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Systematic Review

Effects of Tai Chi on physical and psychological outcomes in children and adolescents: a systematic review

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ABSTRACT

Introduction Exercise supports the physical, mental, and social development of children and adolescents. Although Tai Chi is a well-documented mind-body exercise with established benefits in adults, its effects in younger populations remain unclear. This systematic review examined the physical, psychological, and safety outcomes of Tai Chi in children and adolescents and explored its potential underlying mechanisms. **Methods** Electronic searches of randomized controlled trials involving Tai Chi in children and adolescents were conducted from database inception to October 15, 2024, across major English- and Chinese-language databases, including PubMed, Cochrane Library, Embase, Web of Science, China National Knowledge Infrastructure (CNKI), Chinese Scientific Journal Database (VIP), SinoMed, and Wanfang. Two reviewers independently performed the study selection and data extraction. Risk of bias was assessed using the Risk of Bias 2 (RoB 2) tool. **Results** Fifteen trials involving 1004 participants aged 8–18 years, both healthy and with chronic conditions were included. Yang-style Tai Chi was the most frequently used intervention, and control groups received either no Tai Chi or alternative exercise programs. Several studies reported positive effects on balance, physical function, mobility, muscle strength, fall risk, kyphosis, stereotypical behavior, and self-concept, suggesting possible mechanisms of benefit. However, safety data were limited. The overall methodological quality was moderate: three studies (20%) had low risk of bias, six (40%) had some concerns, and six (40%) had high risk. **Conclusion** Tai Chi may improve balance, flexibility, motor skills, physical fitness, and psychological factors such as self-concept in children and adolescents. However, further high-quality research is required to confirm its effectiveness and safety in this population.

KEYWORDS

Tai Chi, children, psychological, adolescents, mind-body

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1. Introduction

Childhood and adolescence are critical periods of physical and mental development. However, children and adolescents worldwide face increasing mental health problems, developmental delays and disabilities, injuries, and chronic diseases such as cardiovascular diseases, diabetes, and asthma. These challenges are often linked to poor nutrition, physical inactivity, overweight, obesity,[1] stress, anxiety, and depression.[2] Sedentary behaviors have become increasingly common, and many young people fail to meet recommended levels of physical activity.[3,4] Physical inactivity is associated with numerous adverse outcomes, including obesity, diabetes, cardiovascular disease, impaired cognitive function and concentration, poor academic performance, and psychosocial issues such as low self-esteem and depression.[5–7] Despite growing concern about the public health burden of excessive sedentary time,[7] research on the mental and physical health benefits of exercise in youth remains limited compared to the substantial evidence available for adult populations.

Tai Chi is a mind-body exercise originating in China.[8] Rooted in traditional Chinese medicine and the principles of yin and yang, Tai Chi incorporates gentle, flowing movements with deep diaphragmatic breathing and meditative focus, typically performed in standing or dynamic postures.[9,10] It is considered safe for diverse populations, including individuals with reduced mobility and cognition impairments, because of its lower risk of injury and capacity to enhance concentration, self-awareness, and mental calmness.[8] Extensive evidence from adult studies has demonstrated improvements in balance, cardiorespiratory fitness, cognition, mobility, proprioception, sleep, and muscular strength.[10]

Recent studies have begun to examine the effects of Tai Chi in children and adolescents. Tai Chi may support emotional development, enhance self-awareness, and promote confidence through its emphasis on concentration, precision, and controlled movement.[11] Clinical research in children with various conditions has reported both physical and psychological benefits.[9,12,13] For instance, Tai Chi has improved chest expansion, spine extension, and balance in children with intellectual disabilities;[12] enhanced leg strength and limb coordination in children with intellectual disability;[13] reduced fatigue in college students;[14] and improved pulmonary function and quality of life in children with asthma.[15,16] Systematic reviews of mind-body exercise interventions also suggest that Tai Chi may improve balance and behavioral outcomes in children with autism,[17] reduce depressive symptoms in adolescents, and alleviate Internet addiction symptoms in young adults.

Two systematic reviews have examined the effects of Tai Chi and Qigong in children and adolescents. A 2019 review reported potential improvements in physical health and function but inconclusive effects on psychological well-being and behavior.[8] A more recent review focusing on adolescents suggested that these practices may reduce depression, anxiety, and cortisol levels.[18] However, both reviews combined Tai Chi and Qigong and included evidence from both randomized and non-randomized studies. A comprehensive

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review focusing exclusively on Tai Chi and randomized controlled trials (RCTs) is therefore needed to clarify its health benefits in children and adolescents.

