Effectiveness of Scoliosis Specific Exercises in Improving Cobb's Angle-A Systematic Review and Meta-Analysis

Malik Waseem Ahmed Majoka[1], Sohail Rasool[2], Sheikh Muhammad Ebad Ali[3], Omer Islam[4], Maleeha[5], Muhammad Osama Siddiqui[6], Fatima Shahid[7]

[1]Dow University of Health Sciences (DUHS), [2]IPS Portlaoise, Ireland, [3]University Hospital Wishaw, UK, [4]Jinnah Postgraduate Medical Center, [5]Aga Khan University, [6]Liaquat National Hospital and Medical College, [7] Karachi Medical and Dental College, Karachi

ABSTRACT

Background: Scoliosis is defined as a Three-dimensional deformity that can be diagnosed by measuring the spinal curves. For measuring the curvature, we employ Cobb's method to calculate Cobb's angle on the anteroposterior radiograph of the spine. The commonest type of scoliosis is adolescent idiopathic scoliosis (AIS) that is seen in adolescent females. Our literature research revealed a scarcity of systematic reviews regarding the role of Scoliosis specific exercises (SSE) in reducing Cobb's angle in scoliosis. This review of the literature evaluates the role of SSE compared to the standard treatment practices in reducing Cobb's angle in scoliosis patients.

Methods: The literature was scrutinized according to PRISMA guidelines where PubMed, Google Scholar, and Cochrane Library were searched for randomized controlled trials in the English language with the search words "Cobb's angle", "physiotherapy", "outcomes", "scoliosis specific exercises", "correction of" and "scoliosis" in different combinations published between 2016 to 2022. One group i.e. interventional group consisted of SSE with standard care while the other group i.e. control group did not receive SSE. Mean ± SD was used to measure the change in Cobb's angle. The difference was pooled by standardized mean difference (SMD) into forest plots. The risk of bias was assessed by the Oxford quality scoring system (OQSS).

Results: The SMD was pooled from five studies where SMD remained -0.717 (-1.142, -0.291) (CI=95%, p-value< 0.05) between the intervention and control group. Heterogeneity by the I2 test was reported to be moderate and non-significant (I2 = 52.42%, p-value>0.05)

Conclusion: We concluded that SSE produced a decrease in Cobb's angle compared to the group without SSE. However, good quality randomized controlled trials with larger sample sizes and longer follow-ups are needed to strengthen the role of SSE.

Keywords: Low Angle Scattering, Physical Therapy Modalities, Scoliosis.

Corresponding Author:
Dr. Sheikh Muhammad Ebad Ali
University Hospital Wishaw,
United Kingdom.
Email: ebadvirgo@gmail.com

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INTRODUCTION

Scoliosis is defined as a three-dimensional deformity of the spine and it is diagnosed based on the measurement of major curves of the spine[1]. The lateral curvature angle of the spine is most commonly measured by Cobb's method called Cobb's angle[1]. Scoliosis is of three types; idiopathic scoliosis, syndromic scoliosis, congenital scoliosis[2]. Scoliosis most commonly affects adolescent girls. Scoliosis diagnosed in adolescence is termed Adolescence Idiopathic Scoliosis which is the most common type of scoliosis. A study was carried out in Portugal which showed a very high prevalence of scoliosis in school-going children[3]. Cobb's angle remains the most frequent source for deciding the further management plan in scoliosis patients[4]. It can be measured from standing anteroposterior radiographs of the complete spine by Cobb's method[5]. With recent advances, computerized software, and automatic labeling systems are being developed that may help in finding Cobb's angle easily. Another classification was adopted to provide braces to scoliosis patients while the previous classifications were being used to treat patients surgically[6]. Negrini and Donzelli introduced guidelines called SOSORT guidelines (2016) [7]. Table 1 displays the summary of SOSORT guidelines of 2016 which was based upon two measures i.e., Cobb's angle and Risser grade.

