

Traditional Chinese Medicine Manual Therapies for Idiopathic Scoliosis: A Systematic Review and Meta-Analysis

Kangqing ZHOU, Peng WANG, Chunming MA

Department of Pre-Rehabilitation Medicine, Taihe Hospital, Hubei University of Medicine, Shiyan 442000, China

Abstract [**Objectives**] This meta-analysis evaluated the efficacy of Traditional Chinese Medicine (TCM) manual therapies (Tuina, Daoyin, acupotomy) for idiopathic scoliosis (IS), with dual focus on radiographic outcomes (Cobb angle, vertebral rotation) and patient-centered metrics (pain, disability, quality of life). [**Methods**] This study systematically searched PubMed, Cochrane Library, EMBASE, Web of Science, CNKI, Wanfang, and VIP databases (from inception to July 2025) for randomized controlled trials (RCTs) comparing TCM manual therapies against controls (bracing, exercise, sham, or no intervention). Two reviewers independently extracted data and assessed methodological quality using the PEDro scale. Meta-analyses employed random-effects models (Stata 18) to calculate Hedges' g with 95% confidence intervals (CI). Heterogeneity was quantified via I^2 statistics, and subgroup analyses examined intervention types (standalone versus combined) and control groups. [**Results**] Radiographic outcomes: TCM therapies significantly reduced Cobb angle (Hedges' $g = -0.93$; 95% CI: $-1.37, -0.49$; $p < 0.001$) and vertebral torsion rotation (VTR; $g = -0.71$; 95% CI: $-0.91, -0.51$; $p < 0.001$) versus controls; patient-centered outcomes: substantial pain reduction (VAS; $g = -1.47$; 95% CI: $-2.64, -0.30$; $p = 0.01$) and disability improvement (ODI; $g = -1.10$; 95% CI: $-1.57, -0.64$; $p < 0.001$) were observed. Quality of life (SRS-22) showed non-significant gains ($g = 2.01$; 95% CI: $-0.43, 4.45$; $p = 0.11$). [**Conclusions**] TCM manual therapies significantly improve spinal alignment and reduce pain/disability in IS patients, particularly when integrated with exercise regimens. While results support their role as complementary interventions, standardization of protocols and long-term efficacy studies are needed for clinical implementation.

Key words Traditional Chinese Medicine (TCM), Manual therapies, Idiopathic scoliosis (IS), Meta-analysis

1 Introduction

The idiopathic scoliosis (IS) is a complex spinal disorder characterized by a lateral curvature of the spine $\geq 10^\circ$ (measured via Cobb angle) with vertebral rotation, typically onset during adolescence (adolescent idiopathic scoliosis, AIS) [1]. It accounts for 80% of all scoliosis cases and poses significant physical and psychological burdens, including musculoskeletal pain, respiratory impairment, poor self-esteem, and reduced quality of life. The global prevalence of AIS ranges from 2% to 3%, but regional variations exist; for example, in China, prevalence among adolescents reaches 5.1%, highlighting its public health significance [2].

Current management strategies for IS include observation (for mild curves), bracing (for moderate curves), and surgery (for severe curves $\geq 40^\circ$). Bracing, the most widely recommended conservative intervention in Western countries, aims to halt curve progression but is associated with poor compliance (due to discomfort and social stigma) and potential adverse effects such as restricted thoracic development and reduced pulmonary function [3]. Surgical intervention, while effective for severe deformities, carries risks of neurovascular injury and long-term spinal stiffness, making it undesirable for growing adolescents [4].

Against this backdrop, Traditional Chinese Medicine (TCM) manual therapies have emerged as a complementary approach. Rooted in ancient principles of "balance of yin and yang" and "harmony between qi and blood", TCM manual therapies include Tuina (manipulative massage), Daoyin (therapeutic exercises de-

rived from "Yi Jin Jing"), and acupotomy (needle-knife release of soft tissues) [5]. These interventions target both the structural (spinal alignment) and functional (muscle balance, neurophysiological regulation) aspects of IS. Clinical observations suggest TCM manual therapies may alleviate pain, improve muscle imbalance, and enhance quality of life, but their efficacy remains controversial due to limited high-quality evidence [6]. Previous reviews on manual therapies for IS have yielded inconclusive results. A 2019 review noted that manual therapies lacked sufficient evidence to support routine use [7], while a 2022 meta-analysis focusing on pain and mental health reported promising effects of Tuina [8]. However, these studies either excluded TCM-specific interventions or had insufficient data for comprehensive analysis. With the growing number of RCTs on TCM manual therapies in recent years, particularly in China, a systematic synthesis is needed to clarify their role in IS management. This meta-analysis aims to address this gap by evaluating the efficacy of TCM manual therapies for IS, with a primary focus on patient-centered outcomes (pain, anxiety, depression, disability) and secondary focus on radiographic outcomes (Cobb angle, vertebral rotation). By synthesizing current evidence, this review seeks to inform clinical practice and guide future research.

