HUMAN MOVEMENT (ISSN 1899-1955)
2026; 27(4): 17–32

The effect of task-oriented interventions on motor performance of children with developmental coordination disorder: a systematic review

© Wroclaw University of Health and Sport Sciences

review paper
DOI: https://doi.org/10.5114/hm/241314

ELENI NOMIKOU[1], VASILIKI SAKELLARI[1], THEOFANI BANIA[2], NIKOLAOS CHRYSAGIS[1]

[1] Physiotherapy Department, Faculty of Health and Care Sciences, University of West Attica, Egaleo, Greece
[2] Physiotherapy Department, School of Health Rehabilitation Sciences, University of Patras, Rio, Greece

ABSTRACT

Purpose. Developmental coordination disorder (DCD) is a common neurodevelopmental disorder characterized by marked impairment in coordination of both gross and fine motor skills. Task-oriented interventions are highly recommended for children with DCD, to improve their motor performance and participation in daily activities. The aim of the present study was to evaluate the effectiveness of task-oriented interventions in children with DCD.

Methods. This systematic review was performed in accordance with PRISMA guidelines, and its protocol was registered in PROSPERO with the identification number CRD42025650044. A comprehensive literature search was conducted across PubMed, Scopus, ScienceDirect, Google Scholar, and Pedro Databases for randomized controlled trials (RCTs) involving children with developmental coordination disorder (DCD), utilizing the key terms: "motor performance", "postural control", "balance", "task-oriented intervention", and "task-oriented training". The methodological quality of the included studies was assessed with PEDro scale.

Results. This review included 10 studies (RCTs) with moderate to high methodological quality. Evidence supports the significant role of task-oriented training in enhancing sensory organization, postural control, and stability in this population.

Conclusions. The findings of this systematic review suggest that task-oriented interventions may be effective in enhancing motor performance, particularly in areas such as balance, sensory organization, and muscle strength. These benefits appear especially prominent in children with more severe impairments in fine and gross motor skills. Nonetheless, the strength of evidence regarding overall motor performance is limited due to the variability in methodological quality among the included studies.

Key words: paediatric rehabilitation, neurodevelopmental disorder, motor skills, postural control, motor learning

Introduction

Developmental coordination disorder (DCD) is a common neurodevelopmental disorder with a prevalence ranging from 2% to 20% across different studies and populations, depending on diagnostic criteria, while a rate of 5%–6% is the most commonly reported among school-aged children (5–11 years) [1, 2]. DCD is also often observed as comorbid to other neurodevelopmental disorders such as autism spectrum disorder (ASD), attention deficit and hyperactivity disorder (ADHD) or learning disorders such as dyslexia [3]. The onset of symptoms usually manifests early in development, with children with DCD primarily exhibiting impaired static and dynamic balance, as well as motor coordination issues in fine and gross motor skills. These challenges often result in slow, awkward, or imprecise motor performance [4–7]. Moreover, children with DCD often experience sensory processing difficulties, particularly in proprioceptive and vestibular systems, which may further impair motor planning and motor learning [2]. These impairments and limitations are typically observed in the absence of any intellectual disability or other neurological condition affecting movement, which could explain these motor-sensory deficits [1, 3, 8]. Further, these motor difficulties have a significant impact

Correspondence address: Eleni Nomikou, Physiotherapy Department, Faculty of Health and Care Sciences, University of West Attica, Agiou Spidonos 28, 12243 Egaleo, Greece, e-mail: enomikou@uniwa.gr, eleni_nomikou@yahoo.gr; https://orcid.org/0009-0005-9549-6313

Received: December 30, 2025
Accepted for publication: October 02, 2026

Citation: Nomikou E, Sakellari V, Bania T, Chrysagis N. The effect of task-oriented interventions on motor performance of children with developmental coordination disorder: a systematic review. Hum Mov. 2026;27(4):17–32; doi: https://doi.org/10.5114/hm/241314.

on the daily activities of children with DCD, including academic skills, social interaction and participation, as well as activities of daily living (ADLs) [1, 8–10]. Emerging evidence also suggests that compared to their peers, children with DCD may have a lower overall quality of life [11]. Between 30% and 70% of individuals with DCD continue to experience these functional restrictions during adolescence and adulthood [8]. Therefore, it is very important to address the motor difficulties of children with DCD through appropriate interventions in early childhood.

Intervention strategies to improve motor performance in children with DCD are grouped in three main types: (a) traditional /conventional physical and occupational therapy: a combination of common treatment modalities and non-invasive techniques such as strength or balance training, aerobic exercises, fine motor exercises, ultrasound and electric stimulation [12–14], (b) process-oriented approaches: specifically designed activities which focus on understanding and remediating underlying processes such as sensory integration, core stability, muscle strength not developed adequately in children with DCD and affect their motor skills [12, 14, 15] and (c) task-oriented approaches: use of specific tasks and daily life activities to improve motor performance and participation [10, 15, 16].

Task-oriented interventions, also referred to as task-specific training, are based on the principles of motor learning and neuroplasticity and use specific activities that focus on engaging children in tasks that enhance their motor skills through practical, goal-directed activities in natural environments [17]. These interventions, which focus on the activity and participation domains of the International Classification of Functioning, Disability and Health: Children and Youth Version (ICF-CY) [6, 14, 18], are designed to improve motor performance and to increase children's participation in daily life activities. Specifically, the task and environment settings are progressively modified throughout the program to become more challenging for the child, allowing targeted improvements in motor performance (*i.e.* motor proficiency, motor coordination, and balance). Additionally, whether delivered to individuals or in small group programs, these interventions are considered to positively impact the children's motivation and involvement in both academic and social activities [15, 18, 19]. As it is crucial to increase the motor performance and participation of children with DCD, task-oriented interventions are important for these children.

