (spinal deformity) AND (random controlled trial) OR (clinical trial) OR (random allocation) OR (controlled trial) OR (control group).

2.3. Inclusion criteria

Studies that met the following inclusion criteria were included in this review: studies included participants diagnosed with any form of scoliosis, such as adolescent idiopathic scoliosis and idiopathic scoliosis; both males and females were included; only randomized control trials (RCTs) were included; experimental group included all types of Pilates/Pilates exercise; comparison group included waiting list, conventional physiotherapy, or other non-surgical treatments clearly described in detail, including frequency, intensity, and application method; clinician-assisted interventions performed in alone or within a multimodal treatment approach; and studies using within- or between-group outcome measures with the primary outcome: Cobb angle, and the secondary outcomes: pain level, trunk ROM, ATR, and QOL, which were assessed immediately after treatment. Participants were excluded from the study if they were diagnosed with scoliosis due to one of the following causes: congenital, neuromuscular, structural, neurofibroma, and interstitial lesions.

2.4. Study identification and data extraction

One review author conducted electronic searches. Two review authors independently screened the search results by reading the titles and abstracts. No disagreements occurred during screening for inclusion; therefore, a third reviewer was not required.

Additionally, reference lists of included studies, clinical guidelines, and recently published systematic reviews had been searched for potentially eligible studies. One review author screened the full text in order to extract the following data from the included studies: study design (RCT), study characteristics (country, recruitment modality, study funding, risk of bias), patient characteristics (number of participants, age, gender, severity of scoliosis at baseline), description of the experimental and comparative interventions, adverse effects, duration of follow-up, assessment outcomes and results. One reviewer conducted data extraction using a standardized data extraction form and cross-checked for accuracy and completeness by another reviewer.

2.5. Assessment of study quality

The NHMRC hierarchy of evidence was adopted to evaluate evidence level.^[13] Level II evidence (RCT) was considered the best methodology to answer intervention-related questions in a systematic review.

Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) scale.^[14] It is comprised of 11 items. The first item relates to external validity. The remaining 10 items are used to calculate the final score, which ranges from 0 to 10.^[15] The maximum score on the PEDro scale was 10 points (item 1 was not counted in the total score), where scores of 9 to 10 are classified as excellent quality, 6 to 8 as good quality, 4 to 5 as fair quality, and <4 as poor quality. Scores are only awarded when a criterion is clearly met in accordance with its description.^[16] The PEDro scale has been proven to be valid and reliable in evaluating the methodological quality of clinical trials.^[17] It is commonly used to evaluate physiotherapy research.

2.6. Ethical consideration

The adverse effects of the intervention were identified for inclusion in the study and reported as a composite outcome. All included studies had appropriate ethical approval.

2.7. Data analysis

The results for each study were entered into Review Manager software (version 5.3) for further analysis. Pooled-effect estimates were obtained using between-group difference values. Calculations were performed using the random-effects method. 95% confidence intervals (CIs) was considered statistically significant. Cochran Q test and the inconsistency I^2 test were used to assess statistical heterogeneity of treatment effects between studies, where values above 25% and 50% were considered to be markers of moderate and high heterogeneity, respectively.^[18] Heterogeneity between studies was explored by re-running the meta-analyses, removing 1 paper at a time to check if any individual study was responsible for heterogeneity.

3. Results

3.1. Study identification

The search yielded 752 articles, of which 52 studies were considered potentially relevant and were retrieved for detailed analysis. Forty-two articles were excluded, including 37 ineligible due to their interventions (non-Pilates), 5 due to study design (no comparison groups).^[19–23] Ten studies met the eligibility criteria

