

Differences between the Schroth Method and Core Stabilisation in Terms of Curvature Degree and Quality of Life in Adolescents with Scoliosis

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ABSTRACT

Introduction: Scoliosis is a three-dimensional musculoskeletal spinal deformity commonly found in adolescents, particularly females during puberty. This condition affects not only the structure of the spine but also significantly reduces patients' quality of life. Physiotherapy interventions, including core stabilisation exercises and Schroth exercises, have demonstrated benefits in the management of scoliosis; however, direct comparisons of their effectiveness on both curve severity and quality of life remain limited. To determine the differences in the effects of core stabilisation exercises and Schroth exercises on reducing curve severity and improving quality of life in female adolescents aged 13–15 years with scoliosis. **Methods:** This study employed a quasi-experimental design using a pre- and post-test, two-group approach. Twenty female adolescents with mild functional scoliosis were divided into two groups via purposive sampling: Group I received core stabilisation exercises (n=10) and Group II received Schroth exercises (n=10). Interventions were administered over 4 weeks at a rate of 2 sessions per week. Curve degree was assessed using a scoliometer via the Angle of Trunk Rotation (ATR) during the Adam's Forward Bend Test, whilst quality of life was measured using the Scoliosis Research Society-22 (SRS-22) questionnaire. A paired t-test was used for within-group comparisons and an independent t-test for between-group comparisons. **Results:** Both interventions demonstrated statistically significant reductions in ATR and improvements in SRS-22 scores within each group (p=0.001). A comparison between the groups revealed no significant difference in SRS-22 delta scores (p=0.210), although a greater trend towards curve reduction was observed in the Schroth exercise group. **Conclusion:** Both core stabilisation exercises and Schroth exercises are equally effective in reducing the degree of curvature and improving quality of life in female adolescents with scoliosis aged 13–15 years, with no significant difference between the two interventions.

Keywords: *scoliosis, core stabilisation exercises, Schroth exercises, scoliometer, quality of life*

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INTRODUCTION

Adolescence is a transitional period between childhood and adulthood characterised by anatomical and physiological changes. Between the ages of 10 and 16, the muscles and skeletal system develop significantly, to the extent that changes in a person's posture become apparent (Centemeri et al. 2024). The physical changes that occur during this period are associated with a susceptibility to postural disorders (Dop et al. 2024), particularly when accompanied by non-ergonomic postural habits in daily activities, including maintaining a seated

position for prolonged periods and sitting with an asymmetrical body posture, which contributes to the development of musculoskeletal disorders and spinal problems (Pacheco et al. 2023). One of the most common spinal disorders found during adolescence is scoliosis, a three-dimensional deformity shaped like the letters C or S. Approximately 80–85 per cent of scoliosis cases are of the idiopathic type, which emerges during puberty (Dunn et al. 2018). The global prevalence of scoliosis in children and adolescents is 1.65% (95% CI 1.38–1.94), being almost twice as high in girls as in boys, with a peak among girls aged



12–14 years (Wang et al. 2025). This high prevalence makes scoliosis a public health issue requiring serious attention, particularly amongst adolescents who are in a phase of active growth (Xu et al. 2024). The impact of scoliosis is not limited to structural changes, but also has a significant effect on the quality of life of those affected (Kaya et al. 2022). Overall quality of life (QOL) encompasses physical, psychological and social aspects (Archer et al. 2021). In adolescents with scoliosis, a decline in QOL often results from back pain, impaired ability to perform daily activities, physical discomfort, and psychological effects such as low self-confidence regarding body image (Zhang 2023). Physiotherapy plays a vital role in the management of scoliosis through various exercise-based approaches. Core stabilisation exercises target the deep core muscles to improve spinal stability, correct posture, and support functional activities (Lubis et al. 2022). Schroth exercises are a scoliosis exercise method based on three-dimensional postural correction to reduce the degree of curvature and improve patients' functional capacity (Chen et al. 2024). Although exercise-based interventions are increasingly used as a conservative approach for patients with AIS, the effectiveness of various types of exercise still yields mixed results (Wang et al. 2024). Various exercise approaches, including stabilisation exercises and scoliosis-specific exercises, have been studied, with the majority of research focusing on changes in curve severity (Lu et al. 2025). However, radiographic changes in curve degree do not always reflect an improvement in patients' quality of life (QoL) (Gözel et al. 2025), even though QoL is one of the key outcomes that illustrates the impact of scoliosis from the patient's perspective (Güttinger et al. 2025). Consequently, evaluations of the effectiveness of interventions for AIS must consider both structural outcomes and patient-reported outcomes simultaneously. Schroth exercises and core stabilisation exercises have different therapeutic principles and objectives, and thus have the potential to yield different responses regarding changes in curve degree and quality of life in AIS patients (Wang et al. 2024). However, evidence regarding the effectiveness of both

