

Effects of a 3-week Schroth physiotherapy program on sagittal spinal alignment in girls with mild adolescent idiopathic scoliosis (AIS): a pilot study

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Michał Olba¹, Anna Mickiewicz¹, Elżbieta Piątek-Krzywicka², Bożena Ostrowska³

¹ Faculty of Medical and Technical Sciences, The Karkonosze University of Applied Sciences, Jelenia Góra, Poland

² Department of Physiotherapy in Musculoskeletal Dysfunction and Kinesiology, Wrocław University of Health and Sport Sciences, Wrocław, Poland

³ Department of Fundamentals of Physiotherapy and Occupational Therapy, Wrocław University of Health and Sport Sciences, Wrocław, Poland

Abstract

Introduction. Adolescent idiopathic scoliosis (AIS) is commonly treated with physiotherapeutic scoliosis-specific exercises such as the Schroth method. However, evidence regarding the short-term effects on sagittal spinal alignment in patients with mild curves remains limited.

Methods. This prospective pilot study evaluated the effects of a 3-week Schroth physiotherapy program on sagittal spinal curvatures in girls with mild AIS (Cobb angle < 25°). Fourteen participants aged 10–16 years completed daily 45-minute supervised sessions. Thoracic kyphosis, lumbar lordosis, and sacral slope were assessed using a Rippstein plurimeter before and after the intervention. Statistical analysis included paired *t*-tests or Wilcoxon signed-rank tests depending on the distribution of differences.

Results. Thoracic kyphosis increased significantly from 14.29 ± 7.71° to 23.07 ± 6.41° (mean difference 8.79°, 95% CI 5.25–12.32; *p* < 0.001; Cohen's *d* = 1.43). No statistically significant changes were observed in lumbar lordosis (*p* = 0.142) or sacral slope (*p* = 0.068; Holm-adjusted *p* = 0.136).

Conclusions. A short-term Schroth physiotherapy program may contribute to the normalisation of thoracic sagittal alignment in girls with mild AIS. Further controlled studies with larger samples are required to confirm these findings.

Key words: adolescent idiopathic scoliosis, Schroth therapy, sagittal spinal alignment, thoracic kyphosis, physiotherapeutic scoliosis-specific exercises (PSSE)

Introduction

Scoliosis refers to a broad classification of conditions characterised by alterations in the morphology and alignment of the spine, thoracic cage, and trunk [1]. The concept of idiopathic scoliosis (IS), established by Kleinberg [2], is used for patients in whom the aetiology of spinal deformity remains unknown [3]. A diagnosis of idiopathic scoliosis requires a Cobb angle greater than 10° and the presence of deformity in all three anatomical planes [1, 4].

Idiopathic scoliosis may develop at any stage of childhood or adolescence [5], with adolescent idiopathic scoliosis (AIS) typically associated with rapid pubertal growth and slowing after skeletal maturity [6]. In managing idiopathic scoliosis with a Cobb angle below 25°, clinicians typically recommend intensive exercise programs that address the spine and thorax in all three planes. Following the guidelines of the Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT), treatment is based primarily on physiotherapeutic scoliosis-specific exercises (PSSE) [7]. Among these, the Schroth method remains one of the most widely used and well-documented approaches [1, 8, 9]. Evidence suggests that structured, high-intensity Schroth-based physiotherapy programs can produce noticeable postural improvement within a few weeks [10].

Beyond coronal plane deformity, alterations in sagittal spinal alignment are frequently observed in AIS, particularly reduced thoracic kyphosis [11, 12]. Restoration of physiologi-

cal sagittal curvature is considered a key therapeutic goal, as sagittal alignment influences spinal biomechanics, postural balance, and may contribute to the progression of deformity [13, 14]. Most studies on PSSE, including Schroth-based interventions, primarily focus on coronal plane outcomes, such as Cobb angle reduction, while evidence regarding their effects on sagittal spinal alignment remains limited [7, 9].

