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Motor development and motor skills benefits of martial arts training in children and adolescents: a systematic review across disciplines and outcome domains

Juanda Putra

Universitas Negeri Padang, Indonesia

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ABSTRACT

Motor competence acquired during childhood underpins lifelong physical activity, yet declining motor proficiency and rising inactivity have intensified the search for engaging developmental interventions. Martial arts, which integrate balance, coordination, agility, and controlled whole-body movement, are increasingly proposed as a vehicle for youth motor development, but the evidence remains dispersed across disciplines and styles. This systematic literature review synthesised experimental evidence on the effects of martial arts training on motor development and motor skills in children and adolescents. Following the PRISMA 2020 framework, a structured search of the Scopus database identified 182 records; after removal of duplicates and records not meeting format criteria, 72 records were screened, 39 full texts were assessed, and 20 experimental and quasi-experimental studies were included. Eligible studies encompassed taekwondo, judo, karate, wushu, pencak silat, and mixed combat sports, with outcomes spanning balance and postural control, fundamental motor skills and proficiency, agility and lower-limb power, motor learning, and visuomotor coordination. Across designs, martial arts interventions consistently improved balance and coordination, with especially robust effects in preschoolers and children with coordination difficulties. Findings support martial arts as an effective, inclusive strategy for physical education and coaching, while highlighting the need for larger trials, standardised outcomes, and broader stylistic and geographic representation.



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Corresponding Author:

Juanda Putra,
Universitas Negeri Padang,
Email: juandaputra@fik.unp.ac.id

Introduction

Motor development in childhood is widely regarded as a cornerstone of lifelong health, and the mastery of fundamental movement skills provides the behavioural foundation from which more complex physical competencies emerge (Gallahue et al., 2012; Stodden et al., 2008). Motor competence in early life is reciprocally linked with physical activity, cardiorespiratory fitness, cognitive functioning, and healthy weight trajectories, such that children with well-developed motor skills are more likely to remain active into adolescence and adulthood (Lubans et al., 2010; Robinson et al., 2015). Against this backdrop, the global decline in children's motor proficiency and the parallel rise in sedentary behaviour and obesity have prompted researchers and educators to seek structured, engaging, and developmentally appropriate movement interventions (Jaksic et al.,

2020; Li et al., 2022). Sport-based programmes delivered in schools and clubs are attractive because they couple motor stimulation with social and psychological benefits.

Within this search for effective interventions, martial arts have attracted particular attention. As highly structured movement systems, martial arts require the simultaneous coordination of posture, locomotion, balance, and rapid limb movements, thereby exercising several domains of motor development at once (Huang et al., 2023; Saraiva et al., 2023). Disciplines such as taekwondo, judo, karate, wushu, and pencak silat combine repetitive technical practice with dynamic, whole-body actions that challenge equilibrium and inter-limb coordination. Beyond their physical demands, martial arts embed values of discipline, respect, and self-regulation, which may enhance adherence and engagement in young learners (Giardullo et al., 2024; Georgiev et al., 2025). These characteristics position martial arts as a plausible and pedagogically rich avenue for fostering motor competence in children and adolescents.

A growing body of experimental research has examined martial arts across diverse populations and outcomes. Studies of taekwondo have reported improvements in standing balance, sensory organisation, and lower-limb control, particularly in children with developmental coordination disorder (Fong, Tsang, & Ng, 2012; Fong et al., 2013; Ma et al., 2018). Karate and wushu interventions have targeted motor proficiency, postural control, and lower-limb explosive power in typically developing and clinical samples (Ghadiri et al., 2022; Luo, Xu, et al., 2026; Yudhistira et al., 2026). Judo-based programmes have been used to develop balance, coordination, and even neurocognitive processes linked to motor skill acquisition (Al-Odat, 2024; Ludyga et al., 2022). Collectively, this literature suggests broadly favourable effects, yet it remains scattered across martial arts styles, outcome measures, and participant groups.

Recent years have also seen methodological maturation in this field. Investigators have increasingly adopted randomised controlled designs, standardised assessment batteries such as the Movement Assessment Battery for Children and the Bruininks–Oseretsky Test of Motor Proficiency, and instrumented measures including force platforms and eye-tracking (Ju et al., 2018; Luo, Fan, et al., 2026; Ma et al., 2018). Parallel work has extended martial arts to inclusive contexts, examining children with attention-deficit/hyperactivity disorder, autism spectrum disorder, and Down syndrome (Ludyga et al., 2022; Maussier et al., 2025; Suarez-Villadat et al., 2026). These advances strengthen causal inference and broaden the relevance of martial arts to special-needs and mainstream education alike.

Despite this progress, the evidence base is fragmented in ways that limit its usefulness for practitioners. First, studies are siloed by discipline, and no synthesis has integrated findings across the several martial arts most commonly delivered to young people. The heterogeneity of outcome constructs—ranging from static balance and agility to motor learning and visuomotor integration—makes it difficult to discern which aspects of motor development are most responsive to martial arts training (Boutios et al., 2021; Marchenko et al., 2024). A consolidated overview is therefore needed to map the landscape of effects and to identify where the evidence is strongest and where it is thin.

Second, important methodological and representational limitations persist. Many trials are small, brief, and geographically concentrated, and only a minority isolate the specific training characteristics—frequency, intensity, duration, and modality—responsible for observed gains (Kabadayı et al., 2022; Ouergui et al., 2020). Certain styles dominate the literature while others, notably pencak silat, remain markedly underrepresented despite their cultural prominence and structured technical repertoire (Effendi et al., 2025). Reviews to date have tended to focus on single disciplines or single populations, leaving a cross-cutting, motor-development-focused synthesis largely absent.

This systematic literature review addresses these gaps by synthesising experimental and quasi-experimental evidence on martial arts training and motor outcomes in children and adolescents. Grounded in the PRISMA 2020 framework and appraised with the Mixed Methods Appraisal Tool, it consolidates findings across disciplines and outcome domains to inform physical education, coaching, and adapted physical activity. The review is guided by two research questions:

RQ1: What are the effects of martial arts training on the motor development and motor-skill outcomes of children and adolescents?