interventions on these two outcomes simultaneously, particularly in adolescent girls aged 13–15 years, remains limited. Therefore, this study aims to analyse the differences in the effects of Schroth exercises and core stabilisation exercises on curve degree and quality of life in adolescent girls with scoliosis. The hypothesis of this study is that there is a difference in the effects of Schroth exercises and core stabilisation exercises on curve severity and quality of life in this population.

METHODS

This study employed a quasi-experimental design using a two-group pre- and post-test approach. Sampling was carried out using purposive sampling at the AsSalimiyyah Islamic Boarding School, Nogotirto, Gamping Sub-district, Sleman Regency, Special Region of Yogyakarta. The study was conducted from December 2023 to January 2024 and was approved by the Health Research Ethics Committee of 'Aisiyiah University of Yogyakarta under reference number 3348/KEP-UNISA/1/2024.

The study participants were adolescent girls meeting the following inclusion criteria: aged 13–15 years; diagnosed with functional scoliosis; with an ATR value of $\geq 10^\circ$ and $< 20^\circ$ as measured using a scoliometer; and willing to participate in all intervention sessions, with informed consent signed by a parent or guardian. Exclusion criteria included: structural scoliosis requiring surgical intervention; a history of vertebral fractures; acute pain limiting movement; and comorbid conditions that could affect measurement results.

The sample size was determined based on the accessible population using the Slovin formula. The study population at the research site totalled 57 individuals. With a tolerated error rate of 20%, the calculation indicated a required sample size of 17 respondents. To account for potential dropouts, 20 per cent was added to this figure, resulting in a final sample size of 20 participants. All participants meeting the study criteria were divided equally into two groups: the core stabilisation exercise group comprising 10



participants and the Schroth exercise group comprising 10 participants.

Both groups received the intervention over a period of 4 weeks, with 2 sessions per week, each lasting 45–60 minutes, and conducted under the supervision of a physiotherapist. The core stabilisation exercise group performed exercises comprising pelvic tilt, the cat-camel pose (back raise), basic trunk curl (crunch), bridge with knee extension, and quadruped. Each movement was performed as 1 set of 12 repetitions. For each repetition, the end position of the movement was held for 2–3 seconds before returning to the starting position. The exercises were administered twice a week for 4 weeks. The Schroth exercise group received exercises comprising three-dimensional corrective breathing, supine shoulder counter-traction on the left side, side-lying shoulder counter-traction, sideways hanging between two poles, and the Schroth gait. Each movement was performed as 1 set of 12 repetitions. The corrective component was held for 2–3 seconds during each repetition, according to the participants' ability.

The Angle of Trunk Rotation (ATR) was measured using a scoliometer during the Adam's Forward Bending Test. During the examination, the respondents were asked to stand with their feet parallel and then bend forwards with both arms hanging freely until the trunk was in a forward-flexed position. The scoliometer was placed at the area of greatest trunk rotation or the peak of asymmetry to obtain the ATR value in degrees.

ATR measurement using a scoliometer during the Adam's Forward Bending Test has a sensitivity of 78.3 per cent and a specificity of 88.9 per cent in detecting scoliosis confirmed by a Cobb angle $\geq 10^\circ$, and demonstrates good validity ($r = 0.70$) (Komang-Agung et al. 2017). ATR measurements also demonstrate excellent reliability, with inter-examiner reliability (ICC(2,1)) of 0.92 and intra-rater reliability (ICC(3,3)) ranging from 0.98 to 1.00 (Prowse et al. 2017).

Quality of life (QoL) was measured using the Scoliosis Research Society-22 (SRS-22) questionnaire, which is a specific instrument for assessing quality of life in individuals with scoliosis. The questionnaire comprises 22 items

covering five domains: function/activity, pain, self-image, mental health, and satisfaction with care. SRS-22 scores range from 22 to 110, with higher scores indicating a better quality of life in patients with scoliosis (Zaina et al. 2023).

ATR and QoL measurements were taken before the intervention (pre-test) and after the entire 4-week intervention programme had been completed (post-test). ATR values were used to measure changes in the degree of trunk rotation, whilst SRS-22 scores were used to assess changes in the respondents' quality of life.

