Effects of Physiotherapeutic Scoliosis-Specific Exercise for Adolescent Idiopathic Scoliosis Cobb Angle: A Systematic Review

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Abstract:

Background: The study of physiotherapeutic scoliosis-specific exercise (PSSE) for adolescent idiopathic scoliosis (AIS) is rapidly progressing. However, there are limited reports on the medium- to long-term effects of PSSE on scoliosis.

Methods: A systematic review and meta-analysis feasibility study were conducted according to the Cochrane and Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. In our exhaustive search, we employed nine search formulas and four search databases according to a preregistered protocol. Identification, screening, eligibility, inclusion, and meta-analysis were performed through repeated meetings involving all coauthors. Each process was conducted by three or more authors.

Results: A total of 1,518 studies were identified in the initial search. After manually reviewing abstracts and full texts, 11 studies were chosen for evaluation and reporting. The overall risk-of-bias was high in approximately half of the studies and moderate in the other half, with none found to have a low risk-of-bias. Only two randomized controlled trials (RCTs) specifically evaluated the therapeutic effect of PSSE on over a 1-year clinical course and the preventive ability of PSSE on surgery. One RCT reported that Cobb angle was substantially smaller in the PSSE group than in the control group at the final follow up, whereas the other found no significant difference between the groups. The methods of exercise intervention, control group selection, and timing of outcome assessments were not standardized in the selected studies. Thus, conducting a meta-analysis of the literature was deemed unfeasible at this time.

Conclusions: The certainty of the evidence that PSSE reduces the progression of Cobb angle in patients with AIS in the short and long term was extremely low. Accordingly, healthcare providers should carefully examine the current evidence when explaining and applying PSSE in such patients. High-quality studies addressing the long-term changes in Cobb angle and Cobb angle at bone maturity as primary outcomes are warranted.

Level of Evidence: Level 1

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Introduction

Scoliosis is the most common pediatric deformity of the spine[1,2], with the majority of cases detected during adolescence between the ages of 10 and 18 years[3-6]. The International Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) has estimated the global incidence of adolescent idiopathic scoliosis (AIS) to be 0.93%-12%[7]. Even after the completion of bone growth at over 18-20 years of age, scoliosis with a Cobb angle exceeding 40° is believed to progress by roughly 0.5°-1° annually. Severe scoliosis not only compromises appearance but also limits lung capacity[7], causes back pain[8,9], and results in a high medical burden[10,11]. As corrective surgery can lead to complications, pain, and an extended recovery period[12], preventive treatment to avoid AIS surgery is crucial. Cobb angle has been used to evaluate the severity of scoliosis, with observation recommended for mild scoliosis (10°-25°), bracing for moderate scoliosis (25°-45°), and surgery for severe scoliosis[4].

In recent years, physiotherapeutic scoliosis-specific exercise (PSSE) has been increasingly reported as an option for the conservative treatment of AIS. The SOSORT recommends PSSE to stop or slow down scoliotic curve progression[13]. PSSE includes all forms of outpatient physiotherapies with evidence of an effect on scoliosis outcomes[7,14-17]. PSSE has been divided into various schools, including Schroth; Scientific Exercises Approach to Scoliosis (SEAS); Barcelona Scoliosis Physical Therapy School (BSPTS); the fixation, elongation, derotation method (FED); Functional Independent Treatment for Scoliosis (FITS); Lyon; Side Shift; and DoboMed, with all methods sharing the same basic principles[13]. In the past 11 years, several systematic and other reviews have investigated the certainty of evidence on the therapeutic effects of exercise therapy for AIS[17-27]. However, to the best of our knowledge, the efficacy of PSSE in preventing scoliosis Cobb angle progression over the long term is uncertain as compared with the literature on observation and brace treatment.

The present investigation conducted a systematic review and meta-analysis feasibility study to address the following questions: 1) Can PSSE prevent scoliosis progression in the short and long term equivalently to brace treatment? 2) Can PSSE help avoid surgical intervention?

Materials and Methods

The systematic review and meta-analysis feasibility study were conducted to determine the effectiveness of PSSE for patients with AIS. The investigation strictly adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Before the data extraction and analysis, the data were registered in the University Hospital Medical Information Network clinical trial registration (UMIN-CTR) system (https://www.umin.ac.jp/).