RQ2: Which martial arts training characteristics (frequency, intensity, duration, and type of intervention) are associated with improvements in children's and adolescents' motor development?

By answering these questions, the review contributes an integrated, evidence-graded overview that clarifies where martial arts most reliably benefit youth motor competence, and sets a targeted agenda for higher-quality, more representative future research.

Method

Research Design and Framework

A systematic literature review (SLR) design was adopted to identify, appraise, and synthesise the available experimental evidence in a transparent and reproducible manner (Tranfield et al., 2003; Liberati et al., 2009). The review process, from record identification through screening, eligibility assessment, and inclusion, was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021). This structured approach was selected to minimise selection bias, ensure methodological rigour, and support replication.

Search Strategy

Prior to constructing the search string, the review questions were decomposed using a PICOS logic to ensure systematic identification of key concepts. The Population comprised children and adolescents; the Intervention/Interest was martial arts training (including style-specific and supplementary training delivered within martial arts); the Comparison was no intervention, conventional physical education, another activity, or a pre-post contrast; the Outcomes were motor-development constructs (fundamental motor skills, motor proficiency, balance and postural control, coordination, agility, and motor learning); and the Study designs of interest were randomised controlled trials, quasi-experimental, experimental, and longitudinal intervention studies. Each element was translated into a cluster of synonyms and combined with Boolean operators. The exact Scopus search string was:

TITLE-ABS-KEY(("pencak silat" OR silat OR "martial arts" OR taekwondo OR karate OR judo OR wushu OR "kung fu" OR "combat sport*") AND (child* OR children OR adolescent* OR youth OR "school-age" OR preschool* OR pupil*) AND ("motor development" OR "motor skill*" OR "gross motor skill*" OR "fine motor skill*" OR psychomotor OR coordination OR balance OR agility OR "motor proficiency") AND (training OR exercise OR intervention OR practice))

Truncation and wildcards were applied to capture morphological variants (e.g., child* for “child”, “children”, “childhood”; skill* for “skill” and “skills”). The field code TITLE-ABS-KEY restricted matching to the title, abstract, and keyword fields, and Boolean operators combined the four concept clusters. The string was piloted and refined iteratively; an initial narrower string focused solely on “pencak silat” returned too few records, so the intervention cluster was broadened to the principal martial arts disciplines while retaining the motor-development outcome cluster to preserve topical precision.

Database and Information Sources

Scopus served as the single, primary bibliographic source for this review, selected for its broad coverage of peer-reviewed sport science, health, and education literature and its consistent, structured metadata. The search was executed on 26 August 2026. No supplementary databases were used; reliance on a single high-coverage index is acknowledged as a scope decision and is revisited in the limitations. The decision to search a single database was deliberate: Scopus provides broad multidisciplinary coverage of sport science, health, education, and rehabilitation literature in a single structured index, enabling consistent, reproducible metadata export. It is acknowledged that PsycINFO, SPORTDiscus, and Web of Science hold complementary records, and their exclusion is listed as a scope limitation. The search date of 26 August 2026 is documented to enable temporal replication.

Eligibility Criteria

Records were included or excluded according to the criteria in Table 2. Studies were eligible if they employed an experimental or quasi-experimental design, involved child or adolescent participants, delivered a martial art-based intervention, and reported at least one motor-development or motor-skill outcome.

Table 2. Inclusion and exclusion criteria.

Criterion	Inclusion	Exclusion
Population	Children and adolescents (≤ 18 years), including preschool, clinical, and athlete samples	Adults, older adults, or samples with no separable youth data
Intervention	Martial arts training (taekwondo, judo, karate, wushu, pencak silat, mixed combat sports) or supplementary training delivered within a martial art	Non-martial-arts activities; mixed programmes where martial arts cannot be isolated
Outcome	At least one motor-development / motor-skill outcome (balance, coordination, agility, gross/fine motor skills, motor proficiency, motor learning)	Purely physiological, anthropometric, nutritional, psychosocial, or injury-mechanism outcomes

Criterion	Inclusion	Exclusion
Study design	RCT, quasi-experimental, experimental, or longitudinal intervention with pre-post or control comparison	Cross-sectional, correlational, descriptive, protocol, review, or bibliometric studies
Document type	Journal article (final publication stage)	Conference paper, book chapter, editorial, note
Language	English	Non-English
Accessibility	Full text available	Abstract only / not retrievable

Study Selection Process

Selection proceeded in three stages. First, titles and abstracts of screened records were examined against the eligibility criteria, and clearly irrelevant records (e.g., non-youth populations, non-motor outcomes, secondary studies) were removed. Second, the full texts of potentially eligible reports were assessed in detail. Third, studies meeting all criteria were retained for synthesis. Records for which eligibility was uncertain were discussed and resolved by consensus among the review team, with disagreements adjudicated against the written criteria. The flow of records across stages is reported in the PRISMA 2020 diagram (Figure 1). To establish screening reliability, titles and abstracts were assessed independently by two reviewers. Inter-rater agreement was quantified using Cohen's kappa; a threshold of $\kappa \geq 0.80$ was established a priori as satisfactory. Full-text assessments were subsequently conducted by both reviewers independently, with kappa recalculated for this stage. Disagreements at each stage were resolved by discussion with reference to the written eligibility criteria; where consensus could not be reached by discussion, the record was retained for full-text review to minimise premature exclusion.

Quality Assessment

Methodological quality was appraised with the Mixed Methods Appraisal Tool (MMAT), version 2018 (Hong et al., 2018), selected for its suitability across the heterogeneous designs anticipated in this literature. For each study, the design category was first classified (quantitative randomised controlled, quantitative non-randomised, or quantitative descriptive), and the corresponding five MMAT criteria were rated as Yes (1), Can't tell (0.5), or No (0). Studies meeting at least 60% of criteria (≥ 3 of 5) were considered to be of adequate methodological confidence; consistent with MMAT developer guidance, no study was excluded on the basis of its quality score alone, and lower-scoring studies were retained but weighted accordingly in interpretation. The appraisal summarised in Table 3 was derived from the information reported in each source record; where reporting was insufficient to judge a criterion, a conservative "Can't tell" was recorded, and full-text verification with independent dual rating (with agreement quantified by Cohen's kappa) is recommended before final publication.