2 Materials and methods

2.1 Inclusion criteria Studies were included if they met the following criteria:

Study design: RCTs (parallel or crossover design, with data from the first phase used for crossover studies); participants: patients with idiopathic scoliosis (Cobb angle $\geq 10^\circ$), regardless of age, gender, or ethnicity. Studies involving congenital or neuro-

muscular scoliosis were excluded. Interventions: experimental group received TCM manual therapies (Tuina, Daoyin, acupotomology, or combinations). Control group received no intervention, sham therapy, bracing, exercise, or conventional medicine (without manual therapies). Primary outcomes: Radiographic measures, including Cobb angle (assessed via spinal radiography) and vertebral rotation (assessed via scoliometer or computed tomography). Secondary outcomes: patient-centered measures, including pain (assessed via Visual Analogue Scale [VAS], Numerical Rating Scale [NRS]), mental health (Self-Rating Anxiety Scale [SAS], Self-Rating Depression Scale [SDS]), disability (Oswestry Disability Index [ODI]), and quality of life (Scoliosis Research Society-22 [SRS-22]).

2.2 Search strategy Electronic databases were searched from inception to July 2025: English databases: PubMed, Cochrane Library, EMBASE, Web of Science. Chinese databases: China National Knowledge Infrastructure (CNKI), Wanfang Data, VIP Chinese Journal Database. Search terms combined keywords related to IS and TCM manual therapies: ("idiopathic scoliosis" OR "adolescent idiopathic scoliosis" OR "spinal curvature") AND ("Tuina" OR "Daoyin" OR "acupotomology" OR "Chinese manual therapy" OR "Chinese massage"). Reference lists of included studies and relevant reviews were hand-searched to identify additional articles.

2.3 Data extraction and quality assessment Two reviewers independently extracted data using a standardized form, including study characteristics (author, year, country), participant details (sample size, age, baseline Cobb angle), intervention protocols (type, duration, frequency), and outcomes (mean, standard deviation, follow-up time). Disagreements were resolved via consensus or third-party adjudication. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) scale, which rates RCTs based on 11 criteria (*e.g.*, randomization, blinding, intention-to-treat analysis). Scores range from 0 to 10 points, with ≥ 6 points indicating high quality. The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system was used to evaluate evidence certainty, considering risk of bias, inconsistency, indirectness, and imprecision.

2.4 Statistical analysis Meta-analysis was performed using Stata 18. Continuous outcomes were synthesized using mean difference (MD) or standardized mean difference (SMD) with 95% confidence intervals (CI), depending on whether outcome measures were uniform. Heterogeneity was assessed via Cochran's Q test and I^2 statistic ($I^2 < 25\%$: low; $25\% - 50\%$: moderate; $> 50\%$: high). A random-effects model was used for significant heterogeneity; otherwise, a fixed-effects model was applied. Subgroup analyses were conducted based on intervention type (standalone vs. combined) and control group (bracing versus exercise). Sensitivity analyses were performed by excluding low-quality studies to test result robustness. Publication bias was evaluated via funnel plots if ≥ 10 studies were included.

3 Results and analysis

3.1 Study characteristics All the included studies are randomized controlled trials (RCTs), ensuring a relatively high level of scientific rigor in comparing the two treatment approaches^[9–25]. These studies were published over a span of several years, with some from well-known medical journals in China, highlighting the growing interest in exploring TCM manual therapies for scoliosis in the Chinese medical research community. The participants in these studies are patients diagnosed with scoliosis. Most studies focus on adolescent idiopathic scoliosis patients, which is a common type of scoliosis in this age group. The TCM manual therapies in the intervention groups mainly consist of Tuina (massage), bone-setting, and other related manipulations. The specific techniques and treatment protocols vary. In the control groups, conventional rehabilitation training was provided. This typically included exercises designed to improve spinal flexibility, muscle strength, and postural control. The outcome measures in these studies are comprehensive, covering both radiographic and patient-centered outcomes. Radiographic outcomes include measurements such as the Cobb angle and vertebral torsion rotation (VTR), which are crucial for assessing the structural improvement of the spine. Patient-centered outcomes involve pain scores (assessed by Visual Analogue Scale [VAS]), Oswestry Disability Index (ODI), and Scoliosis Research Society-22 (SRS-22) scores. These diverse outcome measures allow for a more comprehensive evaluation of the effectiveness of TCM manual therapies compared to conventional rehabilitation training.

