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Original Article

Effectiveness of Kinesio Taping Compared to Other Interventions in Children and Adolescents with Idiopathic Scoliosis: A Systematic Review and Meta-Analysis

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Abstract

Background: Kinesio taping (KT) is used to treat people with scoliosis. However, there is limited evidence to to clarify its mechanism and effectiveness in treating idiopathic scoliosis in children and adolescents. Therefore, this study aimed to evaluate the effectiveness of KT for idiopathic scoliosis in children and adolescents. **Methods:** The search was conducted in the following databases from inception to November 2022: Scopus, Cochrane Library, Cumulative Index of Nursing and Allied Health Literature, Web of Science, and PubMed. The methodological quality of the included RCTs was assessed for subjects diagnosed with idiopathic scoliosis in children and adolescents. Primary outcomes included pain intensity, Cobb angle, and back muscle endurance. Meta-analysis was conducted to pool the results using standardised mean difference (SMD). **Results:** Four RCTs (160 participants) were included. The effect of KT with exercises group had better improvement on Cobb angle than other exercise only (SMD = -0.49, 95% confidence interval (CI) -0.89° to -0.09°; p = 0.02; I^2 = 25%); but there was no difference between groups on back muscle endurance (SMD = 0.63, 95% CI -0.50 to 1.39 seconds; p = 0.36; I^2 = 65%). Data on pain outcomes were insufficient for meta-analysis due to heterogeneity in reporting methods However, two studies showed that KT combined with exercises effectively minimised pain for patients with scoliosis. **Conclusion:** This systematic review and meta-analysis suggest that adding KT to other interventions improves the Cobb angle and may reduce pain in patients with idiopathic scoliosis. However, due to the limited number of included studies and participants, further high-quality RCTs are needed to confirm these findings.

Keywords: Kinesio taping; Idiopathic scoliosis; Cobb angle; Pain; Back muscle endurance.

Introduction

Idiopathic scoliosis is a three-dimensional spine deformity in healthy pubertal children with a rotation of the spine in the horizontal plane and a lateral bend in the frontal plane greater than 10°

(Choudhry, M. N., & Ahwas smalla, R. 2016). This deformity causes an asymmetry in the trunk muscles and rib cage (Choudhry, M. N., & Ahwas smalla, R. 2016; Negrini, S. et al., 2018). Although the exact causes of idiopathic scoliosis are unknown, some of its many contributing factors are the uneven growth of the front and rear vertebrae, neurological anomalies, connective tissue abnormalities, genetic predisposition, and aberrant muscular contraction mechanisms (Jada, A. et al., 2017; Weinstein, S. L., & Dolan, L. A. 2015). In idiopathic scoliosis, abnormal mechanical stresses acting on the spine cause alterations in the trunk segment's biomechanics and physiology (Monticone, M., et al., 2014). Scoliosis is a complex spinal deformity that can lead to various symptoms, including unbalanced posture, restricted spinal movement, muscle weakness in the spine, chronic pain, psychological issues, impaired exercise tolerance, decreased muscle endurance, and physical deconditioning, all of which can be present in mild cases of the condition (Balne, N. K., Jabeen, S. A., & Mathukumalli, N. 2021).

The most used parameter for quantifying spine curvature is the Cobb angle, which is measured by radiographs in a standing position and defined as the angle between the upper border of the upper vertebra and the lower borders of the lowest vertebra. The prevalence of idiopathic scoliosis with a curve angle of >10° is approximately 2.5% in the general population, so it is the most common spine deformity in the maturing population. The idiopathic scoliosis is present in 2–4% of adolescents and occurs in ages 10–16, with girls being more at risk for severe progression by a ratio of 3.6 to 1 (Weinstein, S. L., et al. 2008; Konieczny, M. R., Senyurt, H., & Krauspe, R. 2013).

For the treatment of idiopathic scoliosis, both surgical and non-surgical methods are employed. Surgical surgery is advised when the Cobb angle is less than 40°; this occurs about 1 in 25 times (or 0.1% of all cases) (Yoon, S., & Rhee, M. H. 2016).

The non-surgical treatments include physical therapy, physical exercise, and wearing a brace. The choice of treatment to be adopted depends on the severity of the scoliotic curve (Liu, D. et al., 2020). The conservative management of idiopathic scoliosis typically entails wearing braces, spinal adjustment therapy, and exercise therapy, including core segment exercises, flexibility exercises, such as Pilates and yoga, and the application of Kinesio taping (KT) (Alves de Araújo, M. E., et al., 2012). Another goal of the conservative treatments is to stop curve progression during pubertal growth. The emergence of respiratory, cardiopulmonary, and back pain problems will also be lessened or possibly prevented by doing this (Gür, G., Ayhan, C., & Yakut, Y. 2017; Hides, J. et al., 2006).

Recently, there have been several conservative approaches of therapeutic exercises, such as the Schroth method and the core stabilisation exercises. The Schroth method is a three-dimensional program of exercises including a combination of stretching and strengthening exercises, and the respiratory and thoracic movements are performed towards the opposite side of the trunk torsion. On the other hand, core stabilisation exercises involve trunk muscles to improve body balance and reduce postural asymmetries. The meta-analysis study by Dimitrijević et al. provided evidence that the Schroth method and core stability exercises positively affect the Cobb angle, the angle of trunk rotation, and the quality of life of idiopathic scoliosis patients (Dimitrijević, V. et al., 2022). Even though, Schiller et al. (Schiller, J. R., & Eberson, C. P. 2008) suggested that people with scoliosis should exercise to be able to move better. Additionally, there is another study about the strength of the muscle groups used in the posture of children with scoliosis aged 10–16. The study found that using this method of intense muscle training from 2 to 6 months eliminated scoliosis with a non-surgical treatment (Sarcevic, Z. 2010). However, some of the conservative methods show limitations in improving patients' symptoms.