Table 3. MMAT (2018) methodological quality appraisal of included studies.

Author(s), Year	Design category	S1	S2	S3	S4	S5	Score /5	Rating
Li et al. (2022)	Quant. RCT	Y	Y	Y	CT	Y	4.5	High
Luo, Xu, et al. (2026)	Quant. RCT	Y	Y	Y	CT	Y	4.5	High
Luo, Fan, et al. (2026)	Quant. RCT (cluster)	Y	Y	Y	CT	CT	4.0	High
Fong, Tsang, & Ng (2012)	Quant. RCT	Y	Y	Y	CT	Y	4.5	High
Fong et al. (2013)	Quant. RCT	Y	Y	Y	CT	Y	4.5	High
Ma et al. (2018)	Quant. RCT	Y	Y	Y	CT	CT	4.0	High
Ghadiri et al. (2022)	Quant. non-randomized	Y	CT	Y	CT	CT	3.5	Medium
Ludyga et al. (2022)	Quant. RCT	Y	Y	Y	CT	Y	4.5	High
Huang et al. (2023)	Quant. non-randomized	Y	CT	CT	CT	CT	3.0	Medium
Al-Odat (2024)	Quant. descriptive	Y	CT	CT	CT	CT	3.0	Medium
Saraiva et al. (2025)	Quant. non-randomized	Y	CT	Y	CT	CT	3.5	Medium
Gomes et al. (2017)	Quant. RCT	Y	Y	Y	CT	CT	4.0	High
Gomes et al. (2025)	Quant. RCT	Y	Y	Y	CT	CT	4.0	High
Ju et al. (2018)	Quant. non-randomized	Y	CT	Y	CT	CT	3.5	Medium
Yudhistira et al. (2026)	Quant. non-randomized	Y	CT	Y	CT	CT	3.5	Medium
Kabadayı et al. (2022)	Quant. RCT	Y	Y	Y	CT	CT	4.0	High
Öztürk et al. (2025)	Quant. RCT	Y	Y	Y	CT	CT	4.0	High
Mischenko et al. (2020)	Quant. non-randomized	Y	CT	CT	CT	CT	3.0	Medium
Genç et al. (2026)	Quant. RCT	Y	Y	Y	CT	CT	4.0	High
Effendi et al. (2025)	Quant. non-randomized	Y	CT	Y	CT	CT	3.5	Medium

Data Extraction Procedure

A standardised extraction form was used to record, for each included study: authors and year; country or study setting; study design; sample size, age, and population type; martial arts discipline and intervention parameters

(frequency, session duration, and programme length); outcome measures and instruments; and principal findings. Extracted data populated the descriptive tables and the thematic synthesis.

Network and Bibliometric Analysis Methodology

Formal co-authorship and co-citation network analyses were not undertaken, as the review prioritised a design- and outcome-focused synthesis of intervention effects. Descriptive bibliometric characteristics of the included set-temporal distribution, disciplinary distribution, and geographic setting-were tabulated and visualised (Figures 2–5) to characterise the evidence base.

Data Analysis and Synthesis

Given the heterogeneity of interventions, outcomes, and measurement tools, a narrative thematic synthesis was applied rather than statistical meta-analysis (Thomas & Harden, 2008). Findings were coded inductively into motor-outcome domains-balance and postural control, fundamental motor skills and proficiency, agility and lower-limb power, motor learning, and coordination/visuomotor function-and then examined for convergence, divergence, and moderating training characteristics. Syntheses were organised around the two research questions.

Reporting and Documentation

The review was documented in accordance with the PRISMA 2020 checklist (Page et al., 2021). The record flow, exclusion reasons, and final counts are reported transparently in the flow diagram and narrative, ensuring numerical consistency across the Methods, Results, and figures.