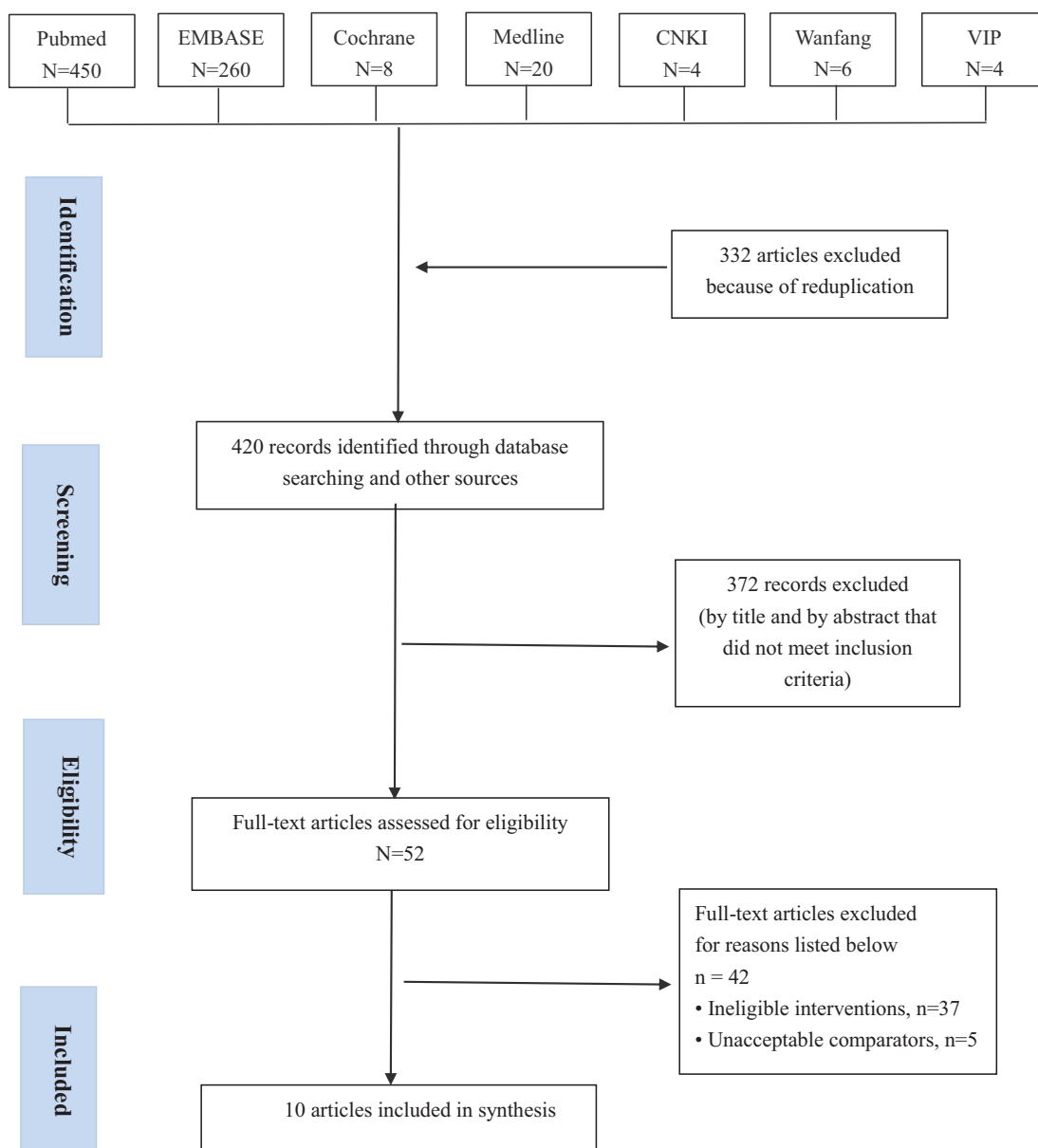


Figure 1. PRISMA flow diagram outlining the study selection process. CNKI = China National Knowledge Information database, VIP = Chinese Science and Technology Periodical Database.

and were retained for analysis. Figure 1 shows the PRISMA flow diagram of the studies included in this review.