Cobb's angle	Riser grade	Radiography/Referral	Treatment
10 to19	0 to 1	Radiography every six months, no referral	Observe
10 to19	2 to 4	Radiography every six months, no referral	Observe
20 to29	0 to 1	Radiography every six months, referral	Brace after 25 degrees
20 to29	2 to 4	Radiography every six months, referral	Observe or brace
29 to40	0 to 1	Referral	Brace
29 to40	2 to 4	Referral	Brace
>40	0 to 1	Referral	Surgery

Table 1: SOSORT guideline[7].

Mild scoliosis without any respiratory or cardiac complications can be managed with exercises to obtain optimum spine deformity correction. The principle of these exercises is to shorten the muscles on the convex side of the curvature while lengthening the muscles on the concave side of the curvature. This results in natural traction provided by muscular strengthening producing spine corrections. Exercises that are used for the correction of spinal deformity are termed scoliosis-specific exercises (SSE). Different schools of thought came up with their modifications of SSE which are named Lyon (France); Scientific Exercises Approach to Scoliosis (Italy); Schroth (Germany); Barcelona Scoliosis Physical Therapy School; DoboMed Method (Poland); Side Shift Method (London); Functional Individual Therapy of Scoliosis (Poland).

Romano and Minozzi published a meta-analysis that included only two trials [8]. The review concluded that further clinical trials are necessary to provide high-quality evidence regarding the role of SSE in scoliosis. Kalichman and Kendelker also reported the same results[9]. However, they reported exercise-based therapy to reduce curve progression and showed maximum efficacy when braces were combined with specific physical exercises.

This review focuses on the differences in Cobb's angle in terms of improvement or deterioration produced if SSE were used compared to the other techniques used according to SOSORT guidelines.

METHODS

"Preferred reporting items for systematic reviews and meta-analysis (PRISMA)" was used systematically by the author to obtain literature. Literature was segregated by title, abstract, and removal of duplication. After that full texts were reviewed and the quality of the studies was assessed by the author. Any confusion was resolved at any stage after a discussion with an expert in our department. Figure 1 shows a PRISMA-labeled diagram.

PubMed, Google Scholar, and Cochrane Library were searched for articles with the keywords "Cobb's angle", "physiotherapy", "outcomes", "scoliosis specific exercises" and "scoliosis" in different combinations. Articles were filtered by clinical trials with a duration of 10 years in the English language carried on humans.

All the studies that were being reviewed by full texts were assessed by the "Oxford quality scoring system" for randomized trials, respectively[10]. For the Oxford

quality scoring system, a score of 5 or 4 suggests a good-quality trial; 3 or 2 suggests a fair-quality trial while 1 or 0 signifies a poor-quality study. A senior expert from our department also assessed the biases among articles and disagreements were resolved between him and the author after discussions. A third person was involved in the case of inconclusive discussion between the author and the expert regarding disagreements.

The author developed a criterion for the selection of randomized controlled trials which was primarily based upon the induction of scoliosis patients in scoliosis-specific exercises along with standard care without any surgical intervention. The control subgroup which was regarded as a non-interventional group continued standard care in the form of non-specific exercises, braces along analgesics without any surgical correction. Only good or fair-quality trials were included due to the previous meta-analysis which also included studies with a high risk of bias. Letters, case reports, case series, cross-sectional studies, commentaries, conference papers, and editorials were excluded. Trials including participants with pre-intervention Cobb's angle >40, previous surgical corrections, less than 6 months follow-ups, pathological fractures associated with scoliosis, and exercises other than SSE in the interventional group were also excluded.

