INPLASY

Optimal Exercise Prescription Parameters in Schroth Training for Adolescent Idiopathic Scoliosis: A Systematic Review and Meta-Analysis

INPLASY202570022
doi: 10.37766/inplasy2025.7.0022
Received: 6 July 2025
Published: 6 July 2025

Kang, YZ; Wen, JF; Qi , YF.

Corresponding author:
Yazhi KANG

s1153564@s.eduhk.hk

Author Affiliation:
Hefei Normal University.

ADMINISTRATIVE INFORMATION

Support - Anhui Province Higher Education Institutions Scientific Research Program.

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202570022

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 6 July 2025 and was last updated on 6 July 2025.

INTRODUCTION

Review question / Objective This systematic review and meta-analysis aims to determine the optimal exercise prescription parameters for Schroth training in adolescent idiopathic scoliosis (AIS) by examining the relationships between exercise frequency, intensity, duration, and progression with clinical outcomes. The review seeks to address the following primary research questions.

Condition being studied Adolescent idiopathic scoliosis (AIS) affects 2-4% of the adolescent population worldwide, representing the most common spinal deformity in this age group. Conservative management through exercise therapy has gained significant recognition, with the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) formally accepting physiotherapeutic scoliosis-specific exercises (PSSE) as an evidence-based therapeutic intervention (Burger et al., 2019; Schreiber et al., 2015; Zhou et al., 2021). Among all PSSE approaches, Schroth exercises represent the most studied and widely implemented method internationally. The Schroth method is recognized as the most widely studied and used PSSE approach, with multiple studies receiving SOSORT awards for research excellence. Current evidence demonstrates that Schroth exercises significantly improve Cobb angles (mean difference = -3.18°; 95% CI: -4.30, -2.07) (Kwan et al., 2017), quality of life, and trunk rotation compared to standard care alone. However, substantial heterogeneity exists in exercise prescription parameters across existing studies. Current literature reveals significant variation in training frequency (2-7 sessions per week), session duration (30-90 minutes), total intervention duration (6-52 weeks), and progression protocols. This variability creates uncertainty for clinicians regarding optimal exercise prescription, potentially limiting treatment effectiveness and compromising patient outcomes. Despite the growing evidence base supporting Schroth exercise effectiveness, no systematic review has specifically examined the relationships between exercise prescription parameters and

clinical outcomes. Understanding these parameter-outcome relationships is critical for developing evidence-based exercise prescription guidelines, optimizing treatment efficiency, improving patient adherence, and establishing cost-effective healthcare delivery protocols (Barker, 2024; Burger et al., 2019; Kwan et al., 2017). This systematic review will address this critical knowledge gap by providing the first comprehensive analysis of exercise prescription parameters in Schroth training, offering clinically actionable evidence for optimal protocol design and implementation.

METHODS

Participant or population

Inclusion Criteria:
a)Adolescents aged 10-18 years
b)Diagnosis of idiopathic scoliosis with Cobb angle ≥10°
c)Any curve pattern (thoracic, lumbar, thoracolumbar, double major)
d)Any skeletal maturity level (Risser 0-5)
e)Both male and female participants
f)Studies conducted in any setting (clinical, outpatient, home-based)
14.2.Exclusion Criteria:
a)Age 18 years
b)Non-idiopathic scoliosis (congenital, neuromuscular, degenerative)
c)Previous spinal surgery
d)Participants with severe comorbidities unrelated to scoliosis
e)Studies focusing exclusively on adult populations
f)Studies without clear documentation of participant age ranges.

Intervention A comprehensive search strategy will be implemented across four major electronic databases to identify all relevant randomized controlled trials examining Schroth exercise interventions for AIS.

Comparator Control Groups:
The comparator must include one of the following:
1)Standard care/observation only
2)Different Schroth exercise prescription (varying frequency, duration, or intensity)
3)Other conservative interventions (bracing, other exercise types)
4)Waitlist control groups
16.2.Control Group Requirements:
1)Same population characteristics as intervention group
2)Same outcome measurement timepoints
3)Same intervention duration for comparison studies
4)Clearly documented control intervention
Studies without appropriate control groups will be excluded.