3.2. Evidence hierarchy and methodological appraisal

The majority of included studies were determined to be of poor quality. Ten articles^[9,24–31] with an RCT methodology (100%) were classified as providing level II evidence. The PEDro scale of included studies was ranked from 3 to 10, with a mean score of 5.3/10 for all articles judged to be of fair quality. 70% (7/10) of the studies did not meet items 5 (subject-blinded), 6 (therapist-blinded), and 7 (assessor-blinded),^[9,24–26,28,29,31,32] 80% (8/10)^[24–26,28–32] and 90% (9/10)^[9,24–26,28–32] of the studies did not meet items 2 (random allocation) and 3 (concealed allocation). Table 1 summarizes the results of the methodological appraisal.

3.3. Characteristics of included studies

Ten RCTs were included, with a total of 359 participants. All participants were diagnosed with scoliosis. Four studies compared Pilates exercise training with Schroth exercise,^[9,26,26,32] 2 studies compared Pilates with waiting lists,^[27,28] 3 studies compared Pilates with conventional activity^[29,31] or physiotherapy,^[30] and 1 study compared Pilates exercise training with lateral breathing exercises.^[24] Two studies were conducted in Brazil,^[27,28] 3 in Korea,^[24–26] 2 in China,^[9,32] 2 in India,^[29,31] and 1 in Italy.^[30] The sample sizes of these 10 studies were small, ranging from 16 to 130, with mild to moderate scoliosis in people aged 7 to 52 years. Nine studies reported that the subjects were young population aged between 7 and 22 years.^[9,24–29,31,32] One study recruited subjects with a mean age of 51.6.^[30] Six studies reported a 3-month intervention duration,^[24–29] 1 study reported

Table 1
Evidence hierarchy and methodological appraisal.

Author year	Sample Size	Evidence level	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Score
Tang 2019	32	II	1	1	0	1	0	0	0	1	1	1	1	6/10
HwangBo 2018	16	II	1	0	0	1	0	0	0	1	1	1	1	5/10
Kim 2016	24	II	1	0	0	1	0	0	0	1	1	1	1	5/10
HwangBo 2016	16	II	1	0	0	1	0	0	0	1	1	1	1	5/10
Maria 2012	31	II	1	1	1	1	1	1	1	1	1	1	1	10/10
Erivânia 2010	31	II	1	0	0	1	0	0	0	1	1	0	1	4/10
Bipin 2018	30	II	1	0	0	1	0	0	0	1	1	1	1	5/10
Marco 2016	130	II	1	0	0	1	1	0	0	1	1	1	1	6/10
Mehdi 2019	25	II	1	0	0	1	0	0	0	1	0	1	1	4/10
Li 2018	24	II	1	0	0	1	0	0	0	1	0	1	0	3/10

Item 1, eligibility criteria; item 2, random allocation; item 3, concealed allocation; item 4, similar baseline; item 5, subjected blinded; item 6, therapists blinded; item 7, assessors blinded; item 8, <15% dropouts; item 9, intention-to-treat analysis; item 10, between-group comparison; item 11, point measures and variability data; 1, described explicitly and in details; 0, unclear, inadequately described.

2 months,^[31] 1 study reported 50 times,^[9] and others had 5 months^[30] and 6 months.^[32] A variety of measures were used in the retained studies. Ten studies used the Cobb angle,^[9,24–32] 2 studies used the ATR,^[24,28,30] 2 studies used the pain level,^[27,28,30] 2 studies used trunk ROM,^[24,27] 1 utilized weight distribution,^[26] 2 used a QOL questionnaire,^[9,30] and 1 used a depression questionnaire.^[26] Table 2 summarizes the characteristics of the studies included in this systematic review. Table 3 summarizes the baseline data of the retrieved studies.