Another conservative intervention method is KT,

which was created by Dr Kenzo Kase in 1979 and still in use today. It is an elastic tape made to fit the characteristics of the surface of human skin. The tape is manufactured pre-stretched by 15–25% as it is applied to the backing paper. It is characterised by its ability to stretch to 120–140% of its original length and, following application, recoil back towards its unstretched length (Bassett, K. T., Lingman, S. A., & Ellis, R. F. 2009). Its latex adhesive might also lessen the chance of skin discomfort. The proper use of this tape is intended to achieve the following objectives: To correct joint movement by realigning misaligned joints, strengthen weak muscles, and restore them to their normal resting positions (Kamel M. I. et al., 2022). It also corrects muscle function by strengthening weak muscles. In addition, it helps in reducing pain through neurological suppression, stimulation of pain receptors in the skin, and improved blood and lymph circulation beneath the skin (Bassett, K. T., Lingman, S. A., & Ellis, R. F. 2009; Zakaria, A. et al., 2012).

The KT has also been demonstrated to lessen pain. A previous study compared the use of KT to non-elastic tape for children with idiopathic scoliosis, the results showed that the KT group had a better spine angle and more toned muscles (Álvarez-Álvarez, S. et al., 2014; Duangkeaw, R. et al., 2019). Furthermore, it has been demonstrated that the KT could reduce or stop the course of structural spine deviation by addressing the three-dimensional character of the deviation in accordance with biomechanical principles to meet both functional and aesthetic requirements (Borzì, F. et al., 2018). Vercelli et al. (Vercelli, S. et al., 2017) concluded that the KT enhanced blood and lymphatic reflux by creating skin wrinkles that widened the space between the skin and the underlying connective tissue. Additionally, they found that KT enhanced the range of motion, stability, pain suppression, and proprioceptive input. Furthermore, it was suggested that the cutaneous stretch stimulation made possible by KT might prevent the transmission of unpleasant mechanical stimuli while supplying afferent inputs that support the systems that reduce pain (Bischoff, L. et al., 2018). A case report showed an association between normalised muscle performance and acute back pain relief (Hwang-Bo, G., & Lee, J. H. 2011).

Previous studies have investigated the efficiency of several treatment modalities for children and adolescents with idiopathic scoliosis. While various studies have focused on traditional interventions such as physical therapy, exercise and bracing, there remains a notable gap in the literature regarding the specific role of KT as an adjunctive treatment. For instance, Kamel M. I. et al., 2022 examined how adding KT to other conventional exercises affected discomfort, Cobb angle, and the endurance of the trunk extensor muscles. Similar to this, another study (Álvarez-Álvarez, S. et al., 2014) investigated the effect of KT on the lumbar extensor muscles' resilience to exhaustion. Despite these findings, the therapeutic potential of KT for idiopathic scoliosis is still understudied compared to its application in conditions such as plantar fasciitis, anterior cruciate ligament rupture, occupational (Hwang-Bo, G., & Lee, J. H. 2011), and non-specific low back pain (Castro-Sánchez, A. M. et al., 2012) have also been the subject of various research that have looked at KT. Additionally, while Balne et al., explored the effects of physical therapy on various aspects of spinal mobility, the specific contribution of KT in this context remains unclear.

Although the KT is widely used to treat idiopathic scoliosis, there is insufficient scientific evidence to fully understand how it works to treat idiopathic scoliosis and other spine curvature diseases. To address this gap, our study aims to systematically evaluate the effectiveness of KT in improving key outcomes for children and adolescents with idiopathic scoliosis. Specifically, we investigate whether KT leads to improvements in Cobb angle, pain, and back muscle endurance when compared with other conservative interventions.

This study aims to systematically evaluate the effectiveness of Kinesio Taping in improving Cobb angle, reducing pain, and enhancing back muscle endurance in children and adolescents with

idiopathic scoliosis, compared to other conservative interventions.

Methodology

Design

This systematic review and meta-analysis included randomized controlled trials (RCTs) and was registered in PROSPERO (ID: CRD42022373559) on [06 November 2022]. A comprehensive search of multiple electronic databases was conducted to identify relevant studies. This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, including the use of a PRISMA flow diagram to document the study selection process. (Page, M. J. et al., 2021).

Identification and selection of studies

A comprehensive literature search was conducted in the following databases from inception to November 2022: Scopus, Cochrane Library, Cumulative Index of Nursing and Allied Health Literature, Web of Science, and PubMed. The search strategy involved key terms related to KT, Cobb angle, spine deviation, spine curvature disorders, and scoliosis. The complete research strategy conducted is provided in the appendix (Appendix Table 1). The reference lists of the identified studies were also reviewed to identify other potentially relevant studies. The search was also performed for relevant grey literature sources, reports, and dissertations. The search for the information sources was conducted by one reviewer (AA). Two reviewers (AA and HD) independently screened the identified papers for inclusion following the protocol (Table 1). Disagreements were settled by discussion or the addition of a third reviewer (HA). The screening process was conducted initially by screening titles with abstracts and, finally, the full text. A paper was assumed to be possibly relevant, and its full text was then examined based on the title and abstract after two independent reviewers discussed it (Liberati, A. et al., 2009; Tacconelli, E. 2010). The full text of each paper that was not excluded based on the title or abstract was evaluated. As recommended, the number of papers included and excluded at each stage was recorded and shown in a PRISMA flowchart (Figure 1) (Hicks, C. M. 2009).

Table 1: Inclusion and exclusion criteria of the studies

Inclusion criteria
- Design: Randomised controlled trial - Participants: Subjects diagnosed with idiopathic children and adolescents' scoliosis of approximately 10 degrees. - Intervention: Kinesio taping - Comparisons: Other conservative interventions
Exclusion criteria
- Any study design other than randomised controlled trial
- Participants with Pregnancy, local regional or systemic infection, malignity, decompensated heart failure, neurodermatitis, skin diseases. - Participants diagnosed with intervertebral disc disease, asthma, epilepsy, spinal fusion, spinal cord tumours and anomalies, and any pathological spinal abnormality, such as spondylolisthesis, lumbosacral transitional, or spondylolysis. - Studies with any interventions, comparisons, or outcomes other than mentioned in inclusion criteria are excluded.