Identification and selection of studies

The PubMed, Cochrane Library, Scopus, and Google Scholar databases were searched for relevant articles published between January 2000 and May 2024. The core keyword was "Scoliosis," with the addition of one of the following nine additional keywords: "Physiotherapeutic scoliosis-specific exercise," "Schroth," "SEAS," "BSPTS," "FED," "FITS," "Lyon," "Side Shift," and "DoboMed." A total of nine searches from the combination of core and additional keywords were conducted. Only randomized controlled trials (RCTs) were included in this systematic review. Furthermore, the bibliographies of the meta-analyses and systematic reviews were examined to ensure the inclusion of all relevant literature. To this aim, a manual search of the reference lists of the selected publications was performed to identify additional studies for potential inclusion.

Identification, screening, eligibility, and inclusion were performed independently by at least two authors. In cases of disagreement, the first author reviewed the matter and made the final decision. In each instance of disagreement, a web conference was held among the authors to reach a consensus.

The article search process was recorded in Excel format, with the history saved in dedicated files. All processes were performed according to a preregistered plan. At the end of each process, the first author shared the most recent data file with all project members through e-mail.

Eligibility criteria

The inclusion of studies was made according to the following population, intervention, comparison, and outcome (PICO) items.

- Population: individuals diagnosed with AIS.
- Intervention: use of some form of PSSE.
- Comparison: control group defined as not receiving treatment, bracing, or nonspecific exercise intervention.
- Outcome: major scoliosis Cobb angle (as evaluated by X-ray), ATR, and QOL.
- Design: RCT.

We did not specify the timing of outcome assessments.

We also excluded nonEnglish language papers.

Assessment of methodological quality

The Cochrane Risk-of-Bias 2.0 (RoB 2.0) tool was used to assess the risk-of-bias. Two experienced raters (AM, RS) independently scored each study. The RoB 2.0 tool determines the potential bias and the internal validity of studies and classifies them as "low," "unclear," or "high" risk based on five criteria[28]. All signaling questions were rigorously evaluated after reviewing the full text of each RCT. The evaluation of each domain was determined by the automatic judgment function of the RoB 2.0 tool. In the case of disagreement between the authors, the first author reviewed the matter and made the final decision.

Data synthesis and analysis

For meta-analysis consideration, we evaluated the effect of PSSE on coronal Cobb angle, ATR, and Scoliosis Research Society (SRS)-22r score (subtotal) from the eligible studies. Each data point, including the mean and standard deviation, was extracted by two reviewers from all the included studies at followup intervals of 3 months, 6 months, 1 year, and 2 years or more after the initiation of exercise intervention. The decision to conduct a meta-analysis was carefully considered among the coauthors in relation to the existing body of literature and the clinical relevance of the findings. Random-effects models and the I^2 test were planned to evaluate the pooled effect size and 95% confidence interval for the outcome of interest and statistical heterogeneity, respectively.

Results

Flow of studies through a review

The PRISMA selection flowchart is presented in Fig. 1. Our database search identified 1,518 potential studies for analysis. After screening and eligibility assessment, 11 RCTs were finally included in this systematic review[29-39]. Eight papers focused on Schroth exercises[29-36], in addition to one paper each on SEAS[37], scoliosis-specific exercise (SSE)[38], and self-correction and task-oriented exercises (SCTO)[39]. Several interesting controlled clinical trials[40-43] and prospective studies[44-50] were also identified but were ultimately excluded as only RCTs were included in this investigation.

Research summary

The PICO and outcome data for all studies included in the final evaluation are summarized in Table 1, 2.

Risk-of-bias

Fig. 2, 3, 4 present the risk-of-bias regarding each outcome across the studies. Two domains, "selection of the reported result" and "deviation from the intended interventions," were judged as having some concerns or a high risk in all studies. Five studies demonstrated an overall high risk-of-bias. All studies had a low risk-of-bias with respect to the "measurement of the outcome" domain.