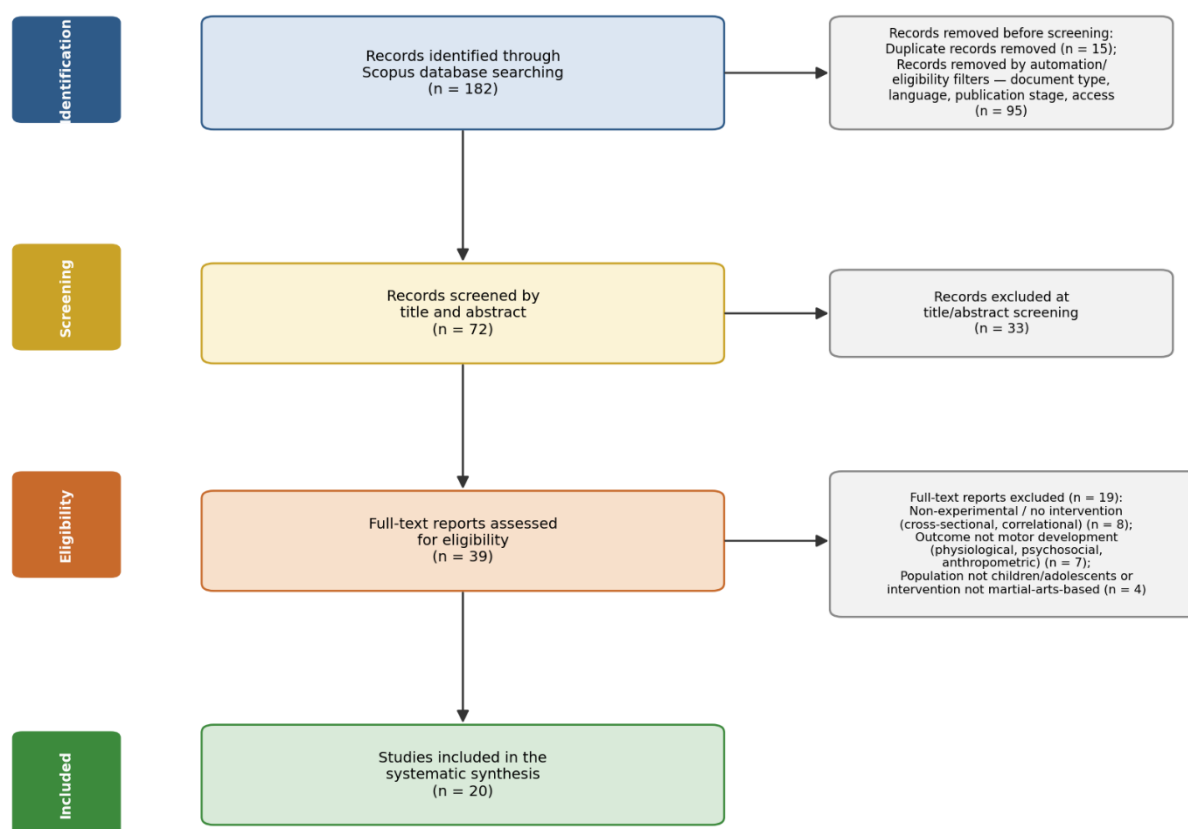


Figure 1. PRISMA 2020 flow diagram of the identification, screening, eligibility assessment, and inclusion of studies (Page et al., 2021).

Results and Discussions

Study Selection Results

The Scopus search identified 182 records. Before screening, 15 duplicate records were removed and a further 95 records were excluded by eligibility filters relating to document type, language, publication stage, and accessibility, leaving 72 records for screening. Title and abstract screening excluded 33 records that were clearly outside scope (e.g., adult or older-adult samples, non-motor outcomes, or secondary studies), and 39 full-text reports were assessed for eligibility. Of these, 19 were excluded: 8 for a non-experimental design (cross-sectional or correlational, without an intervention), 7 for reporting outcomes that were not motor-

developmental (physiological, psychosocial, or anthropometric), and 4 because the population was not children or adolescents or the intervention was not martial-arts-based. Twenty studies met all criteria and were included in the synthesis (Figure 1).

Table 4. Summary characteristics of the included studies (n = 20).

Author(s), Year	Full title	Country	Design	Sample & age	Key findings
Li et al. (2022)	Effects of Chinese Martial Arts on Motor Skills in Children between 5 and 6 Years of Age: A Randomized Controlled Trial	China	RCT (3 arms)	87 preschoolers, 5–6 y; 10 wk, 2×/wk	Both martial-arts teaching groups improved balance versus free activity; the sensory-teaching group achieved the highest total motor and manual-dexterity scores, outperforming both traditional teaching and free activity.
Luo, Xu, et al. (2026)	Effects of a 10-Week Wushu Program on Static, Dynamic, and Dual-Task Balance and Physical Fitness in Preschool Children	China	RCT	73 preschoolers, 5–6 y; 10 wk, 3×/wk	The Wushu group significantly outperformed controls in single-leg stance, balance-beam walking, standing long jump, zigzag run and mediolateral postural control; dynamic-balance gains correlated with lower-limb coordination and jumping agility.
Luo, Fan, et al. (2026)	Effects of Wushu Programs on Lower-Limb Explosive Power in Preschool Children Aged 5–6 Years: A Cluster-Randomized Controlled Trial	China	Cluster-RCT (2 experiments)	199 preschoolers, 5–6 y; 4 & 10 wk	Both 4- and 10-week Wushu programs improved standing long jump versus control; the 10-week program additionally improved continuous jumping and zigzag-run agility, indicating task-specific lower-limb motor gains.
Fong, Tsang, & Ng (2012)	Taekwondo training improves sensory organization and balance control in children with developmental coordination disorder: A randomized controlled trial	Hong Kong SAR	RCT	44 children with DCD, 7.6 y; 3 mo daily	Taekwondo produced significantly greater gains in vestibular ratio and single-leg-stance sway velocity than DCD controls, bringing balance to a level comparable with typically developing peers.
Fong et al. (2013)	Differential effect of Taekwondo training on knee muscle strength and reactive and static balance control in children with developmental coordination disorder: A randomized controlled trial	Hong Kong SAR	RCT	44 children with DCD, 7.6 y; 3 mo daily	Taekwondo improved isokinetic knee strength at 180°/s and static single-leg balance to typically-developing levels, although reactive balance control did not improve.
Ma et al. (2018)	Adapted Taekwondo Training for Prepubertal Children with Developmental	Hong Kong SAR	RCT	145 prepubertal children with DCD; 12 wk	Adapted taekwondo improved eye-hand coordination movement time and helped skeletal development catch up; MABC scores improved