Task-oriented interventions are progressively gaining acceptance in addressing the motor coordination and balance deficits experienced by children with Developmental Coordination Disorder (DCD). However, there exists conflicting evidence concerning their efficacy in individuals with DCD, as previous systematic reviews have adopted a broader perspective on motor skills interventions, inclusive of studies employing approaches other than task-oriented or task-specific methods to address motor deficits [15, 16, 20]. Notably, the most recent meta-analysis by Gao *et al.* [21], has explored motor- based interventions under a broader lens, encompassing different methodologies and psychosocial/participation outcomes. Moreover, this study has included extensive age ranges expanding into adolescence and heterogeneous samples with comorbid neurodevelopmental conditions, reducing the ability to draw specific conclusions regarding the effectiveness of task-oriented interventions in children with DCD. The most recent review focused on task-oriented interventions systematic was conducted by Miyahara *et al.* [18]. However, the low methodological quality of included randomized controlled trials (RCTs) limited the strength of the conclusions in this review. This previous review was also published several years ago, while new relevant RCTs are available in literature. Therefore, the current systematic review aimed to evaluate the effectiveness of task-oriented interventions on motor performance of children with DCD, using information only from RCTs, and to provide a comprehensive synthesis of current evidence.

Material and methods

Protocol and registration

This systematic review was conducted according to PRISMA guidelines. The protocol of this review was registered in PROSPERO under the identification number CRD42025650044.

Search strategy

A systematic literature review was conducted in electronic databases PubMed, Scopus, Science Direct, Google Scholar, and Pedro Databases until June 2025, and with no date restrictions. The following MeSH terms and keywords and their combinations (using the Boolean operators "OR" and "AND') were used: "motor skills disorder [MeSH]", "developmental coordination disorder", "DCD" "motor performance", "postural control", "balance", "QoL", "task-oriented intervention", "task-oriented training", "task-specific intervention", "task-oriented motor programme". Filters for RCTs and children were applied. We also con-

ducted a manual search of the reference lists of the included studies and previous systematic reviews to identify additional references. The detailed search strategy for PubMed is available in Supplementary materials.

Eligibility criteria

The inclusion criteria, were defined according to the study design and PICO strategy as follows: (a) randomized controlled trials (RCTs) (b) participants were children aged 3–12 years old, with DCD, or with possible DCD, or at risk of developing DCD (c) studies implementing task-oriented interventions in rehabilitation centres or clinics, in school settings or at home (d) the control group received no therapy or physiotherapy/occupational therapy that involved any task-oriented intervention (e) outcome measures of motor performance, static and dynamic balance.

To address potential heterogeneity and enhance conceptual consistency, a predetermined intervention taxonomy was established. Eligible interventions were classified under the umbrella term "task-oriented intervention," defined as structured approaches that are goal-directed and focus on improving performance in functional tasks based on the principles of motor learning and neuroplasticity [10, 12, 21]. Task-oriented interventions were further categorized into four subtypes according to the primary mode of delivery and the relative emphasis on motor tasks or cognitive strategies: (a) task-specific interventions, involving repetitive practice of context-specific motor tasks designed to improve motor performance [22]; (b) sports-based interventions, incorporating structured and progressive sports activities to facilitate skill acquisition [23]; (c) cognitive task-oriented approaches, focusing on cognitive strategies and guided discovery to enhance daily functioning [24]; and (d) group motor skills programs, top-down interventions delivered in groups [14].

Exclusion criteria included: (a) studies that included participants with DCD and other comorbidities, such as autism or ADHD, and reported results not separately for children with DCD, and (b) studies published in languages other than English.

Data extraction and quality assessment

Two independent reviewers of the research team (EN, NC) performed the study selection according to eligibility criteria and extracted data. Any disagreement between the two reviewers was discussed, and if consensus could not be reached, a third reviewer (TB) resolved the issue(s).

The methodological quality of included trials was assessed by 2 reviewers (EN, NC) independently, using the valid and reliable Physiotherapy Evidence Database (PEDro) scale. The PEDro scale consists of 11 items including eligibility criteria, random and concealed allocation of participants, baseline similarity, blinding of participants, assessors and therapists, outcome measures, intention-to-treat analysis, statistical comparisons and measures of variability [21]. The first item assesses external validity, items 2 to 9 assess internal validity, and the last two items (10 & 11) are concerned with statistical reports [25, 26]. Each item is scored as either "yes" (1) when the criterion is clearly satisfied or "no" (0). The maximum score is 10 points, as the first criterion is excluded from the total PEDro score. A total score ≤ 3 indicates "poor" methodological quality, a score 4-5 corresponds to "fair" quality, and scores 6–8 and 9–10 indicate "good" and "excellent" quality, respectively [26]. If a study had already been scored in the PEDro database, we used that score. A third reviewer resolved any disagreement between the two reviewers in scoring.

Results

Study selection

During the initial search, a total of 408 studies were identified through database searching. After removing duplicates (n = 84), 103 records were excluded via automated database filters to restrict the search to RCTs and English language publications to conform to predefined inclusion criteria. A preliminary screening of titles and abstracts of 221 articles led to the exclusion of 179 articles based on our inclusion criteria. A total of 42 full-text articles were assessed for eligibility and 32 articles subsequently excluded for different reasons (*e.g.* irrelevant content, the control group received task-oriented training, included participants with DCD and other comorbidities such as autism or ADHD, or results not analyzed separately for DCD). Finally, 10 studies were included in this systematic review. The PRISMA flow diagram for the study selection process is presented in Figure 1.