Meta-analysis

Five studies reported Cobb angle at 3 months (10-16 weeks) after the initiation of exercise intervention[29,31,33,37]. The intervention in these reports was the Schroth method as compared with observation in one study[33], Pilates in two[31], and core exercise also in two[34,37]. As regards studies targeting patients with skeletal immaturity (i.e., Risser grade 0-3), Hwangbo et al. included patients with a Cobb angle over 20°, whereas Kocaman et al.[34] considered patients with Lenke type 1 and Cobb angle ranging from 10°-30°. Regarding ATR, data at 3 months of followup were available in five studies[30,33-35,37]. The control group was observation in two studies[30,33], core exercise in two[34,37], and home-program Schroth methods in one[35]. The mid- to long-term results over 1 year of followup were available in two studies[36,39]. Although both reports focused on patients with a Cobb angle below 25°, Monticone et al. used traditional exercise as the control, whereas Zepata et al. employed observation.

Based on a rigorous review of these collected data, we ultimately opted not to conduct a meta-analysis for the following reasons: 1) marked heterogeneity of patient background relevant to the risk of Cobb angle progression, 2) heterogeneity of the comparison groups, and 3) the small number of eligible studies with mid- to long-term outcomes, which were the primary outcomes of interest in this investigation.

Discussion

This systematic review summarized the literature on the treatment effects of PSSE for AIS, mainly focusing on Cobb angle changes. All RCTs published up to May 2024 were included in our search, which revealed four key findings. First, a total of 11 RCTs investigated the intervention impact of PSSE on AIS. Second, the followup period of most studies was short; thus, the long-term results of PSSE for AIS remain unknown. Third, RCTs investigating the effect of PSSE on AIS had an overall high risk-of-bias. Fourth, this field still lacks the research necessary to conduct a meta-analysis.

Exercise therapy for AIS has a decade-long history. In 2013, Romano et al.[18] conducted a Cochrane systematic review investigating the advantages of SSE in patients with AIS and identified only one RCT and one prospective study. Nine subsequent systematic reviews on similar topics have failed to prove the efficacy of exercise therapy for AIS[17-27]. Recently, Romano et al.[27] conducted a review of the Cochrane database of systematic reviews, exhaustively searching all articles published until January 2023, although the certainty of the evidence on the effect of exercise therapy for AIS on Cobb angle was extremely low. The present study, which extended the survey period to January 2024, identified 11 RCTs. Four RCTs were reported from Tur-

