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Original Article

Effects of after-school and out-of-school-time interventions on fundamental movement skills in school-aged children: A systematic review and meta-analysis

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Abstract
This systematic review and meta-analysis aimed to evaluate the effects of after-school and out-of-school-time interventions on fundamental movement skills (FMS) and related motor competence outcomes in school-aged children. Three electronic databases, PubMed, the Web of Science platform, and Scopus, were systematically searched. Study selection was guided by predefined eligibility criteria based on the PICOS framework. Eligible studies included intervention studies conducted in after-school, out-of-school-time, extracurricular, or similar settings, with outcomes related to FMS, motor competence, locomotor skills, object-control skills, or other motor skill performance measures. Methodological quality was assessed using the JBI Critical Appraisal Checklist for Quasi-Experimental Studies. Where data were compatible, post-intervention continuous motor skill outcomes were synthesized using standardized mean differences (SMDs) with a random-effects model. A total of 268 records were identified, and seven studies were included in the systematic review. Of these, four studies were included in the main meta-analysis. The pooled result showed a statistically significant positive effect of after-school or out-of-school-time interventions on children's post-intervention motor skill outcomes (SMD = 0.58, 95% CI 0.05 to 1.11, Z = 2.15, p = 0.03). Moderate heterogeneity was observed (I^2 = 56%). Skill-specific findings from Foweather et al. (2008) indicated significant improvements in balance proficiency and kick proficiency, while other skill outcomes did not reach statistical significance. Narrative findings suggested that implementation quality, program leader training, equipment availability, and intervention structure may influence intervention effectiveness. Overall, after-school and out-of-school-time interventions may have positive effects on selected FMS and motor competence outcomes in school-aged children. However, the evidence remains preliminary due to the limited number of studies, small samples, methodological concerns, and heterogeneity in intervention content and outcome measurement. Future high-quality randomized or cluster-randomized trials with standardized measurement tools and follow-up assessments are needed.
Keywords: after-school program; out-of-school time; fundamental movement skills; motor competence; children; meta-analysis

Introduction

Fundamental movement skills (FMS) form the foundation of children's motor development and are commonly grouped into locomotor, object-control, and stability skills. These skills support participation in play, physical activity, and more complex sport-specific movements (Stodden et al., 2008). Motor competence is also linked to broader developmental and health trajectories. Earlier reviews associated FMS proficiency with physical activity, cardiorespiratory fitness, and weight status (Lubans et al., 2010; Robinson et al., 2015). More recent longitudinal evidence provides strong support for relationships between motor competence, weight status, and physical fitness, while evidence for the motor competence–physical activity pathway remains less consistent (Barnett et al., 2022). Accordingly, the development of FMS is not only an objective of physical education but also a foundation for children's sustained participation in active lifestyles and for positive physical and psychosocial development.

Despite this importance, population-level FMS proficiency remains suboptimal. A systematic review of 64 studies using the TGMD-2 reported that children generally demonstrated below-average to average FMS levels relative to normative data, highlighting substantial scope for development (Bolger et al., 2021). Mature movement patterns do not emerge automatically through growth alone; they typically require repeated practice, developmentally appropriate instruction, feedback, and opportunities to apply skills in varied contexts. Structured FMS interventions have therefore become an important strategy for improving motor competence. Earlier evidence showed that developmentally appropriate FMS programs can improve gross motor, locomotor, and object-control outcomes (Morgan et al., 2013). More recent reviews suggest that FMS interventions may also contribute to children's moderate-to-vigorous physical activity when motor skills are clearly conceptualized

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and deliberately integrated into intervention design (Graham et al., 2022). Likewise, a systematic review comparing theory-based and atheoretical motor competence interventions found that most programs produced immediate and/or longer-term improvements, with no clear difference in overall success between the two approaches; the authors also emphasized developmentally appropriate pedagogy for motor skill instruction (Khodaverdi et al., 2022). A recent meta-analysis of school-based FMS interventions further reported positive pooled effects on overall FMS proficiency and suggested that intervention duration, frequency, and session length may influence outcomes (Yin et al., 2025).

Schools are central settings for children's movement development, but the regular school day does not always provide sufficient time or flexibility for repeated skill practice. Curriculum demands, academic pressures, limited physical education time, and uneven access to facilities can restrict opportunities for children to receive targeted motor skill instruction (Beets et al., 2009). After-school and out-of-school-time (OST) settings therefore offer a potentially valuable extension of the school day. These settings can provide longer or more flexible activity periods, game-based learning, repeated practice, and additional opportunities for feedback outside formal physical education lessons. Evidence from OST research indicates that physical-activity-focused programs can improve fitness and moderate-to-vigorous physical activity during programming, and that organization-level or programmatic approaches may complement school-day efforts to support youth health behaviors (Sliwa et al., 2023). Recent intervention research also shows that play-based after-school programs can improve coordination and physical fitness, reinforcing the potential of after-school settings as practical environments for children's motor development (Kurnaz et al., 2024).