Study characteristics

The characteristics of the 10 included studies are summarized in Table 1. The included studies were RCTs published between 2010 and 2023 and involved a total of 526 children with DCD aged 4 to 10 years old. The diagnosis of DCD was confirmed according to stand-

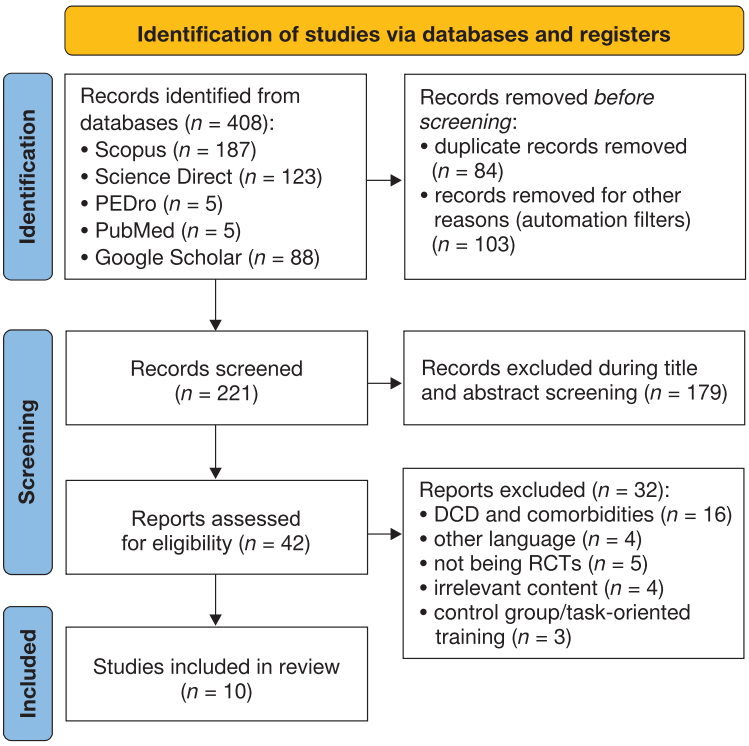


Figure 1. PRISMA flow diagram for literature search and study selection

ardized diagnostic criteria for DCD, such as Diagnostic and Statistical Manual of Mental Disorders, 4th and 5th Edition (n = 6 studies) in combination with motor performance tests (M-ABC or M-ABC-2/ n = 5 studies, BOT or BOT-2/n = 5 studies) [17, 26–35]. Two studies also used the Developmental Coordination Disorder Questionnaire (DCDQ) to identify children with DCD [33, 35].

Three studies implemented task-specific balance training programmes [30, 31, 33], three studies task-oriented motor training programmes [17, 27, 34] one Cognitive Orientation to daily Occupational Performance (CO-OP) intervention [35] and three task-specific sports training [28, 29, 32]. All programmes were delivered in individual sessions, except for two programmes that were group-based [27, 34]. The duration of the programmes was short-term ranging from 6 weeks [32] to 12 weeks [28–31]. In general, the frequency of sessions ranged from once per week [17, 28, 29, 32, 35] to three times per week [27, 33]. In three studies, the intervention involved a combination of weekly supervised sessions and daily home exercises [17, 28, 29]. The duration of each session ranged from 30 [32] to 90 minutes [30, 31] with an average duration of approximately one hour. The control group in 9 studies received no intervention and continued their regular daily activities [27–35].

The included studies examined the effect of task-oriented interventions in four different domains of motor performance: manual dexterity, muscle strength, static and dynamic balance, and ball skills. The Movement Assessment Battery 1st (M-ABC) and 2nd Edition (M-ABC2) and the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) were the main outcome measures used to evaluate motor performance in most studies [17, 27, 30, 32, 34, 35]. Additionally, several studies applied the Sensory Organization Test (SOT) and posturography to evaluate postural control and balance [17, 28–31].

Methodological quality

Overall, the PEDro scoring ranged from 5/10 to 8/10 with a mean score of 6.6/10, which is indicative of good methodological quality (Table 2). Specifically, out of the 10 included studies, three received a score of 5/10, one received a score of 6/10, three studies were scored 7/10, and another three studies obtained the highest score 8/10. The majority of the studies demonstrated good internal validity, based on their scores on items 2–9 of PEDro scale. However, because of the nature of intervention the blinding of participants and therapists was not feasible.

Task-oriented interventions and motor performance

Changes in overall motor performance and in particular domains, were assessed in six studies with BOT [17] and M-ABC /M-ABC2 [27, 30, 32, 34, 35] as a primary outcome measure. Table 3 presents the outcome measures and results of the included studies on motor performance. Statistically significant improvements in overall motor performance test batteries or individual subtests compared to other therapy or no intervention were found in four studies [27, 30, 34, 35]. Three of these studies were of fair quality (PEDro = 5), while one was deemed as of excellent methodological quality (PEDro ≥ 7). One study with good methodological quality [17] showed no differences between the TST and control groups ($p > 0.05$, Cohen's $d = 0.27$). In the study of Hillier *et al.* [32], the statistical significance between groups was borderline ($p = 0.057$), suggesting a trend towards significance for the aquatic therapy group. Farhat *et al.* [27] demonstrated significant improvements in the M-ABC2 total score ($p < 0.001$, Cohen's $d = 3.22$) as well as in all M-ABC2 domains after 8 weeks group task-training compared to the control group performing regular activities. Similarly, Said-