The paediatric population is subject to the principle of minimising radiation exposure [15]. Therefore, there is a need for reliable, noninvasive tools for monitoring postural and functional changes during conservative treatment. The Rippstein plurimeter is a clinical instrument commonly used for the assessment of sagittal spinal curvatures, including thoracic kyphosis and lumbar lordosis. It is characterised by high reliability and measurement repeatability in children and adolescents [16, 17]. Its use may be particularly valuable for detecting short-term functional changes that are not visible on radiographs.

Despite increasing interest in PSSE, evidence regarding their short-term effects on sagittal spinal alignment in patients with mild adolescent idiopathic scoliosis remains limited. This is particularly important because correction of sagittal plane deformities is considered one of the most challenging goals of conservative scoliosis management. Therefore, the aim of this pilot study was to evaluate the effect of a 3-week Schroth physiotherapy program on sagittal spinal curvature parameters in girls aged 10–16 years diagnosed with mild adolescent idiopathic scoliosis (Cobb angle < 25°), using the Rippstein plurimeter as a non-invasive assessment tool.

Correspondence address: Anna Mickiewicz, The Karkonosze University of Applied Sciences, Lwówecka Street 18, 58-506 Jelenia Góra, Poland, anna.mickiewicz@kans.pl; <https://orcid.org/0000-0002-4554-2386>

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Subjects and methods

Study design

This prospective single-group pilot intervention study evaluated the short-term effects of a 3-week Schroth physiotherapy program on sagittal spinal alignment in girls with mild adolescent idiopathic scoliosis.

Participants

A total of 52 girls aged 10–16 years with adolescent idiopathic scoliosis (AIS) were assessed for eligibility. The diagnosis of adolescent idiopathic scoliosis was confirmed by an independent orthopaedic specialist/rehabilitation physician who was not involved in the study procedures. Twelve participants were excluded, primarily because they did not meet the clinical criteria for inclusion ($n = 6$; Cobb angle $\geq 25^\circ$ or non-AIS scoliosis), had medical conditions preventing safe participation in exercise-based therapy ($n = 3$), were unable to attend daily sessions due to organisational barriers ($n = 2$), or declined participation ($n = 1$).

Forty participants were enrolled and began the 3-week Schroth intervention combined with daily home exercises. During the intervention, 20 participants discontinued the program, mainly due to medical reasons such as increased back pain or unrelated injuries ($n = 6$), organisational difficulties including transportation or school conflicts ($n = 7$), insufficient adherence to the home exercise program ($n = 5$), or family-related decisions to withdraw ($n = 2$). An additional six participants were lost to follow-up. Consequently, 14 participants completed the full intervention and post-intervention assessment and were included in the final analysis. The flow of participants through the study is shown in Figure 1.

Inclusion criteria

- diagnosis of adolescent idiopathic scoliosis (AIS) confirmed by a rehabilitation physician or orthopaedic specialist based on the posterior-anterior (PA) radiograph,
- Cobb angle $< 25^\circ$,
- female sex,
- age between 10 and 16 years,

– no prior treatment using Schroth physiotherapy or any PSSE methods.

Exclusion criteria

- Participants were excluded if they had:
- a history of surgical treatment for scoliosis,
 - scoliosis of non-idiopathic origin (e.g., neuromuscular, congenital, or functional scoliosis),
 - neurological, pulmonary, cardiac, or psychiatric conditions that could limit participation in exercise therapy,
 - other health conditions preventing safe participation in the intervention.

The demographic and clinical characteristics of the participants are presented in Table 1. Baseline comparisons between participants who completed the study and those who discontinued the intervention showed no statistically significant differences in demographic or clinical characteristics (Table 1).

All participants presented mild scoliosis, with Cobb angles ranging from 11° to 24° . Most curves were in the thoracic and thoracolumbar regions, with apex levels most commonly between Th7 and L2. Curve patterns included: 14.3% of single lumbar curve, 14.3% of single thoracic curve, and 71.4% of double major scoliosis.