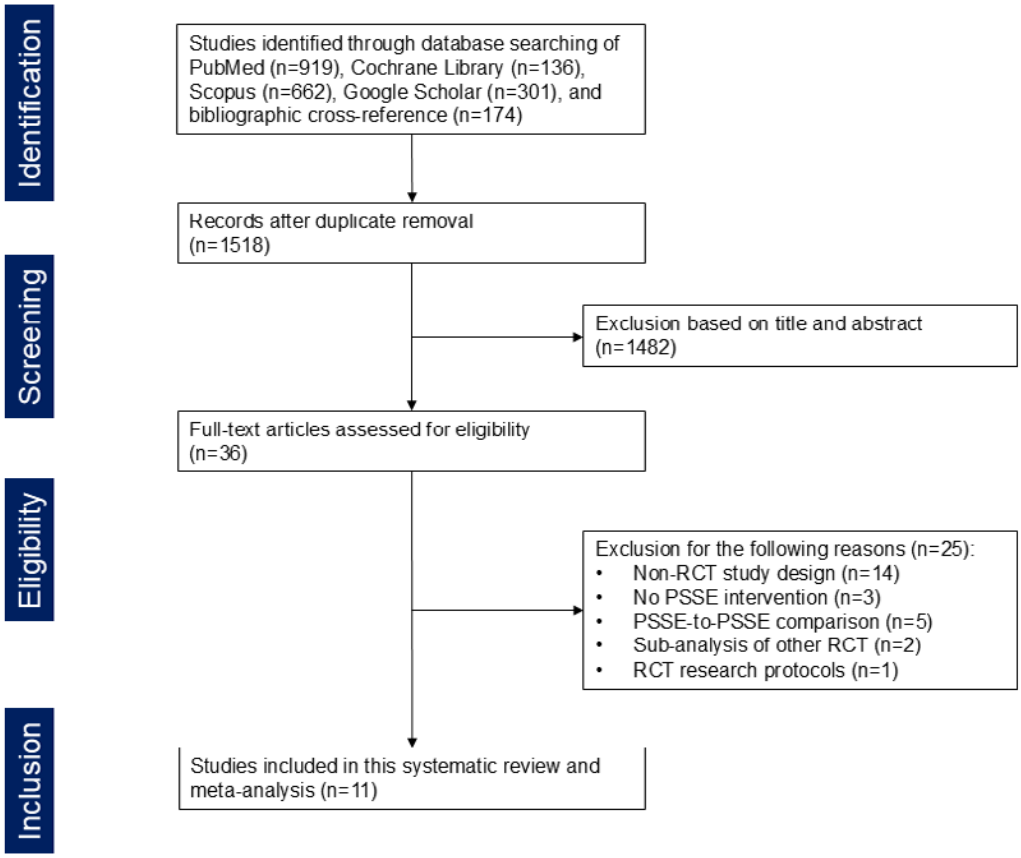

Figure 1. PRISMA flow diagram of the review process.
Abbreviations: PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PSSE, physiotherapeutic scoliosis-specific exercise; RCT, randomized control trial

key[30,34,35,37], three from Korea[29,31,33], and one each from Canada[32], the USA[36], Sweden[38], and Italy[39]. The types of PSSE were the Schroth method in eight studies[29-36], SEAS in one[37], SSE in one[38], and SCTO also in one[39]. Several other reports had placed PSSE in the control group and a new conservative treatment in the intervention group, but these were excluded from the current systematic review.

The risk-of-bias for each outcome among the 11 RCTs was not low. In fact, when Cobb angle was considered, 60% (6/10) had a high overall risk and 40% (4/10) had some concerns. There were no examples of low risk. The reason for this may be the high risk-of-bias in D2 (deviations from the intended interventions) and D5 (selection of the reported results). These factors should be carefully considered when conducting future RCTs in this area to lower the risk-of-bias. We did not identify any studies with low overall risk for either ATR or SRS-22 as outcomes.

We have additional concerns regarding bias from the viewpoint of Cobb angle evaluators. It was not definitively stated that the study evaluator was distinct from the study conductor in almost any paper. This bias is not reflected in Fig. 2, 3 or 4 as the RoB 2.0 tool did not ask whether the measurer and conductor were different. As is the case in numerous clinical studies, it is undesirable for the study conductor to be involved in measurements. Furthermore, not all papers fully explained how the radiographs were taken; it is possible that the posture at the time of imaging was different immediately after the exercise therapy intervention, which influenced the Cobb angle. To understand the impact of short-term exercise intervention on the true morphology of the spine, it will be necessary to evaluate the Cobb angle in standing full-length X-rays taken in a natural posture at bone maturity. Indeed, the results should be carefully judged in terms of the risk of measurement bias.

Assessment of the background information of patients plays a pivotal role in conducting a systematic review and meta-analysis. When properly done, such analyses are considered to have the highest level of evidence. However, their reliability can be compromised by the heterogeneity and quality of the included studies as well as any reporting biases[51]. A recent network meta-analysis that included 12 papers from more than 7 databases concluded that exercise intervention, particularly yoga, improved the Cobb angle by 4.6° in patients with AIS[26]. However, it contained patients with a wide mean age range (10.1-33.9 years), indicating a comparison of subjects harboring varying progression risks. Another meta-analysis of four studies concluded the effectiveness of Schroth exercise on the Cobb angle, not by conducting a meta-analysis for the Cobb angle but rather by using the SRS-22r and SRS-23 scores[20]. The study acknowledged its limitations regarding result applicability given the limited number of studies that prevented them from conduct-

Table 1. PICO of the Literature Included in This Analysis.