However, simply providing an after-school program does not guarantee meaningful improvement. Effects across after-school interventions are often inconsistent. Mears and Jago (2016), for example, found mixed effects of after-school interventions on moderate-to-vigorous physical activity, with the pooled confidence interval crossing zero. Such findings suggest that the value of after-school programming depends not only on the amount of activity offered but also on how activities are organized and delivered. Process-evaluation evidence in motor competence interventions indicates that intervention dose, duration, lesson planning, implementation fidelity, and contextual factors may help explain variability in outcomes, yet these features are often under-reported (Ma et al., 2021). Similarly, a systematic review and meta-analysis of physical literacy interventions found beneficial effects across physical competence, motivation and confidence, knowledge and understanding, and physical activity, but also substantial heterogeneity and a need to identify program characteristics that drive effectiveness (Carl et al., 2022). These findings make implementation quality, program leader preparation, access to equipment, progression, feedback, and the structure of skill practice important considerations when evaluating after-school FMS interventions.

Within this broader literature, evidence specifically concerning FMS and motor competence in after-school and OST settings remains fragmented. Existing studies use a wide range of intervention models and outcome measures. Some use the TGMD-2 to assess locomotor or object-control skills, whereas others employ PLAYfun, video-based process measures, single-skill tests, or broader physical literacy indicators. PLAYfun, for example, captures multiple dimensions of motor competence and has demonstrated acceptable measurement properties, but its scoring framework is not directly equivalent to TGMD-based outcomes (Cairney et al., 2018). This measurement diversity complicates quantitative synthesis. In addition, recent school-based FMS reviews primarily synthesize interventions delivered within the broader school context (Yin et al., 2025), whereas OST reviews have largely focused on physical activity, fitness, nutrition, or general health behaviors rather than motor competence as a primary outcome (Sliwa et al., 2023). Thus, a focused synthesis is needed to determine whether after-school and OST interventions improve FMS or related motor competence outcomes, to identify which data can be combined quantitatively, and to clarify the practical conditions under which these programs may be most useful. Therefore, this study aimed to systematically evaluate the effects of after-school and out-of-school-time interventions on fundamental movement skills and related motor competence outcomes in school-aged children. Specifically, the review (1) synthesized eligible intervention evidence using a systematic review and meta-analysis, (2) estimated the overall effect of compatible post-intervention motor skill outcomes using standardized mean differences, (3) summarized skill-specific and narrative findings from studies that could not be incorporated into the main pooled analysis, and (4) interpreted the findings in relation to methodological quality, implementation conditions, and implications for future after-school practice and research.

Materials and Methods

Design and Reporting Guidelines

This study employs a systematic review and meta-analysis approach to comprehensively evaluate the effects of after-school and out-of-school-time interventions on fundamental movement skills (FMS) and related motor competence outcomes in school-aged children. The report adheres to the PRISMA 2020 statement to enhance the transparency and completeness of the literature search, screening, inclusion, quality assessment, and results presentation processes (Page et al., 2021).

Since this study is a secondary analysis of published literature and does not involve the recruitment of new participants, experimental interventions, or the collection of personal data, no additional ethical approval was required. This study was not prospectively registered. To enhance the traceability of the research process,

this paper provides a detailed account of database sources, search strategies, eligibility criteria, study selection, data extraction, methodological quality assessment, and data synthesis methods.

Search Strategy

This study systematically searched three electronic databases: PubMed, the Web of Science platform, and Scopus. The search focused on four core concepts: after-school or out-of-school-time settings, fundamental movement skills or motor competence, school-aged children, and intervention studies. Search terms included, but were not limited to, “after-school”, “after school”, “afterschool”, “out-of-school time”, “out of school time”, “extracurricular”, “fundamental movement skill”, “motor skill”, “motor competence”, “gross motor”, “TGMD”, “Test of Gross Motor Development”, “child”, “student”, “youth”, “school-aged”, “schoolchildren”, “intervention”, “program”, “trial”, “evaluation”, and “training”.

Field adjustments were made according to the syntax of each database platform. The PubMed search was limited to the Title/Abstract fields; the Web of Science platform used Topic search; and Scopus used the TITLE-ABS-KEY fields fo the search. The complete search strategy is presented in Supplementary Table S1. The final search yielded a total of 268 records, including 42 from PubMed, 128 from the Web of Science platform, and 98 from Scopus.

Eligibility Criteria

Inclusion and exclusion criteria were established based on the PICOS framework. The population consisted of school-aged children, primarily those in elementary school or of a similar age group. Studies involving special clinical populations, or those with research objectives or outcomes that deviated significantly from the general development of FMS or motor competence in children, were excluded from this study.

Interventions were defined as those targeting FMS, motor competence, physical literacy, physical activity, or skill-focused development conducted in after-school, out-of-school-time, extracurricular, or similar settings. Interventions occurring solely within regular physical education classes, standard school curricula, or outside of after-school/out-of-school time were excluded.

Comparators included no-intervention controls, usual after-school programming, traditional after-school programs, standard recreational after-school activity programs, sports-based after-school programs, or other similar comparison conditions. Studies without an independent control or comparison group were considered for narrative synthesis when their research questions and findings were highly relevant to this review; however, they were not included in the main meta-analysis.

Eligible outcomes included FMS, motor competence, gross motor competence, locomotor skills, object-control skills, or other measures that explicitly reflected children’s motor skill performance. Acceptable measurement tools included the TGMD-2, TGMD-3, PLAYfun, MABC-2, video-based proficiency assessments, or specific skill tests used to assess motor skill performance. Studies reporting only MVPA, fitness, BMI, cognitive function, or psychological outcomes without a relevant motor skill outcome were not included in the main analysis.

Eligible study designs included randomized controlled trials, cluster-randomized trials, quasi-experimental studies, controlled pre-post studies, pilot intervention studies, and other intervention-evaluation designs. Systematic reviews, study protocols, cross-sectional studies, purely observational studies, conference abstracts, theses, qualitative studies, and reports for which sufficient information to determine eligibility could not be obtained were excluded.

