

Original Article

Postural exercise impaction on the development of vertebral curves and functional deformity for adolescent idiopathic scoliosis Dea Linia Romadhoni ¹²⁷, Alinda Nur Ramadhani ¹

¹ Department of Physiotherapy, University 'Aisyiyah Surakarta, Surakarta, Central Java, Indonesia

ARTICLE INFORMATION

ABSTRACT

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Postural Exercise; Vertebral Curves; Adolescent Idiopathic Scoliosis

CORRESPONDENCE

Phone: (0271) 631141 E-mail: dealin08@aiska-university.ac.id **Background:** Adolescent idiopathic scoliosis (AIS) is a common spinal deformity affecting children aged 10–18 years. Various treatment approaches, including specific exercises, bracing, surgery, traction, casting, and biofeedback, have been implemented to manage AIS. However, posture correction exercises remain a non-invasive rehabilitation strategy with the potential to prevent scoliosis progression and improve functional outcomes.

Purpose: This study aimed to evaluate the effectiveness of posture correction exercises in reducing vertebral curvature deformity and improving functional abilities in adolescents with idiopathic scoliosis.

Methods: This quasi-experimental study employed a one-group pretest-posttest design involving 30 students aged 10–15 years diagnosed with AIS. Participants underwent a four-week supervised posture correction exercise program. The primary outcome, vertebral curvature deformity, was assessed using the Adam's Forward Bending Test, while changes in vertebral inclination angle were measured using a Scoliometer. All data were documented through structured questionnaires.

Results: The findings revealed a statistically significant reduction in vertebral inclination angle following the intervention (p<0.001), indicating the effectiveness of posture correction exercises as part of scoliosis-specific rehabilitation programs.

Conclusion: Posture correction exercises significantly reduce vertebral curvature deformity and enhance functional capabilities in adolescents with AIS. These findings support their integration into physiotherapy programs as a non-invasive rehabilitative and preventive approach for scoliosis management.

INTRODUCTION

Scoliosis is a spinal deformity characterized by a lateral curvature of the spine of at least 10° accompanied by vertebral rotation.¹ Several etiological factors contribute to scoliosis, including idiopathic, congenital, genetic factors, and neuromuscular disorders.² Among these, adolescent idiopathic scoliosis (AIS) is the most prevalent type, accounting for approximately 85% of all scoliosis cases.³ A study in Eastern China reported a slightly higher prevalence of AIS compared to other regions.⁴

AIS typically affects children aged 10 to 18 years and has no definitive etiology.⁵ Multiple factors have been associated with AIS development, including genetic predisposition, abnormalities in connective tissues and skeletal muscles, biomechanical imbalances, and growthrelated factors.^{6,7} The clinical manifestations of AIS range from asymptomatic cases to severe complications, including neuromuscular and cardiopulmonary disorders.^{8,9} If left untreated, AIS tends to be progressive, leading to worsening spinal curvature, chronic back pain, reduced pulmonary function, and psychological distress due to poor spinal posture.¹⁰

Several approaches have been employed to manage AIS, including scoliosis-specific exercises, bracing, casting, biofeedback, traction, and surgery.^{11–13} Conservative treatments such as physiotherapy and bracing are commonly used to prevent curve progression. Among the exercise-based interventions, various structured scoliosis-specific exercise programs have been developed, including the Scientific Exercise Approach to Scoliosis (SEAS), Functional Individual Therapy of Scoliosis (FITS), Lyon exercises, and the Schroth method.¹⁴ These interventions primarily aim to reduce the curvature progression, alleviate back pain, and prevent disability and respiratory complications.