Author(s), Year	Full title	Country	Design	Sample & age	Key findings
Ghadiri et al. (2022)	Coordination Disorder: A Randomized, Controlled Trial The effect of karate interventions on the motor proficiency of female adolescents with developmental coordination disorder (DCD) from high and low socio-economic status	Iran	Quasi-experimental	16 adolescent girls with DCD, 12–13 y; 8 wk, 3×/wk	across groups, suggesting maturation also contributed to motor gains. Karate-Do improved manual dexterity, bilateral coordination, strength and total motor proficiency (BOT-2) in both SES groups; high-SES adolescents improved significantly more than low-SES peers.
Ludyga et al. (2022)	Behavioral and neurocognitive effects of judo training on working memory capacity in children with ADHD: A randomized controlled trial	Switzerland	RCT	57 children with ADHD, 8–12 y; 3 mo	Judo training improved visuospatial working-memory capacity (behavioral K-score and contralateral delay activity) versus waitlist, though MABC-2 motor scores did not differ between groups.
Huang et al. (2023)	QUALITY IN BALANCE SENSITIVITY THROUGH MARTIAL ARTS APPLIED TO CHILDREN	China	Controlled experiment	Children, 8–12 y	A structured children's martial-arts set significantly improved balance quality in the experimental versus control group ($p < 0.01$), underscoring the role of sensory-quality training in balance development.
Al-Odat (2024)	The impact of an educational program on some judo skills on developing motor balance	Jordan	Pre-post experimental	15 junior judoka, 15–18 y; 8 wk	A judo-skills educational program produced statistically significant improvements in forward and backward motor-balance measures (modified star flight test), supporting judo for developing equilibrium and lower-limb control.
Saraiva et al. (2025)	Effects of different modalities of combat sports on the motor skills of children and adolescents	Brazil	Controlled intervention	109 children/adolescents; 9 mo, 2×/wk	Nine months of judo or Muay Thai improved lateral jumps, platform transfer and single-leg jump relative to controls, showing combat sports enhance children's motor skills.
Gomes et al. (2017)	Effects of distinct practice conditions on the learning of the o soto gari throwing technique of judo	Brazil	RCT (motor learning)	64 children, 9.2 y	No between-group differences emerged, but within-group gains indicated that uchikomi practice incorporating pre-kuzushi helped learners manage the pulling/pushing actions needed to unbalance the opponent.
Gomes et al. (2025)	Whole practice combined with Kuzushi preparation enhances learning of Tai Otoshi in	Brazil	RCT (motor learning)	32 experienced young judoka, 8.6 y	Whole practice with pre-kuzushi preparation produced the greatest gains in actual opponent-unbalancing and technique

Author(s), Year	Full title	Country	Design	Sample & age	Key findings
	experienced young judokas				retention, outperforming traditional and segmented practice schedules.
Ju et al. (2018)	Effects of combat training on visuomotor performance in children aged 9 to 12 years - an eye-tracking study	Taiwan	Pre-post controlled	56 children, 9–12 y; 8 wk, 2×/wk	Combat training produced significantly earlier secondary-saccade onset latencies than controls, indicating enhanced visuomotor function in children.
Yudhistira et al. (2026)	The effect of core stability training on improving balance moderated by strength in early age karate students	Indonesia	2×2 factorial experiment	40 male karateka, 6–8 y	Core-stability training significantly improved balance (SEBT; $\eta^2 = 0.71$), with a significant interaction showing effects are moderated by each child's core-muscle strength.
Kabadayı et al. (2022)	Effects of Core Training in Physical Fitness of Youth Karate Athletes: A Controlled Study Design	Türkiye	RCT (parallel)	29 youth karateka, 12–13 y; 8 wk, 3×/wk	Core-strength training significantly improved core endurance, karate-kick performance and 20-m sprint versus sport-specific training alone; change-of-direction and jump gains appeared within-group.
Öztürk et al. (2025)	Effect of static and dynamic core exercises on kicking impact, kicking speed and balance in adolescent taekwondo athletes	Türkiye	RCT	33 adolescent athletes; 8 wk, 3×/wk	Static and dynamic core exercises improved kicking speed and dynamic (Y-balance) performance; dynamic-core work increased non-dominant kicking impact but slightly reduced static balance.
Mischenko et al. (2020)	Trampolines-acrobatic exercises in training of 7 year-old Taekwondo athletes	Russia	Pedagogical experiment	24 boys, 7 y; one school year	Adding trampoline-acrobatic exercises to taekwondo produced significantly greater gains in speed, static/dynamic balance, coordination and technical readiness than the standard program.
Genç et al. (2026)	Effects of 8-week plyometric training program on balance, reaction time, and attention on elite adolescent female taekwondo athletes	Türkiye	RCT	20 adolescent female athletes, 14.9 y; 8 wk	Plyometric training added to taekwondo significantly improved static and dynamic balance versus control, with no significant effects on reaction time or attention.
Effendi et al. (2025)	Agility Training in Adolescent Pencak Silat Athletes: A Randomized Controlled Experimental Study	Indonesia	Quasi-experimental (two-group)	30 male adolescent athletes, 13–15 y; 4 wk, 4×/wk	Ladder-drill training significantly improved agility in the pencak silat group (Illinois test, +2.7%, $p < 0.05$) with no significant change in controls, confirming ladder drills as an effective agility stimulus.

Note. Country reflects the reported study setting or lead-author institutional context; affiliation metadata were not present in the bibliographic export and were supplemented from information within each source record. DCD = developmental coordination disorder; ADHD = attention-deficit/hyperactivity disorder.

Table 5. Classification of included studies by martial art, design, and motor outcome.