Study Selection and Data Extraction

All retrieved records were merged and deduplicated. Duplicate records were primarily identified based on DOI, PMID, and title, with manual verification conducted by cross-checking authors, year, and title similarity. After deduplication, the remaining records proceeded to title and abstract screening. During screening, the primary criteria for inclusion were whether the literature met core criteria such as an after-school/out-of-school-time setting, school-aged children, intervention design, and motor skill-related outcomes.

During the full-text screening phase, the study population, intervention context, comparison conditions, outcome measures, and data extractability were further verified. Ultimately, 7 studies were included in the systematic review; of these, 4 provided continuous post-intervention data suitable for the main meta-analysis, while the remaining studies were presented using skill-specific synthesis or narrative synthesis.

Data extraction included author, publication year, country, study design, participant characteristics, sample sizes of the intervention and control groups, intervention content, comparison condition, intervention duration, measurement tools, primary outcomes, post-intervention means, standard deviations, sample sizes, and eligibility for inclusion in the meta-analysis. For continuous outcomes, priority was given to post-intervention means, standard deviations, and sample sizes. For skill-specific proficiency outcomes, extracted information included risk ratios, confidence intervals, standard errors, or other data required for calculation. If a study did not provide data in a format compatible with the main meta-analysis, it was retained for skill-specific or narrative synthesis rather than pooled quantitatively.

Methodological Quality Assessment

The methodological quality of included studies was assessed using the JBI Critical Appraisal Checklist for Quasi-Experimental Studies. JBI critical appraisal tools are used to assess the credibility, relevance, and applicability of study results and to support interpretation of the evidence (Joanna Briggs Institute, 2020). Because the included studies primarily employed quasi-experimental, controlled pre-post, or similar intervention-evaluation designs, the JBI quasi-experimental checklist was used rather than applying an RCT tool uniformly to all studies. Barker et al. (2024) recently revised and clarified the JBI risk-of-bias appraisal tool for quasi-experimental studies; their recommendations were also considered when interpreting the appraisal findings.

This study conducted the appraisal based on nine items: 1) whether the causal sequence is clear; 2) whether the comparison groups are comparable; 3) whether the treatment in each group is similar except for the intervention; 4) whether a control group is present; 5) whether multiple pre- and post-tests are conducted; 6) whether follow-up is complete or whether reasons for loss to follow-up are explained; 7) whether outcome measurements are consistent across groups; 8) whether outcome measurements are reliable; 9) whether the statistical analysis is appropriate.

Each criterion was rated as Yes, No, or Unclear. The results of the quality assessment were not used as grounds for directly excluding studies, but rather to interpret the credibility of the evidence and the limitations of the studies.

Data Synthesis and Statistical Analysis

Studies providing post-intervention mean, standard deviation, and sample size were included in the primary meta-analysis using RevMan. Since the motor skill measurement tools and scoring scales used in the included studies were not entirely consistent, this study adopted the standardized mean difference (SMD) as the effect size and reported the 95% confidence interval. For studies using different scales to assess similar continuous outcomes, the SMD can be used to standardize effect estimates across different scales (Higgins et al., 2024).

Given the differences among the included studies in terms of participants, intervention content, intervention duration, comparison conditions, and outcome measures, a random-effects model was used for the main analysis. This model allows for true differences in effects across studies and is therefore more suitable for a study like this one, where there is heterogeneity in intervention content and measurement tools. Heterogeneity was assessed using the Chi-square test, Tau^2, and the I^2 statistic.

The primary meta-analysis focused on post-intervention motor skill outcomes and included four studies: Albaloul et al. (2025), Burrows et al. (2014), Crozier et al. (2022), and Lee et al. (2020). Regarding Foweather et al. (2008), as it reported skill-specific proficiency outcomes rather than a continuous composite motor competence score, it was not included in the main continuous meta-analysis. The seven skill outcomes from this study were presented separately as risk ratios with 90% confidence intervals, consistent with the original results and RevMan settings. For Matvienko and Ahrabi-Fard (2010) and Bremer et al. (2020), a narrative synthesis was employed because the outcome format or extractable data were not suitable for pooling with the main analysis.
Since the main meta-analysis included fewer than 10 studies, this study did not perform a funnel plot or publication bias test.

This approach aligns with systematic review methodological recommendations, which state that funnel plots and related tests have limited interpretive value when the number of included studies is small (Higgins et al., 2024). All statistical results were interpreted with caution, taking into account methodological quality, the number of studies, sample size, and heterogeneity.

Results

Study selection

A total of 268 records were identified through database searches, including 42 records from PubMed, 128 records from the Web of Science platform, and 98 records from Scopus. After removing 110 duplicate records, 158 records remained for title and abstract screening. Of these, 142 records were excluded because they did not meet the eligibility criteria.

Sixteen full-text reports were then assessed for eligibility. Nine reports were excluded following full-text assessment, primarily because they were ineligible intervention studies, did not involve an eligible after-school or out-of-school-time intervention setting, did not report eligible motor skill outcomes, or were not compatible with the focus of the review. Finally, seven studies were included in the systematic review. Of these, four studies were included in the main meta-analysis, while three studies were synthesized narratively or presented as skill-specific evidence.

