

## SYSTEMATIC REVIEW

**THE EFFECTIVENESS OF COMBINED BRACING AND PHYSICAL THERAPY EXERCISES IN ADOLESCENT IDIOPATHIC SCOLIOSIS: A SYSTEMATIC REVIEW**Ayesha Bibi<sup>1</sup>, Nazish Faiz<sup>1</sup>, Ume Farwa<sup>2</sup>, Aqsa Sharif<sup>3</sup>, Hazrat Bilal<sup>4</sup>**ABSTRACT**

**Introduction:** Adolescent Idiopathic Scoliosis (AIS) is a prevalent disorder that affects a significant percentage of children between the ages of 10 and 16. Despite its prevalence, the cause of this condition remains unknown. There are several treatment options available for AIS, with bracing and physiotherapy being the most used. However, the effectiveness of combining these two treatments has not been thoroughly evaluated.

**Material & Methods:** The objective of this essay was to review the existing literature on the effectiveness of combined bracing and physical therapy exercises in treating AIS. To achieve this, a thorough search of databases such as PubMed, PEDro, Cochrane Library, and Google Scholar was conducted. Primary variables, such as Cobb angle reduction, and secondary variables, including balance control and quality of life improvement, were extracted from the selected studies. The quality of the studies was critically appraised using the Newcastle Ottawa Scale.

**Results:** The results of the review revealed that four prospective cohort studies met the inclusion criteria, with each study scoring an average of 6.5 on the Newcastle Ottawa Scale, indicating their high quality. The findings from these studies demonstrated that the combination of Physiotherapeutic Specific Scoliosis Exercises (PSSE) and Schroth exercises, along with bracing, had a significant impact on reducing the Cobb angle when compared to the use of bracing alone.

**Conclusion:** In conclusion, the review suggests that combining bracing with exercise therapy can lead to improvements in Cobb angles, balance control, and quality of life for individuals with AIS. Furthermore, this combined approach has the potential to reverse brace-induced deformities in these individuals. This finding underscores the potential benefits of integrating physiotherapy exercises with bracing in the treatment of AIS and highlights the need for further research in this area to better understand the long-term effects of this combined approach.

**Key Words:** Adolescent idiopathic scoliosis; bracing; Cobb angle; conservative treatment; physical therapy exercises; physiotherapy scoliosis specific exercises; systematic review

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**INTRODUCTION**

Scoliosis is a complex three-dimensional spine abnormality that occurs when the spine deviates laterally from its usual vertical line by at least a 10-degree angle.<sup>1-4</sup> Adolescent Idiopathic Scoliosis (AIS) is the most common type of scoliosis affecting children aged 10-16 years, with an unknown aetiopathology. The severity of scoliosis is usually assessed using the Cobb angle, which primarily assesses the lateral angle of the spine on the frontal surface.<sup>5,6</sup> This disorder causes discomfort, pain, decreased spine flexibility, chest complications, respiratory problems, and postural control issues due to the three-dimensional spinal and rib cage deformity caused by AIS.<sup>7-10</sup>

The treatment of AIS is divided into two categories: conservative and surgical procedures. Conservative treatment includes observation, physical therapy, electrical stimulation, and bracing, while surgical procedures mainly involve spinal fusion techniques.<sup>11</sup> Current guidelines from the International Scientific Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT) recommend physical therapy and/or bracing for AIS when the Cobb angle is between 25-45 degrees.<sup>12-14</sup>



Figure 1: A typical case of AIS showing a right thoracic curvature and a smaller compensatory lumbar curvature to the left. Various strategies can be used to effectively correct spinal deformities using braces, including passive and active components. The passive approach relies on external assistance to guide the realignment process, while the active component requires patient active participation. Physical therapy treatment in AIS uses Physical Scoliosis Specific Exercise

(PSSE), which is crucial for improving posture, preventing postural collapse, improving breathing, and strengthening any unequal muscle groups.<sup>9,15,16</sup> PSSE is divided into four categories: side-shift exercises, Schroth exercises, core stability exercises, and scientific exercise approach to scoliosis (SEAS).<sup>17,18,19</sup>

Although the majority of AIS patients are treated conservatively for years, there is still no systematic review of prospective cohort studies concerning the combined effect of bracing and physical therapy exercises in AIS. The current evidence for the combined effect of bracing and physical therapy exercises in AIS is insufficient. This study aims to reduce the research gap between clinicians and evidence regarding the effectiveness of combined bracing and physical therapy exercise in AIS by systematically reviewing the literature.