	Population*					Intervention			Comparison	Outcome	
Study	n (at start/at analysis)	Sex (female/male)	Age (years, range)	Risser sign (grade, range)	Scoliosis Cobb angle (degree, range)	Program	n	Intervention period (months)			Evaluation period
Kim et al., 2016[29]	24/24	24/0	NA	NA	NA	Schroth	12	3	Pilates	Cobb	12 W
Kuru et al., 2016[30]	45/45	39/6	10–18	0–3	10–60	Schroth at hospital, Schroth at home	15, 15	6	Observation	Cobb, ATR, SRS-22	6 W 12 W 24 W
HwangBo et al., 2016[31]	16/16	16/0	10–18	0–3	>20	Schroth	8	3	Pilates	Cobb	12 W
Schreiber et al., 2016[32]	50/50	47/3	10–18	0–5	10–45	Schroth	25	6	Observation	Cobb	24 W
Lee et al., 2020[33]	15/15	13/2	NA	NA	NA	Schroth	8	3	Observation	Cobb, ATR	12 W
Kocaman et al., 2021[34]	28/28	21/7	10–18	0–3	10–30	Schroth	14	2.5	Core exercise	Cobb, ATR, SRS-22	10 W
Akyurek et al., 2022[35]	30/29	29/0	10–17	0–5	10–45	Schroth	15	2	Home program Schroth methods	ATR	8 W
Zapata et al., 2023[36]	98/57	41/16	10–16	0	12–24	Schroth	69	12	Observation	Cobb	1 Y 2 Y
Yagci et al., 2019[37]	30/30	30/0	>12	2–3	20–45	SEAS	15	4	Core exercise	Cobb, ATR, SRS-22	3 W 16 W
Dufvenberg et al., 2021[38]	135/132	111/24	9–17		25–40	SSE	45	6	Bracing/ observation	Cobb, ATR, SRS-22	24 W
Monticone et al., 2014[39]	110/110	80/30	10	0–2	10–25	SCTO	52	43	Basic exercise	Cobb, ATR, SRS-22	3.5 Y 4.5 Y

*All patients had adolescent idiopathic scoliosis.

Abbreviations: W, week; Y, year; Cobb, major scoliosis Cobb angle; ATR, angle of trunk rotation; SRS, Scoliosis Research Society; SEAS, Scientific Exercises Approach to Scoliosis; SSE, scoliosis-specific exercise; SCTO, self-correction and task-oriented exercises; NA, not applicable

ing a meta-analysis on the actual outcome of interest. However, the authors' conclusion presented in the abstract could potentially mislead readers in terms of generalizability. Given the heterogeneity of previous studies in the present systematic review, we decided against conducting a meta-analysis that could also be misinterpreted by readers.

The substantial patient background heterogeneity in our systematic review highlights the need for high-quality studies to compile sufficient evidence on the benefits of physical therapy in patients with AIS. Considering the reliable evidence on bracing for patients with moderate to high risk of progression[52], future studies should investigate the effect of physical therapy on Cobb angle progression, bracing conversion, and surgical intervention over the years in patients with a mild risk of progression, such as those with a Cobb angle less than 25° in skeletally immature patients. Zapata et al. conducted a multicenter RCT on this subset and showed a significantly lower rate of bracing at a 1-year followup in the exercise group, although a 42% dropout rate was also observed at that time[36]. A high dropout rate may introduce bias and limit generalizability as Cobb angle progression directly affects the patient's and parents' decisions regarding treatment changes.

Measurement error and expectation biases are also important considerations in studies on exercise intervention. Monticone et al. reported favorable data from a RCT with 3.5-year exercise intervention and 1-year followup, demonstrating an improvement of 5° from baseline at the last followup in patients with mild to moderate risk of Cobb angle progression. However, the 5° improvement was at the borderline of measurement error mentioned in their study despite the difference between the groups reaching statistical significance. Compounding this was the fact that the authors employed a single blinded reviewer for Cobb angle measure-

Table 2. Outcomes and Key Findings of the Literature Included in This Analysis.