3.4. Effects of interventions

3.4.1. Cobb angle. The effect of Pilates on the Cobb angle (°) was assessed in 7 trials^[9,24–27,30,31] (n=274). Pilates exercise

training was effective in improving spinal deformity compared to controls (standardized mean difference [SMD] = 1.23, 95% CI = 0.11–2.35; $I^2=91%$, $P=.03$), based on a randomized-effects model (Fig. 2).

3.4.2. ATR. The effect of Pilates on ATR (°) was assessed in 2 studies^[24,32] (n=146). On the basis of their findings, they reported that Pilates may have some benefit in improving trunk rotation (SMD=1.37, 95% CI=1.01–1.73; $I^2=0%$, $P<.001$) (Fig. 3).

3.4.3. Pain level. Three trials evaluated the effect of Pilates on pain levels^[27,28,30] (n=192). Pilates exercise training provided levels of pain than controls (SMD=2.78, 95% CI=1.55–4.01;

Table 2
Characteristics of included studies in this systematic review.

Author year	Participants (PG/CG) population	Cobb angle range	Intervention	Duration and intensity	Outcomes
Tang 2019	32(16/16) Age between 7–20 years	15°–45°	PG: Pilates + Schroth exercise CG: Schroth exercise	50 times	Cobb angle Quality of life questionnaire
HwangBo 2018	16(8/8) Age between 20–21years	10°–20°	PG: Pilates exercise CG: Lateral breathing exercise	3 times/wk for 3 mos	Cobb angle Angle of trunk rotation Trunk range of motion
Kim 2016	24(12/12) Age between 15–16 years	≥20°	PG: Pilates exercise CG: Schroth exercise	3 times/wk for 3 mos, each 60-min session	Cobb angle Weight distribution
HwangBo 2016	16(8/8) Female high school students	≥20°	PG: Pilates exercise CG: Schroth exercise	3 sessions/wk, 3 mos	Cobb angle Korean version of the Beck Depression Inventory
Maria 2012	31(20/11) Female students	NR	PG: Pilates exercise CG: Waiting list	2 times/wk for 60 min per session for 3 mos	Cobb angle Pain Trunk range of motion
Erivânia 2010	31(20/11) Academical subjects	NR	PG: Pilates exercise CG: Waiting list	24 sessions for 3 mos	Cobb angle Pain Angle of trunk rotation
Bipin 2018	30(15/15) School boys	NR	PG: Pilates exercise CG: Regular activity	6 days/wk for 3 mos	Cobb angle
Marco 2016	130(65/65) Adults with idiopathic scoliosis	<35°	PG: Pilates self-correction, task-oriented exercise CG: General physiotherapy	1 60-min session/wk for 5 mos	ODI Pain level Cobb angle Angle of trunk rotation
Mehdi 2019	25(11/14) Adult women	5°–20°	PG: Pilates exercise CG: Regular activity	60-min session/wk for 2 mos	SRS-22 Cobb angle Y balance test
Li 2018	24(12/12) Academic students	15°–45°	PG: Schroth + Pilates exercise CG: Schroth exercise	2–3 times/wk for 6 mos	Cobb angle

PG= Pilates group, CG= control group, NR=not reported, wk=week, mos=months, ODI= Oswestry Low Back Disability Questionnaire, SRS-22= Scoliosis Research Society-22 Questionnaire.

Table 3
Baseline of retrieved studies.