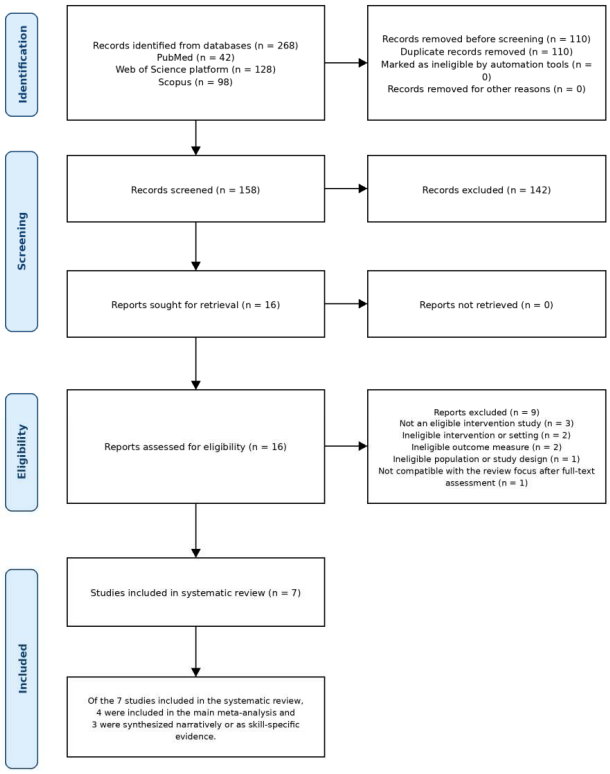

Figure 1. PRISMA 2020 flow diagram of study selection.

Characteristics of included studies

The seven included studies were published between 2008 and 2025 and were conducted in the United Kingdom, the United States, and Canada. The study designs included quasi-experimental studies, pre-post controlled studies, school- or site-level intervention comparisons, and exploratory controlled trials. Participants were school-aged children, ranging from kindergarten and early elementary school students to children aged up to 13 years.

The interventions were delivered in after-school, out-of-school-time, or extracurricular settings. Intervention approaches varied across studies and included an after-school multiskills club, a NutriActive after-school program, low-organized games, FMS-based after-school programming, physical literacy-focused after-school activity programming, and a CSPAP-based after-school overhand throwing intervention. Intervention duration ranged from 4 weeks to 6 months. Motor skill outcomes were measured using instruments such as the Test of Gross Motor Development-Second Edition, PLAYfun, video-based process-oriented skill assessments, and specific skill tests such as rope jumping, kicking accuracy, and throwing distance.

Four studies provided post-intervention continuous motor skill outcome data suitable for inclusion in the main meta-analysis. Foweather et al. (2008) was not included in the main pooled continuous analysis because it reported skill-specific proficiency outcomes rather than a composite continuous motor competence score. Matvienko and Ahrabi-Fard (2010) and Bremer et al. (2020) were synthesized narratively because their outcome formats were not directly compatible with the main pooled analysis. The characteristics of the included studies are summarized in Table 1.

Table 1. Characteristics of included studies

Study	Country	Design	Participants	Intervention	Comparator	Duration	Outcome measure	Use in synthesis
Foweather et al. (2008)	United Kingdom	Exploratory trial; school-level allocation	Children aged 8–9 years; multiskill club group (n = 19) and control group (n = 15)	After-school multiskills club designed to improve fundamental movement skills	Usual school routines	9 weeks; 18 coaching sessions	Seven process-oriented FMS proficiency measures assessed via video analysis	Skill-specific synthesis; not included in the main pooled analysis

Matvienko & Ahrabi-Fard (2010)	United States	Quasi-experimental study	Kindergarten and first-grade students; intervention group (n = 42) and control group (n = 28)	NutriActive after-school program including physical activity lessons emphasizing motor skill development, nutrition/health lessons, snack, and active play	No-intervention control schools	4 weeks, with follow-up after summer break	Rope jumping, kicking accuracy, throwing distance, fitness, and anthropometric outcomes	Narrative and skill-specific synthesis; not included in the main pooled analysis
Burrows et al. (2014)	Canada	Quasi-experimental study	40 children aged 6–10 years from two existing after-school physical activity programs; low-organized games program (n = 25) and sports-based program (n = 15)	Low-organized games-based after-school program	Sports-based after-school program	11 weeks	TGMD-2 Gross Motor Quotient, locomotor score, and object-control score	Included in main meta-analysis
Lee et al. (2020)	United States	Quasi-experimental pre-post controlled study	Elementary school children in grades K–2; intervention group (n = 20) and control group (n = 11)	FMS-based after-school program focusing on locomotor and object-control skills	Traditional after-school program	8 weeks; 3 sessions per week; 60 minutes per session	TGMD-2 total motor skills, locomotor skills, object-control skills; MVPA; cognitive functioning	Included in the main meta-analysis
Bremer et al. (2020)	Canada	Controlled intervention study across after-school sites	Children aged 7–13 years from eight after-school programs; experimental sites (n = 47) and control sites (n = 43)	Physical literacy intervention targeting movement competence, affect, confidence, and motivation	Standard after-school programming	12 weeks; 30 minutes per day, 5 days per week	PLAYfun movement competence and physical literacy-related questionnaire outcomes	Narrative synthesis; not included in the main pooled analysis
Crozier et al. (2022)	Canada	Pre-post comparison study	Children aged 5–12 years; physical literacy-focused ASAP group (n = 14) and standard recreational ASAP group (n = 15)	Physical literacy-focused after-school activity program	Standard recreational after-school activity program	6 months	TGMD-2 total raw score, object-control skills, physical activity, body composition, aerobic capacity	Included in the main meta-analysis
Albaloul et al. (2025)	United States	Quasi-experimental study	Students from a Title I school; CSPAP group (n = 60) and control group (n = 20)	Five-week after-school CSPAP component targeting overhand throwing	Control condition	5 weeks; 25 minutes once a week	Overhand throwing assessed by TGMD-2; perceived motor competence	Included in the main meta-analysis