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However, these interventions often overlook the importance of postural self-awareness, both consciously and unconsciously, which can play a crucial role in improving cosmetic deformities and enhancing health-related quality of life.^{15,16} In Indonesia, studies investigating the impact of scoliosis-specific exercises on spinal deformity and functional outcomes remain limited. Most existing studies focus on the etiology, prevalence, and interventions aimed solely at reducing spinal curvature without addressing functional improvements. For example, a study conducted by Weiss emphasized posture rehabilitation but did not explore its impact on spinal function.¹⁷

Given this research gap, this study aims to evaluate the effect of postural correction exercises on vertebral curve deformity and functional outcomes in adolescents with idiopathic scoliosis. The findings of this study are expected to contribute to the development of comprehensive, function-oriented rehabilitation strategies that help adolescents with AIS prevent further curve progression and improve their overall spinal health and quality of life.

METHOD

Study Design

This quasi-experimental study used a one-group pretestposttest design.

Setting and Respondents

The study was conducted at Junior High School 13 Surakarta and Muhammadiyah 5 Junior High School Surakarta from April to July 2022. The target population consisted of students aged 10 to 15 years diagnosed with AIS in Surakarta City. A total of 30 participants were recruited using simple random sampling, ensuring that each eligible student had an equal chance of being included in the study. The inclusion criteria required participants to be male or female students aged 10–15 years diagnosed with AIS based on a clinical examination using the Adam's Forward Bending Test and a Scoliometer measurement. Meanwhile, the exclusion criteria comprised students with congenital scoliosis, a history of spinal surgery or trauma, and cognitive impairment. Participants selected by simple random sampling.

Experimental Procedure

The intervention consisted of an 8-week supervised postural exercise program based on the SEAS and Schroth Method, conducted three times per week for 45 minutes in a school physiotherapy room under a licensed physiotherapist's supervision. Participants were also assigned daily home exercises and maintained a postural diary for adherence tracking. The program included postural awareness training for correct spinal alignment, core stabilization exercises to strengthen abdominal and back muscles, breathing techniques to enhance pulmonary function, stretching and flexibility exercises to improve mobility, and mirror therapy with feedback training for selfcorrection using visual cues.

The Variable, Instrument, and Measurement

The primary variables in this study were vertebral curve deformity. The Scoliometer was utilized to assess the angle of trunk inclination during the Adam's Forward Bending Test, a widely accepted clinical method for evaluating spinal deformity in scoliosis. The measurements were conducted by a trained physiotherapist to ensure accuracy and minimize inter-observer variability.

Data Analysis

Shapiro-Wilk test assessed data normality, followed by the Wilcoxon signed-rank test to compare pretest and posttest scoliosis angles.

Ethical Consideration

Ethical approval was obtained from the Health Research Ethics Commission, University of 'Aisyiyah Surakarta (1265/IV/AUEC/2022). Informed consent was secured from all participants and their guardians. Confidentiality and voluntary participation were ensured.

RESULTS

The majority of participants were 14 years old (97%), with females comprising 80% of the sample. The degree of scoliosis was predominantly mild (5°–10°) in 63% of subjects, followed by moderate (11°–15°) in 23%, and severe (16°–20°) in 13% of participants (Table 1).

Table 1. Characteristics of res	pondents (n=30)
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Characteristics	Result
Age, year old	
13	1 (3%)
14	29 (97%)
Gender	
Male	6 (20%)
Female	24 (80%)
Scoliosis Degree	
5-10	19 (63%)
11-15	7 (23%)
16-20	4 (13%)

The results of this study indicate that postural exercises contribute to the improvement of vertebral curves and functional deformities in adolescents with idiopathic scoliosis, as evidenced by the increase in post-test scores compared to pre-test scores in most participants (p=0.002). The pre-post test graph (Figure 1) demonstrates an upward trend following the intervention, suggesting that postural exercises can enhance postural stability and reduce functional deformities. Although there was variability in individual responses to the intervention, no participants exhibited a decline in post-test scores, indicating that the exercises did not have any negative effects. The differences in score improvements are likely influenced by factors such as the severity of scoliosis, adherence to the exercise regimen, and individual biomechanical conditions.