## MATERIAL AND METHODS

A systematic review of prospective studies was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2009 guidelines.

**Search Strategy:** To search the relevant articles on the effectiveness of combined bracing and physical therapy exercises in AIS, the following electronic databases: PubMed, PEDro and the Cochrane Library were used to conduct a systematic literature search. Additional records were identified by searching Google Scholar. The limits applied were English language studies, full-text studies, human studies published after the between 2000 and 2022. The following search strategy was performed by using: “AIS” OR “bracing”, “AIS” AND “bracing”, “AIS” OR “physical therapy exercises”, “AIS” AND “physical therapy exercises”, “AIS” OR “combined bracing and physical therapy exercises” and, “AIS” AND “combined bracing and physical therapy exercises”. The following combination of relevant keywords along with Medical Subject Heading (MeSH) was identified for every database individually and was used during the search: curved spine, s-shaped spine, lateral curvature of the spine, Disorder of spine, c-shaped spine, orthotic device or lumbosacral orthosis. Other sources for study identification were screening the reference lists of the relevant studies.

**Selection Criteria:** Prospective cohort studies were included, Age  $\geq 8$  year and  $< 18$ -year,

Curve angle  $> 10^\circ$  and  $< 45^\circ$ , Skeletal immaturity on Risser scale is 0-3, Ability to attain all physical therapy sessions.

Studies were excluded if study design was other than prospective cohort study, books/book chapters, workshop papers, grey literature, diagnosed other than AIS, systemic illness or disabilities which affect the exercise performance. Articles were also excluded if done with other previous treatments for AIS.

#### **Study Quality and Risk of Bias Assessment:**

Data regarding research design, study groups, participant count, participant details, intervention group (types of bracing, duration of use, follow-up, type of exercise, duration of exercise and frequency of exercise), control group (intervention details in control group), primary and secondary outcome measurements and study ID (first author name with the year and reference) were all extracted for external validity and reporting quality. The study's quality was evaluated using the New Castle Ottawa scale (NOS). The study's quality was assessed by three separate reviewers and any differences or conflicts were settled by comparing the recorded data and talking to the relevant author. The NOS scale contains nine points: four for selection, two for comparability and three for the outcomes that determine if the included articles were biased (19). A score of 7-9 indicated that the study's quality was excellent, a score of 4-6 indicated that it was moderate and a score of 0-3 indicated that it was low. Each of the below responses that is highlighted with an asterisk is added one point to determine the score. Each study is subjected to a quality assessment and disagreements over the findings are settled by consensus.

**Data Extraction:** Three independent reviewers gathered information on sample size, data extraction for the primary and secondary variables. Any differences or conflicts were settled through discussion with the relevant author and comparison of the recorded data. The included study's texts, tables and figures were mined for data.

Information extracted from the studies regarding authors, publication date, sample size, age of included participants, Cobb's angle and the country where the research was executed.

**Ethical consideration and informed consent:** This review article is based on

previous published studies; the authors did not conduct any clinical or preclinical interventions involving humans or animals.

#### **RESULTS**

The study selection process, as demonstrated in the flow chart in Figure 2, included a total of 4 articles, each providing valuable information on the characteristics of the studies, the patient demographics, the interventions used, and the outcomes observed.