Note. FMS = fundamental movement skills; TGMD-2 = Test of Gross Motor Development-Second Edition; MVPA = moderate-to-vigorous physical activity; ASAP = afterschool activity program; CSPAP = Comprehensive School Physical Activity Program

Methodological quality

The methodological quality of the seven included studies was assessed using the JBI Critical Appraisal Checklist for Quasi-Experimental Studies. Overall, all studies were retained for synthesis, although each was judged as "include, with concerns." Most studies clearly established the temporal sequence between the

intervention and outcome assessment and used consistent and generally reliable motor skill measures. However, several methodological limitations were identified.

Common concerns included unclear baseline comparability between groups, limited information on whether groups received similar treatment apart from the intervention, incomplete or insufficiently explained follow-up, and the absence of multiple measurements before and after the intervention. Most studies included a control or comparison group, but the degree of randomization and control over contextual factors varied across studies. The JBI quality assessment results are presented in Table 2.

Table 2. Methodological quality assessment of included studies using the JBI checklist

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Overall assessment
Foweather 2008	Y	U	Y	Y	N	N	Y	Y	Y	Include, with concerns
Albaloul 2025	Y	U	Y	Y	N	U	Y	Y	Y	Include, with concerns
Burrows 2014	Y	U	U	Y	N	U	Y	Y	Y	Include, with concerns
Crozier 2022	Y	Y	Y	Y	N	U	Y	Y	Y	Include, with concerns
Lee 2020	Y	U	U	Y	N	Y	Y	Y	Y	Include, with concerns
Matvienko 2010	Y	U	U	Y	Y	Y	Y	U	Y	Include, with concerns
Bremer 2020	Y	U	U	Y	N	U	Y	Y	Y	Include, with concerns

Note. Y = yes; N = no; U = unclear. Q1 = clear causal relationship; Q2 = similarity of comparison groups; Q3 = similar treatment apart from the intervention; Q4 = presence of a control group; Q5 = multiple measurements before and after the intervention; Q6 = complete follow-up or adequate explanation of attrition; Q7 = consistent outcome measurement; Q8 = reliable outcome measurement; Q9 = appropriate statistical analysis.

Effects on post-intervention motor skill outcomes

Four studies were included in the main meta-analysis of post-intervention motor skill outcomes: Albaloul et al. (2025), Burrows et al. (2014), Crozier et al. (2022), and Lee et al. (2020). Because the included studies used different motor skill measures and scoring scales, the standardized mean difference was used as the effect measure. A random-effects model was applied to account for clinical and methodological heterogeneity across interventions, samples, and outcome measures.

The pooled results showed a statistically significant positive effect of after-school or out-of-school-time interventions on children's post-intervention motor skill outcomes. The overall effect size was SMD = 0.58, with a 95% CI of 0.05 to 1.11. The overall test for effect was statistically significant ($Z = 2.15$, $p = 0.03$). Heterogeneity was moderate, with $Tau^2 = 0.16$, $Chi^2 = 6.75$, $df = 3$, $p = 0.08$, and $I^2 = 56\%$. The forest plot for the main meta-analysis is shown in Figure 2.

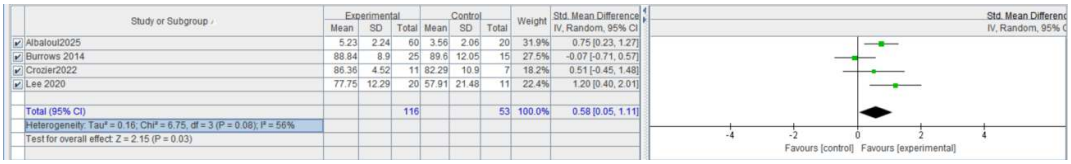

Figure 2. Forest plot of the main meta-analysis for post-intervention motor skill outcomes.

Skill-specific and narrative findings

Foweather et al. (2008) was analyzed separately because it reported skill-specific proficiency outcomes rather than a continuous composite motor competence score. Seven process-oriented FMS proficiency outcomes were examined: balance, leap, vertical jump, sprint run, kick, catch, and throw. The results showed significant improvements in balance proficiency and kick proficiency. Balance proficiency showed a risk ratio of 2.21, with a 90% CI of 1.81 to 2.70 and $p < 0.00001$. Kick proficiency showed a risk ratio of 3.29, with a 90% CI of 1.35 to 8.01 and $p = 0.03$. The remaining skill outcomes—including leap, vertical jump, sprint run, catch, and throw—did not reach statistical significance, although most effect estimates favored the intervention group. The skill-specific results are summarized in Table 3.

Matvienko and Ahrabi-Fard (2010) were included in the systematic review but not in the main meta-analysis because they primarily reported individual skill-specific outcomes rather than a composite motor competence score compatible with the main pooled analysis. The study examined a 4-week NutriActive after-school program among kindergarten and first-grade students and reported improvements in specific motor skill outcomes such as rope jumping, kicking accuracy, and throwing distance.