Skeletal maturity varied across participants, with Risser scores ranging from 0 to 4, indicating different stages of growth. Body mass index (BMI) values ranged from 14.70 to 28.63 kg/m², reflecting variability in body composition within the study group.

Most participants had reached menarche, although two participants had not yet begun menstruation. None of the participants had previously undergone Schroth therapy or other physiotherapeutic scoliosis-specific exercises.

The variability in skeletal maturity and curve characteristics should be considered when interpreting the results.

The distribution of primary curve type was balanced, with thoracic and lumbar curves observed in 7 participants each (50% vs. 50%) (Table 1).

Table 1. Baseline characteristics of participants who completed and discontinued the study

Variable	Completers (<i>n</i> = 14)	Non-completers (<i>n</i> = 26)	<i>p</i> -value
Demographics			
Age (years)	13.00 [11.00–14.00]	13.00 [12.00–14.00]	0.788
Body mass (kg)	48.00 [44.00–51.00]	50.15 ± 7.58	0.281
Height (m)	1.62 ± 0.09	1.64 [1.58–1.69]	0.734
BMI (kg/m ²)	17.89 [16.73–18.87]	18.88 ± 1.31	0.061
Scoliosis characteristics			
Cobb angle (°)	13.00 [12.00–15.00]	15.96 ± 3.56	0.217
Primary curve – thoracic, <i>n</i> (%)	7 (50.0%)	10 (38.5%)	–
Primary curve – lumbar, <i>n</i> (%)	7 (50.0%)	16 (61.5%)	–
Skeletal maturity			
Risser sign	3.50 [0.00–4.00]	3.00 [1.00–4.00]	0.921

Values are presented as mean ± SD for normally distributed variables and median [IQR] for non-normally distributed variables. Normality was assessed using the Shapiro–Wilk test. Baseline comparisons between completers and non-completers were performed using the Mann–Whitney *U* test.

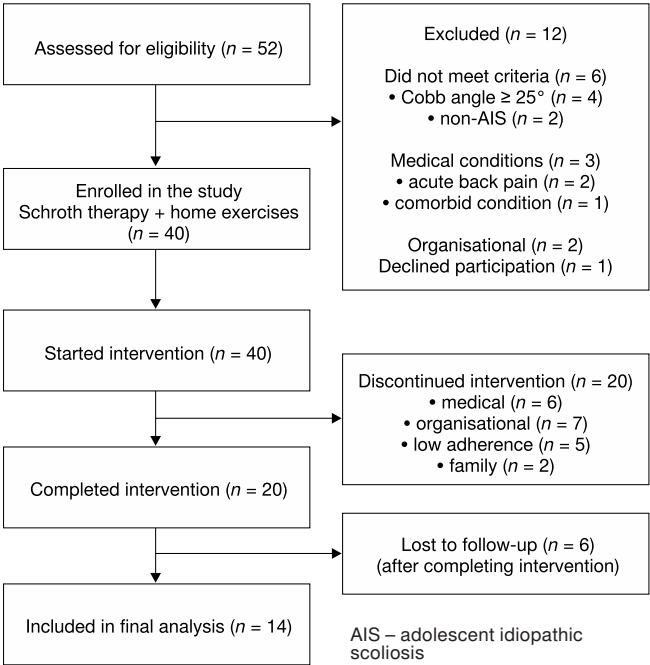


Figure 1. Flowchart of study participants

Intervention

All participants completed a 3-week Schroth physiotherapy program consisting of daily 45-minute supervised sessions. Exercise programs were personalised to curve type (thoracic primary vs. lumbar primary) and focused on postural correction, rotational breathing, and trunk stabilisation. The first three sessions focused on learning individualised corrective postures and breathing techniques characteristic of the Schroth method [1, 8, 9].

Subsequent sessions included exercises aimed at three-dimensional spinal correction. These included passive mobilisation of the primary curve, basic tension exercises combined with spinal elongation and Schroth physiotherapy-specific exercises such as shoulder counter traction (SCT) in both supine and sitting positions, muscle cylinder exercise in the side-lying position and conscious gait training. Each session consisted of corrective positioning, active exercise performance, and breathing-based postural stabilisation [1, 8, 9].