This systematic review aimed to examine the physical and psychological outcomes of RCTs of Tai Chi in children and adolescents, evaluate its effectiveness and safety, and explore the underlying mechanisms and rationale supporting its use.

2. Methods

2.1. Protocol and registration

This study was registered in the International Prospective Register for Systematic Reviews (registration no.: CRD42024565470). The reporting of this review follows the PRISMA guidelines.[19]

2.2. Eligibility criteria

We included parallel RCTs and first-phase crossover RCTs. Children and adolescents aged <18 years at the time of the trial were eligible for inclusion, with no restrictions on sex or ethnicity.

Any style or form of Tai Chi was eligible as the main intervention. Eligible control conditions included no intervention, waitlists, other exercise programs, and usual care. We excluded studies that used other traditional or mind-body exercises, such as yoga, Qigong, or meditation, as control interventions. We also excluded controls involving other traditional Chinese medicine or complementary therapies, including acupuncture, massage, or Chinese herbal medicine. Trials with co-interventions were included if they were applied across all study arms.

The primary outcomes were physical function (strength, balance, flexibility, pulmonary function, and motor skills), evaluated using validated measures. Secondary outcomes included psychological measures such as anxiety, depression, stress, mood, quality of life, and adverse events.

2.3. Literature search

An electronic literature search was conducted in major English- and Chinese-language databases, including PubMed, Cochrane Library, Embase, Web of Science, China National Knowledge Infrastructure (CNKI), Chinese Scientific Journal Database (VIP), SinoMed, and Wanfang, from their inception to October 15, 2024.

We also searched the following trial registries to identify unpublished data from completed trials: Australian New Zealand Clinical Trials Registry (ANZCTR) (www.anzctr.org.au), Chinese Clinical Trial Registry (ChiCTR) (www.chictr.org.cn/enindex.aspx), Clinical Research Information Service (CRiS) (https://cris.nih.go.kr/), Current Controlled Trials (www.controlled-trials.com), and ClinicalTrials.gov (www.clinicaltrials.gov). Gray literature sources were also searched, and reference lists of relevant studies were screened manually to identify additional clinical trials.

Four reviewers (SYC, OKK, XLC, and JLH) worked in pairs to independently search the literature using a search strategy developed by two reviewers (SYC and GYY). Appendix 1 presents examples of search syntaxes used in both Chinese and English databases.

2.4. Study selection

Search results from the English databases were exported to EndNote (version X21, Clarivate, Philadelphia, PA) and those from the Chinese databases were exported to NoteExpress (version 3.2, Beijing Aegean Software, Beijing, China). Duplicates were removed both automatically and manually. Four reviewers (SYC, OKK, XLC, and JLH) worked in pairs to independently screen titles, abstracts, and full texts based on the eligibility criteria. To increase consistency, all reviewers completed calibration exercises before screening began. Discrepancies were resolved through discussion with a third reviewer (GYY).

2.5. Quality assessment

Four authors (SYC, OKK, XLC, and JLH) independently assessed the quality and risk of bias of the included studies. The revised Cochrane Risk-of-Bias (RoB) tool for RCTs (RoB-2) was applied.[20] RoB-2 evaluates five domains: (Ⅰ) randomization process, (Ⅱ) deviations from the intended interventions, (Ⅲ) missing outcome data, (Ⅳ) measurement of the outcome, and (Ⅴ) selection of the reported result. RoB judgements for each domain were categorized as low, some concerns, or high.

To enhance consistency, all reviewers performed calibration exercises and discussed their assessments prior to rating the RCTs and appraising the certainty of the evidence. The four reviewers collaborated in pairs to independently evaluate study quality.

2.6. Data collection

Two reviewers (SYC and GYY) developed and piloted a predefined data extraction form. Extracted data included: (Ⅰ) citation information (author, year); (Ⅱ) participant characteristics (sample size, age, health status or condition); (Ⅲ) study design (randomization, allocation, and blinding); (Ⅳ) Tai Chi intervention details (style, form, duration, frequency, content, and instructor background); (Ⅴ) control conditions (type, duration, and frequency); and (Ⅵ) outcomes and main findings. The original study authors were contacted through email for missing or unclear information.

2.7. Data synthesis

Statistical analyses were performed using Excel and the Cochrane Review Manager Web software (RevMan Web, Cochrane Collaboration, London, United Kingdom). Frequencies are presented as counts and percentages. For continuous outcomes, mean difference (MD) with 95% confidence intervals (CI) were calculated; for dichotomous outcomes, risk ratio (RR) with 95% CI were used. Clinical heterogeneity was assessed based on the study characteristics, participant populations, and intervention details.[21] Statistical heterogeneity was evaluated using the I^2 statistic. Statistical heterogeneity was considered moderately significant if the I^2 statistic was greater than 50% and highly significant if the I^2 statistic was greater than 75%.[21] If the I^2 statistic was less than 75%, the data were pooled using a random effects model for meta-analysis and fixed model if the I^2 statistic was less than 25%.