Bremer et al. (2020) was also synthesized narratively. This study evaluated a 12-week physical literacy intervention delivered across after-school sites. Although no significant group differences were observed in children's movement competence, self-efficacy, or motivation, the intervention group showed improvement in affect. Program leaders also reported increased knowledge and self-efficacy following training, while noting implementation challenges such as equipment availability and behavior management. These findings suggest that after-school interventions may influence broader physical literacy-related domains, but implementation quality and contextual constraints may affect their impact on motor competence.

Overall, the skill-specific and narrative findings suggest that after-school and out-of-school-time interventions may produce positive effects on selected motor skill outcomes, particularly when the intervention includes structured opportunities for skill practice. However, the effects were not consistent across all skill domains or studies, and the findings should be interpreted in light of methodological limitations and variation in intervention content, duration, measurement tools, and implementation conditions.

Table 3. Skill-specific outcomes from Foweather et al. (2008)

Outcome	Study	Effect measure	Effect estimate	Z	P-value	Interpretation
Balance proficiency	Foweather et al. (2008)	Risk ratio (90% CI)	2.21 [1.81, 2.70]	6.56	< 0.00001	Significant improvement
Leap proficiency	Foweather et al. (2008)	Risk ratio (90% CI)	1.19 [0.77, 1.85]	0.65	0.52	Not statistically significant
Vertical jump proficiency	Foweather et al. (2008)	Risk ratio (90% CI)	1.10 [0.86, 1.41]	0.63	0.53	Not statistically significant
Sprint run proficiency	Foweather et al. (2008)	Risk ratio (90% CI)	1.12 [0.71, 1.77]	0.41	0.68	Not statistically significant
Kick proficiency	Foweather et al. (2008)	Risk ratio (90% CI)	3.29 [1.35, 8.01]	2.20	0.03	Significant improvement
Catch proficiency	Foweather et al. (2008)	Risk ratio (90% CI)	1.87 [0.97, 3.61]	1.57	0.12	Not statistically significant
Throwing proficiency	Foweather et al. (2008)	Risk ratio (90% CI)	1.76 [0.66, 4.70]	0.95	0.34	Not statistically significant

Note. The table summarizes single-study skill-specific analyses for Foweather et al. (2008) generated in RevMan. Because only one study contributed to each outcome, heterogeneity was not applicable. The analyses were presented using risk ratios with 90% confidence intervals, consistent with the RevMan settings shown in the output screenshots.

Discussion

Principal findings

This study conducted a systematic review and meta-analysis on the effects of after-school and out-of-school-time interventions on fundamental movement skills and related motor skill outcomes in school-aged children. Based on the inclusion criteria established earlier, this study ultimately included 7 studies, of which 4 provided continuous outcome data suitable for the main meta-analysis, while the remaining studies were presented in the form of skill-specific syntheses or narrative syntheses. The included interventions comprised after-school multiskills clubs, FMS-based after-school programs, physical literacy-focused after-school activity programs, low-organized games-based after-school programs, the NutriActive after-school program, and the after-school CSPAP component, all of which aligned with the after-school or out-of-school-time settings of interest in this study.

The main meta-analysis showed that after-school and out-of-school-time interventions had a significant positive effect on children's post-intervention motor skill outcomes, with a pooled effect size of SMD = 0.58, 95% CI 0.05–1.11, p = 0.03. These results suggest that, compared to control conditions, structured after-school or out-of-school-time interventions may help improve children's FMS or motor competence. However, moderate heterogeneity was observed across studies (I^2 = 56%), suggesting differences in sample characteristics, intervention content, duration, and measurement tools. Therefore, this result is best interpreted as preliminary support for the potential positive effects of after-school interventions, rather than as evidence that all after-school programs consistently improve children's FMS.

In addition to the main analysis, the skill-specific results reported by Foweather et al. (2008) indicate that after-school multisport clubs had a more pronounced effect on certain specific skills. Specifically, balance proficiency and kick proficiency showed statistically significant improvements, whereas leap, vertical jump, sprint run, catch, and throw did not reach statistical significance. This suggests that the effects of after-school interventions may be skill-specific, particularly in programs where the practice content closely aligns with the measured skills, the skill structure is well-defined, or children have ample opportunities for practice. Based on the combined results of the main meta-analysis and the skill-specific findings of Foweather et al. (2008), the

existing evidence supports the potential of after-school and out-of-school-time interventions to promote children's motor skill development, although this effect is not entirely consistent across all skill dimensions.

Interpretation of the main findings

This study used SMD as the effect size in the main analysis, primarily because the measurement tools and scoring scales used in the included studies were inconsistent, including TGMD-2, PLAYfun, video-based proficiency assessment, and specific skill tests. In other words, the pooled results reported in Section 3 reflect the standardized effect of after-school or out-of-school-time interventions on overall motor skill outcomes, rather than changes in scores on any specific scale.

All four studies included in the main meta-analysis featured some degree of structured movement practice. The FMS-based after-school program evaluated by Lee et al. (2020) focused on locomotor and object-control skills; Burrows et al. (2014) compared a low-organized games-based after-school program with a sports-based program; Crozier et al. (2022) employed a physical literacy-focused after-school activity program; and Albaloul et al. (2025) used an after-school CSPAP component to target overhand throwing. Collectively, these studies suggest that the after-school period can increase not only the duration of physical activity but also opportunities for skill learning, repeated practice, and movement feedback through purposeful activity planning.
This may be a key reason for the positive combined effect observed in this study. The development of FMS typically requires repeated practice, age-appropriate task design, clear feedback, and progressive activity organization, and cannot rely solely on children's spontaneous activities. Compared to unstructured free play, structured after-school programs are more likely to provide clear movement goals, skill practice, game-based learning, and feedback. For children with limited daily physical education time, insufficient after-school sports opportunities, or a lack of physical activity resources, the after-school setting may serve as an important supplementary environment for promoting motor competence.