Data extraction

The data were extracted from the included articles by two independent reviewers (AA, HD) using a standardized Excel sheet designed for this review. A third reviewer (HA) resolved any disagreements. Extracted data included study characteristics (first author, publication year, study design, country, sample size, study arms, and conclusions), demographic details (age, gender, height, weight, BMI), intervention specifics, and outcome measures. To ensure accuracy, the extracted data were double-checked between the reviewers, and any discrepancies were resolved by the third reviewer. The inter-rater reliability was assessed by calculating the percentage agreement between the

two reviewers on the extracted data. Ethical approval was not required for this systematic review and meta-analysis as it involved the analysis of previously published data.

Quality assessments

Methodological quality was critically appraised using the Physiotherapy Evidence Database (PEDro) scale. The PEDro scale consists of 10 items: random allocation, concealed allocation, similarity at baseline, subject blinding, therapist blinding, assessor blinding, completeness of follow-up, intention-to-treat analysis, between-group statistical comparisons, and point measures and variability (Maher, C. G. et al., 2003). Two authors independently scored the articles. In the case of discrepancies, a consensus was reached through verbal discussion. Items are scored as either present (1) or absent (0), and a score out of 10 is obtained by summation. Scores on the PEDro scale range from 0 (very low methodological quality) to 10 (high methodological quality), although the highest possible score for a trial of a sport intervention is 8/10, as blinding of participants and deliverers is not possible. A score ≥6/10 on the PEDro scale was considered moderate to high quality.

Data analysis

A meta-analysis was conducted using RevMan (version 5.4), with data pooled using a fixed-effect model if no significant heterogeneity was detected. Heterogeneity was assessed using Cochrane's Q and the I^2 statistic, with I^2 > 50% indicating substantial heterogeneity. If high heterogeneity was observed, a random-effects model was applied. Mean differences were standardized using the standardized mean difference (SMD), with effect sizes interpreted as small (≤0.2), moderate (0.5), or large (≥0.8). Results were visualized using forest plots with 95% confidence intervals. Due to the inclusion of fewer than five studies, publication bias could not be assessed. Given the small sample size, findings should be interpreted with caution as the meta-analysis may be underpowered to detect small effect sizes.

Results

Study screening and selection

Overall, 311 articles were identified. After removing duplicates, 175 articles remained. After screening articles by titles and abstracts, 10 articles were found to be eligible for evaluation by full text. Of the 10 articles, four articles met the pre specified inclusion criteria for qualitative synthesis. The screening process for eligible studies is presented in Figure 1, with the number of studies in each stage.

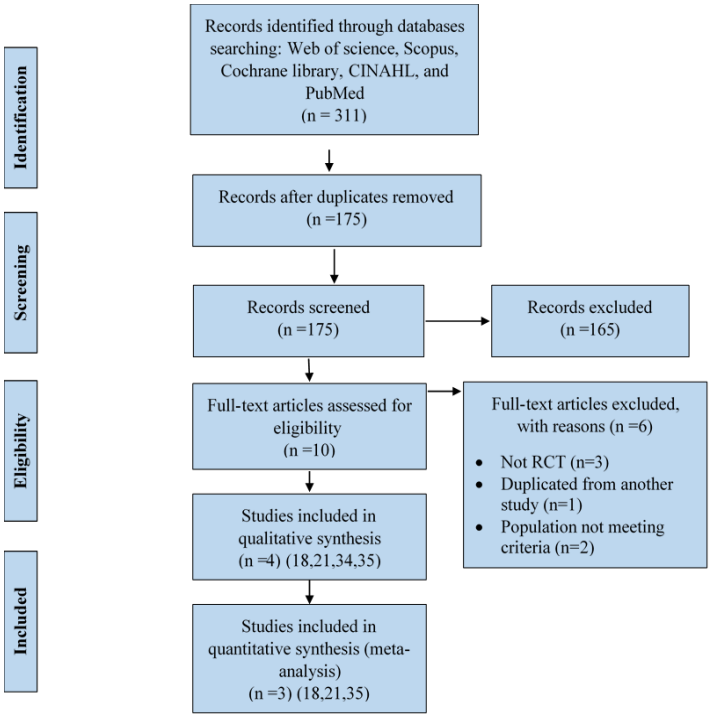

Figure 1: PRISMA flowchart outlining the search strategy and details of the studies finally included in the meta-analysis.

Quality assessments

All four studies (Duangkeaw, R. et al., 2019; Bac, A. et al., 2009; Mohamed, E. A. et al., 2016) scores were 6 out of 10 in the PEDro score. Table 2 represents the scoring items of each study. This shows moderate-to-high methodological quality (PEDro score ≥6). All participants were randomly allocated, and all studies provided between-group

comparisons and the calculation of point estimates and variability. None of the trials blinded participants, therapists, or assessors. The item concerning the allocation concealment to the group was unclear in all four studies.

Participants

This systematic review included four RCTs (Kamel M. I. et al., 2022; Duangkeaw, R. et al., 2019; Bac, A. et al., 2009; Mohamed, E. A. et al., 2016). Tables 3 and 4 present the summary and the baseline characteristic of the included studies. Overall, 160 children and adolescents with idiopathic scoliosis were included. Most participants were females (32 males compared to 128 females). The age of the patients ranged from 10 to 19.

Table 2: PEDro scale and items with scores for each study

Study Id	1	2	3	4	5	6	7	8	9	10	Total (0 to 10)
Bac 2009 (34)	√	X	√	X	X	X	√	√	√	√	6
Mohamed 2016 (35)	√	X	√	X	X	X	√	√	√	√	6
Duangkeaw 2019 (21)	√	X	√	X	X	X	√	√	√	√	6
Abd El-Hakim 2022 (18)	√	X	√	X	X	X	√	√	√	√	6

√ meets criteria; X does not meet criteria. 1 = random allocation, 2 = concealed allocation, 3 = baseline comparability, 4 = blinded participants, 5 = blinded therapists, 6 = blinded assessors, 7 = adequate follow-up, 8 = intention-to-treat analysis, 9 = between-group comparisons, 10 = point estimates and variability.