3. Results

3.1. Study selection

Figure 1 illustrates the PRISMA flowchart of the study selection process. A total of 3908 studies were initially identified, and 456 duplicates were excluded. The titles and abstracts of the remaining 3452 studies were screened, and 80 met the inclusion criteria. Among these, 65 full-text articles were assessed for eligibility, resulting in the exclusion of 50 studies for specific reasons. Ultimately, 15 RCTs met the inclusion criteria and were included. Appendix 2 presents a list of the excluded studies and reasons for exclusion.

3.2. Characteristics of included studies

The 15 included RCTs, published between 2010 and 2022, were conducted in mainland China, Hong Kong (China), Turkey, and Iran. Six studies were published in English and nine in Chinese. Sample sizes ranged from 18 to 200 participants, with an average of 80, totaling 1204 participants (children in eight studies and adolescents in seven studies). Most Tai Chi interventions were conducted in school settings (11/15, 73.3.7%),[22-31] with one implemented in a university physical activity room.[32] Three studies did not report their study settings. Overall, interventions were delivered as part of educational or extracurricular programs rather than clinical or community-based programs.

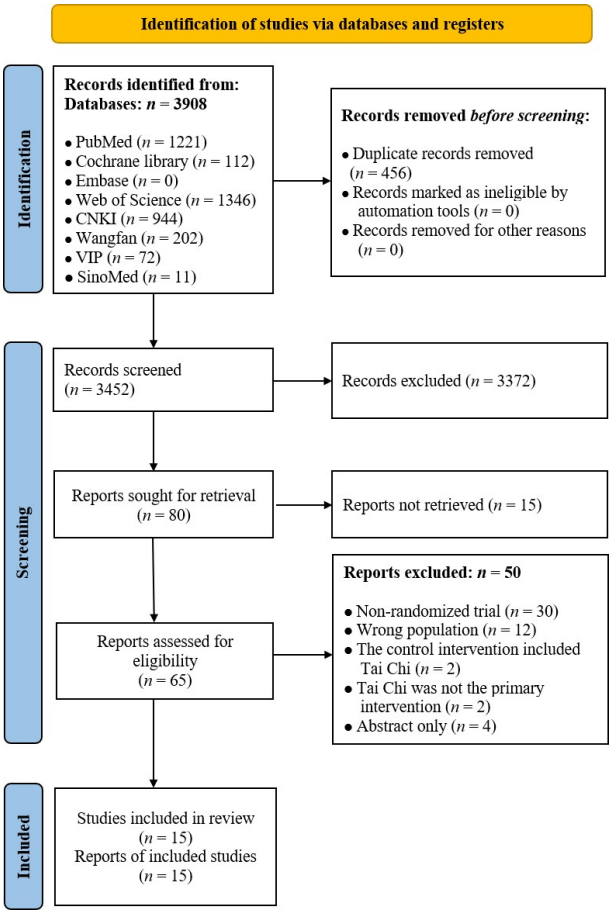

Figure 1 Search process

Notes: CNKI: China National Knowledge Infrastructure; VIP: Chinese Scientific Journal Database.

3.3. Characteristics of diseases/conditions

Table 1 summarizes the characteristics of the eight RCTs involving children. Two studies included healthy children (2/8, 25.0%).[24,29] The remaining studies focused on children with congenital hearing loss (1/8, 12.5%),[22] developmental coordination disorder (1/8, 12.5%),[32] intellectual disability (1/8, 12.5%),[12] autism spectrum disorder (2/8, 25.0%),[33,34] and attention-deficit/hyperactivity disorder (ADHD) (1/8, 12.5%).[23]

Table 2 presents the characteristics of seven RCTs involving adolescents. Five studies enrolled healthy adolescents (5/7, 71.4%),[26,27,30,31,35] one focused on adolescents with cervical spondylosis (1/7, 14.3%),[28] and one included adolescents with stress syndrome (1/7, 14.3%).[25]

All included studies involved both boys and girls, with three reporting results separately for sex.[26,27,31]

3.4. Characteristics of intervention

Most studies (9/15, 60%) used the 24-form simplified Tai Chi or a modified version. One study employed an 8-form simplified routine, and the remaining studies did not specify the type of Tai Chi form. Among the 12 studies that reported styles, all used Yang-style Tai Chi (12/15, 80.0%). Twelve studies reported the number of forms practiced, which ranged from 5 to 24; the 24-form routine was the most common (6/15, 40.0%). Appendix 3 provides the details of the interventions.