Author(s), Year	Martial art	Research design	Primary motor outcome domain	Primary measure / test	Reported effect
Li et al. (2022)	Kung Fu (Chinese martial arts)	RCT (3 arms)	Fundamental motor skills & balance (MABC-2)	MABC-2	Positive (balance, dexterity)
Luo, Xu, et al. (2026)	Wushu	RCT	Balance / postural control	Single-leg stance; beam walk; CoP	Positive
Luo, Fan, et al. (2026)	Wushu	Cluster-RCT (2 experiments)	Agility & lower-limb power	Standing long jump; zigzag run	Positive
Fong, Tsang, & Ng (2012)	Taekwondo	RCT	Balance / postural control	SOT; unilateral stance (sway velocity)	Positive
Fong et al. (2013)	Taekwondo	RCT	Balance / postural control & strength	Isokinetic strength; unilateral stance	Positive (partial)
Ma et al. (2018)	Taekwondo (adapted)	RCT	Motor proficiency & coordination	MABC; eye–hand coordination	Positive (coordination)
Ghadiri et al. (2022)	Karate	Quasi- experimental	Motor proficiency & coordination	BOT-2 (short form)	Positive (SES- moderated)
Ludyga et al. (2022)	Judo	RCT	Fundamental motor skills & working memory	MABC-2; Change Detection (K-score)	Mixed (WM ↑, MABC ns)
Huang et al. (2023)	Martial arts (general)	Controlled experiment	Balance / postural control	Balance sensitivity battery	Positive
Al-Odat (2024)	Judo	Pre–post experimental	Balance / postural control	Modified star flight (balance) test	Positive
Saraiva et al. (2025)	Judo & Muay Thai	Controlled intervention	Fundamental motor skills	Beam balance; lateral/single-leg jumps	Positive
Gomes et al. (2017)	Judo	RCT (motor learning)	Motor learning (technique)	Technique/kuzushi video analysis	Within-group only
Gomes et al. (2025)	Judo	RCT (motor learning)	Motor learning (technique)	Tai-otoshi technique checklist	Positive (whole practice)
Ju et al. (2018)	Combat sports (karate-based)	Pre–post controlled	Coordination / visuomotor	Eye-tracking saccade latency; target hitting	Positive (visuomotor)
Yudhistira et al. (2026)	Karate	2×2 factorial experiment	Balance / postural control	Star Excursion Balance Test	Positive (strength- moderated)
Kabadayı et al. (2022)	Karate	RCT (parallel)	Agility & lower-limb power	Core endurance; change-of-direction; kick	Positive (partial)
Öztürk et al. (2025)	Taekwondo	RCT	Balance / postural control & kicking	FSKT-10s; flamingo; Y-balance	Positive (mixed)
Mischenko et al. (2020)	Taekwondo	Pedagogical experiment	Coordination	Coordination & technical readiness battery	Positive
Genç et al. (2026)	Taekwondo	RCT	Balance / postural control	Static/dynamic balance; reaction time	Positive (balance)
Effendi et al. (2025)	Pencak Silat	Quasi- experimental (two-group)	Agility & lower-limb power	Illinois agility test	Positive (agility)

Note. Country reflects the reported study setting or lead-author institutional context; affiliation metadata were not present in the bibliographic export and were supplemented from information within each source record. DCD = developmental coordination disorder; ADHD = attention-deficit/hyperactivity disorder.

Descriptive Characteristics of the Included Studies

The 20 included studies were published between 2012 and 2026, with a marked concentration in the most recent years: four studies each appeared in 2022, 2025, and 2026, reflecting rapidly growing interest in martial arts as

a developmental tool (Figure 2). Taekwondo was the most frequently studied discipline (six studies), followed by judo (four), and karate and wushu (three each); combat sports of mixed modality, pencak silat, and general martial arts accounted for the remainder (Figure 3). By outcome, balance and postural control dominated (eight studies), followed by fundamental motor skills and proficiency (five), agility and lower-limb power (three), and motor learning and coordination/visuomotor function (two each) (Figure 4). Geographically, the evidence clustered in East Asia, Türkiye, Brazil, and, to a lesser extent, Europe and the Middle East (Figure 5); country was determined from the study setting reported in each record, as affiliation metadata were absent from the export.

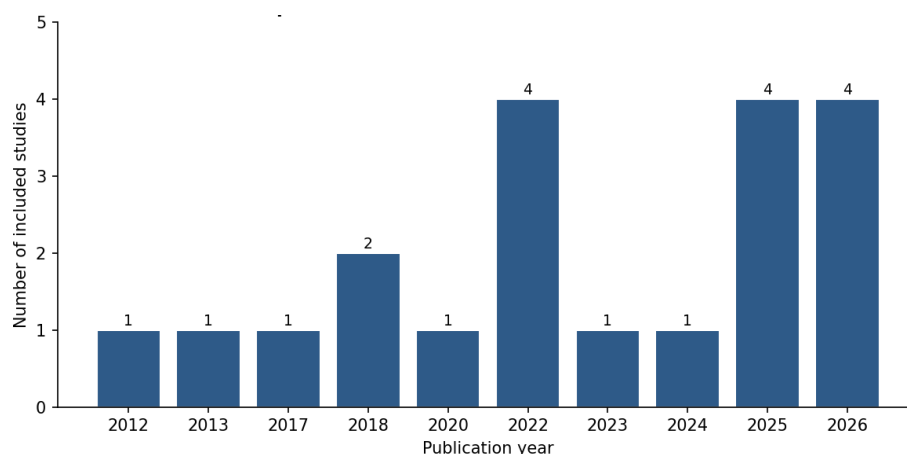


Figure 2. Temporal distribution of the included studies (n = 20).

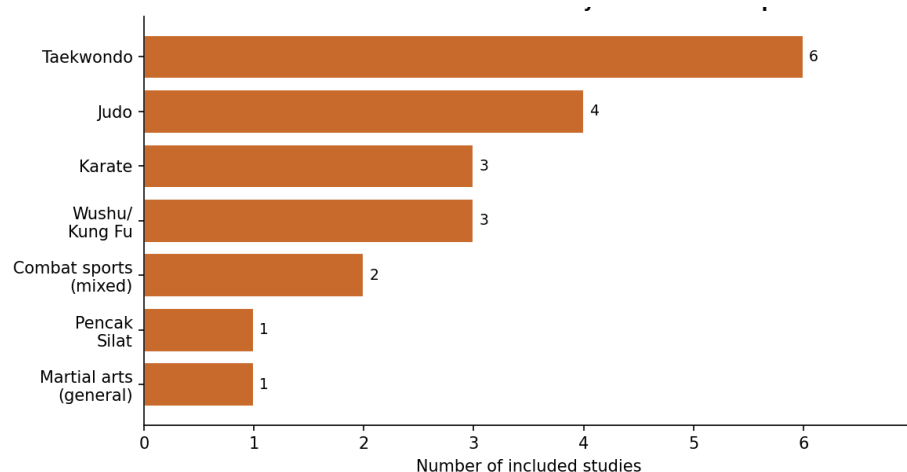


Figure 3. Distribution of the included studies by martial arts discipline.