Table 3: Summary of studies' characteristics selected for analysis.

Study ID	Follow up	Country	Total sample size	Study arms		Patients' main inclusion criteria	Study conclusion
				KT	C		
(34) Bac 2009	3 weeks	Poland	44	22	22	Children with low angle scoliosis	The results of this study seem to support the hypothesis that Kinesiology taping can be a good adjunct to traditional therapy in children with low-angle scoliosis.
(35) Mohamed 2016	6 weeks	Egypt	40	20	20	Adolescent females complain from scoliosis	Exercises for scoliosis and exercises augmented by KT had a significant effect on reduction of both the Cobb angle and pain intensity.
(21) Duangkeaw 2019	6 weeks	Thailand	16	10	6	No history of spinal surgery, no history of allergies KT, and able to participate throughout the study	3-dimension Schroth exercises and KT with Schroth exercises can increase maximal expiratory pressure, back muscle endurance, and angle of trunk rotation at the thoracic and the lumbar level.
(18) Abd El-Hakim 2022	12 weeks	Egypt	60	30	30	Children and adolescents between 9 and 16 years old, having AIS with a Cobb angle of 10–25º, back pain for more than 3 months caused by scoliosis, and able to participate and complete this study	Adding KT to CS exercises yields improvement on pain, reduction in the Cobb angle, and improvement in back muscle endurance more than CS alone in idiopathic scoliosis.

Interventions

Table 4 shows the interventions used by the included studies in this review. In all the included studies, subjects in the experimental groups were given the same intervention of the control group in addition to the KT. In a study by Bac et al. (2009), KT was given for subjects for 45 minutes, three times per week over three weeks and they were also prescribed exercise 3 sessions per week for 6 weeks. In the studies, Bac et al. and Mohamed et al. (Bac, A. et al., 2009; Mohamed, E. A. et al., 2016), the KT was maintained for five days then removed and the subject had a rest for 2 days then applied KT again (Mohamed, E. A. et al., 2016) or Schroth exercises whose sessions were scheduled for 2 days per week, 2 h per day for 6 consecutive weeks (total twelve days) while the KT was changed every time before exercise (Duangkeaw, R. et al. 2019), which are based on kinesthetic and sensorimotor principles, including postural corrective exercises, postural self-corrective exercises, and postural home exercises, and they are conducted through a mirror and adopting exercise repetition. In addition, core stabilization exercises can be used, which recruit spinal stabiliser muscles and improve the ability to straighten the spine as all exercises in the session included a 10-minute warm-up, a 40-minute CS exercise, and a 10-minute cool down. The twenty minutes of stretching, strengthening, and breathing exercises (traditional exercises) while the tape was changed every week for 12 weeks and replaced with new tape (KT applied for five-days before removal and two days interval was maintained before the patient given another KT applications) (Kamel M. I. et al., 2022). The core muscles limit the forces of compression, distortion, and rotation of the spine (Dimitrijević, V. et al. 2022). Facilitation on the convex side of the curve and mechanical correction on the rib cage was done to help the individual with derotation and deflexion. The tape is measured along the length of the vertebral arch with the trunk flexed. The patient is in the erect position when the bases are affixed and is then requested to bend forwards. The base is confirmed paravertebrally, and the tape is affixed over the muscles. The tape ends are affixed without tension. The follow-up period in the included studies ranged from 3–12 weeks.

Comparators

Table 4 shows the comparator interventions used in the included studies. The comparators of the included studies were the control group, which were the traditional exercises (Bac, A. et al., 2009; Mohamed, E. A. et al., 2016), Schroth exercises (Duangkeaw, R. et al. 2019), or core stabilization exercises (Kamel M. I. et al., 2022,). These exercises were applied alone to be compared with the experimental group who were also given the same intervention in addition to the KT.

Outcomes

As shown in Table 5, three outcomes were assessed in the included studies: Pain intensity, Cobb angle, and back muscle endurance. Pain intensity was measured in two studies (Kamel M. I. et al., 2022; Bac, A. et al. 2009), using the visual analogue scale (VAS). The back muscle endurance was measured in duration in seconds in two studies (Kamel M. I. et al., 2022; Duangkeaw, R. et al. 2019). Finally, the Cobb angle was measured in two studies (Kamel M. I. et al., 2022; Mohamed, E. A. et al. 2016), using the degree (°) unit. From the three outcomes extracted, only the Cobb angle and back muscle endurance were represented in the meta-analysis.

Pain VAS score

The pain intensity was assessed in two studies

(Kamel M. I. et al., 2022; Bac, A. et al. 2009). There was insufficient data for the meta-analysis of the pain outcome due to different data representations in terms of statistics; however, the conclusions of these two studies showed that the KT intervention was effective in minimising pain in patients.

Table 4: Characteristics of patients in studies selected for analysis.

Study ID	Arm	Follow up	No	AGE (Mean±SD)	SEX (M/F)	Height (cm) (Mean ± SD)	Weight (Kg) (Mean ± SD)	BMI (Kg/m2) (Mean ± SD)	Cobb Angle(o) (Mean ± SD)
Bac 2009 (34)	Special therapeutic exercises	3 weeks	22	10	(7/15)	NA	NA	NA	8.3 in thoracic and 9.3 in lumbar
	Therapeutic exercise in addition to KT		22	10	(7/15)	NA	NA	NA	9 in thoracic and 8.8 in lumbar
Mohamed 2016 (35)	Therapeutic exercises	6 weeks	20	18.04 ±1.33	(0/20)	163.28 ± 3.96	63.54±6.99	23.72 ± 1.95	23.55 ± 7.32
	Therapeutic exercise in addition to KT		20	17.84±1.24	(0/20)	161.84±4.71	62±4.1	23.61 ± 1.76	26.45 ± 7.6
Duangkeaw 2019 (21)	Kinesio tape with Schroth exercises	6 weeks	10	17.0±1.63	(0/10)	162.30±4.74	45.3±3.56	NA	more than 7 degrees
	Three-dimension Schroth exercises		6	14.67±2.34	(0/6)	156.83±8.60	40.25±8.97	NA	more than 7 degrees
Abd El-Hakim 2022 (18)	Traditional exercises and KT	12 weeks	30	12.91±1.4	(10/20)	153.01±10.71	44.11±8.1	NA	19.29 ± 2.32
	Traditional exercises only		30	13±1.71	(8/22)	158.01±10.51	50.6±10.01	NA	18.46 ± 1.98

Table 5: Outcomes extracted from the selected studies.