Intervention duration ranged from 2 to 52 weeks, with 12 weeks most common (5/15, 33.3%). Session frequency ranged from once to 14 times per week, with three times per week (6/15, 40.0%) and five times per week (6/15, 40.0%) being most frequent. Session lengths ranged from 30 min to 90 min, with 60 min reported most often (6/15, 40.0%). One study on adolescents with exam anxiety implemented twice daily Tai Chi sessions for two weeks.

All interventions were delivered face-to-face; none used online formats. Seven studies (7/15, 46.7%) reported the time of day sessions and contexts, such as "longer break between classes," "during physical education class," and "afternoon."

Ten studies (10/15, 66.7%) described session structure, typically including a warm-up (10 min), Tai Chi practice (30–40 min), and cool-down (10 min). Eight studies (8/15, 53.33%) detailed overall program structure, such as introducing new movements weekly or dividing the program into learning (e.g., weeks 1–5) and reinforcement phases (e.g., weeks 6–20). Seven studies (7/15, 46.7%) reported the principles or key focus areas guiding the intervention, emphasizing balance, physical fitness, body awareness, neuromuscular control, and proprioceptive coordination. One study specified a target heart rate of 120–135 beats per minute.

Thirteen studies (13/15, 86.7%) reported instructor qualifications. One study noted that sessions were led by an instructor and two assistants, while another reported supervision by a physiotherapist with delivery by a certified Tai Chi and fitness instructor.[32,34] One study specified that an experienced physiotherapist with Tai Chi certification conducted the sessions.[22] The remaining studies (10/15, 66.7%) described the instructors as "professionally certificated martial arts instructor," or a "professional" or "qualified" Tai Chi instructor.

Few studies described how intervention protocols were developed. One study involving children with autism outlined guiding principles focused on strengthening fundamental skills, such as balance, physical fitness, body awareness, neuromuscular control, and proprioceptive coordination, by selecting six forms from the 24 Yang style.[33] Another study tailored its protocol to participants' functional abilities, incorporating elements that fostered self-confidence, motivation, responsiveness to external cues, and predictability, including the use of concrete imagery (e.g., relating to hand movements to clouds in the sky).[34]

Most studies (12/15, 80.0%) used non-exercise control groups that continued usual daily routines. One study compared Tai Chi with gymnastic intervention conducted with matched frequency and duration.[35] Two studies compared Tai Chi with other forms of exercise (i.e., conventional balance exercises or muscle power training), also matching frequency and duration.[22,32]

3.5. Outcomes and main findings

Among the 15 included studies, eight (8/15, 53.3%) evaluated physical outcomes, and seven (7/15, 0.46.7%) evaluated psychological outcomes (Table 2). None of the studies formally assessed safety; but one reported no adverse effects. Seven studies provided information on participant withdrawal or loss to follow-up. No participants discontinued due to Tai Chi-related adverse events. Reported reasons for withdrawal included loss of interest, school transfers, personal commitments, and physical discomfort or hospitalization unrelated to Tai Chi.[25,31,32,35]

3.5.1. Children

Individual studies reported positive effects on balance,[12,22,27,32,33] muscle strength,[32] fall risk,[32] functional mobility,[22] kyphosis,[12] motor coordination[33] in children with lower limb stability,[26] physical function,[31] physical fitness, cardiopulmonary function, and cervical symptoms.[28] Other studies have indicated that Tai Chi is effective in self-regulation,[25] stereotypic behavior,[34] and ADHD symptoms and behavior[23] in children with autism or ADHD. Additionally, Tai Chi was superior to the non-exercise control group in children.[22-24,33]

3.5.2. Adolescents

Five studies (5/15, 33.3%) evaluated the effects of Tai Chi on physical parameters. Individual studies exhibited that Tai Chi has a positive effect on balance,[26-28] lower limb stability,[26] physical function,[31] cervical symptoms, pain, cardiopulmonary function, flexibility,[28] vital capacity, sit-and-reach, standing long jump, 50-meter sprint, eyes-closed single-leg stance duration, and body