Study	Population			Age				Cobb angle			Duration
	Number			Range		Average		Range	Average		
	Total	PG	CG	PG	CG	PG	CG	PG	CG		
Tang 2019	32	16	16	7–21	7–20	13.16±2.87	13.36±2.91	15°–45°	23.87±4.02	24.57±3.96	50 repetitions
HwangBo 2018	16	8	8	NR		21.08±1.95	20.94±0.32	10°–20°	19.02±9.01	18.98±4.03	3 mos
Kim 2016	24	12	12	NR		15.3±0.8	15.60±1.1	≥20°	24.0±2.6	23.63±1.5	3 mos
HwangBo 2016	16	8	8	NR		18.88±1.55	18.14±1.60	≥20°	21.20±3.95	22.07±6.81	3 mos
Marco 2016	130	65	65	NR		51.6±8.1	51.7±8.5	<35°	28.2±4.9	27.5±5.0	5 mos
María 2012	31	20	11	18–25		NR	NR	NR	7.6±3.5	7.1±2.8	3 mos
Erivânia 2010	31	20	11	18–25		22±2		NR	NR	NR	3 mos
Bipin 2018	30	15	15	11–14		NR		NR	NR	NR	3 mos
Mehdi 2019	25	11	14	NR		65.3±4.27		5°–20°	12.38±2.85	10.96±3.39	2 mos
Li 2018	24	12	12	NR		15.75		15°–45°	NR	NR	6 mos

PG= Pilates group, CG=control group, mos=months, NR=not reported.

$I^2=85%$, $P<.001$) and based on a randomized-effects model, Pilates exercise training could have some benefit for spinal pain compared to controls (Fig. 4).

3.4.4. Trunk ROM. Two trials evaluated the effect of Pilates on trunk ROM ($^{\circ}$)^[24,27] ($n=47$). A higher ROM was provided by Pilates exercise training (SMD=1.23, 95% CI=0.45–2.00; $I^2=28%$, $P=.002$), and based on a randomized-effects model, there may be some benefit of Pilates exercise training on trunk ROM compared to the waiting list or breathing exercise (Fig. 5).

3.4.5. QOL. Two studies^[9,30] ($n=162$) assessed Pilates exercise compared with a control group and found that the Pilates group scored higher than the control group on QOL questionnaire (SMD=3.05, 95% CI=2.59–3.51; $I^2=0%$, $P<.001$) (Fig. 6).

3.4.6. Adverse effects. There were no adverse effects reported in 10 studies.

4. Discussion

This study aimed to systematically review published evidence to determine whether Pilates exercise training is an efficacious

treatment for scoliosis. Ten studies, including a total of 359 participants, were evaluated. Of the 10 studies assessed using the PEDro scale, only 1 study was considered to be of high methodological quality (10/10),^[27] while the other included studies found fair quality ranging from 3 to 6/10. The results demonstrated that compared to other interventions (waiting lists, breathing exercises, regular activities, and general physiotherapy), Pilates exercise training reduced the Cobb angle, the ATR, relieve pain, increase trunk ROM, and improve QOL in patients with scoliosis.

Pilates exercise is a mind-body exercise that focuses on core stability, flexibility, posture control, and breathing^[33] and has become a target of interest in recent years as a beneficial form of exercise.^[34] Many studies have demonstrated that Pilates exercise training can improve symptoms in patients with spine-related diseases.^[35–37] Previous reviews have reported that Pilates exercise can improve posture and dynamic balance in older adults,^[34,38] reduce pain and disability in individuals with chronic low back pain,^[39,40] and also improve spine curvature and alignment in adolescents,^[37] and increase lower and upper limb strength, aerobic endurance, whole-body flexibility, and agility in elderly people.^[38,41]