Table 1. Characteristics of included studies

Study	Age range (y)	Group E1/E2/C	Experimental group intervention	Control group intervention	Duration	Frequency
Au *et al.* [17]	6–9	11/-/11	warm-up (5 min) task-oriented training: functional tasks which included body stability and body transport standing: *e.g.* walking, running, jumping, hopping, skipping and galloping cool down (5 min)	warm-up (5 min) core stability programme physioball in supine, prone, sitting and standing positions cool down (5 min)	8 weeks	1 session per week (1 hour) daily: home xercises
Farhat *et al.* [27]	6–10	14/-/27	group training warm-up (10 min) functional tasks and exercises: balance, core stability, motor agility exercises, ball skills, strength, flexibility *e.g.* high-knee march, hopscotch game, slalom between plastic sticks, shooting at goal, turning and jumping over rope recovery (5 min)	regular classroom activities, physical education classes and physical activities most important: fundamental gross motor skills (hopping, jumping, throwing and catching) and basic motor abilities/skills in sport team to be prerequisite for skills in sport team	8 weeks	3 sessions per week (1 hour)
Fong *et al.* [28]	6–9	21/23/18	TKD classes and self-practice warm-up and stretching (5–15 min) TKD training protocol: punching and blocking in horseback riding stance (body punch, rising block *etc.*), kicking in fighting stance (side kick, front kick, back kick) cool down and stretching (10 min)	no intervention	12 weeks	1 session per week (TKD classes) (1 hour) daily: home exercises (excluding the TKD class days) (1 hour)
Fong *et al.* [29]	6–9	21/23/18	TKD classes and self-practice warm-up and stretching (5–15 min) TKD training protocol: punching and blocking in horseback riding stance (body punch, rising block *etc.*), kicking in fighting stance (side kick, front kick, back kick) cool down and stretching (10 min)	no intervention	12 weeks	1 session per week (TKD classes) (1 hour) daily: home exercises (excluding the TKD class days) (1 hour)
Fong *et al.* [30]	7–10	55/-/53	FMT – task-specific training* concurrent with EMG *task-specific training/*e.g.*: two-leg balance on a stability trainer, one-leg balance on the ground, double-leg hop or jump forward, walk and balance a ball on a peg board simultaneously	no intervention	12 weeks	2 sessions per week (1.5 hours)
Fong *et al.* [31]	7–10	53/55/53	E1/FMT – task-specific training* concurrent with EMG E2/FMPT – task-specific training* and power training** *task-specific training/*e.g.*: two-leg balance on a stability trainer, one-leg balance on the ground, double-leg hop or jump forward, walk and balance a ball on a peg board simultaneously **power training/*e.g.*: squatting exercise, isolated knee extension in sitting, seated calf raises	no intervention	12 weeks	2 sessions per week (1.5 hours)
Hiller *et al.* [32]	5–8	6/-/6	aquatic physiotherapyHalliwick method and WST: graded task-specific training was integrated into the program (ball skills, standing balance, and walking/running)	no intervention	6–8 weeks	1 session per week (30 min)
Jahanbakhsh *et al.* [33]	7–9	13/13/13	task-specific balance training (single leg stance, double leg stance, balance path, forward hop on marking sheets) E1 – dual-task training group: task specific balance training and cognitive tasks (*e.g.* counting numbers, naming things, remembering things) E2 – one -task training group: task specific balance training	no intervention	8 weeks	3 sessions per week (45 min)
Saidmamatov *et al.* [34]	4–6	17/-/7	E – motor skills training programme /task-oriented/group training body stability (*e.g.* standing) body transport (*e.g.* hopping, skipping, running, jumping, walking, galloping) manual dexterity, aiming – catching/balance	regular classroom activities, physical education classes and physical activities	10 weeks	2 sessions per week (45 min)
Yasunaga *et al.* [35]	5–6	14/-/14	CO-OP intervention 10 types of activities among these activities, the ones most commonly selected were handicraft activities using craft scissors, writing exercises playing catch	no intervention	8 weeks	1 session per week (40 min)

E1 – experimental group 1, E2 – experimental group 2, C – control group, TST – task-specific training, TKD – taekwondo, FMPT – functional movement–power training, FMT – functional movement training, EMG – electromyography, WST – water specific therapy, CO-OP – cognitive orientation to daily occupational performance, SA – school assistant, PT – physical therapist

Table 2. PEDro Scale scores of the included studies

Study	Eligibility criteria	Random allocation	Concealed allocation	Baseline comparability	Blind subjects	Blind therapists	Blind assessors	Adequate follow-up	Intention-to-treat analysis	Between-group comparisons	Point estimates and variability	Total
Au *et al.* [17]	–	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8/10
Farhat *et al.* [27]	–	Y	N	Y	N	N	N	Y	N	Y	Y	5/10
Fong *et al.* [28]	–	Y	N	Y	N	N	Y	Y	Y	Y	Y	7/10
Fong *et al.* [29]	–	Y	N	Y	N	N	Y	Y	Y	Y	Y	7/10
Fong *et al.* [30]	–	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8/10
Fong *et al.* [31]	–	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8/10
Hiller *et al.* [32]	–	Y	Y	Y	N	N	Y	Y	U	Y	Y	7/10
Jahanbakhsh *et al.* [33]	–	Y	N	Y	N	N	Y	Y	N	Y	Y	6/10
Saidmamatov *et al.* [34]	–	Y	N	Y	N	N	N	Y	N	Y	Y	5/10
Yasunaga et al. [35]	–	Y	N	Y	N	N	N	Y	Y	Y	Y	5/10

Y – yes, N – no, U – unclear

mamatov *et al.* [34] reported significant improvements in the total score ($p < 0.001$, Cohen's $d = 3.22$) and across all M-ABC2 domains in the task-training group compared to the control group that proceeded with exercises of everyday living. Yasunaga *et al.* [35] observed a statistically significant improvement exclusively in the manual dexterity component scores of the M-ABC2 ($p < 0.05$). However, the calculated effect size was minimal, with Cohen's $d = 0.03$.