Descriptive statistics were calculated for the studies in the form of mean with standard deviation (SD). The standardized mean difference (SMD) was computed to evaluate the effect sizes by using Hedges' g equation to pool standard deviations. The sample sizes in the study vary from 17 to 25 in the SSE subgroup and 12 to 25 in the control group. Hedges' g equation provides better effect size measurements for small sample-sized controlled trials. Heterogeneity was explored by using I^2 statistics in which I^2 value < 25% is mild heterogeneity; 25.1%-74.9% is moderate heterogeneity; and 75% to 100% considerable heterogeneity. The significance of heterogeneity was assessed based on the p-value. For p-value >0.05 fixed effect model was used while a random effect model was adopted for p-value<0.05 i.e., statistically insignificant. For the assessment of publication bias, we evaluated by funnel plot. A forest plot was drawn to compare the SMD among the interventional and non-interventional arms. Open Meta Analyst software was employed for statistical analysis.

In the case of more than 10 studies included, a funnel plot-based method shall be employed to evaluate the publication biases among the included studies. Hedge's g-measured SMD was used to assess publication bias as effect size on the x-axis against standard error on the y-axis of the plot. A straight vertical line in the plot indicated the zone in which 95% of studies should be if there was no publication bias. Egger's regression test was also carried out to assess publication bias.

RESULTS

This review includes 101 and 97 participants in SSE and control group from 5 randomized controlled trials in which 2 were held in Canada while one each was conducted in Turkey, USA, and China, with a mean age of 13.3±0.7 years. SMD of change in Cobb's angle was reported to be -0.717 (-1.142, -0.291) (CI=95%, p-value< 0.05). The results show that SSE improved Cobb's angle by reducing it by the mean value of -0.717 degrees compared to pre-exercise Cobb's angle. Heterogeneity by the I2 test was reported to be moderate and non-significant (I2 = 52.42%, p-value>0.05). Hence a fixed effect model was adopted. The negative sign with Cobb's angle proves improvement in Cobb's angle after scoliosis-specific exercises (SSE). The results are concluded in the forest plot shown in Figure 2. Table 3 summarizes the outcomes of clinical trials which were reviewed.

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Figure 1: PRISMA Flowchart.