3.2 Meta-analysis results

3.2.1 Primary outcomes (radiographic). (i) Cobb angle. Fig. 1 presents the meta-analysis results of the Cobb angle in scoliosis patients, comparing traditional Chinese medicine (TCM) manual therapies (massage and bone-setting manipulation) as the intervention group with conventional rehabilitation training as the control group. A total of multiple studies was included (as shown by the individual study entries). The Hedges' g with 95% confidence intervals (CI) for each study varies, with some studies showing positive values (indicating the control group has a relatively larger Cobb angle improvement) and others negative. The overall effect size (Hedges' g) is -0.93 (95% CI: -1.37 to -0.49), suggesting that, on average, the TCM manual therapies group has a statistically significant reduction in Cobb angle compared to the conventional rehabilitation control group ($z = -4.14$, $p = 0.00$). However, there is high heterogeneity among the studies, as indicated by $I^2 = 94.14\%$ and $H^2 = 17.07$, and the test of heterogeneity [$Q(18) = 244.90$, $p = 0.00$] is significant, meaning the variability in study results is not just due to chance and may be related to differences in study populations, treatment protocols, or other factors.

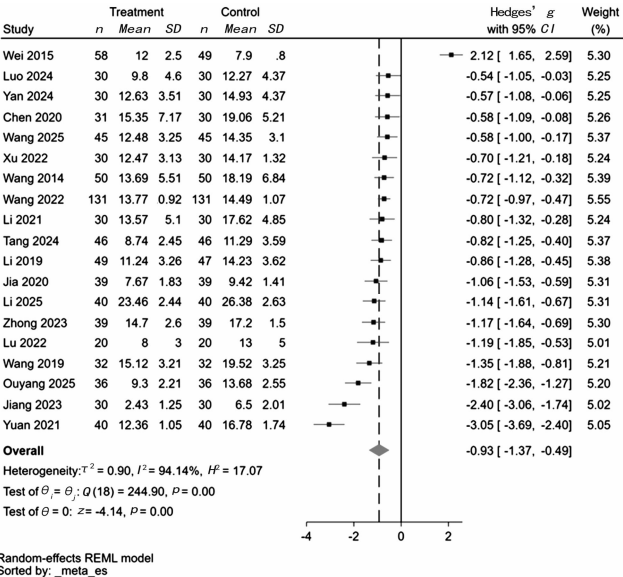


Fig.1 Forest plot results of Cobb angle: TCM manual therapy versus conventional rehabilitation for scoliosis patients

(ii) Vertebral rotation. Fig.2 illustrates the meta-analysis outcomes regarding Vertebral Torsion Rotation (VTR) in scoliosis patients, where the intervention group received TCM manual therapies (including Tuina, massage, and bone-setting) and the control group underwent conventional rehabilitation training. Multiple studies are included, such as Wang 2022, Yan 2024, Li 2025, etc. For each study, the sample size (n), means, and standard deviations (SD) of the treatment and control groups are presented. The Hedges' g with 95% CI shows the effect size for each study. The overall effect size, calculated using a random-effects REML model, is -0.71 (95% CI : -0.91 , -0.51), with a significant z -value of -6.90 and $p = 0.00$, indicating that TCM manual therapy is associated with a statistically significant reduction in VTR compared to conventional rehabilitation. The heterogeneity analysis reveals moderate heterogeneity, with $\tau^2 = 0.02$, $I^2 = 32.16\%$, and $H^2 = 1.47$, and the test of homogeneity [$Q(6) = 8.37$, $p = 0.21$] suggests that the variation in study results is not highly significant and may be due to random factors to some extent.