Task-oriented interventions and balance

The effect of the task-oriented interventions on balance was investigated in seven studies [27–30, 33–35] and statistically significant between-groups changes for at least one assessed parameter have been reported in six of them [27–30, 33, 34]. Four of these studies had good methodological quality [28–30, 33], while three studies had fair methodological quality [27, 34, 35]. Outcome measures and results on balance are presented in Table 3. Specifically, Fong *et al.* [28, 29] reported significantly greater improvement in average Center of Pressure (CoP) sway velocity in the Unilateral Stance Test in children with DCD after a three-month task training, compared to control group ($p < 0.001$). However, reactive balance control, as measured by the MCT composite score did not show significant changes within or between groups ($p > 0.005$) [29]. Jahanbakhsh *et al.* [33], assessed balance using the Y-balance test and stork balance test and found that a dual-task training programme significantly improved static ($p < 0.001$, Cohen's $d = 0.86$) and dynamic ($p < 0.001$ Cohen's $d = 0.36$) balance compared to single task training. Two of the studies with fair quality measured balance through the MABC-2 balance domain [27, 34] and reported significant differences between groups ($p < 0.001$), yielding large-size effects of 1.93 and 0.626. However, Yasunaga *et al.* [35], in a study also rated as of fair-quality, found no significant improvement in M-ABC2 balance score in children with DCD after 3 months of cognitive orientation to daily occupational performance intervention compared to no intervention ($p > 0.05$).

Task-oriented interventions and sensory organization

Sensory organization was investigated in four out of the ten included studies, using the Sensory Organization Test (SOT) [17, 28, 30, 31]. The methodological quality, as reflected in the PEDro scores, was high for all four studies. Au *et al.* [17] reported no statistically significant change ($p > 0.05$) in somatosensory, vestibular or visual ratios within both experimental and control group. Similarly, the between-group comparison did not reveal a statistically significant difference in these outcomes. Fong *et al.* [30] found a significant difference in the somatosensory ratio in children with DCD ($p < 0.001$, Cohen's $d = 0.95$) after task-specific balance training (Functional Movement Therapy) compared to no training. Vestibular and visual ratios re-

Table 3. Outcome measures and results of included studies

Study	Outcome (unit)	Group	Baseline (mean ± *SD*)	Post / change score (mean ± *SD*)	Within groups *p*	Between groups *p*	Cohen's *d*
Au *et al.* [17]	BOT-2 standard score	TST	39.7 ± 3.9	44.8 ± 5.5	< 0.05	> 0.05	0.27
		Core	40.6 ± 6.2	46.9 ± 8.4	< 0.05		
	BOT-2 percentile rank	TST	17.0 ± 9.7	32.2 ± 19.1	> 0.05	> 0.05	NR
		Core	21.5 ± 17.0	40.8 ± 27.2	> 0.05		
	SOT composite score	TST	56.3 ± 13.3	62.3 ± 11.9	> 0.05	> 0.05	0.84
		Core	55.3 ± 9.1	55.3 ± 11.1	< 0.05		
	SOT somatosensory ratio (%)	TST	94.4 ± 8.2	96.7 ± 3.7	> 0.05	> 0.05	NR
		Core	92.5 ± 6.6	92.3 ± 8.0	> 0.05		
	SOT vestibular ratio (%)	TST	37.6 ± 18.1	47.1 ± 17.3	> 0.05	> 0.05	NR
		Core	33.0 ± 17.9	40.2 ± 17.4	> 0.05		
	SOT visual ratio (%)	TST	65.1 ± 19.3	71.9 ± 17.6	> 0.05	> 0.05	NR
		Core	64.4 ± 14.9	61.1 ± 13.3	> 0.05		
Farhat *et al.* [27]	MABC-2/TIS	TST	17.00 ± 4.50	8.10 ± 3.50	< 0.001	< 0.001	3.22
		DCD/NT	15.30 ± 2.70	15.20 ± 2.90	> 0.05		–0.06
		CG	3.60 ± 1.90	3.64 ± 1.86	> 0.05		–0.02
	MABC-2 / manual dexterity	TST	8.60 ± 3.40	5.30 ± 2.20	< 0.001	< 0.001	1.68
		DCD/NT	7.50 ± 3.20	7.30 ± 2.70	> 0.05		0.11
		CG	3.00 ± 2.20	2.96 ± 2.20	> 0.05		0.04
	MABC-2 / ball skills	TST	2.90 ± 3.10	1.20 ± 1.70	< 0.05	< 0.001	1.02
		DCD/NT	3.50 ± 2.20	3.80 ± 1.70	> 0.05		–0.25
		CG	0.14 ± 0.53	0.20 ± 0.60	> 0.05		–0.8
	MABC-2 / balance	TST	5.53 ± 3.30	1.70 ± 2.50	< 0.001	< 0.001	1.93
		DCD/NT	4.20 ± 1.40	4.00 ± 1.50	> 0.05		0.33
		CG	0.40 ± 1.16	0.46 ± 1.15	> 0.05		–0.04
	MAT (s)	TST	10.26 ± 1.00	9.48 ± 0.80	< 0.05	< 0.01	0.89
		DCD/NT	10.70 ± 0.90	10.60 ± 1.00	> 0.05		0.02
		CG	9.10 ± 0.52	8.94 ± 0.50	> 0.05		0.44
	THD (m)	TST	3.00 ± 0.28	3.39 ± 0.37	< 0.001	< 0.01	–1.68
		DCD/NT	3.00 ± 0.20	3.10 ± 0.30	> 0.05		–0.37
		CG	3.76 ± 0.40	3.98 ± 0.40	> 0.05		–0.11
	5JT (m)	TST	5.7 ± 0.55	6.30 ± 0.60	< 0.001	< 0.001	–1.38
		DCD/NT	5.70 ± 0.50	5.70 ± 0.50	> 0.05		–0.04
		CG	6.41 ± 0.95	6.43 ± 0.86	> 0.05		–0.04
Fong *et al.* [28]	SOT: somatosensory ratio	DCD/TKD	0.93 ± 0.07	0.91 ± 0.13	> 0.01	> 0.05	NR
		DCD/CG	0.91 ± 0.09	0.92 ± 0.07	> 0.01		
		CG	0.96 ± 0.04	0.97 ± 0.04	> 0.01		
	SOT: visual ratio	DCD/TKD	0.58 ± 0.19	0.73 ± 0.19	< 0.001	< 0.001	NR
		DCD/CG	0.57 ± 0.24	0.57 ± 0.23	> 0.05		
		CG	0.74 ± 0.15	0.75 ± 0.16	> 0.05		
	SOT: vestibular ratio	DCD/TKD	0.32 ± 0.16	0.55 ± 0.23	< 0.001	< 0.001	NR
		DCD/CG	0.35 ± 0.21	0.34 ± 0.20	> 0.05		
		CG	0.51 ± 0.20	0.52 ± 0.17	> 0.05		
	SOT: composite score	DCD/TKD	49.00 ± 10.36	58.05 ± 16.55	0.001	< 0.05	NR
		DCD/CG	49.26 ± 12.30	52.13 ± 12.51	< 0.05		
		CG	57.83 ± 8.00	60.94 ± 9.87	> 0.05		
	COP sway velocity (cm/s)	DCD/TKD	3.18 ± 2.17	2.21 ± 1.88	< 0.001	0.001	NR
		DCD/CG	3.56 ± 1.85	3.79 ± 1.77	> 0.05		
		CG	1.68 ± 0.70	1.71 ± 1.06	0.001		