The characteristics of the included studies, as summarized in Table 1, provide a comprehensive overview of the patient demographics and the interventions used. The sample sizes ranged from 20 to 73 patients, with a total of 190 patients included in the four studies.<sup>20-23</sup> The participants were divided into experimental and control groups, with a total of 145 females and 45 males. The average age of the participants was between 8 and 14 years, and the average duration of an exercise session was 44.75 minutes, with a frequency of 4 days per week. The average duration of wearing a brace was 21.3 hours, and the average follow-up period for brace usage was 14.25 months. Importantly, the experimental and control groups did not differ significantly in terms of baseline characteristics.

All patients included in the studies had been diagnosed with Adolescent Idiopathic Scoliosis (AIS), and the main difference between the experimental and control groups was the type of intervention they received. The experimental groups received a combination of exercise and bracing, while the control groups received bracing alone. The specific types of exercises and braces varied across the studies, with some utilizing postural correction, core stabilization, and breathing exercises, while others used patient-specific asymmetric exercises and 3D brace correction. The main goal of all four studies was to improve the Cobb angle, with secondary objectives including improving balance control and enhancing the quality of life for AIS patients. The results of the studies showed varying degrees of improvement in the Cobb angle, with different rates of compliance to exercise and brace usage observed in the experimental and control groups.