Statistical analysis was carried out using SPSS version 25. The Shapiro-Wilk test was used to assess the normality of the data. Within-group hypothesis testing utilised a paired t-test to determine the effect of each intervention, whilst between-group comparisons used an unpaired t-test with the delta score (post-pre difference) as the input. The significance level was set at $p < 0.05$.

RESULTS

Table 1 shows that the baseline characteristics of the two groups did not differ statistically ($p > 0.05$), whether in terms of age, degree of curvature or quality-of-life scores.

Table 1. Baseline characteristics of the study subjects

Characteristics	Group I Core stabilisation (n=10)	Group II Schroth Exercise (n=10)	<i>P</i>
Age (years)	14.20 $\pm$ 0.79	14.10 $\pm$ 0.88	0.761
Curvature ($^\circ$) (Baseline)	7.40 $\pm$ 1.58	7.60 $\pm$ 1.43	0.732
Quality of Life Score (Baseline)	77.40 $\pm$ 8.21	75.60 $\pm$ 7.87	0.571

Unpaired t-test for numerical variables. A p -value > 0.05 indicates that there is no statistically significant difference between groups at baseline.

The results of the paired t-test in Table 2 show a statistically significant reduction in the degree of curvature and an increase in quality of life scores in each group ($p=0.001$). In Group I, the degree of curvature decreased by an average of 2.20 degrees and the quality of life score



increased by an average of 18.20 points after 4 weeks of core stabilisation exercises. In Group II, the curve degree decreased by an average of 2.80 degrees and the quality of life score increased by an average of 20.90 points after 4 weeks of Schroth exercises.

Table 2. Comparison of mean curve degrees and quality of life scores before and after the intervention in each group (Paired t-test)

Variable	Group	Pre	Post	Difference in Means	p
Curve Degree (°)	Group I	7.40 ± 1.58	5.2 ± 1.32	2.20	0.001*
	Group II	7.60 ± 1.43	4.8 ± 1.23	2.80	0.001*
Quality of Life Score	Group I	77.40 ± 8.21	95.6 ± 7.83	18.20	0.001*
	Group II	75.60 ± 7.87	96.50 ± 8.12	20.90	0.001*

*Statistically significant at $p < 0.05$. Mean difference = pre-test value minus post-test value for curve degree (decrease) and post-test value minus pre-test value for quality of life score (increase).

The results of the unpaired t-test showed that there was no statistically significant difference between Group I and Group II, either in terms of the change in the degree of curvature ($p=0.118$) or the change in the quality-of-life score ($p=0.210$). Although, descriptively, the Schroth exercise group showed a slightly greater reduction in the degree of curvature and a slightly greater improvement in quality-of-life scores, these differences were not sufficient to reach statistical significance.

Table 3. Comparison of the mean differences in curve degree and quality of life scores between groups (unpaired t-test)

Variable	Group I	Group II	p
Curve Degree Delta (°)	2.20 ± 0.92	2.80 ± 0.87	0.118
Delta Quality of Life Score	18.20 ± 4.66	20.90 ± 2.82	0.210

Unpaired t-test. Delta was calculated from the difference between pre- and post-test scores in each group. A p-value greater than 0.05 indicates no significant difference between groups.

DISCUSSION

Core Stabilisation Exercises

In this study, core stabilisation exercises had a significant effect on reducing the degree of curvature and improving quality of life; this is consistent with the findings of a study by Ko and Kang (2017), which demonstrated a significant reduction in the lumbar Cobb angle following core stabilisation exercises. The mechanism of improvement may occur through the strengthening of the core muscles (transversus abdominis, multifidus, and diaphragm), which function as dynamic stabilisers of the spine (Lee 2025). When these muscles work synergistically, the distribution of load across the vertebrae becomes more even, thereby reducing postural deformities and improving spinal balance (Lubis et al. 2022).

Previous studies have shown improvements with longer durations (Gür et al. 2017). Whilst this study was conducted over 4 weeks, from an exercise physiology perspective, neuromuscular adaptation from muscle-strengthening exercises generally occurs within the first 2 to 4 weeks through increased motor unit recruitment, before structural adaptations such as muscle hypertrophy emerge in the following weeks (Del Vecchio et al. 2019). This is consistent with the improvements already detected in the core stabilisation group in this study, despite the intervention lasting only 4 weeks.