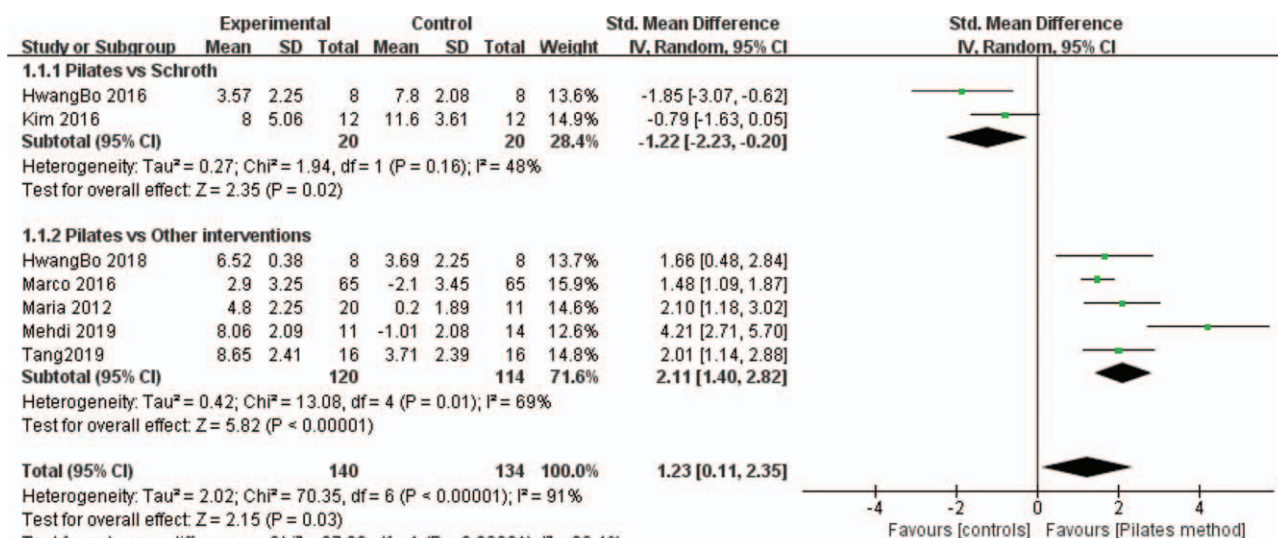


Figure 2. Analysis of Cobb angle. Pilates vs control: Cobb angle.

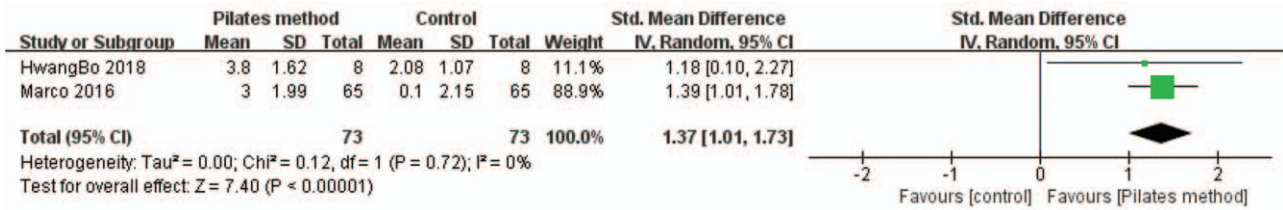


Figure 3. Analysis of angle of trunk rotation. Pilates vs control: angle of trunk rotation.

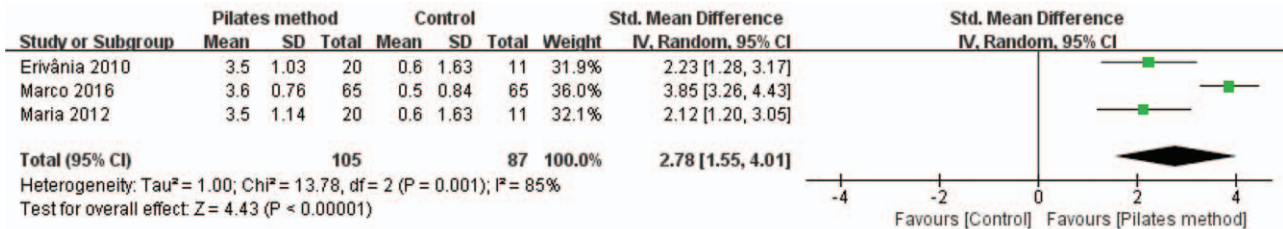


Figure 4. Analysis of pain level. Pilates vs control: Pain level.