Participants were additionally instructed to perform daily home exercises based on the Schroth corrective positions learned during the supervised sessions. The study monitored adherence to the exercise program using patient logbooks, with daily confirmation by a parent and weekly verification by the supervising therapist. The quality and correctness of exercise performance were assessed weekly by the therapist using a standardised checklist.

All therapy sessions were conducted by an experienced physiotherapist certified in the Schroth method. Participants were instructed not to initiate additional physiotherapy interventions during the study period. However, daily physical activity outside the intervention program was not objectively monitored.

Outcome measures

Sagittal spinal curvatures were assessed before and after the intervention using a Rippstein plurimeter (Dr. Rippstein, Switzerland), according to previously described clinical measurement procedures [16, 17]. Anatomical landmarks were identified by palpation and marked on the skin prior to measurement. Thoracic kyphosis was measured between the spinous processes of T1 and T12, lumbar lordosis between L1 and S1, and sacral slope at the level of the sacral base. Measurements were performed with the participant standing in a relaxed upright position with arms hanging freely alongside the body. All measurements were taken by the same examiner to ensure measurement consistency. The reliability of plurimeter-based assessment of sagittal spinal curvatures has been previously demonstrated in paediatric populations [16, 17]. The examiner had clinical experience in the assessment of spinal alignment and was trained in the use of the Rippstein plurimeter. All measurements were performed according to a standardised protocol to ensure consistency.

Although the Rippstein plurimeter is a validated and reliable clinical tool, it provides indirect measurements of spinal curvature and is less precise than radiographic assessment. Clinical measurements are subject to potential intra-examiner variability. Efforts were made to minimise measurement error by using anatomical landmarks and standardised measurement procedures.

The following sagittal spinal parameters were assessed:

- thoracic kyphosis
- lumbar lordosis
- sacral slope

Thoracic kyphosis was defined a priori as the primary outcome, whereas lumbar lordosis and sacral slope were treated as secondary outcomes.

Statistical analysis

Statistical analysis was performed using Statistica software (version 13.3, StatSoft, Poland). For all quantitative variables, descriptive statistics were calculated, including mean, standard deviation (SD), median, interquartile range (IQR), and 95% confidence intervals (CI). The distribution of pre-post differences was assessed using the Shapiro–Wilk test to determine the appropriateness of parametric or non-parametric statistical methods. For variables with approximately normally distributed differences, paired *t*-tests were used to compare pre- and post-intervention values. For variables with non-normally distributed differences, the Wilcoxon signed-rank test was applied. Thoracic kyphosis was the primary outcome, while lumbar lordosis and sacral slope were secondary outcomes. To account for multiple comparisons among secondary outcomes, the Holm correction was used. Effect sizes were calculated using Cohen's *d* for paired *t*-tests and *r* for Wilcoxon tests. The level of statistical significance was set at $\alpha = 0.05$, and *p*-values < 0.05 were considered statistically significant. For all outcomes, 95% confidence intervals were calculated for the observed change between post- and pre-intervention measurements (post–pre). For outcomes with non-normally distributed differences, *p*-values were obtained using the Wilcoxon signed-rank test. Effect sizes were interpreted according to conventional thresholds (small, moderate, large) and were used to support interpretation of the magnitude of observed changes beyond statistical significance.

Due to the exploratory nature of this pilot study, no a priori sample size calculation was performed. The sample size was determined pragmatically based on participant availability and feasibility constraints. The primary aim of the study was to provide preliminary estimates of the effect size to inform future adequately powered studies. Therefore, the results should be interpreted with caution.

Results

Changes in sagittal spinal parameters following the 3-week Schroth physiotherapy program are presented in Table 2.