Core stabilisation exercises in this study also significantly improved quality of life. This finding is consistent with the study by Gür et al. (2017), which found a significant improvement in quality of life after 10 weeks of core stabilisation exercises in adolescents with idiopathic scoliosis. However, in a direct comparison by Kocaman et al. (2021), the improvement in quality of life in the core stabilisation group was found to be smaller than that in the Schroth exercise group, suggesting that whilst core stabilisation is effective in improving quality of life, the



magnitude of this benefit is likely not as great as that of scoliosis-specific postural correction exercises.

In terms of mechanism, the five core stabilisation movements in this study train the coordinated contraction of the ‘dynamic muscular corset’, which results in increased trunk rigidity to maintain stability (Selkow et al. 2017). This increased stability, supported by improved neuromuscular activation, reduces the load on the spinal structures and alleviates back pain (Gökdemir et al. 2026). The reduction in pain, coupled with improvements in postural symmetry, further enhances patients’ self-image and functional capacity. Collectively, these effects contribute to an improvement in quality of life (Gökdemir et al. 2026), particularly in the domains of pain and activities of daily living on the SRS-22 questionnaire.

Schroth Exercises

In this study, Schroth exercises significantly reduced the degree of curvature after 4 weeks of intervention. This finding is consistent with the study by Kocaman et al. (2021), which found a significant improvement in the Cobb angle in the Schroth group. In terms of mechanism, Schroth exercise movements are designed to shorten the muscles on the extended side and strengthen the muscles surrounding the spine (Tian et al. 2026), with a focus on correcting posture, breathing patterns, and postural perception (Weiss 2011). When the movements are performed in the correct dosage, the shortened muscles on the concave side will be stretched, whilst the excessively elongated muscles on the convex side will return closer to their original position, thereby stabilising the spine (He et al. 2022). These exercises are designed to halt the progression of abnormal curvature and, where possible, partially reverse the curve to improve spinal balance and stability (Park et al. 2018). In this study, the Schroth method also significantly improved quality of life.

These findings are consistent with those showing a greater improvement in quality of life in the Schroth group compared with the core stabilisation group after 10 weeks. The improvement in quality of life in this group is

likely to have occurred through several mechanisms simultaneously, namely improved postural appearance, which has an impact on self-confidence (Tombak et al. 2024), improvements in breathing patterns through rotational breathing exercises that support functional capacity (Dimitrijević et al. 2025), and a reduction in pain resulting from improved balance of the back muscles (He et al. 2022).

Comparison Between Groups

The results of the independent t-test showed no statistically significant difference between the two groups in either the delta in the degree of curvature or the delta in quality of life; however, descriptively, the Schroth exercise group showed a slightly higher average improvement in both variables. This pattern is consistent with the findings of Kocaman et al. (2021), who found that Schroth exercises were significantly superior to core stabilisation in improving the Cobb angle, trunk rotation angle, cosmetic deformity, spinal mobility and quality of life, whilst core stabilisation was superior in increasing peripheral muscle strength. On the other hand, the absence of significant differences in this study is also consistent with the systematic review by Dimitrijević et al. (2022), which concluded that, in general, there is as yet no strong evidence of the superiority of one method over the other.

These two sets of findings can be explained by the fundamental differences in how each intervention works. Core stabilisation exercises work through strengthening and stabilisation, which improve spinal stability via neuromuscular control and co-activation of flexor and extensor muscles (Gusti Pratiwi 2022). Schroth exercises, on the other hand, work through three-dimensional postural correction specifically targeted at the patterns of scoliosis deformity (Jiménez-Jiménez et al. 2025). The higher descriptive trend observed in the Schroth group, albeit over just 4 weeks, is consistent with the Schroth method’s more specific mechanism of action regarding scoliosis deformities; this is in line with research by Kocaman et al. (2021). However, it is possible that the small sample size and short duration of the exercises were



insufficient to demonstrate statistically significant differences between the groups.

CONCLUSION

Core stabilisation exercises and Schroth exercises both had a significant effect on reducing the degree of curvature (ATR) and improving quality of life in adolescent girls with scoliosis aged 13–15 years following a 4-week intervention. However, there was no statistically significant difference between the two interventions in terms of changes in the degree of curvature or quality of life. These findings suggest that both interventions are effective in improving the degree of curvature and quality of life in the study population. Nevertheless, the results must be interpreted with caution due to the relatively short duration of the intervention and the limited sample size. Further research with a longer intervention duration and a larger sample size is required to confirm these findings and strengthen the generalisability of the results.

For future researchers, it is recommended to consider a longer duration of exercise and higher intensity in order to achieve more optimal results. The inclusion of a control group, randomisation, and the measurement of the degree of curvature using radiological methods (Cobb angle) to complement the scoliometer will enhance the methodological quality of the research.

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