Fong *et al.* [29]	isokinetic peak torque of knee extensors 180°/s (Nm)	DCD/TKD	80.29 ± 21.60	100.67 ± 11.09	< 0.001	< 0.001	NR
		DCD/CG	81.49 ± 16.74	75.53 ± 18.01	> 0.05		
		CG	98.22 ± 20.29	98.67 ± 20.37	> 0.05		
	isokinetic peak torque of knee flexors 180°/s (Nm)	DCD/TKD	44.90 ± 5.06	60.00 ± 8.89	< 0.001	< 0.001	NR
		DCD/CG	43.26 ± 13.98	45.91 ± 15.36	< 0.05		
		CG	56.39 ± 13.19	47.94 ± 14.96	0.05		
	UST/COP sway velocity (cm/s)	DCD/TKD	3.71 ± 2.03	1.46 ± 0.46	< 0.001	< 0.001	NR
		DCD/CG	3.94 ± 2.27	3.60 ± 2.38	> 0.05		
		CG	2.15 ± 1.05	2.11 ± 1.35	> 0.05		
	MCT	DCD/TKD	128.16 ± 44.00	128.54 ± 44.76	> 0.05	> 0.05	NR
		DCD/CG	138.10 ± 33.96	137.67 ± 33.02	> 0.05		
		CG	108.00 ± 51.14	107.50 ± 50.89	> 0.05		
Fong *et al.* [30]	SOT: somatosensory ratio	FMT	0.96 ± 0.06	0.02 ± 0.04*	> 0.05	< 0.001	0.95
		CG	0.97 ± 0.07	0.01 ± 0.03*	> 0.05		
	SOT: visual ratio	FMT	0.61 ± 0.17	–0.01 ± 0.09*	> 0.05	< 0.001	0.00
		CG	0.59 ± 0.22	0.01 ± 0.08*	> 0.05		
	SOT: vestibular ratio	FMT	0.38 ± 0.16	0.01 ± 0.12*	> 0.05	< 0.001	0.09
		CG	0.43 ± 0.22	0.00 ± 0.08*	> 0.05		
	MABC-TIS	FMT	15.36 ± 6.52	0.39 ± 3.08*	> 0.05	< 0.05	0.09
		CG	15.48 ± 4.17	0.73 ± 2.59*	> 0.05		
	MABC / balance	FMT	2.97 ± 2.07	–1.00 ± 2.25*	> 0.05	< 0.05	0.79
		CG	2.54 ± 1.50	–0.17 ± 0.64*	> 0.05		
	UST/COP sway velocity (cm/s)	FMT	2.56 ± 1.30	0.61 ± 1.17*	> 0.05	< 0.05	0.59
		CG	2.66 ± 2.07	–0.05 ± 0.31*	> 0.05		
Fong *et al.* [31]	SOT overall S.S.	FMPT	87.01 ± 3.61	1.30 ± 4.30*	> 0.05	FMPT *vs.* CG:	0.30
		FMT	86.82 ± 3.64	0.24 ± 2.69*	> 0.05	> 0.05	0.38
		CG	86.81 ± 4.67	–0.08 ± 2.93*	> 0.05	FMT *vs.* CG: > 0.05	
	peak force of knee extensors (Nm)	FMPT	7.21 ± 2.30	0.54 ± 2.10*	< 0.05	FMPT *vs.* CG:	0.02
		FMT	7.45 ± 0.78	0.46 ± 2.05*	> 0.05	> 0.05	0.33
		CG	7.47 ± 3.22	–0.18 ± 1.65*		FMT *vs.* CG: > 0.05	
	peak force of knee flexors (Nm)	FMPT	5.97 ± 1.76	–0.12 ± 1.60*	> 0.05	FMPT *vs.* CG:	0.31
		FMT	5.81± 2.65	–0.02 ± 1.85*	> 0.05	> 0.05	0.05
		CG	5.92 ± 2.42	–0.19 ± 0.99*	> 0.05	FMT *vs.* CG: > 0.05	
	time to peak force of knee extensors (ms)	FMPT	2.22 ± 0.49	–0.10 ± 0.57*	> 0.05	FMPT *vs.* CG:	0.37
		FMT	2.22 ± 0.49	0.01 ± 0.36*	> 0.05	> 0.05	0.03
		CG	2.22 ± 0.46	–0.01 ± 0.33*	> 0.05	FMT *vs.* CG: > 0.05	
	time to peak force of knee flexors (ms)	FMPT	2.24 ± 0.52	–0.25 ± 0.71*	> 0.05	FMPT *vs.* CG:	0.48
		FMT	2.21 ± 0.39	–0.15 ± 0.38*	> 0.05	> 0.05	0.25
		CG	2.05 ± 0.50	–0.01 ± 0.65*	> 0.05	FMT *vs.* CG: > 0.05	
Hiller *et al.* [32]	M-ABC	ATG	19.4 ± 6.7	15.5 ± 4.1	NR	> 0.05	0.89
		CG	18.2 ± 4.9	20.8 ± 6.5			
	PSPCSA	ATG	2.6 ± 2.4/3.6	2.7 ± 2.4–3.4	NR	> 0.05	NR
		CG	3.3 ± 2.2–3.8	3.3 ± 2.4–3.9			
Jahanbakhsh *et al.* [33]	SBST (s)	DT	5.43 ± 0.34	8.76 ± 0.55	< 0.001	< 0.001	0.86
		ST	5.53 ± 0.48	8.17 ± 0.79	< 0.001		
		CG	5.41 ± 0.41	5.45 ± 0.61	> 0.05		
	YBT (cm)	DT	80.07 ± 6.54	86.82 ± 3.96	< 0.001	< 0.001	0.72
		ST	79.46 ± 5.34	84.35 ± 4.16	0.001		
		CG	80.51 ± 5.22	80.56 ± 5.09	> 0.05		