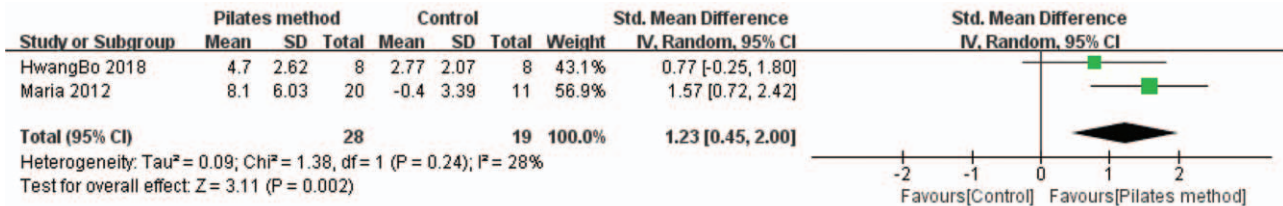


Figure 5. Analysis of trunk range of motion. Pilates vs control: trunk range of motion. ROM = range of motion.

The combined results found that Pilates exercise can reduce spinal deformity as the primary outcome was a decrease in Cobb angle compared to controls. The Pilates techniques of lengthening, expanding the chest, and enhancing core stability are key to improving spinal deformity,^[42] which is consistent with other authors.^[43-45] Li et al^[23] and Rrecaj et al^[46] reported that Pilates exercise was effective for mild to moderate scoliosis, but less effective for severe scoliosis. In this review, the subjects included in the studies all demonstrated mild to moderate scoliosis (Table 3), which is consistent with their results. We also found the subgroup results of the control groups using Schroth method^[25,26] demonstrated that Pilates exercise training is not superior to Schroth in improving the Cobb angle. They claimed

that Schroth was more effective than Pilates in reducing the Cobb angle because the 3-dimensional corrective exercise and breathing techniques were prescribed according to the shape of each participant's curve.^[24,47,48] However, the Schroth method is a static exercise that tends to fatigue patients^[32] while the Pilates exercise can not only provide the patient with various tips to help complete the exercise, but also allow the patients to synchronize the exercise to music and is less likely to fatigue. This may encourage the participation of patients with scoliosis.^[32]

The Pilates exercise also demonstrated benefits in decreasing ATR compared to the control groups (breathing exercise/general physiotherapy). In addition to the Cobb angle, ATR is another very important variable in determining the severity of scoliosis.

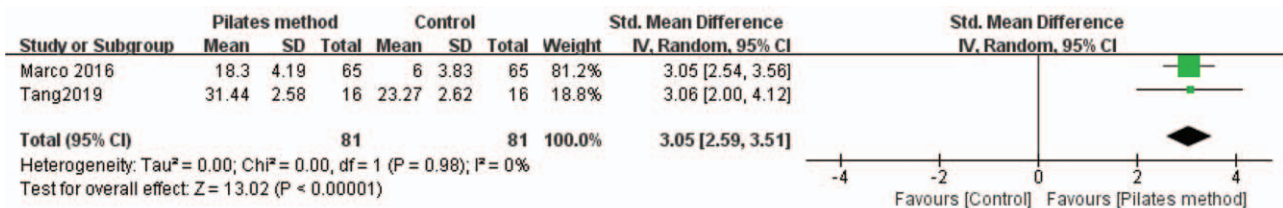


Figure 6. Analysis of quality of life. Pilates vs control: quality of life.