Study designs to be included Included Study Designs: Randomized controlled trials (RCTs) only Parallel-group or crossover designs Single-blind, double-blind, or open-label trials Multi-centre or single-centre studies17.2.Minimum Study Requirements: Intervention duration ≥4 weeks Sample size ≥10 participants per group Adequate randomization procedures Appropriate control group as defined above Clear documentation of exercise prescription parameters.

Eligibility criteria

Inclusion Criteria:
1)Study Design: Randomized controlled trials (parallel or crossover design)
2)Population: Adolescents aged 10-18 years with idiopathic scoliosis (Cobb angle ≥10°)
3)Intervention: Schroth exercise training with documented prescription parameters
4)Comparator: Control group or different exercise prescription as defined above
5)Outcomes: At least one primary outcome measure (Cobb angle, quality of life, trunk rotation)
6)Duration: Intervention period ≥4 weeks
7)Language: Published in English
8)Publication Date: Published between January 1, 2014, and June 30, 2025
9)Publication Status: Published in peer-reviewed journals
10)Data Availability: Sufficient data for meta-analysis (means, standard deviations, or extractable effect sizes)
18.2.Exclusion Criteria:
1)Study Design: Non-randomized studies, observational studies, case reports, case series, reviews, conference abstracts
2)Population: Adult populations (>18 years), non-idiopathic scoliosis, post-surgical patients
3)Intervention: Non-Schroth exercise interventions, passive treatments, combined interventions without separate analysis
4)Comparator: No appropriate control group, same intervention in all groups
5)Outcomes: Studies not reporting any outcomes of interest
6)Duration: Intervention <4 weeks, acute studies (single session effects only)
7)Publication Date: Studies published before 2014 or after June 30, 2025
8)Data: Insufficient data for analysis, duplicated publications, non-English language.

Information sources As detailed in the search strategy section, comprehensive searches will be conducted across four major databases: PubMed/

MEDLINE, Web of Science Core Collection, Scopus, and SPORTDiscus.
19.2.Additional Sources:
Hand searching of reference lists from included studies and relevant systematic reviews
Contact with corresponding authors for additional unpublished data or clarification of methods
Reference Management:
All references will be managed using Zotero and Eppi Reviewer software for systematic duplicate removal, organization by screening stage, and comprehensive study management throughout the review process.This systematic review will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines for search strategy, study selection, data extraction, and result reporting.

Main outcome(s)

Primary Outcomes:
1)Cobb Angle Change: Change in primary and secondary curve Cobb angles from baseline to post-intervention, measured via standing posterior-anterior radiographs
2)Quality of Life: Change in health-related quality of life scores measured by validated instruments (SRS-22, SRS-23, SAQ).

Quality assessment / Risk of bias analysis

Assessment Tools:
Cochrane Risk of Bias Tool 2.0 (RoB 2) for randomized controlled trials
Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach for overall evidence quality
23.2.Publication Bias Assessment:
Funnel plots (when ≥10 studies available)
Egger's test for small study effects
Assessment of selective outcome reporting
23.3.Quality Assessment Domains:
Randomization process
Deviations from intended interventions
Missing outcome data
Measurement of the outcome
Selection of the reported result
Overall risk of bias.