A statistically significant increase in thoracic kyphosis was observed after the intervention. The mean thoracic kyphosis increased from $14.29 \pm 7.71^\circ$ before therapy to $23.07 \pm 6.41^\circ$ after therapy, with a mean difference of 8.79° (95% CI: 5.25–12.32; $p < 0.001$). The effect size was large (Cohen's *d* = 1.43), indicating a substantial magnitude of change. The observed increase moved the mean thoracic kyphosis closer to the physiological range reported for adolescents.

No statistically significant changes were observed for the secondary outcomes. Lumbar lordosis increased slightly from $19.29 \pm 7.56^\circ$ to $20.71 \pm 7.30^\circ$, but the difference was not statistically significant (mean difference 1.43° , 95% CI -0.34 to 3.19 ; $p = 0.142$). Sacral slope decreased from $23.93 \pm 7.64^\circ$ to $22.14 \pm 6.99^\circ$. Although a trend toward reduction was observed (mean difference -1.79° , 95% CI -3.61 to 0.04), the change was not statistically significant ($p = 0.068$) and remained non-significant after Holm correction (adjusted $p = 0.136$).

Normality analysis showed that differences in thoracic kyphosis followed a normal distribution (Shapiro–Wilk $p = 0.69$), whereas differences in lumbar lordosis and sacral slope were non-normally distributed.

Table 2. Treatment outcomes after 3-week Schroth therapy (n = 14)

Outcome	Pre (mean ± SD)	Post (mean ± SD)	Mean difference (°)	95% CI	p-value	Effect size
Primary outcome						
thoracic kyphosis	14.29 ± 7.71	23.07 ± 6.41	8.79	[5.25, 12.32]	< 0.001	d = 1.43
Secondary outcomes						
lumbar lordosis	19.29 ± 7.56	20.71 ± 7.30	1.43	[-0.34, 3.19]	0.142	r = 0.39
sacral slope	23.93 ± 7.64	22.14 ± 6.99	-1.79	[-3.61, 0.04]	0.136*	r = 0.49

* Holm-adjusted p-value

Mean difference represents the change between post- and pre-intervention measurements (post–pre). 95% confidence intervals refer to the mean difference. Normality of pre–post differences was assessed using the Shapiro–Wilk test. Thoracic kyphosis was defined as the primary outcome, whereas lumbar lordosis and sacral slope were secondary outcomes. Paired *t*-tests were used for variables with normally distributed differences, and the Wilcoxon signed-rank test was used for variables with non-normally distributed differences. Effect sizes are reported as Cohen’s *d* for paired *t*-tests and *r* for Wilcoxon tests.

Discussion

The aim of this pilot study was to evaluate the short-term effects of a 3-week Schroth physiotherapy program on sagittal spinal alignment in girls with mild adolescent idiopathic scoliosis. The results showed a statistically significant increase in thoracic kyphosis following the intervention, while no significant changes were observed in lumbar lordosis or sacral slope. These findings suggest that short-term Schroth-based physiotherapy may positively influence thoracic sagittal alignment in adolescents with mild scoliosis.

The baseline thoracic kyphosis values indicated relative hypokyphosis. The observed increase following the intervention period may be interpreted as a normalisation toward physiological sagittal alignment rather than a general improvement. To the best of our knowledge, no established minimal clinically important difference (*MCID*) values are currently available for thoracic kyphosis assessed using the Rippstein plurimeter in adolescents with AIS.

In addition to statistical significance, the observed change in thoracic kyphosis appears to be clinically meaningful. It reflects a shift toward physiological spinal alignment. The large effect size may further support the potential practical relevance of this finding. However, the magnitude of the observed effect should be interpreted cautiously due to the limited sample size and exploratory character of the study. The intervention may potentially support postural correction, although further controlled studies are required to confirm its clinical significance.

Reduced thoracic kyphosis is frequently observed in adolescents with idiopathic scoliosis [11, 12] and may negatively affect spinal biomechanics and postural balance [13]. Restoration of physiological sagittal curvature is therefore considered an important goal of conservative scoliosis management.