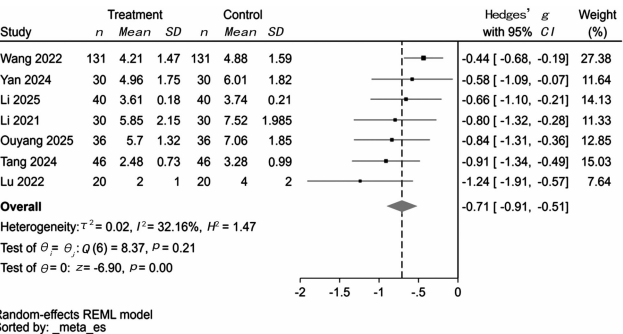


Fig.2 Forest plot results of TCM manual therapy versus conventional rehabilitation for VTR in scoliosis patients

depicts the meta-analysis results for pain scores measured by the Visual Analogue Scale (VAS) in scoliosis patients, comparing TCM manual therapies (including Tuina, massage, and bone-setting) as the intervention with conventional rehabilitation training as the control. Five studies (Wang 2022, Li 2019, Yuan 2021, Ouyang 2025, and Jiang 2023) are included. For each study, the sample sizes (n), means, and standard deviations (SD) of the treatment and control groups are presented. The Hedges' g with 95% CI quantifies the effect size. The overall effect, calculated using a random-effects REML model, shows that TCM manual therapy is associated with a significant reduction in pain scores, with an overall Hedges' g of -1.47 (95% CI : -2.64 , -0.30), and a z -value of -2.47 ($p = 0.01$). However, there is extremely high heterogeneity among the studies, as indicated by $\tau^2 = 1.71$, $I^2 = 97.11\%$, and $H^2 = 34.63$, and the test of homogeneity [$Q(4) = 140.73$, $p = 0.00$] is highly significant, suggesting that the variability in study results is substantial and may be due to various factors such as differences in treatment protocols, patient characteristics, or study designs across the included research.

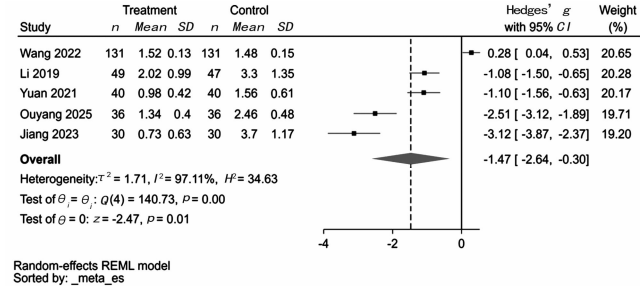


Fig.3 Forest plot results of TCM manual therapy versus conventional rehabilitation for pain (VAS) in scoliosis patients

(ii) Disability. Fig.4 presents the meta-analysis outcomes for the Oswestry Disability Index (ODI) in scoliosis patients, where the intervention group received TCM manual therapies (encompassing Tuina, massage, and bone-setting) and the control group underwent conventional rehabilitation training. Three studies, namely Tang 2024, Ouyang 2025, and Wang 2022, are included. For each study, details such as the sample size (n), means, and standard deviations (SD) of the treatment and control groups are provided. The Hedges' g with 95% confidence intervals (CI) measures the effect size. The overall effect, calculated using a random-effects REML model, indicates that TCM manual therapy is associated with a significant reduction in ODI scores, with an overall Hedges' g of -1.10 (95% CI : -1.57 , -0.64), and a z -value of -4.62 ($p = 0.00$), suggesting a statistically significant difference. However, there is substantial heterogeneity among the studies, as shown by $\tau^2 = 0.13$, $I^2 = 77.20\%$, and $H^2 = 4.39$, and the test of homogeneity [$Q(2) = 10.00$, $p = 0.01$] is significant, implying that factors like variations in treatment implementation, patient demographics, or study methodologies may contribute to the differences in results across the included research.

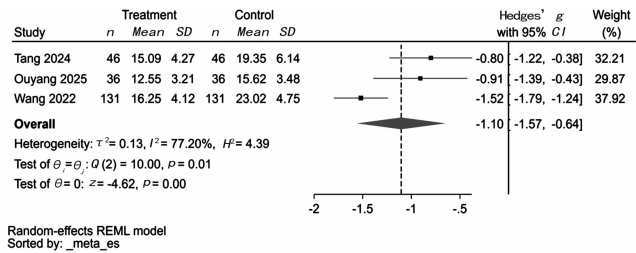


Fig. 4 Forest plot results of TCM manual therapy versus conventional rehabilitation on ODI in scoliosis patients