At the same time, an I^2 of 56% indicates that the effects across studies are not entirely consistent. This heterogeneity may be related to differences in intervention duration, frequency, target skills, implementer background, and measurement tools. For example, some studies focus directly on FMS or object-control skills, while others take a physical literacy or broader after-school activity program approach. Cairney et al. (2018) demonstrated that PLAYfun is a tool within physical literacy assessment designed to evaluate motor competence, covering dimensions such as running, locomotor skills, object control, and balance, and exhibiting good interrater agreement. Therefore, although both PLAYfun and TGMD-2 are related to motor competence, their measurement focuses are not entirely the same, which is one reason why the pooled results should be interpreted with caution.

Implementation Considerations

The findings of this study also suggest that the effectiveness of after-school and out-of-school-time interventions depends largely on implementation quality rather than merely on the existence of a program. Mears and Jago (2016) found that the effects of after-school interventions on MVPA were generally mixed, with a pooled increase of 4.84 min/day whose 95% CI crossed zero. This pattern is consistent with broader motor competence intervention research. Ma et al. (2021) found that process evaluation was reported in only half of the motor competence intervention studies they reviewed and identified intervention duration, dose, provision of lesson plans, and implementation-related factors as potential moderators of outcomes. Likewise, Carl et al. (2022) reported positive effects of physical literacy interventions across physical competence and other domains but emphasized heterogeneity and the need to identify program characteristics that influence effectiveness. Together, these findings indicate that the after-school setting is promising, but positive effects are likely to depend on program design, implementation fidelity, and context.
The study by Bremer et al. (2020) further illustrates this point. This study implemented a 12-week physical literacy intervention at after-school sites; although no significant between-group improvements were observed in movement competence, self-efficacy, or motivation, the intervention group showed improvements in affect. Additionally, program leaders reported increased knowledge and self-efficacy following training, while also identifying equipment availability and behavior management as major challenges during implementation. This suggests that after-school interventions may influence not only motor skill outcomes but also children's emotional experiences during activities and program leaders' implementation capabilities; however, without sufficient support for equipment, space, staff training, and behavior management, even well-conceived interventions may struggle to translate into sustained improvements in motor competence.

Therefore, future after-school FMS interventions should not merely aim to "increase activity time," but should emphasize structured and skill-oriented activity content. Ideal programs should include clear FMS learning objectives, developmentally appropriate activity design, sufficient repetition, progression, feedback, game-based practice, as well as training and implementation supervision for program leaders. Particularly in out-of-school-time settings, where interventionists may not be professional physical education teachers, the availability of instructional materials and equipment, the quality of training, and the consistency of program implementation can all directly influence intervention outcomes. Stoepker et al. (2026) support this view. Their OST pilot study improved program leaders' PA-promoting behaviors through a data-sharing process and

observed significant improvements in boys' locomotor skills, though children's MVPA did not increase significantly. This suggests that the effectiveness of out-of-school-time interventions may depend not only on activity levels but also on program leaders' behaviors, feedback mechanisms, and implementation strategies.

Strengths and Limitations

This study has several strengths. First, the research question is well-focused, specifically evaluating the effects of after-school and out-of-school-time interventions on the fundamental motor skills (FMS) and motor competence of school-aged children, rather than broadly discussing school-based physical activity interventions. Second, this study systematically searched PubMed, the Web of Science platform, and Scopus and reported study selection according to the PRISMA 2020 guidelines, enhancing the transparency of the research process. Third, this study distinguished between the main meta-analysis, skill-specific synthesis, and narrative synthesis based on data types, thereby avoiding the forced inclusion of continuous outcomes, dichotomous proficiency outcomes, and non-combinable data into a single model. Fourth, this study used the JBI Critical Appraisal Checklist for Quasi-Experimental Studies to assess the quality of included studies, allowing for the interpretation of results in conjunction with study quality.

This study also has limitations. First, the number of included studies is limited; the main meta-analysis comprises only four studies. Consequently, the stability of the pooled effects is limited, and it is not possible to conduct sufficient subgroup analyses, sensitivity analyses, or assessments of publication bias. Second, the sample sizes of the included studies were generally small, and most were quasi-experimental studies, pre-post comparison studies, or exploratory trials, with limited randomization. The JBI quality assessment indicated that all 7 studies were classified as "included, with concerns," with primary issues centered on baseline comparability, consistency of non-intervention treatments, follow-up completeness, and insufficient multiple measurements.

Third, there was heterogeneity in intervention content and measurement tools. The forms of intervention included in the study encompassed multiskills clubs, the NutriActive after-school program, low-organized games, FMS-based after-school programs, physical literacy interventions, and CSPAP components; measurement tools included the TGMD-2, PLAYfun, video-based proficiency assessments, and individual skill tests. Although this study employed SMD and a random-effects model to address some of this heterogeneity, the results should still be interpreted with caution. Fourth, some studies did not provide post-intervention means, standard deviations, and sample sizes that could be directly incorporated into the main meta-analysis. For example, Foweather et al. (2008) reported proficiency outcomes, which could therefore only be presented separately as risk ratios; Matvienko and Ahrabi-Fard (2010) and Bremer et al. (2020) were not suitable for the main analysis due to the nature of their outcomes or data formats, and thus could only be included in a narrative synthesis.