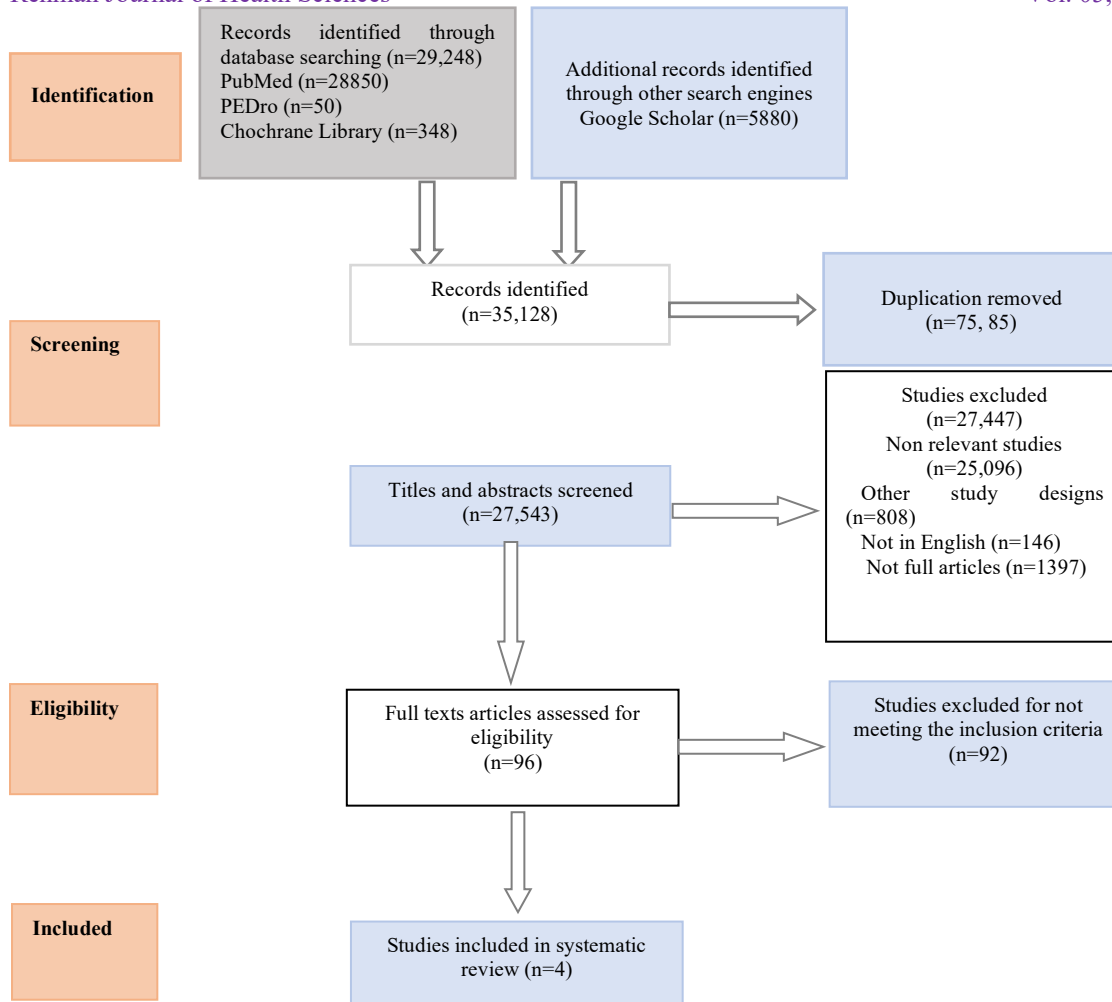


Figure 2: PRISMA flow diagram

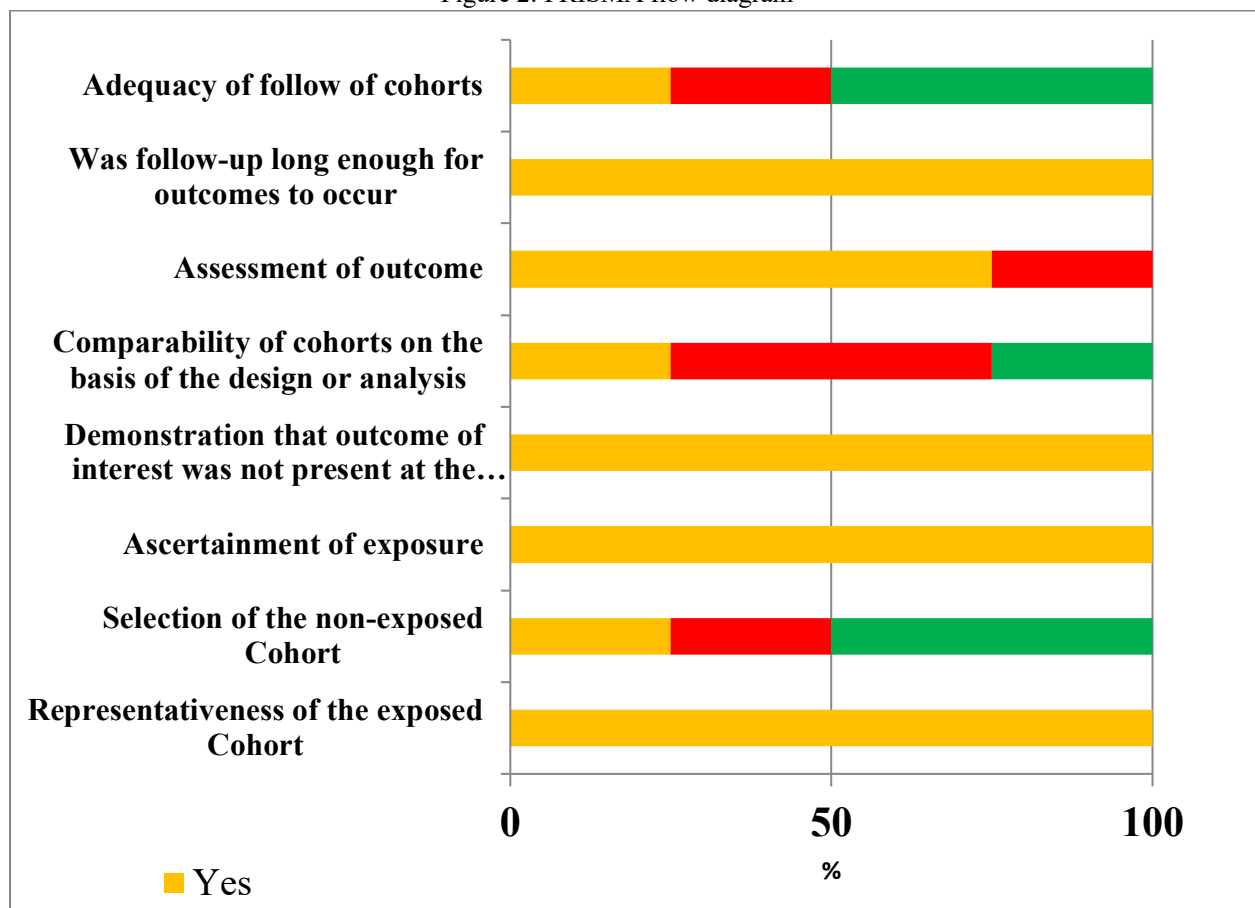


Figure 3: Risk of bias graph. The review author’s judgments about each risk of bias item are presented as percentages across all included studies

Table: 1 Table showing quality of the included studies

|   | NOS points   | Negrini et al 2014<br>Hong Kong<br>(20) | Kwan et al 2017<br>Italy<br>(21) | Burcin Akcay Bayraktar 2018<br>United States<br>(22) | Zaptal et al 2019<br>Turkey<br>(23) |
|---|--|---|----------------------------------|--|-------------------------------------|
| 1 | Representativeness of the exposed Cohort                                     | *                                       | *                                | *  | *                                   |
| 2 | Selection of the non-exposed Cohort  | *                                       | ●                                | ●  | ●                                   |
| 3 | Ascertainment of exposure  | *                                       | *                                | *  | *                                   |
| 4 | Demonstration that outcome of interest was not present at the start of study | *                                       | *                                | *  | *                                   |
| 5 | Comparability of cohorts on the basis of the design or analysis              | ●*                                      | **                               | * ●  | * ●                                 |
| 6 | Assessment of outcome  | *                                       | *                                | ●  | *                                   |
| 7 | Was follow-up long enough for outcomes to occur                              | *                                       | *                                | *  | *                                   |
| 8 | Adequacy of follow of cohorts  | ●                                       | *                                | ●  | ●                                   |
| 9 | Total Score  | 7/9                                     | 8/9                              | 5/9  | 6/9                                 |

In assessing the quality of the included studies, the New Castle Ottawa Scale was used to determine the methodological quality of the evidence. The studies were found to range from moderate to high methodological quality, with some issues related to the representativeness of the exposed cohort, exposure determination, and comparability based on the study design. Overall, the quality assessment indicated that the included studies provided valuable and reliable evidence.