Table 1 Characteristics of included studies on Tai Chi in children

Study ID	Age (years)	Disease/condition	Sample size	Intervention	Duration (weeks)	Control	Outcomes and measurements
Cetin 2020	I: 12.46 ± 1.12; Conv: 12.38 ± 1.19; C: 12.46 ± 1.12	Children with congenital sensorineural hearing loss	29	60 min exercise program twice a week	10	Conventional static and dynamic balance exercises	Balance: Pediatric Balance Scale, the balance subtest of Bruininks-Oseretsky Test 2-Short Form, and the Functional Reach Test; Functional mobility: Timed Up and Go Test and the Timed Up and Down Stairs Test
Fong 2022	9.7 ± 1.7	Children with developmental coordination disorder	121	Tai Chi, 90 min per session, once weekly	12	Muscle power training, usual medical care	Limits of stability: LOS, DLOS, MABC; Leg muscular performance: peak force of knee extensors, peak force of knee flexors, time to peak force of knee extensors, time to peak force of knee flexors; Falls: number of falls in past 3 months, number of falls in past 12 months
Heidari 2016	I: 11.6; C: 11.06 (Ave: 11.6)	Children with mild intellectual disability and nonstructural kyphosis	30	Tai Chi, 45 min per session, three weekly	8	No exercise	Kyphosis angle (flexible rulers), chest expansion (tape measure), coefficient of Delmas (stoke test), spine extension and static and dynamic balances (Y test)
Sarabzadeh 2019	I: 8.88 ± 1.76; C: 8.22 ± 1.92	Children with autism spectrum disorder	18	Tai Chi, 60 min each session, three times a week	6	No exercise	Motor skills: MABC-2
Tabeshian 2022	9.60 ± 1.40	Children with autism spectrum disorder	23	Three days a week	12	No intervention	Stereotypic behavior: Gilliam Autism Rating Scale 2 Scores
Chen 2016	I: 8.48 ± 0.52; C: 8.51 ± 0.50	Children with attention deficit hyperactivity disorder	36	Tai Chi, 60 min per session, three times a week	16	Original activity	Child behavior; sensory synthesis; adaptive behavior
Mi 2016	I: 10.46 ± 0.55; C: 10.39 ± 0.42	Healthy children	48	Tai Chi, 60 min per session, three times a week	12	Original activity	Balance ability
Li 2023	11–13	Primary school children	200	Tai Chi three times per week	8	Regular physical activity	Self-regulation: Response to Challenge Scale, the Strengths and Difficulties Questionnaire, and the Self-Esteem Inventory

Notes: Ave: average; C: control; Conv: conventional; DLOS: dynamic limits of stability score; I: Intervention; LOS: limits of stability; MABC-2: Movement Assessment Battery for Children-Second Edition; min: minute.

mass index to evaluate cardiopulmonary function, flexibility, muscular strength, speed, balance, and body composition in adolescents.[30]

Three studies (3/15, 20%) assessed psychological outcomes. Tai Chi was superior to gymnastics in improving self-concept among healthy adolescent,[35] and two other studies reported reductions in anxiety.[25,31] Overall, seven studies (7/15, 46.6%) exhibited that Tai Chi was superior to non-exercise control group conditions among adolescents.[25-31]

3.6. Summary of mechanism and rationale

Five studies (5/15, 333.3%) discussed the underlying mechanisms of Tai Chi on balance, muscle strength, posture, neurocognitive function, and stress reduction.

Tai Chi has been exhibited to improve balance in children by increasing the duration of one-leg standing (with eyes open and closed) and reducing postural swing in both the forward-backward and lateral directions.[27] The improvement in muscle strength was potentially associated with the semi-sitting position and slow weight-shifting movements, placing a large load on the supporting leg and stimulated isometric as well as eccentric contractions of the quadriceps. Additionally, the wide range of motion of the lower-extremity joints during practice activates joint proprioceptors, further enhancing muscle strength.[32]

Correction of kyphosis in children was explained by the fact that Tai Chi emphasizes stretching, flexibility, and strengthening of the back muscles, which contribute to improvements in posture, chest expansion, and spinal elongation. Additionally, coordinated activation of the core muscle groups during Tai Chi may enhance balance through postural correction.[12]

Tai Chi's physical and cognitive training components may improve inhibitory control across motor, attentional, and behavioral domains. In children with autism or ADHD, Tai Chi has been associated with reductions in anger and distress, improved self-control and discipline, and better character development. Reported neurocognitive benefits include enhanced memory, improved EEG signal synchronization, and strengthened functional brain networks supporting neuromuscular control.[33]

Stress reduction mechanisms in children with autism have been associated with Tai Chi's emphasis on mindful movements, which reduces sympathetic activity and enhances parasympathetic activation. This may modulate autonomic function, influencing cortisol and serotonin levels. Tai Chi may also reduce stereotyped behaviors by increasing gray matter volume and improving cerebellar function. Additionally, alternating internal and external sensorimotor cues during practice may disrupt maladaptive neural patterns and promote neuroplasticity through continuous movement sequencing.[34]