Saidmamatov *et al.* [34]	MABC-2 / manual dexterity	EG	3.82 ± 1.18	7.76 ± 2.25	0.001	< 0.001	0.471
		CG	4.86 ± 1.86	4.00 ± 1.73	> 0.05		
	MABC-2 / aiming and catching	EG	9.47 ± 2.80	13.18 ± 2.24	< 0.05	< 0.05	0.317
		CG	8.29 ± 2.69	9.29 ± 3.35	> 0.05		
	MABC-2 / balance	EG	8.00 ± 2.34	11.12 ± 1.96	0.001	< 0.001	0.626
		CG	7.00 ± 2.30	6.00 ± 1.63	> 0.05		
	Total MABC-2 score	EG	5.76 ± 1.39	10.65 ± 1.53	0.001	< 0.001	0.759
		CG	5.29 ± 1.11	4.71 ± 1.89	> 0.05		
Yasunaga *et al.* [35]	S-AMPS motor skill	CO-OP	2.50 ± 0.43	2.50 ± 0.34	> 0.05	> 0.05	0.08
		CG	2.35 ± 0.41	2.25 ± 0.33	> 0.05		
	MABC-2 / manual dexterity	CO-OP	31.00 ± 4.04	29.00 ± 5.34	> 0.05	0.038	0.03
		CG	29.50 ± 3.40	26.00 ± 7.03	> 0.05		
	MABC-2 / aiming and catching	CO-OP	12.00 ± 4.74	16.00 ± 3.83	> 0.05	> 0.05	0.40
		CG	13.50 ± 4.23	14.00 ± 3.39	> 0.05		
	MABC-2 / balance	CO-OP	31.50 ± 5.25	33.00 ± 2.85	> 0.05	> 0.05	0.38
		CG	32.50 ± 3.25	31.50 ± 3.43	> 0.05		
	Total MABC-2 score	CO-OP	74.00 ± 9.36	81.00 ± 7.73	0.05	> 0.05	0.52
		CG	76.00 ± 6.39	74.00 ± 9.70	> 0.05		

BOT-2 – Bruininks-Oseretsky Test of Motor Proficiency (2nd edition), TST – task specific training, SOT – sensory organization test MABC: Movement Assessment Battery for Children, MABC-2 – Movement Assessment Battery for Children (2nd edition), MABC-2/TIS – total impairment score; lower scores indicate improved motor performance, DCD – developmental coordination disorder, NT – no training, CG – control group, MAT – modified agility test THD, 5JT – 5 jump-test, TKD – taekwondo, UST – unilateral stance test, COP – centre of pressure, MCT – motor control test, FMPT – functional movement–power training, FMT – functional movement training, S.S. – strategy score, NS – no significant difference, PSPCSA – pictorial scale of perceived competence and social acceptance, SBST – stork balance stand test, YBT – Y-balance test, CO-OP – cognitive orientation to daily occupational performance, TGMD – test of gross motor development, LOC – locomotor, OC – object control
E1 – experimental group 1, E2 – experimental group 2, S-AMPS – school assessment of motor and process skills
NR – not reported
Values in the "Post / change score" column marked with an asterisk (*) denote mean change scores (post minus pre ± *SD*) as originally reported, whereas unmarked values represent absolute post-intervention mean ± *SD*. Cohen's *d*: (a) multiple values aligned with distinct groups denote within-group (pre-to-post) effect sizes for each group; (b) a single value represents the between-group (experimental *vs.* control) intervention effects, either as reported in the original study or calculated from available data.

mained stable over time in both groups ($p > 0.05$). Finally, the overall SOT score remained relatively stable in all three groups over time ($p > 0.05$), in another study of Fong *et al.*, while the between group differences did not reach statistical significance ($p > 0.05$) [31] (Table 3).

Task-oriented interventions and muscle strength

Muscle strength was assessed in two studies of good methodological quality [29, 31] and the results are presented in Table 3. Fong *et al.* [29] observed significant improvements in isokinetic knee extensors and flexors muscle strength at 180°/s after a 3-month program of intensive task specific training experience (TST) ($p < 0.001$, Cohen's $d = 0.83$). These improvements were statistically significant both within groups as well as between the two groups favouring the TST group ($p < 0.001$). In the other study, Fong *et al.* [31] also reported that the functional movement power training group showed a statistically significant within group improvement in the peak force of knee extensors ($p = 0.001$), and a significant difference in the time to peak force of knee flexors between the FMPT and the control groups at 3 months post-intervention ($p < 0.05$). Conversely, the between-group differences were not significant with small effect sizes across comparisons.