The increase in thoracic kyphosis observed in this study may be explained by the biomechanical principles of Schroth therapy. Previous studies have demonstrated that Schroth-based interventions may improve spinal curvature parameters, trunk symmetry, and posture in adolescents with idiopathic scoliosis [8, 18]. Systematic reviews also indicate that PSSE can lead to improvements in spinal alignment and func-

tional outcomes in patients with mild scoliosis [7, 9]. Most of these studies have primarily focused on coronal plane outcomes, such as Cobb angle reduction, and only limited data are available regarding changes in sagittal alignment. Importantly, several randomised controlled trials investigating Schroth-based interventions have reported favourable effects on postural parameters and Cobb angle progression; however, direct comparison with the present findings should be made cautiously due to differences in study design, intervention duration, outcome measures, and sample characteristics [8, 18]. The present study findings contribute to the growing but still limited body of evidence suggesting that Schroth-based interventions may also influence sagittal spinal parameters, particularly in patients with reduced thoracic kyphosis.

Given the relatively short duration of the intervention (three weeks), the observed changes are more likely to reflect functional adaptations, such as improved postural control or altered muscle activation patterns, rather than structural modifications of spinal curvature. Structural changes in spinal alignment typically require longer treatment periods. This suggests that the observed increase in thoracic kyphosis may primarily reflect improved neuromuscular control and postural correction rather than structural remodelling of the spinal curvature.

Sagittal spinal alignment is also considered an important factor in the development and progression of AIS. Reduced thoracic kyphosis has been hypothesised to be associated with increased rotational instability of the spine and may contribute to curve progression during growth [14]. Improving the sagittal profile may therefore support more favourable spinal load distribution and biomechanical stability. In this context, the increase in thoracic kyphosis observed in the present study may have clinical relevance for postural control and spinal function in adolescents with mild scoliosis.

In contrast, no statistically significant changes were observed in lumbar lordosis or sacral slope. These parameters are influenced by complex biomechanical interactions between the spine and pelvis and may require longer intervention periods to demonstrate measurable changes. Previous studies suggest that modifications in sagittal spinopelvic alignment may occur gradually over extended treatment periods [19]. Therefore, the relatively short duration of the intervention in this study may partly explain the absence of significant changes in these parameters. The heterogeneity of the study group in terms of skeletal maturity, curve pattern, and BMI may have influenced the individual responses to the intervention and should be considered when interpreting the findings. These factors may partly explain the variability in individual responses observed within the study group.

An additional strength of the present study is the use of the Rippstein plurimeter as a non-invasive clinical tool for assessing sagittal spinal curvature. Reliable monitoring of sagittal spinal alignment is important in conservative scoliosis

management, particularly in growing patients. Previous research has demonstrated good reliability of plurimeter-based measurements in children and adolescents [16, 17]. The use of non-radiographic assessment methods may be particularly valuable in paediatric populations, as repeated radiographic examinations are associated with cumulative radiation exposure [15]. It should also be noted that, although the Rippstein plurimeter is a practical and non-invasive tool, it provides indirect measurement and is less precise than radiographic methods, which may influence the accuracy of the observed changes.

The findings of this pilot study suggest that a short-term Schroth physiotherapy program may contribute to the normalisation of thoracic sagittal alignment in girls with mild AIS. From a clinical perspective, these findings suggest that Schroth-based physiotherapy may be a valuable conservative approach for improving sagittal spinal alignment and supporting physiotherapists in optimising postural correction strategies during rehabilitation. However, the results should be interpreted with caution due to the small sample size and pilot study design.

The absence of a control group represents a major methodological limitation and prevents causal inference. The observed changes cannot be attributed exclusively to the intervention and may partly reflect natural variability, familiarisation with the testing procedure, short-term neuromuscular adaptations, or measurement error. Therefore, the present findings should be interpreted as preliminary exploratory observations rather than definitive evidence of intervention effectiveness. Additionally, the small sample size, short duration of the intervention, and lack of a control group further limit the generalisability of the results. Future studies with larger samples, longer intervention periods, and randomised controlled designs are required to confirm these findings and further explore the role of PSSE in modifying sagittal spinal alignment.