3.7. Risk of bias

The results of the risk of bias assessment for the 15 included RCTs are presented in Figure 2. The overall methodological quality of the included studies was moderate: three RCTs were rated as having a low risk of bias,[28,29,35] six had some concerns,[9,22-25,27] and six were rated as high risk.[12,18,26,32-34] Owing to the nature of Tai Chi interventions, blinding of the participants was not performed in any study. None reported allocation concealment. Two studies had concerns regarding outcome measurement,[24,25] and three were assessed as having selective outcome reporting.[12,32,33]

Table 2 Characteristics of included studies on Tai Chi in adolescent

Study ID	Age (years)	Disease/ condition	Sample size	Intervention	Duration (weeks)	Control	Outcomes and measurements
Bao 2015	14.74 ± 0.66 (13–16)	Healthy adolescent	142	Tai Chi, 60 min per session, 5 times each week	48	China's 8th edition broadcasting gymnastics	PHCSCS: six subscales: behavior, intellectual and school status, physical appearance and attributes, anxiety, popularity, happiness and satisfaction
Liu 2021	I: (male) 13.35 ± 0.38; I: (female) 13.34 ± 0.50; C: (male) 13.25 ± 0.32; C: (female) 13.36 ± 0.55	Healthy adolescent	80	Tai Chi, 40 min per session, 5 times a week	12	Normal activity	Heel raise time, strengthening Romberg sign test time, one-legged standing test time with eyes closed, one-legged standing test time with eyes closed
Wu 2014	I: 17.08 ±1.27; C: 17.00 ±1.32	Cervical spondylosis high school students	79	Tai Chi, 40 min per session, 5 times a week	12	No exercise	Cervical symptom score, TCM symptom score, sign score, daily life action score, VAS score, cervical health score, X-ray cervical curvature
Zhou 2015	I: 13.3 ± 0.33; C: 13.3 ± 0.36	Healthy adolescent	120	Tai Chi, 45 min per session, 5 times a week	34	No exercise	Body shape, body function, physical fitness
Zhang 2016	I: (Male) 16.9 ± 2.3; I: (Female) 16.9 ± 0.3; C: (Male) 16.8 ± 0.2; C: (Female) 17.0 ± 0.3	Healthy adolescent	80	Tai Chi, 30 min per session, 5 times a week	20	Normal activity	Body function
Li 2017	I: 16.64 ± 0.80; C: 16.57 ± 0.84	High school students with test stress syndrome	120	Tai Chi, 60 min per session, 7 times a week	2	No exercise	Test anxiety syndrome
Ma 2015	I: (Male) 17.1 ± 25.6; I: (Female) 17.1 ± 0.3; C: (Male) 16.9 ± 0.1; C: (Female) 17.0 ± 0.2	Healthy adolescent	78	Tai Chi, 30 min per session, 5 times a week	20	Original physical activity	Standing on one foot with eyes open, standing on one foot with eyes closed, maximum swing radius in left and right direction, maximum swing radius in front and back direction

Notes: C: control; I: intervention; min: minutes; PHCSCS: Piers–Harris Children's Self-Concept Scale; TCM: traditional Chinese medicine; VAS: visual analog scale.

4. Discussion

This systematic review, comprising 15 RCTs, evaluated the effects of Tai Chi on physical and psychological outcomes in children and adolescents and summarized the mechanisms and theoretical rationales discussed in the included studies. The health outcomes examined were primarily related to physical function, including balance, functional mobility, fall risk, muscle strength, kyphosis, flexibility, motor skills, physical fitness, and overall body function. Psychological outcomes, such as self-concept, self-regulation, behavior (including stereotypical behaviors or ADHD symptoms), anxiety, and pain, were also assessed.

Findings from individual studies suggest that Tai Chi may have beneficial effects on balance, functional mobility, self-regulation, muscle strength, fall risk, kyphosis, motor coordination, stereotypical behaviors, and ADHD symptoms in children, and on self-concept, lower limb stability, balance, cardiopulmonary function, flexibility, anxiety, physical function, fitness, and cervical symptoms in adolescents. However, large, high-quality RCTs are still needed to confirm these effects. These findings align with those of prior systematic reviews examining Tai Chi and Qigong in children and adolescents.[8,18]

Tai Chi interventions in most studies included in this review were conducted in school settings as part of educational or extracurricular programs, and those reporting style information predominantly employed the Yang style and the 24-simplifed form. Conversely, research in adult populations has utilized a wider range of Tai Chi styles and forms, such as Chen, Wu, Sun, as well as modified styles, and investigated them in various settings, such as clinical and community settings.[36,37] The predominance of school settings in this review may reflect the practicality of accessing large groups of children and adolescents in a structured environment. The lack of diversity in Tai Chi styles and forms may be attributed to the popularity of the 24-form simplified Yang style—widely promoted as part of physical education programs in Chinese schools.[37]

The frequency, session duration, and overall intervention length were broadly similar to those commonly reported in adult Tai Chi studies. However, all interventions for children and adolescents were delivered in group-based, face-to-face formats. In contrast, Tai Chi programs for adults have incorporated live online or hybrid delivery modes. Future research should explore the feasibility, accessibility and effectiveness of alternative delivery methods for younger populations to improve accessibility and scalability, particularly for groups facing geographical or health-related barriers.