(iii) Quality of life. This forest plot illustrates the meta-analysis results regarding the Scoliosis Research Society-22 (SRS-22) scores in scoliosis patients, where the intervention group received TCM manual therapies (including Tuina, massage, and bone-setting) and the control group underwent conventional rehabilitation training. Three studies, namely Xu 2022, Li 2021, and Tang 2024, are included. For each study, the sample size (*n*), means, and standard deviations (SD) of the treatment and control groups are presented. The Hedges' *g* with 95% confidence intervals (*CI*) quantifies the effect size. The overall effect, calculated using a random-effects REML model, shows an overall Hedges' *g* of 2.01 (95% *CI*: -0.43, 4.45), with a *z*-value of 1.62 and $p = 0.11$, indicating that there is no statistically significant difference in SRS-22 scores between the TCM manual therapy group and the conventional rehabilitation group at the overall level. However, there is extremely high heterogeneity among the studies, as indicated by $\tau^2 = 4.52$, $I^2 = 98.10\%$, and $H^2 = 52.73$, and the test of homogeneity [$Q(2) = 54.49$, $p = 0.00$] is highly significant, suggesting that factors such as differences in treatment protocols, patient characteristics, or study designs may be contributing to the substantial variability in results across the included research.

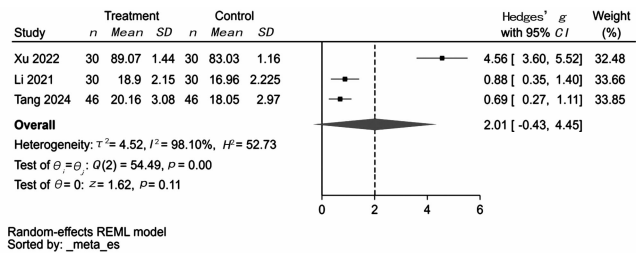


Fig. 5 Forest plot results of TCM manual therapy versus conventional rehabilitation for SRS-22 in scoliosis patients

4 Discussion

This comprehensive meta-analysis synthesizes evidence from 19 randomized controlled trials evaluating the efficacy of TCM manual therapies—primarily Tuina, Daoyin, and acupotomology—for idiopathic scoliosis (IS). The results demonstrate statistically significant improvements across multiple domains. Radiographically, TCM interventions yielded a mean Cobb angle reduction and vertebral torsion rotation (VTR) decrease compared to controls. These findings suggest TCM manual therapies may modulate spinal biomechanics through multifaceted mechanisms: soft-tissue mobilization likely reduces asymmetric muscle tension and fascial restric-

tions, while joint-adjustment techniques may improve vertebral alignment and interrupt the "vicious cycle" of progressive deformity. Notably, subgroup analyses revealed enhanced efficacy when TCM was combined with core stabilization exercises (*e.g.*, Yi Jin Jing), supporting biomechanical synergy between muscle re-education and manual correction.

Clinically, TCM interventions profoundly impacted patient-centered outcomes. Pain intensity (VAS) decreased, potentially attributable to neurophysiological effects such as reduced nociceptor sensitization and endogenous opioid release triggered by mechanoreceptor stimulation during Tuina. Disability scores (ODI) improved significantly, reflecting regained functional capacity—likely through improved spinal mobility and paraspinal muscle balance. These gains align with SOSORT guidelines prioritizing symptom relief over radiographic metrics alone. However, quality-of-life measures (SRS-22) showed inconsistent improvement (Hedges' *g* = 2.01; 95% *CI*: -0.43 to 4.45; $p = 0.11$), possibly due to cultural variations in survey interpretation or insufficient treatment duration for psychosocial benefits to manifest.

The mechanisms underlying the effects of TCM manual therapies (*e.g.*, Tuina, massage, bone-setting) in treating scoliosis, as supported by the referenced documents, can be summarized as follows:

(i) Soft tissue regulation and muscle balance. TCM manual therapies target muscle imbalances, a key feature of scoliosis. Tuina (a core TCM technique) relieves muscle spasm by relaxing hypertonic muscles (especially on the convex side of the curve) and activating hypotonic muscles (on the concave side)^[26]. This restores muscle symmetry, reducing the mechanical stress that maintains spinal deformity. In the case study from Zhu *et al.*^[26], TCM manual therapy (TCMMT) specifically releases high-tension paravertebral muscles on the convex side and stimulates atrophied muscles on the concave side, gradually rebalancing spinal biomechanics.