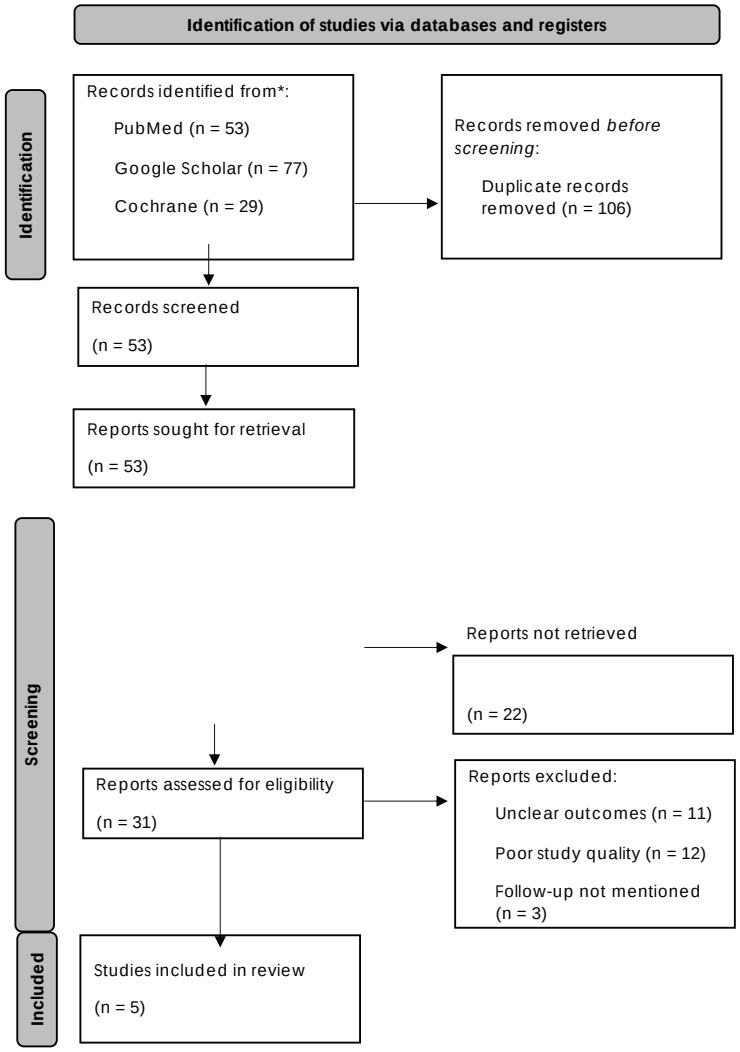

Table 2: Summary results obtained from trials included.

Clinical trial	Year of Study	Country	Number of patients	Change in Cobb's angle	Mean age in years	Last, follow up in months	Risk of bias score
Schreiber, S., et al [9]	2011-2013	Canada	21/23	-1.4°±12.4	13.5±1.6	6	4
				+1.2°±12.5	13.3±0.3	6	
Kuru, T., et al. [11]	2010-2011	Turkey	15/15	-1.4°±10.9	12.9±1.4	6	3
				+1.7°±6.1	12.8±1.2	6	
Gao, C. et al.[12]	2017-2018	China	23/22	-4.9°±5.4	12.2±1.4	6	5
				+2.1°±5.3	12.1±1.3	6	
Schreiber, S., et al.[13]	-	Canada	25/25	-1.8°±3.2	13.5±0.4	6	4
				+2.3°±4.2	13.3±0.3	6	

Zapata, K. A., et al.[14]	-	USA	17/12	+0.4°±5.5	12.5±1.5	6	3
				+3.6°±4.0	11.8±0.9	6	

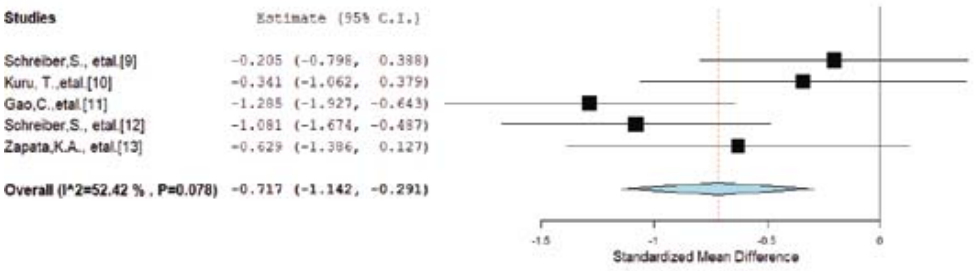

Figure 2: Forest plot showing a comparison between SSE and Control Groups. The plot shows a pooled estimate of -0.717 (-1.142, -0.291) with I^2 =52.42%, P=0.078 which shows the final results favoring the SSE group.

DISCUSSION

The purpose of this review was to discover the role of scoliosis-specific exercises (SSE) in the correction of Cobb's angle among patients with scoliosis which may improve the quality of life and complications such as respiratory difficulties, limb length discrepancies, improper balance, and posture, pain, disability and cosmetic difficulties faced by the patients suffering from scoliosis. Park, Jeon published a meta-analysis but they included non-randomized trials and case series[15]. The significance of SSE was not compared to a proper non-interventional group. No other meta-analysis was found in databases regarding the role of SSE in improving Cobb's angle within the past 10 years.