**DISCUSSION**

The effectiveness of conservative treatment for Adolescent Idiopathic Scoliosis (AIS) has been the subject of numerous studies in recent years. Negrini et al's prospective cohort study in 2014 demonstrated the effectiveness of AIS conservative treatment in the risk group suggested by the SRS criteria, including bracing and exercises.<sup>20</sup> This study, along with others, has provided valuable insights into the use of braces and exercises in the management of AIS.

The literature suggests that certain factors, such as excessive stiffness, high BMI, and a Cobb's angle greater than 30°, indicate the need for specific types of braces, such as the Lyon and Sforzesco brace. Additionally,

studies have shown that the combination of bracing and Physiotherapeutic Specific Scoliosis Exercises (PSSE) can increase the effectiveness of the brace by preventing side effects like spinal stiffness and muscle weakness. The use of the SpineCor brace has also been highlighted as a popular option among AIS patients due to its adjustability and fabric material.<sup>20,25,26</sup>

Furthermore, the addition of Schroth exercises to brace therapy has been found to have a positive impact on curve progression and topographical alterations in AIS patients. Schroth exercises have been shown to increase the overall Quality of Life (QoL) in AIS patients by reducing symptoms and improving postural parameters, thereby impacting the patients' perception of themselves and their level of comfort.<sup>27-29</sup>

In addition to the benefits of PSSE and brace therapy on curve progression and QoL, studies have also examined the effects of these treatments on balance control and postural stability in AIS patients. The results have shown that PSSE involved in spinal stabilization can improve postural balance and muscle function, leading to an improved

ability to maintain self-correction and postural control over time.<sup>20,21</sup>

Moreover, the impact of exercise on QoL in AIS patients has been a focus of research, with some studies reporting that exercise, particularly PSSE, is crucial in raising QoL despite the negative effects of brace treatment. The addition of exercise to brace therapy has been shown to improve body image and overall QoL in AIS patients.