Consistent with adult Tai Chi research,[36,37] the included studies featured a generally balanced representation of male and female participants. Three adolescents trials explored sex differences, indicating a need for further investigation into potential sex-specific variations in outcomes and implementation strategies. Such insights may inform whether Tai Chi interventions should be adapted based on sex.

4.1. Limitations of this study

This study had several limitations. First, we were unable to conduct a meta-analysis because of the substantial clinical heterogeneity among the included studies. Notably, there was considerable variation in outcome measures, assessment tools, and participant conditions or diagnoses. Future studies may benefit from adopting standardized, validated evaluation tools used in existing RCTs to allow for more robust comparisons and synthesis.

Second, none of the included studies directly examined the mechanisms underlying the effects of Tai Chi in children or adolescents. Therefore, only

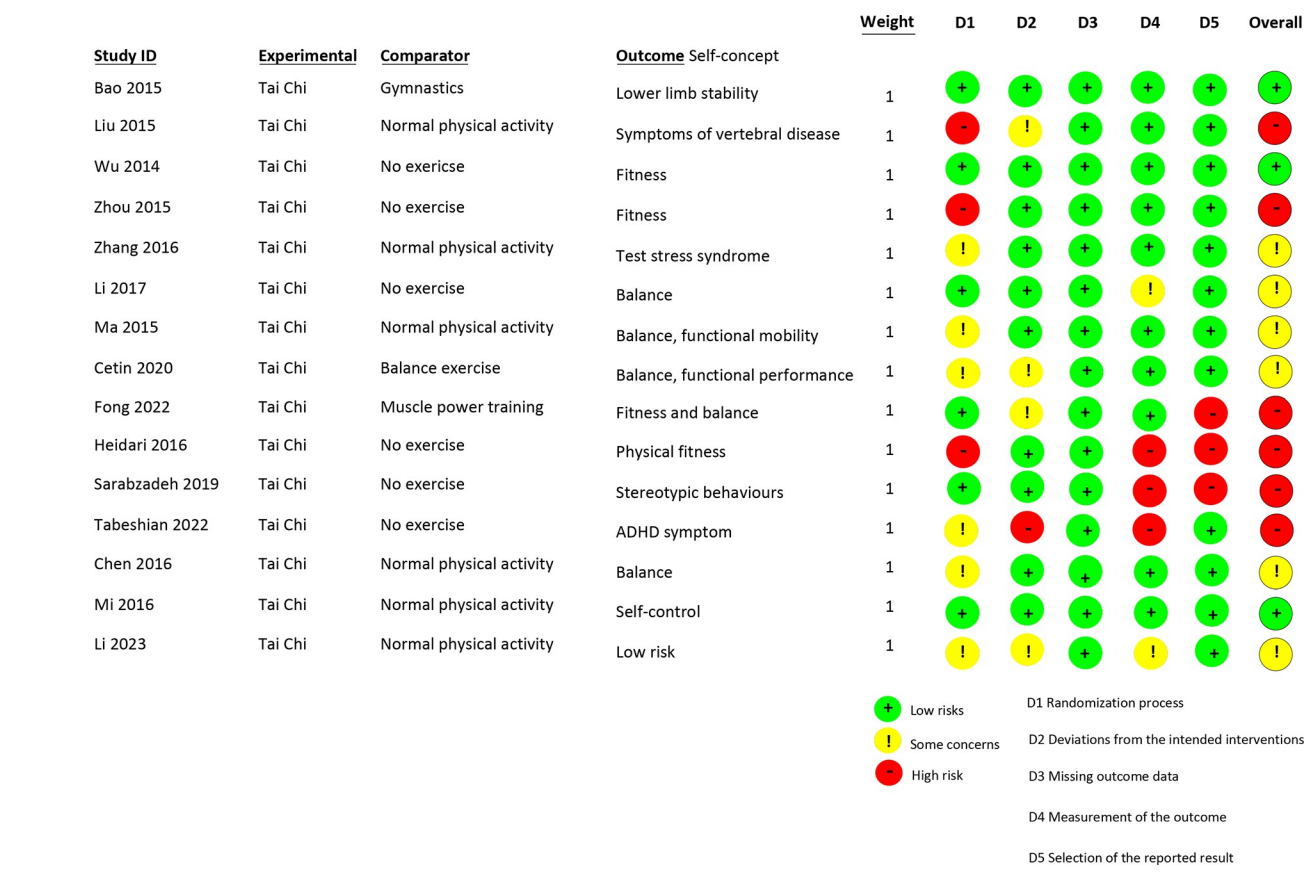

Figure 2 Risk of bias

Notes: ADHD: attention-deficit/hyperactivity disorder.