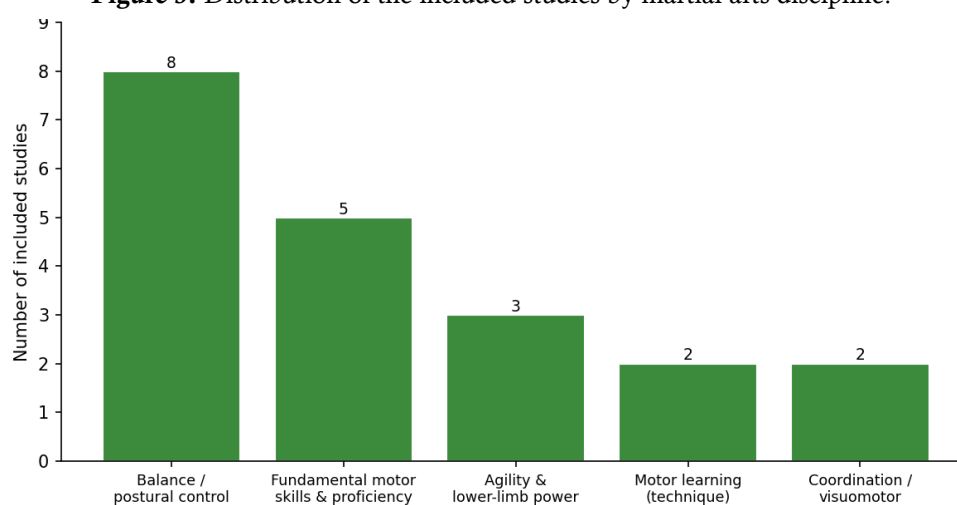


Figure 4. Distribution of the included studies by primary motor outcome domain.

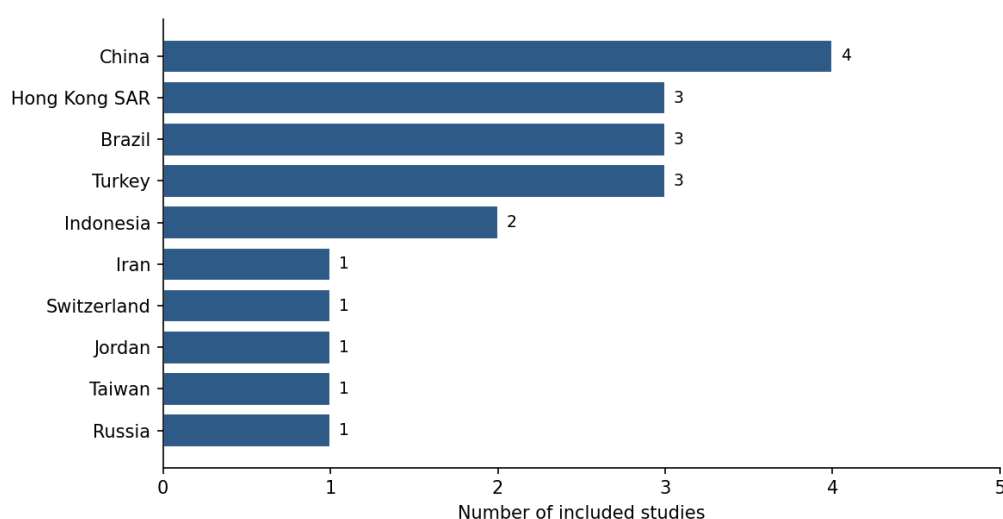


Figure 5. Geographic distribution of the included studies, by reported study setting.

Thematic Synthesis

Findings for RQ1: Effects of martial arts training on motor development

The most consistent finding across the included studies was that martial arts training improves balance and postural control in children and adolescents. In preschoolers, structured wushu and Chinese martial arts programmes enhanced static and dynamic balance and overall motor-skill scores relative to free play, with sensory-oriented teaching producing the largest gains (Li et al., 2022; Luo, Xu, et al., 2026). In children with developmental coordination disorder, three months of taekwondo improved sensory organisation and single-leg-stance control to levels comparable with typically developing peers (Fong, Tsang, & Ng, 2012; Fong et al., 2013). Comparable balance benefits were reported for judo, general martial-arts sets, and supplementary training embedded within martial arts, indicating that equilibrium is a robustly responsive domain across styles and populations (Al-Odat, 2024; Huang et al., 2023; Yudhistira et al., 2026).

Beyond balance, martial arts training enhanced fundamental motor skills, motor proficiency, agility, and coordination. Nine months of judo or Muay Thai improved jumping and transfer tasks in children and adolescents (Saraiva et al., 2025), and karate improved motor proficiency in adolescents with coordination difficulties (Ghadiri et al., 2022). Agility and lower-limb power responded to task-specific stimuli, including ladder-drill training in pencak silat athletes and wushu programmes in preschoolers (Effendi et al., 2025; Luo, Fan, et al., 2026). Coordination and visuomotor function also improved, with combat training producing earlier saccadic responses and trampoline-augmented taekwondo enhancing coordination and technical readiness (Ju et al., 2018; Mischenko et al., 2020). Motor-learning studies further showed that practice structure shapes technique acquisition, with whole practice incorporating pre-kuzushi preparation optimising retention in young judoka (Gomes et al., 2017; Gomes et al., 2025). Effects on higher-order cognition were more equivocal: judo improved working memory in children with ADHD without concurrent MABC-2 gains, suggesting that motor and cognitive benefits do not always co-occur (Ludyga et al., 2022).

Findings for RQ2: Training characteristics associated with improvement

Across studies, effective programmes shared several parameters. Session frequency of two to four times per week and programme durations of roughly 8 to 12 weeks were common among studies reporting significant motor gains, with some benefits emerging from short, intensive blocks (e.g., four weeks of high-frequency ladder drills) and others from longer, lower-frequency schooling programmes sustained over nine months (Effendi et al., 2025; Saraiva et al., 2025). Daily, higher-dose taekwondo over three months produced pronounced balance improvements in clinical samples, suggesting that greater exposure benefits children with baseline motor deficits (Fong, Tsang, & Ng, 2012; Ma et al., 2018). Session durations typically ranged from 30 to 75 minutes, with shorter sessions favoured for younger children.