Limitations

Several limitations of the present study should be acknowledged. First, the sample size was relatively small, with only fourteen participants completing the intervention and post-intervention assessment. This limited sample size reduces the statistical power of the study and limits the ability to detect smaller effects. Additionally, the large observed effect size should be interpreted cautiously, as effect size estimates obtained in small samples may be inflated. As no *a priori* sample size calculation was performed, the findings should be considered exploratory and interpreted with caution. However, the study was designed as a pilot investigation intended to provide preliminary data on the short-term effects of a Schroth physiotherapy program on sagittal spinal alignment.

Second, the study employed a single-group pre-post design without a control group, which represents a major methodological limitation. The design prevents causal inference and therefore limits the ability to attribute observed changes solely to the intervention. The influence of natural variability, testing effects, short-term neuromuscular adaptations, or measurement error cannot be excluded. Future studies should include a randomised controlled design to better determine the effectiveness of the intervention. Additionally, the high attrition rate may have introduced selection bias related to participant adherence, motivation, or tolerance of the intervention.

Third, the duration of the intervention was relatively short (three weeks), which limits the ability to draw conclusions regarding structural changes in spinal alignment. The observed

effects are more likely to reflect short-term functional adaptations. Future studies should include longer intervention and follow-up periods to assess sustainability and structural impact of the therapy.

Another limitation concerns the measurement method. Sagittal spinal curvatures were assessed using a Rippstein plurimeter, which, although reliable and non-invasive, provides indirect clinical measurements and does not offer the same level of anatomical detail as radiographic evaluation. The use of a clinical measurement tool introduces the possibility of measurement error, despite efforts to standardise the procedure. Nevertheless, the use of a non-radiographic method was intentional to minimise radiation exposure to the paediatric population. Future studies should additionally consider the use of more precise assessment methods, including imaging or optoelectronic systems, at least in selected subgroups of participants.

Finally, the study included only female participants, which limits the applicability of the findings to male patients with adolescent idiopathic scoliosis. Future studies should consider including both sexes and larger, more diverse samples to improve the external validity of the results.

Despite these limitations, the study provides preliminary evidence suggesting that a short-term Schroth physiotherapy program may positively influence sagittal spinal alignment in girls with mild adolescent idiopathic scoliosis. It also demonstrates the feasibility of using non-invasive tools such as the Rippstein plurimeter for monitoring postural changes during conservative treatment.

Conclusions

The results of this pilot study suggest that a 3-week Schroth physiotherapy program may lead to normalisation of thoracic kyphosis in girls with mild adolescent idiopathic scoliosis. The observed increase in thoracic kyphosis moved the mean value closer to the physiological range for adolescents, indicating a potential positive effect of the intervention on sagittal spinal alignment.

No statistically significant changes were observed in lumbar lordosis or sacral slope, although small trends toward improvement were noted. These findings suggest that short-term Schroth-based rehabilitation may primarily influence thoracic sagittal alignment, while changes in other sagittal parameters may require longer intervention periods.

The study also demonstrates that the Rippstein plurimeter can be a practical non-invasive tool for monitoring sagittal spinal parameters in adolescents undergoing conservative scoliosis treatment.

Due to the pilot design, small sample size, and lack of a control group, the findings should be interpreted with caution. Future studies with larger samples, longer intervention periods, and controlled study designs are needed to confirm the observed effects and further evaluate the role of Schroth physiotherapy in improving sagittal spinal alignment in patients with adolescent idiopathic scoliosis.

Ethical approval

The research involving human participants complied with all the relevant national regulations and institutional policies, followed the tenets of the Declaration of Helsinki, and was approved by the Ethics Committee of Wrocław University of Health and Sport Sciences (approval No. 12/2024, date: 29/05/2024).

Informed consent

Informed consent was obtained from all individuals included in this study. Participation in the study required written informed consent from the parents or legal guardians of each participant. Guardians were informed about the nature and course of the study and were given the opportunity to ask questions and withdraw their child from the study at any time.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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