Study ID	Arm	No	Pain (VAS) cm (0–10)			Cobb angle (°)			Back muscle endurance (second)		
			PRE	POST	ΔMD (SD)	PRE	POST	ΔMD (SD)	PRE	POST	ΔMD (SD)
Bac 2009 (34)	Special therapeutic exercises	22	10	(5–6) THEN 10	NA	NA	NA	NA	NA	NA	NA
	Therapeutic exercise in addition to KT	22	10	(5–6) THEN 10	NA	NA	NA	NA	NA	NA	NA
Mohamed 2016 (35)	Therapeutic exercises	20	NA	NA	NA	23.55 ± 7.32	8.2 ± 3.4	_15.35 (8.07)	NA	NA	NA
	Therapeutic exercise in addition to KT	20	NA	NA	NA	26.45 ± 7.6	9.35 ± 2.75	_17.1 (8.08)	NA	NA	NA
Duangkeaw 2019 (21)	Kinesio tape with Schroth exercises	10	NA	NA	NA	8.63 ± 4.62 in thoracic and 9.50 ± 7.26 in lumbar	6.97 ± 3.80 in thoracic and 8.17 ± 7.64 in lumbar	NA	90.5 ± 49.98	121.2 ± 69.57	30.7
	Three-dimension Schroth exercises	6	NA	NA	NA	14.61 ± 5.55 in thoracic and 9.33 ± 3.38 in lumbar	11.61 ± 3.67 in thoracic and 7.72 ± 3.42 in lumbar	NA	71.83 ± 62.56	118.5 ± 109.9	46.67
Abd El-Hakim 2022 (18)	Traditional exercises and KT	30	7.86 ± 0.89	3.33 ± 0.71	NA	19.29 ± 2.32	14.95 ± 2.38	_4.34 (3.324)	96.96 ± 14.88	137.33 ± 12.89	40.37(19.687)
	Traditional exercises only	30	7.71 ± 0.79	4.12 ± 0.41	NA	18.46 ± 1.98	16.3 ± 2.11	_2.16 (2.894)	103.23 ± 14.71	127.4 ± 11.31	24.17(18.555)

ΔMD: Mean differences; SD: Standard deviation; VAS: Visual Analog Scale; PRE: Pre-intervention; POST: Post-intervention

Cobb angle

The Cobb angle outcome was assessed and reported in two studies (18,35). Both studies assessed it with the same technique after taking the radiograph with loaded poster anterior view, with the knees together, the chest and waist extended, the body weight equally distributed onto both lower limbs, and both arms elevated while holding one's breath after exhaling a little, by tracing a line parallel to the superior endplate of one vertebra and tracing a line parallel to the inferior endplate of the vertebra, defined as the Cobb angle. The intersection of these two lines detected the angle degree of deviation of the spine. Furthermore, their meta-analysis shown in Figure 2 suggested that patients who underwent KT combined with exercises tended to have better Cobb angle than those who underwent exercises alone (SMD= -0.49, 95% CI -0.89° to -0.09°; heterogeneity: $p = 0.25$; $I^2 = 25\%$).

Back muscle endurance

Back muscle endurance was reported in seconds (Kamel M. I. et al., 2022; Duangkeaw, R. et al. 2019). Both studies used the Biering-Sorensen test to measure the endurance of back extensor muscles. Their meta-analysis shown in Figure 3 demonstrated that there was no difference between groups on back muscle endurance back muscle endurance. There was a non-statistical significance in the meta-analysis (SMD= 0.44, 95% CI -0.50 to 1.39 seconds; heterogeneity: p = 0.36; $I^2 = 65\%$), and the random model was used.