Intervention type also moderated outcomes. Interventions that embedded the martial art itself-technique practice, forms, and sparring drills-tended to improve discipline-specific and transferable motor skills, whereas supplementary conditioning delivered within a martial art (core-stability, plyometric, or trampoline-acrobatic training) reliably augmented balance, agility, or power but with more selective transfer (Genç et al., 2026; Kabadayı et al., 2022; Öztürk et al., 2025). Importantly, individual moderators such as baseline core-muscle strength conditioned the size of balance improvements, indicating that responses are not uniform and that programmes may need to be tailored to the child's starting capacity (Yudhistira et al., 2026).

Comparative and Critical Analysis

Methodologically, the included evidence is dominated by short-duration trials with modest samples, and randomised designs, while present in roughly half of the studies, frequently lacked blinding and detailed allocation reporting (Table 3). Standardised, validated instruments-such as the MABC-2, BOT-2, force platforms, and the Star Excursion/Y-balance tests-were widely used, strengthening comparability of balance and proficiency outcomes; however, technique-specific and bespoke measures in motor-learning and combat-skill studies limited cross-study pooling (Gomes et al., 2017; Ju et al., 2018). Over time, the field has shifted from cross-sectional comparisons of practitioners and non-practitioners toward controlled intervention designs and instrumented measurement, reflecting methodological maturation (Fong, Fu, & Ng, 2012; Fong, Cheung, et al., 2012). Nonetheless, the predominance of taekwondo and the scarcity of pencak silat and other regional styles constrain the generalisability of conclusions across the martial arts spectrum (Effendi et al., 2025).

Interpreted together, the findings indicate that martial arts training is a consistently effective stimulus for youth motor development, most reliably for balance and postural control and, secondarily, for motor proficiency, agility, coordination, and technique learning. Theoretically, these results align with developmental models in which enriched, coordinatively demanding practice drives motor-competence gains that can seed broader engagement in physical activity (Robinson et al., 2015; Stodden et al., 2008). The strong balance effects are consistent with the postural and proprioceptive demands intrinsic to martial arts stances, turns, and controlled kicks, which repeatedly challenge the sensory systems underpinning equilibrium (Fong, Tsang, & Ng, 2012; Luo, Xu, et al., 2026).

Practically, the evidence supports embedding martial arts within physical education and community coaching as an engaging, low-cost avenue for motor development, including for children with coordination difficulties. Programmes of eight to twelve weeks at two to three sessions weekly appear sufficient to elicit meaningful balance and coordination gains, while clinical populations may benefit from higher doses (Ghadiri et al., 2022; Ma et al., 2018). For coaches, the value of aligning practice structure with skill demands-favouring whole, contextualised practice for complex techniques-offers actionable guidance (Gomes et al., 2025). Situated against prior single-discipline reviews and exercise meta-analyses in special populations, the present cross-disciplinary synthesis extends the evidence by showing convergent motor benefits across styles rather than within a single art (Li & Zhang, 2025).

Contradictions nonetheless remain. Motor and cognitive outcomes did not always move together, and some supplementary interventions improved one facet of balance while transiently degrading another, indicating trade-offs that warrant careful programming (Ludyga et al., 2022; Öztürk et al., 2025). Several gaps are apparent: first, pencak silat and other under-studied regional martial arts are represented by a single trial, limiting cultural and stylistic generalisability (Effendi et al., 2025); second, few studies isolate dose-response relationships or report effect sizes and retention; and third, long-term follow-up and transfer to everyday motor function are rarely assessed (Boutios et al., 2021; Marchenko et al., 2024). Inclusive applications for children with autism spectrum disorder and other conditions remain promising but nascent (Maussier et al., 2025; Suarez-Villadat et al., 2026; Yu et al., 2025).

This review has limitations. Reliance on a single database (Scopus), restriction to English-language journal articles, and the absence of a meta-analysis may have omitted relevant evidence and precluded quantitative pooling. Quality appraisal was based on information reported in the source records and should be confirmed by independent dual rating of full texts. The synthesis is also susceptible to the small-sample and short-duration character of the primary studies. Future research should prioritise adequately powered randomised trials with standardised motor batteries and reported effect sizes; systematic dose-response and retention designs; broader representation of pencak silat and other regional styles and of low-resource settings; and mechanistic work linking martial arts practice to the sensory and neuromuscular substrates of motor development (Georgiev et al., 2025; Rutkowski & Chwałczyńska, 2025).

Answer to RQ1. Martial arts training reliably improves motor development in children and adolescents, with the strongest and most consistent benefits for balance and postural control and additional gains in fundamental motor skills, motor proficiency, agility, coordination, and technique learning; effects are especially pronounced in preschoolers and children with coordination difficulties, whereas transfer to higher-order cognition is inconsistent.

Answer to RQ2. Improvements are most consistently associated with programmes of roughly 8–12 weeks at two to four sessions per week and 30–75-minute sessions; higher doses benefit clinical samples, embedding authentic technique practice supports transferable skills, supplementary conditioning within a martial art augments specific capacities, and individual baseline characteristics such as core strength moderate the magnitude of gains.

Conclusions

This systematic review of 20 experimental and quasi-experimental studies shows that martial arts training is an effective and inclusive means of enhancing motor development in children and adolescents, most consistently improving balance and postural control and additionally benefiting fundamental motor skills, motor proficiency, agility, coordination, and technique learning across taekwondo, judo, karate, wushu, pencak silat, and mixed combat sports. Gains are most reliably associated with programmes of about eight to twelve weeks at two to four weekly sessions, with higher doses favouring children who have coordination difficulties. The review's core contribution is a cross-disciplinary, motor-development-focused synthesis that consolidates previously siloed evidence and offers practical guidance for physical education and coaching. Its conclusions are tempered by the small, short, and geographically concentrated nature of the primary studies and by reliance on a single database. Larger, standardised, and more representative trials are needed to confirm dose–response effects and long-term motor benefits.

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