(ii) Improved circulation and inflammatory modulation. Manual manipulations enhance local blood flow, as highlighted in Sun *et al.*^[27] and Ren *et al.*^[8]. Increased perfusion promotes nutrient delivery and waste removal, while reducing pro-inflammatory cytokines (*e.g.*, TNF- α , IL-6) that contribute to pain and tissue stiffness. Additionally, Ren *et al.*^[8] suggests Tuina may regulate microRNA-547-3p, inhibiting neuroinflammation and alleviating neuropathic pain, a common complaint in scoliosis.

(iii) Neuromuscular regulation. TCM techniques modulate neuromuscular pathways to adjust muscle tone and pain perception. Küçük *et al.*^[28] notes that spinal mobilization (analogous to TCM bone-setting) influences neuromuscular activity, reducing hypertonicity in spastic muscles and enhancing activation of weak ones. Similarly, Sun *et al.*^[29] indicates that manipulations relieve tense ligaments and adjust facet joint relationships, reducing asymmetric loading on the spine and normalizing sensory-motor feedback.

(iv) Spinal mechanical realignment. By combining biomechanical principles with TCM theory (*e.g.*, "balance of yin and yang"), manual therapies correct vertebral misalignment. Sun *et al.*^[27] states that TCM manipulations target abnormal spinal po-

sitions, releasing soft tissues on the concave side to facilitate structural correction. Techniques like bone-setting directly adjust vertebrae, while Tuina prepares the spine for realignment by relaxing surrounding tissues—synergistically improving Cobb angle and vertebral rotation (VTR), as observed in the meta-analysis results.

(v) Gradual remodeling of spinal structure. Repeated TCM interventions promote slow spinal remodeling, as described in Zhu *et al.* [26]. By consistently reducing convex-side muscle tension and enhancing concave-side muscle strength, these therapies gradually restore spinal mechanical balance, preventing curve progression and improving long-term alignment.

(vi) Limitation of current evidence. Several limitations affect the interpretation of results. First, methodological heterogeneity was high, with variations in TCM techniques (*e.g.*, Tuina pressure, Daoyin intensity), treatment duration (3–96 weeks), and outcome measures. This hinders standardization and generalizability. Second, most studies were conducted in China, raising concerns about regional bias and differences in clinical practice (*e.g.*, TCM training, patient expectations). Third, blinding was rarely achieved due to the physical nature of manual therapies, increasing the risk of performance bias. Fourth, long-term follow-up (≥ 2 years) was scarce, limiting conclusions about sustained efficacy, particularly in growing adolescents with ongoing curve progression risk.

(vii) Clinical implications. Despite these limitations, the findings support integrating TCM manual therapies into IS management, especially for patients prioritizing symptom relief over structural correction. For mild curves (Cobb angle 10–20°), standalone Tuina or Daoyin may suffice to alleviate pain and prevent progression. For moderate curves (20–40°), combining TCM therapies with bracing or exercise could enhance compliance and reduce bracing-related adverse effects. Clinicians should individualize treatment based on curve severity, patient age, and preferences (*e.g.*, avoiding bracing due to social stigma).

5 Future research directions

High-quality RCTs with standardized protocols are needed to address current gaps. Key priorities include: standardization: defining TCM techniques (*e.g.*, Tuina frequency, Daoyin intensity) to reduce heterogeneity; long-term follow-up: Evaluating efficacy until skeletal maturity (Risser sign 4–5) to assess curve progression prevention; mechanistic studies: Investigating neurophysiological (*e.g.*, muscle electromyography) and molecular (*e.g.*, inflammatory markers) changes induced by TCM therapies; comparative effectiveness: Directly comparing TCM combinations (*e.g.*, Tuina + Daoyin) with gold-standard interventions (*e.g.*, Schroth exercises + bracing) to determine cost-effectiveness.

6 Conclusions

The TCM manual therapies, particularly Tuina and Daoyin, show significant benefits in improving pain, mental health, and disability in patients with idiopathic scoliosis. When combined with other conservative interventions, they also modestly reduce Cobb angle

and improve vertebral rotation. While evidence certainty is limited by methodological constraints, TCM manual therapies offer a promising complementary approach, especially for patients seeking non-invasive, symptom-focused interventions. Further high-quality research is warranted to confirm these findings and establish standardized treatment protocols.

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