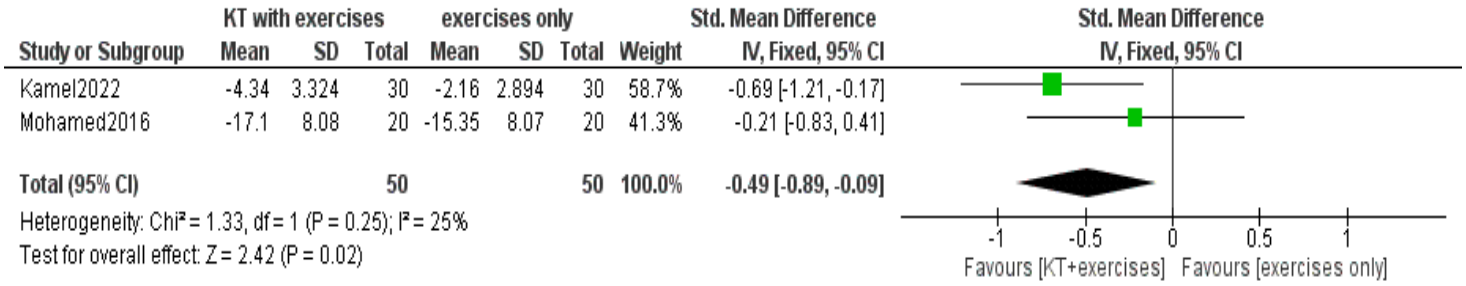

Figure 2. Forest plots for Cobb angle

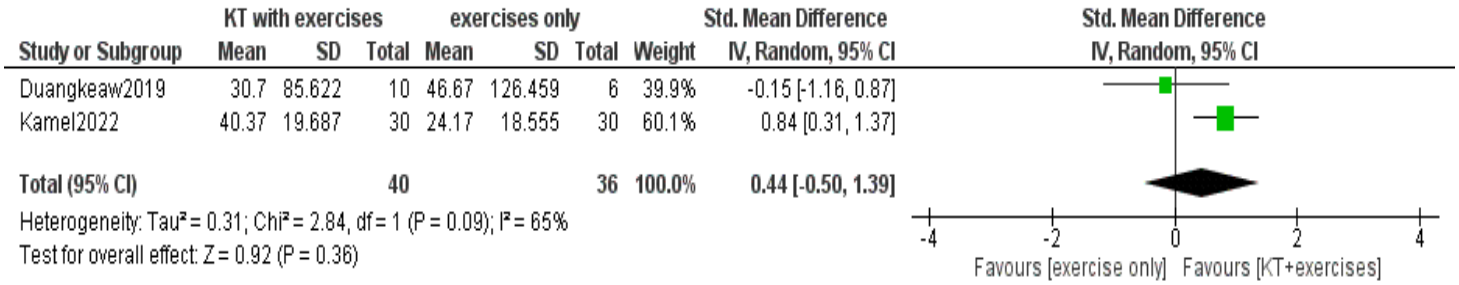

Figure 3: Forest plots for back muscle endurance

Discussion

This review aimed to assess the effectiveness of KT in managing idiopathic scoliosis in children and adolescents. This review found that KT was effective in reducing pain and the Cobb angle and no difference in back muscle endurance compared to control group. This review included four studies with 160 participants (Kamel M. I. et al., 2022; Duangkeaw, R. et al. 2019; Bac, A. et al. 2009; Mohamed, E. A. et al. 2016).

The KT was found to be effective in reducing the Cobb angle. This is mainly consistent with the findings of a study a non-randomized that showed strengthening exercises with KT significantly decreased the participant's Cobb angle in subjects with idiopathic scoliosis (Choi, T. S., Choi, W. S., & Choi, J. H. 2019). Additionally, there is a study investigated the KT in patients with chronic neck pain and demonstrated that the group getting KT therapy had considerably better cervical lordosis angles as determined by the Cobb angle and posterior tangent methods (Özkan, F. Ü. Et al. 2020). This effect might be explained by the beneficial effect of KT in changing muscle and myofascial functions. Another case report on a patient with a Cobb's angle (L1-S1) of 68° showed that posterior pelvic tilt taping favourably affected the pelvic inclination and sacral horizontal angles (Lee, J. H. et al. 2012).

Our results revealed no difference between groups in the back extensor muscles' endurance in participants with idiopathic scoliosis; patients who received KT and conventional exercises had the same back muscle endurance compared to those who received conventional exercises only. Our results disagree with the results of a previous study which showed that KT had a positive impact on low-back muscle exhaustion by showing an increase in back extensor muscle resistance (Álvarez-Álvarez, S. et al. 2014). Other two studies (Castro-Sánchez, A. M. et al. 2012; Chang, N. J. et al. 2018), found that KT significantly enhanced trunk muscular and functional endurance in individuals with back pain. Additionally, other study demonstrated that after the application of kinesiology tape, both the erector spinae taping and total muscle taping groups' back extensor muscular endurance time increased (Kim, D. J., Choi, I. R., & Lee, J. H. 2020). When the KT was applied, the isometric muscle strength temporarily increased, and they hypothesised that this might be because it stimulated the spindles of the striated muscles, causing muscle contractions via the cutaneous mechanoreceptor (Yeung, S. S. et al. 2015). Also, there is a study investigated KT in reducing lower back pain and improving back muscle endurance in adolescents with haemophilia and indicated that the KT group achieved a greater increase in the back muscles' endurance (Azab, A. R. et al. 2020).

This review also found that KT was effective in reducing pain in patients with scoliosis. This result is consistent with studies performed on patients with other musculoskeletal disorders. For example, in patients with chronic low back pain, a previous study found that KT was effective in reducing pain compared to placebo KT (Castro-Sánchez, A. M. 2012). Moreover, another study found that reduction in pain was significantly greater in patients with plantar fasciitis who received KT application and exercises than those who received exercises only (Tsai, C. T., Chang, W. D., & Lee, J. P. (2010). All previous studies concurred that there is insufficient high-quality data to support the use of KT in patients with musculoskeletal illnesses, even though the studies concluded that KT reduces pain intensity, particularly in the short term (Kamel M. I. et al., 2022; Chang, N. J. et al. 2018; Kim, D. J., Choi, I. R., & Lee, J. H. 2020; Azab, A. R. et al. 2020). Therefore, a future high-quality trial investigating the effectiveness of KT in decreasing pain among idiopathic scoliosis patients is recommended.

To the best of our knowledge, this is the first review conducted to investigate KT for treating idiopathic scoliosis in children and adolescents. Given that idiopathic scoliosis causes posture imbalance, decreased spinal movement, muscle weakness, chronic pain, psychological problem, impaired exercise tolerance and physical deconditioning (Balne, N. K., Jabeen, S. A., & Mathukumalli, N. 2021); it is crucial to investigate different ways to

enable appropriate opportunities for children and adolescents to improve their health, quality of life, and normal physical activity as they age. One way to manage idiopathic scoliosis could be by using KT combined with other modalities, such as therapeutic exercises. However, there is still a need for more high-quality clinical trials to confirm these results.

This is the first systematic review with meta-analysis to investigate the effectiveness of KT in managing idiopathic scoliosis. This review included RCT studies which were classified as high quality. It also introduced evidence that KT could be used as effectively as other modalities in treating pain and reducing of Cobb angle. We could report a meta-analysis to summarise the pooled effect of the two outcomes, Cobb angle and back muscles endurance. We conducted this systematic review in accordance with the PRISMA recommendations and by following a protocol registered prospectively on PROSPERO. We have also used a comprehensive search strategy in five medical literature and topic-specific databases.

Limitations

This study has several limitations. First, due to the availability of less than 10 studies per outcome, we were unable to examine publication bias using methods such as funnel plots, Begg's test, or Egger's test. Second, despite our comprehensive search strategy, the limited number of studies reporting on pain intensity prevented us from conducting a meta-analysis for that specific outcome.