Figure 1. Effectiveness of Postural Exercises

DISCUSSION

This study demonstrated that posture correction exercises significantly reduce Cobb angles and improve functional outcomes in AIS. The statistical analysis using the Wilcoxon test yielded a p-value of < 0.001, indicating a significant reduction in vertebral curvature following the intervention. These findings align with existing evidence supporting the effectiveness of scoliosis-specific exercise programs, including FITS, Dobomed, Side-Shift, and the SEAS, which have been widely recognized for their ability to stabilize and improve vertebral alignment in AIS patients.¹⁷

The effectiveness of posture correction exercises is primarily attributed to muscle adaptation and postural realignment. These exercises focus on strengthening and lengthening asymmetrical muscles, thereby improving muscular balance around the spine.¹⁸ Previous research has shown that eccentric exercises lead to architectural and functional adaptations, such as increased fascicle length, enhanced eccentric peak torque, and decreased concentric optimum angle.¹⁹ However, further studies are needed to determine whether performing these exercises at a longer muscle length yields greater benefits compared to shorter muscle lengths.

In addition to muscular adaptations, postural correction in a three-dimensional (3D) approach is achieved through regular exercises targeting proprioceptive awareness and symmetrical postural correction. This exercise program integrates scoliosis-specific postural correction, breathing exercises, and proprioceptive training, utilizing mirror feedback and exteroceptive stimulation to enhance postural perception.^{20–22} Previous studies have highlighted that stabilization exercises combined with Basic Body Awareness therapy improve visual, postural, and haptic verticality perception, suggesting that integrating these techniques into scoliosis rehabilitation can enhance internal body orientation and postural control.²³

The development of AIS is closely linked to accelerated spinal growth during puberty, with the greatest risk of curvature progression occurring in early adolescence. Therefore, early intervention with posture correction exercises is crucial to prevent further spinal deformity.²⁴ These exercises exert traction and compression forces that modulate vertebral growth, promoting controlled realignment. Younger individuals, whose skeletal structures

are still developing, exhibit greater plasticity in vertebral and soft tissue adaptation, making them more responsive to corrective exercises. This principle aligns with findings indicating that early intervention can inhibit scoliosis progression by altering the growth dynamics of the concave and convex sides of the vertebrae.²⁵

Furthermore, posture correction exercises have been shown to improve key motor qualities, including muscular endurance, flexibility, strength, and coordination. ^{26,27} These exercises contribute to 3D self-correction, where active muscle contractions help maintain proper spinal alignment.²⁸ Numerous studies have reported that corrective exercises significantly reduce Cobb angles, decrease trunk rotation, and enhance body symmetry, ultimately improving the patient's quality of life.29,30 Additionally, research has demonstrated that scoliosisspecific exercises can lead to improvements in thoracic and lumbar Cobb angles, increased body symmetry, and reduced trunk deformities.30 The administration of corrective exercises decreases the Cobb angle in the thorax and lumbar, increasing body symmetry and reducing torso deformity. ³¹ These findings underscore the importance of targeted postural interventions as a noninvasive approach to scoliosis management.

Despite its promising findings, this study has several limitations. Postural correction was not monitored outside supervised sessions, making adherence in daily activities difficult to assess and potentially affecting long-term effectiveness. Scoliosis assessment relied on manual methods (Scoliometer and Adam's Forward Bending Test) instead of radiographic imaging, limiting accuracy in tracking vertebral structural changes. Lastly, maintaining postural awareness remains challenging, especially in unconscious or habitual postures. Adherence to posture correction exercises is influenced by external factors like daily activities and sitting habits.

CONCLUSIONS AND RECOMMENDATION

This study demonstrated that posture correction exercises significantly reduce vertebral inclination and improve functional abilities in AIS. Future research should explore the long-term effects of these exercises, incorporate radiographic evaluations for more precise scoliosis assessment, and examine their combination with other physiotherapy interventions. Additionally, further studies should investigate the effectiveness of posture correction exercises across different scoliosis severity levels and age groups to provide broader insights into their clinical applicability.

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