The findings from these studies highlight the potential benefits of conservative treatment, including bracing and exercises, in managing AIS. The combination of specific types of braces with PSSE and other exercises has been shown to be effective in improving curve progression, postural stability, and QoL in AIS patients. Further research in this area will continue to provide valuable insights into the optimal management of AIS.

### CONCLUSION

The findings from the study suggest that a combination of bracing and PSSE treatment is significantly more effective in treating Adolescent Idiopathic Scoliosis (AIS) compared to using either bracing alone or PSSE treatment alone. The evidence indicates that the combination therapy may lead to improvements in Cobb angles, balance control, and overall quality of life for AIS patients. Additionally, the results show that the combined therapy has the potential to reverse the deformity caused by bracing, as exercise alone can only provide temporary relief. This highlights the importance of considering a multifaceted approach when treating AIS, as it may lead to more permanent improvements in patients' conditions.

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| Author and year of publication | Participant Information                    |  | Type Of Interventions   |                         | Improved Patients |     | Worsen Patients |     | Remained stable Patients |     | Brace Compliance |        | Exercise Compliance |     | Adverse Events                | Conclusions   |
|--------------------------------|--|--|---|-------------------------|-------------------|-----|-----------------|-----|--------------------------|-----|------------------|--------|---------------------|-----|-------------------------------|---|
|                                | EG   | CG   | EG  | CG                      | EG                | CG  | EG              | CG  | EG                       | CG  | EG               | CG     | EG                  | CG  |                               |   |
| Negrini et al 2014             | n=37, Sex: M=7, F=30<br>Age(SD)=12.1±1.05  | n=36, sex: M=6, F=30<br>Age(SD)=12.1±1.05  | PSSE with Lyon/Sforzesco<br>Duration:42min/day<br>Frequency: 4day/week                              | CG                      | 52%               | 36% | 4%              | 8%  | 53%                      | 47% | 88.20%           | 93.40% | 82%                 | Nil | Nil                           | Results are improved when bracing and exercise are combined   |
| Kwan et al 2017                | n=24<br>sex: M=5, F=19<br>Age(SD)=11.3±1.9 | n=24<br>sex: M=5, F=19<br>Age(SD)=11.3±1.9 | Schroth Method of exercise<br>With spine cor brace<br>Duration=42min/day<br>Frequency=5day/week     | Spine core brace        | 19%               | 10% | 21%             | 50% | 62%                      | 46% | 70.80%           | 76.90% | 79.20%              | Nil | Nil                           | Exercises using the Schroth method combined with bracing were better than bracing only.                       |
| Burcin Akcay Bayraktar 2018    | n=10<br>sex: M=4, F=6<br>Age(SD)=13.3±1.2  | n=10<br>sex: M=4, F=6<br>Age(SD)=13.3±1.2  | Schroth Method of exercise with modified Cheneau brace<br>Duration=45min/day<br>Frequency=3day/week | modified Cheneaux brace | 45%               | 27% | 18%             | 10% | 64%                      | 36% | 68.90%           | 81.60% | 78.90%              | Nil | Musculoskeletal pain reported | Exercise using the Schroth method in conjunction with brace therapy may significantly improve the Cobb angle. |
| Zaptal et al 2019              | n= 26<br>sex: M=7, F=19<br>Age(SD)=8±5.2   | n= 23<br>sex: M=6, F=17<br>Age(SD)=8±5.2   | PSSE with spine core brace<br>Duration=41min/day<br>Frequency:5day/week                             | Spine core brace        | 41%               | 45% | 16%             | 18% | 58%                      | 42% | 61.80%           | 72.90% |                     | Nil | Nil                           | In comparison to bracing alone, PSSE with brace greatly slows the evolution of curves.                        |