Future Research

Future research should focus on expanding the evidence base by including larger sample sizes and a greater number of studies, especially those evaluating pain intensity. Standardizing outcome measures and reporting protocols will also enhance comparability across studies, allowing for more robust and conclusive assessments of KT's effectiveness in managing idiopathic scoliosis in children and adolescents.

Conclusion

This study addressed the effect of KT used in the treatment of children and adolescents with idiopathic scoliosis. The current review indicates that KT was effective in decreasing pain and Cobb angle. However, this evidence is limited as there was small number of studies included in the review.

Author Contributions

All authors significantly contributed to the work reported, including conception, study design, execution, data acquisition, analysis, and interpretation. They actively participated in drafting, revising, or critically reviewing the manuscript, provided final approval of the version to be published, agreed on the journal submission, and accepted accountabilities for all aspects of the work.

Data Availability Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If need from editorial team.

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Conflicts of Interest

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Reference

Álvarez-Álvarez, S., San José, F., Rodríguez-Fernández, A. L., Güeita-Rodríguez, J., & Waller, B. J. (2014). Effects of Kinesio® Tape in low back muscle fatigue: Randomized, controlled, double-blinded clinical trial on healthy subjects. *Journal of Back and Musculoskeletal Rehabilitation, 27*(2), 203–212.

Alves de Araújo, M. E., Bezerra da Silva, E., Bragade Mello, D., Cader, S. A., Shiguemi Inoue Salgado, A., & Dantas, E. H. M. (2012). The effectiveness of the Pilates method: Reducing the degree of non-structural scoliosis and improving flexibility and pain in female college students. *Journal of Bodywork and Movement Therapies, 16*(2), 191–198.

Azab, A. R., Elnaggar, R. K., Diab, R. H., & Moawd, S. A. (2020). Therapeutic value of kinesio taping in reducing lower back pain and improving back muscle endurance in adolescents with hemophilia. *Journal of Musculoskeletal & Neuronal Interactions, 20*(2), 256–263.

Bac, A., Stagraczyński, Ł., Ciszek, E., Górkiewicz, M., & Szczygieł, A. (2009). Efficacy of Kinesiology Taping in the rehabilitation of children with low–angle scoliosis. *Fizjo Polska, 9*(3), 202–210.

Balne, N. K., Jabeen, S. A., & Mathukumalli, N. (2021). Efficacy of physiotherapy on spinal mobility parameters and pain in persons with adolescent and adult idiopathic structural scoliosis. *Indian Journal of Physiotherapy & Occupational Therapy, 15*(4), 179–187.

Bassett, K. T., Lingman, S. A., & Ellis, R. F. (2009). The use and treatment efficacy of kinaesthetic taping for musculoskeletal conditions: A systematic review. *New Zealand Journal of Physiotherapy, 37*(1), 4–11.

Bischoff, L., Babisch, C., Babisch, J., Layher, F., Sander, K., Matziolis, G., et al. (2018). Effects on proprioception by Kinesio taping of the knee after anterior cruciate ligament rupture. *European Journal of Orthopaedic Surgery & Traumatology, 28*(6), 1157–1164.

Borzì, F., Szychlinska, M. A., Di Rosa, M., & Musumeci, G. (2018). A short overview of the effects of kinesio taping for postural spine curvature disorders. *Journal of Functional Morphology and Kinesiology, 3*(4), 58.

Castro-Sánchez, A. M., Lara-Palomo, I. C., Matarán-Peñarrocha, G. A., Fernández-Sánchez, M., Sánchez-Labraca, N., & Arroyo-Morales, M. (2012). Kinesio taping reduces disability and pain slightly in chronic non-specific low back pain: A randomised trial. *Journal of Physiotherapy, 58*(2), 89–95.

Chang, N. J., Chou, W., Hsiao, P. C., Chang, W. D., & Lo, Y. M. (2018). Acute effects of kinesio taping on pain, disability and back extensor muscle endurance in patients with low back pain caused by magnetic resonance imaging–confirmed lumbar disc degeneration. *Journal of Back and Musculoskeletal Rehabilitation, 31*(1), 85–93.

Choi, T. S., Choi, W. S., & Choi, J. H. (2019). Effects of kinesio-taping and strengthening exercise on Cobb angle and muscle tone in patients with idiopathic scoliosis. *Research Journal of Pharmacy and Technology, 12*(9), 4438–4442.

Choudhry, M. N., & Ahwas smalla, R. (2016). Adolescent idiopathic scoliosis. *Open Orthopaedics Journal, 10*, 143–154.

Dalton, J. E., Bolen, S. D., & Mascha, E. J. (2016). Publication bias: The elephant in the review. *Anesthesia & Analgesia, 123*(4), 812–813.

Dimitrijević, V., Viduka, D., Šćepanović, T., Maksimović, N., Giustino, V., Bianco, A., et al. (2022). Effects of Schroth method and core stabilization exercises on idiopathic scoliosis: A systematic review and meta-analysis. *European Spine Journal, 31*(12), 3500–3511.

Duangkeaw, R., Laddawong, T., Numchai, R., & Burawan, P. (2019). Effects of three-dimension Schroth exercises and kinesio taping on general mobility of vertebrae, angle of trunk rotation, muscle strength and endurance of trunk, and inspiratory and expiratory muscle strength in children with idiopathic scoliosis. *Walailak Journal of Science and Technology, 16*(12), 965–973.

Mohamed I Kamel, Ezzat El Sayed Elawh Moubarak, Bassam A El-Nassag, Ahmed Abd El-Moneim Abd El-Hakim, Radwa S Abdulrahman. (2022)Effects of core stabilization exercise and kinesio taping on pain, Cobb angle and endurance of trunk muscles in children and adolescents with idiopathic scoliosis. Curr Pediatr Res, 26 (3): 1289-1296

Gür, G., Ayhan, C., & Yakut, Y. (2017). The effectiveness of core stabilization exercise in adolescent idiopathic scoliosis: A randomized controlled trial. *Prosthetics and Orthotics International, 41*(3), 303–310.