Strategy of data synthesis

Strategy of Data Synthesis
24.1.Meta-Analysis Approach:
Random-effects meta-analysis using the DerSimonian-Laird method will be the primary analytical approach, accounting for expected heterogeneity between studies due to varying exercise prescription parameters.
24.2.Effect Size Calculation:
Standardized Mean Difference (SMD) using Hedges' g for continuous outcomes measured on different scales
Weighted Mean Difference (WMD) for outcomes measured on the same scale
95% Confidence Intervals for all effect estimates
Number Needed to Treat (NNT) for clinically relevant outcomes when appropriate
24.3.Exercise Parameter Analysis:
The primary innovation of this meta-analysis will be comprehensive exercise parameter modelling:
1)Continuous Parameter Variables:
Sessions per week (frequency)
Minutes per session (duration)
Total intervention weeks
Total exercise exposure time (hours)
2)Meta-Regression Analysis:
Univariate meta-regression for each exercise parameter
Multivariate meta-regression for combined parameter effects
Exploration of parameter-outcome relationships and optimal parameter ranges
3)Subgroup Analyses:
Frequency Categories: Low (1-2 sessions/week), Moderate (3-4 sessions/week), High (≥5 sessions/week)
Session Duration: Short (≤45 minutes), Medium (46-75 minutes), Long (≥76 minutes)
Intervention Duration: Short (4-8 weeks), Medium (9-16 weeks), Long (≥17 weeks)
Population Characteristics: Age groups, curve severity, skeletal maturity
Supervision Level: Supervised vs. home-based vs. hybrid programs
4)Heterogeneity Assessment:
I^2 statistic: 75% (considerable)
τ^2 (tau-squared): Measure of between-study variance
Chi-squared test: Statistical significance of heterogeneity ($p<0.10$)
5)Statistical Software:
Review Manager (RevMan 5.4) for standard meta-analyses and GRADE evidence assessment
R statistical software (metafor package) for advanced meta-regression analyses and exercise parameter modelling
6)Clinical Significance Thresholds:
Pre-defined clinically meaningful changes:
Cobb angle: ≥3° improvement or prevention of ≥5° progression
Quality of life: ≥0.4 points improvement on SRS-22 total score
Trunk rotation: ≥2° improvement in ATR.

Subgroup analysis

Planned Subgroup Analyses:
1)Exercise Prescription Parameters:

Frequency: Low (1-2/week), Moderate (3-4/week), High (≥5/week)
Session Duration: Short (≤45 min), Medium (46-75 min), Long (≥76 min)
Intervention Duration: Short (4-8 weeks), Medium (9-16 weeks), Long (≥17 weeks)
Supervision Level: Supervised, home-based, hybrid programs
2)Population Characteristics:
Age Groups: 10-13 years, 14-16 years, 17-18 years
Curve Severity: Mild (10-25°), Moderate (26-40°), Severe (≥41°)
Curve Pattern: Thoracic, lumbar, thoracolumbar, double major
Skeletal Maturity: Risser 0-2 (immature), Risser 3-5 (mature)
Sex: Male, female, mixed populations
3)Study Characteristics:
Study Quality: Low, moderate, high risk of bias
Sample Size: Small (<30 per group), large (≥30 per group)
Geographic Region: North America, Europe, Asia, other
Publication Year: 2014-2019, 2020-2025
4)Treatment Context:
Combined Interventions: Exercise alone vs. exercise + bracing
Setting: Clinical vs. home-based vs. mixed
Therapist Certification: Certified Schroth therapists vs. other.

Sensitivity analysis

Planned Sensitivity Analyses:
1)Study Quality Assessment:
Excluding studies with high overall risk of bias
Excluding studies with high risk in specific domains
Including only studies with low risk of bias across all domains
2)Statistical Model Choice:
Fixed-effects vs. random-effects models
Alternative heterogeneity estimators
Robust variance estimation methods
3)Population Characteristics:
Including only studies with clearly defined AIS populations
Excluding studies with mixed adult-adolescent populations
Including only studies with baseline Cobb angles ≥15°
4)Intervention Characteristics:
Excluding studies with very short interventions (<6 weeks)
Including only studies with certified Schroth therapists
Excluding studies with significant co-interventions
5)Outcome Measurement:
Including only studies with standardized Cobb angle measurements.
Excluding studies with self-reported outcomes only
Including only studies with validated quality of life measures
6)Data Analysis:
Using change scores vs. post-intervention values
Including vs. excluding crossover studies
Different approaches to handling missing data.

Country(ies) involved China.

Keywords Schroth exercises; adolescent idiopathic scoliosis; exercise prescription; dose response; meta-analysis; systematic review; physiotherapeutic scoliosis-specific exercises; Cobb angle; quality of life.

Contributions of each author

Author 1 - Yazhi KANG.
Author 2 - Jianfei WEN.
Author 3 - Yunqing LI.