Study	Results	Key findings	Major concerns and supplementary information
Kim et al., 2016[29]	The Cobb angle significantly improved in both groups, with greater improvement in the Schroth group.	Both the Schroth and Pilates methods are effective in improving scoliosis.	Scoliosis type and bone maturity not indicated.
	In the Schroth group, the left-right difference under lower extremity loading also improved.		Short followup period of 3 months.
Kuru et al., 2016[30]	The Cobb angle (−2.53°) and ATR (−4.23°) significantly improved only in the Schroth group.	When the Schroth method is indicated, it should be performed under physical therapy supervision.	Scoliosis type unknown.
	No change in SRS-23 was observed.	No intervention effect from home exercises alone.	Small change in the Cobb angle, small clinical significance.
Hwangbo et al., 2016[31]	The Cobb angle significantly improved in both groups, with greater improvement in the Schroth group.	Both the Schroth and Pilates methods have the potential to improve mental health.	Survey conducted after bone maturity at an average subject age of 18 years.
	Depression, self-esteem, and physical self-image significantly improved in both groups, with greater improvements in the Schroth group.		Short followup period of 12 weeks, no information on scoliosis type, and difference in the Cobb angle possibly due to change in shooting posture.
Schreiber et al., 2016[32]	The Cobb angle in the Schroth group significantly improved.	The Schroth method for 6 months in addition to standard treatment is advantageous for preventing scoliosis progression.	Patients indicated for orthotic treatment received orthotic treatment in both groups.
	The dropout rate in the Schroth group was 16% (4 cases), with compliance >70%.	Compliance is also considered to be acceptable and practical in other areas.	Patients with a wide range of bone maturity levels were included.
Lee et al., 2020[33]	Significantly greater changes in the Cobb angle and ATR were observed in the Schroth group.	It is difficult to improve a deformed appearance with the Schroth method.	Treatment for lumbar scoliosis.
	No changes in the left-right difference in ATR under lower extremity loading.		The target age is too high to evaluate the inhibition of deformity progression.
			Short followup period of 12 weeks.
Kocaman et al., 2021[34]	The Cobb angle, ATR, WRVAS, SRS-22 subtotal score, and trunk range of motion improved in the Schroth group compared with the core stabilization group.	In mild AIS, the Schroth method improves the scoliosis deformity, visual assessment, quality of life, and spinal column mobility compared with CS.	Short followup period of 10 weeks.
	Extremity strength improved more in the CS group.	CS improves limb muscle strength.	Cobb angle improvement possibly due to posture.
Akyurek et al., 2022[35]	The Schroth group had improved trunk proprioception, ATR, postural parameters, and WRVAS compared with the home exercise group.	Schroth exercises have a positive impact on spinal joint proprioception, rotational deformity, and postural improvement.	Risk of progression originally small as only cases with advanced bone maturation (Risser ≥ 3) were included.
			Short followup period of 8 weeks.
			No evaluation of the Cobb angle. ATR showed improvement, but the difference was <5° and of little clinical significance.
Zapata et al., 2023[36]	Patient attrition achieved 42% at 1 year and 52% at 2 years.	It is difficult to increase compliance to exercise therapy in patients with mild scoliosis over a long period of time.	Most well-designed study as a multicenter RCT.
	The Cobb angles in the Schroth group and controls were not significantly different at 1 year (16° vs. 18°, P=0.38) or 2 years (15° vs. 19°, P=0.08).	The implementation of the Schroth method may reduce scoliosis progression and the transition to orthotic treatment.	Low followup rate (>40%).
	There was a significantly lower rate of orthotic treatment introduction at 1 year in the Schroth group (26% vs. 55%, P=0.03).		No significant difference between the test groups. The Schroth group did not have progression of scoliosis, indicating an advantage and possibly delaying orthotic adaptation.

Table 2. Outcomes and Key Findings of the Literature Included in This Analysis (continued).

Study	Results	Key findings	Major concerns and supplementary information
Yagci et al., 2019[37]	The Cobb angle, ATR, back appearance, and WRVAS improved comparably in both groups after intervention.	There is no difference between the SEAS and CS exercises combined with brace therapy for improving scoliosis.	Short followup period of 4 months.
	Compliance to bracing therapy was 88% in the CS group and 79.6% in the SEAS group.	The usefulness of exercise therapy itself is inconclusive.	Both groups had bracing (brace correction rate ≥ 30%, wearing time ≥ 23h).
	Compliance to the home exercise program was 61.6% in the CS group and 63.7% in the SEAS group.		The risk of scoliosis progression small as cases of advanced bone maturation (Risser 2 or 3) included.
Dufvenberg et al., 2021[38]	Patient-reported adherence and motivation tended to be higher in the NB group.	NB, SSE, and PA encouragement are viable options for the first 6 months of intervention.	A 6-month midway report of RCT until the end of bone growth in all patients (final results not yet available).
	The Cobb angle increased comparably in all subject groups.		The NB group had in-appliance correction rate ≥ 50% and wearing time ≥ 8h.
	Activity increased in the SSE and PA groups.		Questionnaire collection rate 89% in the NB and SSE groups and 87% in the PA group.
Monticone et al., 2014[39]	The followup rate was 95% in the intervention group and 93% in the control group.	SCTO are useful for reducing scoliosis progression and improving quality of life in patients with AIS at risk of progression.	Comparative verification of the effectiveness of SSE versus stretching and core muscle rehabilitation.
	The intervention group showed significant improvements in Cobb angle, ATR, and SRS-22 scores.		Only cases of AIS with bone immaturity at risk of scoliosis progression was included.
	Scoliosis in the intervention group improved in 69% (Cobb angle decrease ≥ 3°), worsened in 8% (Cobb angle increase ≥ 3°), and stabilized in 23% of the cases.		The followup period was 4.5 years (treatment duration: 3.5 years).