Implications for Future Research and Practice

The findings of this study offer insights for both practice and future research. For schools, communities, and after-school program providers, after-school and out-of-school-time settings can serve as important supplementary environments for promoting children's FMS and motor competence. Compared with regular physical education, after-school programs offer greater flexibility in scheduling and activity formats, creating additional opportunities for repetition, game-based practice, and skill-focused instruction. A recent review of OST programming found that programmatic and organization-level interventions can strengthen environmental supports and youth physical activity during OST, complementing school-day efforts (Sliwa et al., 2023). This reinforces the practical value of treating after-school provision as part of a broader school-community activity system rather than as an isolated recreational period. For children with limited physical activity opportunities or those from lower socioeconomic backgrounds, accessible and well-supported after-school programs may be particularly valuable.

At the practical level, after-school FMS interventions should prioritize program quality. Furthermore, these interventions should not focus solely on whether children complete the prescribed activity volume, but also on their perceived competence, physical self-concept, and intrinsic motivation during activities. Lohbeck et al. (2021) noted that physical self-concept and intrinsic motivation are significantly associated with children's physical performance, suggesting that after-school programs should prioritize children's experiences of success, confidence in participation, and sustained motivation when designing skill practice. Program design should not merely focus on whether children are "active," but also on whether they are practicing movement skills with clear objectives. Future programs should establish clear FMS learning objectives and ensure that activity content aligns with target skills. At the same time, training for program leaders should be strengthened to enable them to provide effective feedback, organize age-appropriate games, maintain children's motivation to participate, and address common issues such as behavior management and equipment shortages.

Future research should further improve methodological quality. First, more large-sample randomized controlled trials (RCTs) or cluster-randomized controlled trials (CRCTs) are needed to strengthen causal inferences. Second, studies should more comprehensively report baseline comparability, attrition, intervention fidelity, attendance, and adverse events. Third, it is recommended to use standardized and validated FMS or motor competence measurement tools, and to fully report post-intervention means, standard deviations, and sample

sizes to facilitate subsequent meta-analyses. Fourth, follow-up assessments should be increased to determine whether the effects of after-school interventions on FMS are sustained.

Furthermore, future research should further explore which children are most likely to benefit from after-school FMS interventions. Children of different ages, genders, baseline motor competence levels, physical activity levels, or socioeconomic backgrounds may respond differently to the interventions. Mears and Jago (2016) also noted that the effects of after-school interventions may vary across different subgroups. Therefore, future research should not only focus on overall effects but also further analyze how intervention components, implementation conditions, and child characteristics collectively influence intervention effectiveness.

Overall, this study provides preliminary support for the role of after-school and out-of-school-time interventions in promoting children's FMS and motor competence. Existing evidence suggests that such interventions may yield positive effects, but findings remain limited by the small number of studies, the limited quality of study designs, and outcome heterogeneity. Future research requires more high-quality, standardized studies with long-term follow-up that emphasize implementation fidelity to further clarify the true effects of after-school FMS interventions and identify best practice models. For example, the CHAMP-Afterschool Program protocol proposed by Robinson et al. (2022) has begun to focus on motor skills interventions implemented by after-school staff and incorporating long-term follow-up, which underscores the need for future research to place greater emphasis on sustainable implementation and long-term effects in real after-school settings. This is also consistent with developmental perspectives suggesting that motor competence is closely linked to children's physical activity, perceived competence, fitness, and healthy weight status across development (Robinson et al., 2015).

Conclusions

This systematic review evaluated the effects of after-school and out-of-school-time interventions on fundamental movement skills and related motor competence outcomes in school-aged children. Across seven included studies, the evidence suggests that structured after-school or out-of-school-time interventions may support motor skill development. The main meta-analysis of four studies showed a statistically significant positive effect on post-intervention motor skill outcomes (SMD = 0.58, 95% CI 0.05–1.11, p = 0.03), while skill-specific findings from Foweather et al. (2008) indicated significant improvements in balance and kicking proficiency.

However, these findings should be interpreted with caution. The number of included studies was limited, sample sizes were generally small, study designs were predominantly quasi-experimental or controlled pre-post designs, and there were differences among studies regarding intervention content, duration, and measurement tools. The JBI quality assessment also indicated that all included studies had certain methodological concerns. Therefore, the current evidence is better understood as preliminary support for after-school and out-of-school-time FMS interventions rather than definitive conclusions.

Future research should conduct larger-scale, higher-quality randomized controlled trials (RCTs) or cluster-randomized controlled trials (CRCTs), using standardized FMS or motor competence measurement tools, and fully reporting intervention fidelity, attendance, follow-up outcomes, and statistical data suitable for meta-analysis. In practice, after-school programs should not focus solely on increasing activity time but should also emphasize structured skill practice, program leader training, and implementation quality to more effectively promote children's FMS development.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (OpenAI) to assist with language editing and with improving the clarity and organization of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Data Availability Statement

All data analyzed in this systematic review and meta-analysis were extracted from previously published studies. Extracted study-level data and analytic inputs are provided in the supplementary materials or are available from the corresponding author upon reasonable request.

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