theoretical explanations could be summarized. For instance, one study suggested that Tai Chi strengthens back muscles and improves flexibility because of emphasis on stretching and extension movements.[32] Because Tai Chi requires coordinated activation of multiple muscle groups, it may enhance core strengthen and maintain natural length–tension relationships between agonist and antagonist muscles, thereby supporting neuromuscular function and potentially improving both dynamic and static balance (Heidari). Further mechanistic research is warranted.

Third, the overall methodological quality of the included studies was moderate, limiting the ability to draw firm conclusions. To enhance rigor and transparency, future RCTs should adhere closely to the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline,[38] particular with respect to randomization procedures and blinding methods.

4.2. Implications for future research

There remains a substantial gap in the literature regarding the effects of Tai Chi in children and adolescents. Only 15 RCTs were identified, many of which focused on healthy adolescents, with far fewer addressing specific clinical populations such as children with hearing loss, developmental coordination disorder, autism, or asthma. High-quality RCTs are needed to evaluate the physical and psychological benefits of Tai Chi across a broader range of pediatric populations.

Given that most existing studies involve healthy adolescents, future research should prioritize children with specific diagnoses and examine Tai Chi as a preventive, therapeutic, or rehabilitative intervention. Key areas include evaluating health benefits (e.g., anxiety reduction and improved balance), implementation challenges, cultural adaptations, and underlying mechanisms. Special attention should be given to children with conditions such as autism, ADHD, asthma, developmental delays, and hearing loss. Strengthening evidence in these populations would support clinical practice, inform policy development, and facilitate the integration of Tai Chi into pediatric health promotion strategies.

Most included studies reported that Tai Chi yielded superior outcomes compared with no-exercise controls. In two trials comparing Tai Chi with muscle power training or conventional balance exercises, similar effects were observed across groups. These findings suggest that Tai Chi may serve as an adjunct or alternative option in rehabilitation programs,[22,23,33] a non-pharmacological therapeutic modality,[25] or a clinician-prescribed intervention.[32,33]

Adequate intervention reporting is essential for transparency and reproducibility. However, descriptions of Tai Chi interventions for children and adolescents remain insufficient. We therefore recommend future researchers to adopt the proposed reporting standard for Tai Chi interventions in clinical trials[39] which builds on the Standards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA) and CONSORT guidelines.[38,40] Comprehensive reporting should include details on the overall program design, session structure, progression plans, guiding principles, learning methods, instructor qualification, co-interventions, and strategies to enhance compliance and implementation.[39]

Given the developmental characteristics of children and adolescents, detailed reporting of any tailored approaches is also crucial. For instance, one included study[34] adapted its protocol to participants' abilities and incorporated elements designed to enhance self-confidence, motivation, responsiveness to external demands, and predictability. The intervention also utilized concrete, relatable stimuli, such as linking hand movements to imagery of clouds, to facilitate engagement.[34] Careful intervention design and adequate reporting will enhance methodological rigor, facilitate replication, and promote the integration of Tai Chi into pediatric health and rehabilitation contexts.

5. Conclusion

Tai Chi appears to offer benefits for children and adolescents by improving physical outcomes such as balance, flexibility, motor skills, and physical fitness, as well as psychological outcomes, including anxiety, self-regulation, self-concept, and behavior. However, the current evidence remains limited. More high-quality RCTs and rigorous meta-analyses are needed to confirm these effects and to elucidate the underlying mechanisms in pediatric populations.

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Author Contribution Statement

Sebahat Yaprak Cetin: Conceptualization, formal analysis, visualization, writing – original draft, and writing – review and editing. **Xiao-long Chen:** Data curation, validation, and writing – review and editing. **Jia-lu Hua:** Data curation, validation, and writing – review and editing. **Ping Wang:** Data curation, validation, and writing – review and editing. **Ozgun Kaya Kara:** Data curation, validation, and writing – review and editing. **Guo-yan Yang:** Conceptualization, supervision, methodology, resources, writing – original draft, and writing – review and editing.

Declaration of Competing Interest

The research reported in this article was not conducted as part of any contractual relationship with these organizations.

Electronic Supplementary Material

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