All patients had adolescent idiopathic scoliosis.

Abbreviations: ATR, angle of trunk rotation; SRS, Scoliosis Research Society; SEAS, Scientific Exercises Approach to Scoliosis; SSE, scoliosis-specific exercise; SCTO, self-correction and task-oriented exercises; CS, core stabilization exercises; NB, Boston-type brace for nighttime

ment by the principal investigator who conducted all treatments, suggesting potential observer-expectation bias[39]. Taken together, while these studies provide promising data, controversy remains on study methods in terms of bias risk, optimal protocol, exercise compliance, monitoring, and impact on mental health[39].

This systematic review has several limitations. Some databases could not be utilized for the survey, and the publication language was limited to English only. These factors limited our search strategy and may have led to missing relevant articles. The failure to limit the study population by age, Cobb angle, or Risser's sign may have also increased the heterogeneity of the study population and incorporated patients at different risks of progression. Although we targeted the Schroth method and several PSSEs developed from it, it remains unclear whether all PSSEs were included.

Lastly, the value of exercise for AIS may extend beyond the Cobb angle reduction; thus, the results of this study do not negate exercise therapy *per se*. However, we observed a lack of definitive evidence that PSSE prevented Cobb angle progression in AIS. Future studies should focus on the identification of strategies to improve exercise compliance and reduce dropout rates, thereby enhancing the reliability and applicability of any findings. Further high-quality research is warranted to establish reliable evidence on physical therapy so as to mitigate the risk of progression or, more optimally, reverse the deformity.

Conclusion

The certainty of evidence that PSSE reduces Cobb angle progression in patients with AIS in the short and long term, as well as its effects on ATR and QOL, is extremely low. Healthcare providers should carefully scrutinize this growing body of evidence when informing patients and parents on exercise therapy for AIS. High-quality studies addressing the long-term changes in Cobb angle and Cobb angle at bone maturity as primary outcomes are warranted.

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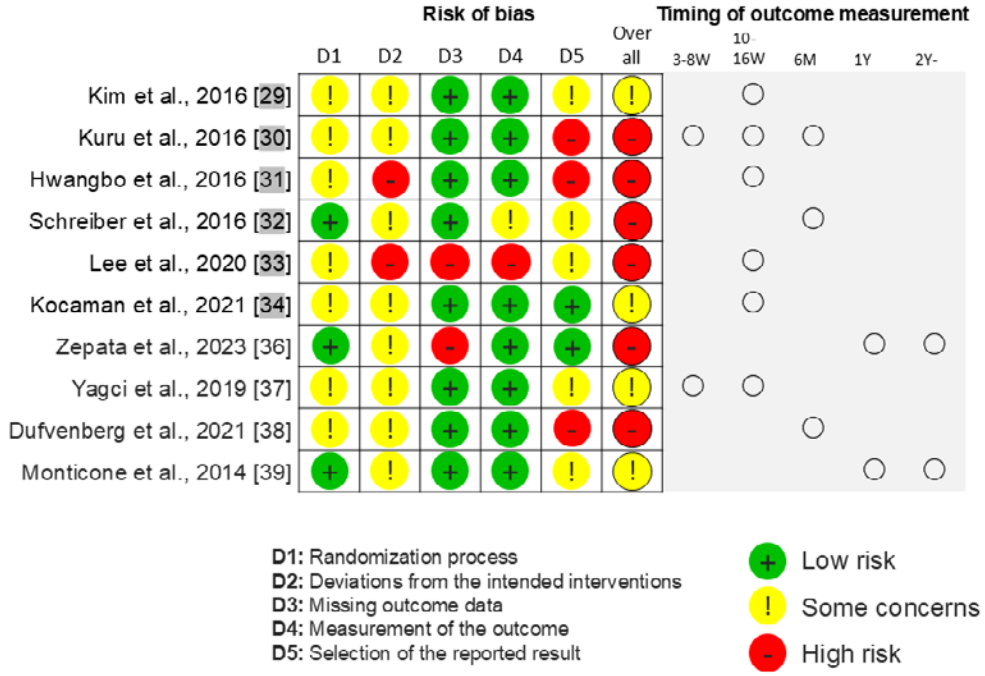