The improper lateral curvature affects the biomechanics of respiration by making the ribs asymmetrical on both sides which leads to unequal distribution of lung volume. Li, Li held a trial and concluded that an increase in Cobb's angle of the main thoracic region was associated with an increase in systolic pulmonary artery pressure[16]. Research was conducted regarding pediatric scoliosis which showed that pulmonary functions worsen if Cobb's angle of the scoliosis patient was not timely corrected[17]. Patients with scoliosis often suffer from limb length discrepancy with the progression of Cobb's angle. This may lead to continuous pain, young onset arthritis, disability, and obesity. Scoliosis produces functional limb length discrepancy more frequently than structural limb length discrepancy[18]. Functional limb length discrepancy leads to overpronation of the unilateral foot, pelvic tilt, and slower gait due to short stride length and higher stride time[19]. Postural changes accompany the progression of Cobb's angle. Heitz and Aubin-Fournier tested for the reliability of indices of postural changes and requested clinicians to use them along with Cobb's angle in follow-ups to assess postural derangements[21]. Cobb's angle is an important assessment tool for the quantitative estimation and classification of scoliosis[21]. It can be measured manually or with the help of automated software which provides convenience and fewer chances of error[22]. With the recent advances in the knowledge of scoliosis, other measures are being proposed for diagnosing scoliosis.

According to Halawi, and Lark, the role of the age of the patients in the treatment of scoliosis is very significant with the younger population securing a better position in terms of Cobb's angle correction[23]. Zhu and Bao showed in their meta-analysis that surgical outcomes in cases of young adult idiopathic scoliosis were also poor compared to adolescent idiopathic scoliosis[24]. In this review, it was evident that all patients were of the adolescent age group when they were assigned scoliosis-specific exercises (SSE). Hence, further clinical trials are needed to evaluate the role of SSE in the young and older adult scoliosis population. There was a generalized trend of decreasing Cobb's angle in most clinical trials except Zapata, and Sucato that were included in our review[14]. An interesting characteristic was noticed in the Zapata, Sucato trial that showed the progression of Cobb's angle after six months by +0.4°± 5.5[14]. However, the participants were followed up for 12 months. Hence it was noticed that in the second follow-up six months after the first one, the Cobb's angle reduced by -0.4°± 5.5. The total change in Cobb's angle was 0° after 12 months. The intervention still managed to abort curve progression in this trial. Berdishevsky, and Lebel in their review described the different schools of thought with their guidelines for treatment by scoliosis-specific exercises[25]. They also provided details regarding the outcomes of each school of physiotherapy. Thompson and Williamson concluded that SSE improved spinal deformity but the evidence was of very poor quality[27]. Negrini and Donzelli conducted a clinical trial where they concluded that SSE also decreased the need for

bracing and provided relief to the patients[27]. The trial also established the role of SSE in comparison to usual physiotherapy. Scoliosis-specific exercises are neglected nowadays by many clinicians and most of them are in favor of usual physiotherapy which implies low-impact stretching and strengthening techniques. Bettany Saltikov, Parent wrote an article in which they described different exercises prescribed by different Schools of physiotherapy along with commonalities and differences[28]. Steinmetz and Segreto assessed the surgeons' attitudes toward prescribing scoliosis-specific exercises to their patients[29]. Steinmetz and Segreto concluded that 52% of the respondent surgeons used SSE as a non-operative tool and 40.3% of the referrals were due to pain29. 48% of surgeons who did not refer their patients for SSE reported skepticism due to a lack of perceived value[29]. According to previous research and guidelines, severe Cobb's angle should not be corrected with only scoliosis-specific exercises and other surgical measures should be implied to correct the deeper lateral curvatures of the spine[30]. From the literature review, it was evident that no authentic clinical trials were found regarding the efficacy of scoliosis-specific exercises prescribed by different schools of thought and comparison among them. Further clinical trials should be carried out to establish the efficacy between different schools of physiotherapy. The trials were also carried out with small sample sizes with short follow-ups. It would be of great clinical interest to carry out large-sized randomized controlled trials and cohort studies with longer follow-up durations to better visualize the significance of SSE.

CONCLUSION

We concluded that scoliosis-specific exercises (SSE) produce a decrease in Cobb's angle compared to the standard care without scoliosis-specific exercises (SSE). However, good quality randomized controlled trials with larger sample sizes and longer follow-ups are needed to strengthen the role of SSE.

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CONFLICT OF INTEREST

None

REGISTRATION

The review has not been registered with any registration body.

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