Other studies have obtained similar results in terms of improved ATR following the application of Pilates exercise.^[46,49,50] The aim of Pilates exercise is to increase the mobility of the thoracic vertebrae and constrained segments and to balance the asymmetric segments to improve the ATR.^[24]

Few studies have reported that Pilates exercise can relieve pain, increase trunk ROM, and improve QOL. Many studies that have investigated interventions for the curves of scoliosis were reduced and whether the spine appeared to be “straighter.” Improvement in symptoms and QOL are also important. Previous studies^[51–55] found that patients participating in Pilates demonstrated a reduction in pain and improved muscle function, which stabilized the spine, leading to muscle rebalance and preventing or minimizing pain from scoliosis.^[55] Improvements in core strength and spine posture can promote postural symmetry to relieve pain in patients with scoliosis.^[52] Other studies have also reported similar results.^[53–55]

However, other authors claim that Pilates is not practical for scoliosis.^[12] General exercise such as Pilates usually consist of low-intensity stretching and strengthening activities. At the same time, scoliosis is a kind of 3-dimensional deformity that cannot be corrected.^[8] As the results of the current study demonstrate, Pilates found some effect for scoliosis patients because it is not only a combination of stretching and strengthening exercise but also utilize mind-body controlled movements which will optimize the spine muscle-skeletal function to improve deformities.

The results of the current analysis found Pilates exercise could improve trunk ROM compared to controls. Previous studies have also reported that Pilates exercises could enhance trunk extensibility by increasing trunk motion and hamstring flexibility.^[56–58] Neural inter-operability may contribute to osseous reorganization in scoliosis patients as their muscles act in a more ‘balanced’ manner during Pilates exercises.^[59]

In this review, only 2 studies reported the benefits of QOL in patients with scoliosis. By creating a positive body image and increasing their participation, Pilates practitioners may convey a positive image about Pilates and encourage them to spend time exercising regularly by realizing their values and improving their QOL.^[60] QOL improved with the improvement of symptoms and increased trunk mobility.^[61]

Many reviews have verified that different types of specific exercises are effective in treating scoliosis. A well-established method is based on Schroth treatment, which only addresses a certain proportion of patients. In contrast, Pilates exercise training has been widely accepted by dancers, physiotherapists, personal trainers, coaches, and others. These practitioners deal with all types of scoliosis patients, which means that they can potentially treat a much larger number of patients using this technique.

5. Limitations

This systematic review has several limitations. First, the grey literature was not explored. The small number of studies ($n=10$) and sample size ($n=359$) included means that the authors cannot explore potential publication biases and mask variation due to systematic error or poor precision. Second, the parameters of Pilates exercise used in each study (including intensity and duration) are pretty different, and the optimal parameters for scoliosis cannot be determined. Third, despite the high heterogeneity scores, all data from all studies were included in

the final analysis due to the limited number of studies. Finally, the overall quality of the research included in this systematic review was fair. Most studies were not blinded for allocation concealment, personnel and outcome assessment, which may have produced selection bias.

6. Clinical implications and recommendations for future studies

These results found that Pilates exercise training seems to improve spine deformity, pain level, trunk ROM, and QOL in patients with scoliosis, suggesting that Pilates exercise training may be a potential intervention for scoliosis.

Further high-quality studies should consider the appropriate parameters for scoliosis and focus on the long-term effects of Pilates exercises on patients with scoliosis.

7. Conclusion

In conclusion, the results suggest that Pilates exercises have a significant effect on decreasing the Cobb angle and decreasing ATR, improving pain, increasing trunk ROM, and improving QOL in scoliosis when compared to controls (breathing exercise/waiting list/regular activity/regular physiotherapy). However, with the limited number and general quality of retained articles, caution is required in interpreting and applying these results. Therefore, more diverse and high-quality studies are needed before any definitive judgements can be made.

Author contributions

Data curation: Huangwei Lei, Yi Zeng, Jing Tao.

Formal analysis: Yanyun Gou, Jing Tao, Weicheng Kong.

Funding acquisition: Yanyun Gou.

Investigation: Jingsong Wu.

Methodology: Huangwei Lei.

Project administration: Yanyun Gou.

Visualization: Huangwei Lei, Jingsong Wu.

Writing – original draft: Yanyun Gou, Yi Zeng.

Writing – review & editing: Yanyun Gou, Jingsong Wu.

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