Hicks, C. M. (2009). *Research methods for clinical therapists: Applied project design and analysis*. Elsevier Health Sciences.

Hides, J., Wilson, S., Stanton, W., McMahon, S., Keto, H., McMahon, K., et al. (2006). An MRI investigation into the function of the transversus abdominis muscle during "drawing-in" of the abdominal wall. *Spine, 31*(6), E175–E178.

Hwang-Bo, G., & Lee, J. H. (2011). Effects of kinesio taping in a physical therapist with acute low back pain due to patient handling: A case report. *International Journal of Occupational Medicine and Environmental Health, 24*(3), 320–323.

Jada, A., Mackel, C. E., Hwang, S. W., Samdani, A. F., Stephen, J. H., Bennett, J. T., et al. (2017). Evaluation and management of adolescent idiopathic scoliosis: A review. *Neurosurgical Focus, 43*(4), E2.

Kim, D. J., Choi, I. R., & Lee, J. H. (2020). Effect of balance taping on trunk stabilizer muscles for back extensor muscle endurance: A randomized controlled study. *Journal of Musculoskeletal & Neuronal Interactions, 20*(4), 541–548.

Konieczny, M. R., Senyurt, H., & Krauspe, R. (2013). Epidemiology of adolescent idiopathic scoliosis. *Journal of Child Orthopaedics, 7*(1), 3–9.

Lee, J. H., & Yoo, W. G. (2012). Application of posterior pelvic tilt taping for the treatment of chronic low back pain with sacroiliac joint dysfunction and increased sacral horizontal angle. *Physical Therapy in Sport, 13*(4), 279–285.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., et al. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *PLoS Medicine, 6*(7), e1000100.

Liu, D., Yang, Y., Yu, X., Yang, J., Xuan, X., Yang, J., et al. (2020). Effects of specific exercise therapy on adolescent patients with idiopathic scoliosis: A prospective controlled cohort study. *Spine, 45*(15), 1039–1046.

Maher, C. G., Sherrington, C., Herbert, R. D., Moseley, A. M., & Elkins, M. (2003). Reliability of the PEDro scale for rating quality of randomized controlled trials. *Physical Therapy, 83*(8), 713–721.

Mohamed, E. A., Rafat Elazab, D., & Hamed, H. M. (2016). Effect of therapeutic exercises augmented by kinesio tape in treatment of scoliosis in adolescent females. *International Journal of Medical Research & Health Sciences, 5*, 326–332. Retrieved from http://www.ijmrhs.com

Monticone, M., Ambrosini, E., Cazzaniga, D., Rocca, B., & Ferrante, S. (2014). Active self-correction and task-oriented exercises reduce spinal deformity and improve quality of life in subjects with mild adolescent idiopathic scoliosis: Results of a randomised controlled trial. *European Spine Journal, 23*(6), 1204–1214.

Negrini, S., Donzelli, S., Aulisa, A. G., Czaprowski, D., Schreiber, S., de Mauroy, J. C., Diers, H., Grivas, T. B., Knott, P., Kotwicki, T., & Lebel, A. (2018). 2016 SOSORT guidelines: Orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. *Scoliosis and Spinal Disorders, 13*(1), 1–48.

Özkan, F. Ü., Boy, F. N., Kılıç, S. E., Külcü, D. G., Özdemir, G. B., Hartevioğlu, H. Ç., Akpınar, P., & Aktaş, İ. (2020). Clinical and radiological outcomes of kinesiotaping in patients with chronic neck pain: A double-blinded, randomized, placebo-controlled study. *Turkish Journal of Physical Medicine and Rehabilitation, 66*(4), 459–466.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *International Journal of Surgery, 88*, 105906.

Sarcevic, Z. (2010). Scoliosis: Muscle imbalance and treatment. *British Journal of Sports Medicine, 44*(Suppl_1), i16.

Schiller, J. R., & Eberson, C. P. (2008). Spinal deformity and athletics. *Sports Medicine and Arthroscopy Review, 16*(1), 26–31.

Tacconelli, E. (2010). Systematic reviews: CRD's guidance for undertaking reviews in health care. *The Lancet Infectious Diseases, 10*(4), 226.

Tsai, C. T., Chang, W. D., & Lee, J. P. (2010). Effects of short-term treatment with kinesiotaping for plantar fasciitis. *Journal of Musculoskeletal Pain, 18*(1), 71–80.

Vercelli, S., Colombo, C., Tolosa, F., Moriondo, A., Bravini, E., Ferriero, G., et al. (2017). The effects of kinesio taping on the color intensity of superficial skin hematomas: A pilot study. *Physical Therapy in Sport, 23*, 156–161.

Weinstein, S. L., & Dolan, L. A. (2015). The evidence base for the prognosis and treatment of adolescent idiopathic scoliosis: The 2015 Orthopaedic Research and Education Foundation Clinical Research Award. *The Journal of Bone and Joint Surgery. American Volume, 97*(22), 1899–1903.

Weinstein, S. L., Dolan, L. A., Cheng, J. C. Y., Danielsson, A., & Morcuende, J. A. (2008). Adolescent idiopathic

scoliosis. *The Lancet, 371*(9623), 1527–1537.

Yeung, S. S., Yeung, E. W., Sakunkaruna, Y., Mingsoongnern, S., Hung, W. Y., Fan, Y. L., et al. (2015). Acute effects of kinesio taping on knee extensor peak torque and electromyographic activity after exhaustive isometric knee extension in healthy young adults. *Clinical Journal of Sport Medicine, 25*(3), 284–290.

Yoon, S., & Rhee, M. H. (2016). Effect of physical therapy scoliosis specific exercises using breathing pattern on adolescent idiopathic scoliosis. *Journal of Physical Therapy Science, 28*(11), 3261–3263.

Zakaria, A., Hafez, A. R., Buragadda, S., & Rao Melam, G. (2012). Stretching versus mechanical traction of the spine in treatment of idiopathic scoliosis. *Journal of Physical Therapy Science, 24*(11), 1127–1131.