Figure 2. Summary of the risk-of-bias and time period for each study in terms of Cobb angle. Abbreviations: W, week; Y, year

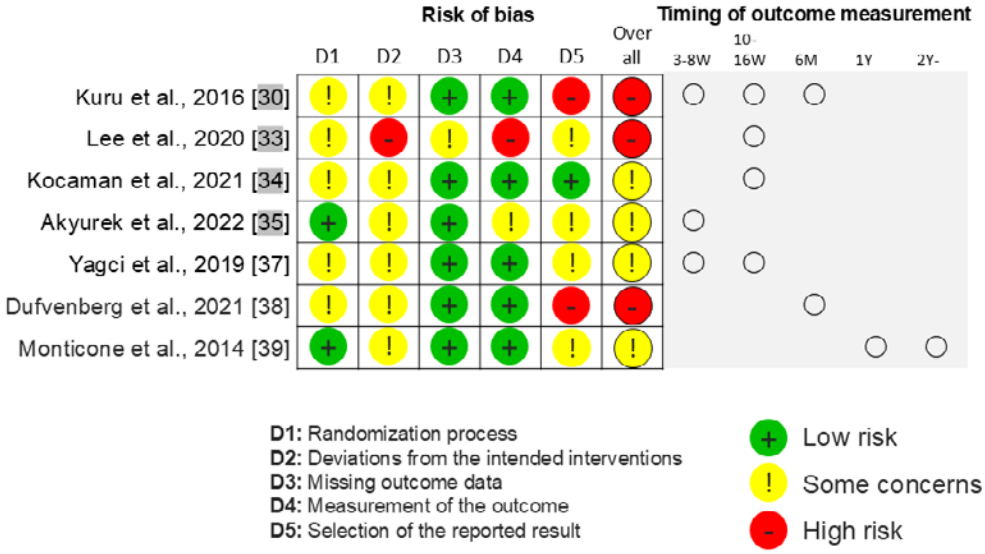

Figure 3. Summary of the risk-of-bias and time period for each study in terms of ATR. Abbreviations: ATR, angle of trunk rotation; W, week; Y, year

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Ethical Approval: Institutional approval was not required for this systematic review of the literature.

Informed Consent: Not applicable

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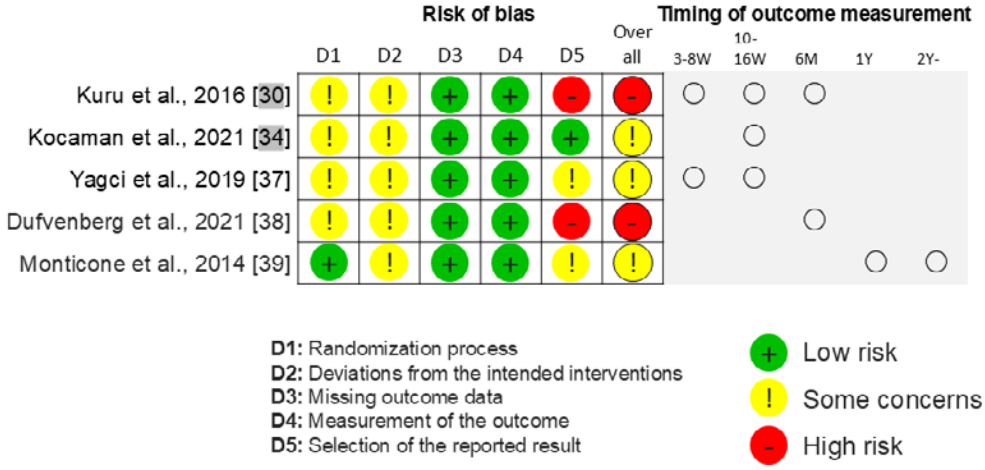

Figure 4. Summary of the risk-of-bias and time period for each study in terms of SRS-22r score. Abbreviations: SRS, Scoliosis Research Society; W, week; Y, year

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