Discussion

Summary of main findings

The aim of this systematic review was to evaluate the effect of task-oriented intervention on motor performance of children with developmental coordination disorder (DCD), by incorporating most recent evidence. We identified 10 randomized controlled trials that met the inclusion criteria. Overall, the PEDro scoring ranged from 5/10 to 8/10 with a mean score of 6.6/10.

Nevertheless, given that the majority of studies lacked concealed allocation and blinding of participants and therapists – thereby introducing a substantial risk of selection and performance bias – the findings should be approached with caution.

The results of included studies, particularly those with higher methodological quality, suggest that task-oriented interventions may be effective in improving motor performance, including gross and fine motor skills, and postural control in this population [17, 27–35], although being limited by relatively small cohorts. This is particularly true for children having more severe impairments in fine and gross motor skills. Moreover, the findings of the present review align with those reported by Miyahara *et al.* [18], who also noted the beneficial effects of task-oriented intervention on motor performance in children with DCD compared to no intervention. However, our review incorporated more recent evidence and included studies with higher methodological quality as assessed on the PEDro scale. Furthermore, unlike Miyahara *et al.* [18], who explored the effect of task-oriented interventions in children with DCD more broadly, the present review focused particularly on motor performance, providing a more targeted examination of intervention effectiveness. Similar results have also been reported in other previous systematic reviews, suggesting that task-oriented interventions are effective in improving motor skills and functioning in children with DCD compared to no intervention or compared to traditional / contemporary physiotherapy [6, 12, 14, 15, 18, 20, 21, 36]. Improvements in motor performance in children with DCD following task-oriented interventions can be attributed to underlying mechanisms of motor learning and neuroplasticity [27, 30, 33, 34]. The repetitive practice of a specific functional task, under specific constraints, reinforces neural paths that include the cerebellum, pre-motor cortex and lateral pre-motor cortex [34].

Importantly, the current systematic review also highlights the significant role of task-oriented interventions in improving postural control and stability in children with DCD, which is consistent with previous evidence [15, 18, 19, 20, 37, 38]. Specifically, in the current review, Fong *et al.* [29] investigated the effect of short-term intensive Taekwondo training on reactive and static control of children with DCD. The DCD-TKD group showed a slower CoP sway velocity, indicating improved static single-leg standing balance. Reactive postural control as measured with the motor control test did not improve, which probably indicates that this type of intervention may not affect reactive postural response. Despite the study's good methodological quality, the high attrition rate in the control group likely also affected the results. Similarly, Fong *et al.* [30] reports that task specific balance training improves balance performance, as depicted in the slower sway velocity of COP, and the improved sensory organization of postural control in children with DCD, which suggests increases in reliance on somatosensory information. Further, the combination of functional movement training with power training proved to be more effective in improving balance strategies and motor performance in children with DCD than functional movement training only [31].

While individual-based interventions are frequently used approaches for children with DCD, similar positive effects were observed in group-based training programs in the current review [27, 34]. Our findings are in line with those reported in previous research [14, 39, 40], while Smits-Engelsman *et al.* [14] stated that working in small groups of 4 to 6 children, may reduce performance anxiety and increase task engagement. These group-based interventions can be applied either at school or at clinic settings, by a health professional or school assistant supervised by a physiotherapist [41].

In three studies of our review [28, 29, 32], children with DCD participated in sports-based training interventions. While the aquatic programme [32] revealed promising trends without reaching statistical significance, the other two studies [28, 29] on Taekwondo training found statistically significant improvements in motor skills. Specifically, these studies implemented an intensive 3-months Taekwondo training, and the results showed significant improvement in balance and muscle strength, as evidenced by low p-values. These findings are in agreement with other previous studies and review findings, supporting that tailored sports-based training and engaging in structured sports activities can be beneficial for children with DCD for improvement in coordination abilities and fitness related outcomes [28, 29, 32, 42–44]. However, there is limited research on this type of training for people with specific neurodevelopmental conditions such as DCD.

In contrast to general task-oriented or sports-based training programmes, task-specific interventions are designed to focus on specific motor impairments that are most challenging for each child. Task-specific balance training appears promising for enhancing postural control, yielding statistically significant improvements and the highest effect sizes in this review, thereby emphasizing the importance of specificity in motor learning [30, 31, 33]. Jahanbakhsh *et al.* [33] examined the effect of an innovative task-specific balance

training programme in 39 children with DCD. They compared the effects of dual-task training focusing on balance and cognitive tasks that simulated real-life balance challenges with the effects of simple task training on balance performance of the children. The findings suggest that dual-task training is more effective in improving static and dynamic balance than simple task training in children with DCD, demonstrating a large magnitude on effect. This finding is consistent with previous recent research, supporting the efficacy of dual task training in improving balance skills [45, 46]. Another interesting finding of Jahanbakhsh *et al.* [33] was that their intervention was not gender specific, in contrast with previous evidence [47, 48], and the programme exerted the same positive effects on both boys and girls. These conflicting results may be attributed to the distinct neurodevelopmental phases represented in the respective samples as well as the nature of the selected tasks.

Cognitive orientation to daily occupational performance (CO-OP) is a task-oriented intervention based on cognitive behavioural therapy [24, 49]. Yasunaga *et al.* [35] implemented this intervention and revealed noticeable improvements in motor and occupational performance. The moderate effect size observed in this study is in alignment with other studies and systematic reviews, supporting the effectiveness of the approach not only in children with DCD but also in children with DCD-traits [18, 24, 49–51]. However, a common conclusion from previous reviews and our systematic review is the need for further high-quality evidence to confirm the effectiveness of CO-OP on motor performance [12, 14].

In the reviewed studies, the average duration of the training programme was 9.7 weeks, and our results support previous research that also found that short-term intervention programmes can significantly enhance motor performance and related competences and can be as effective as long-term ones [1, 10, 15, 18]. A short intervention programme, lasting 6 to 12 weeks, is sufficient to improve muscle strength, static and dynamic balance and gross motor skills, particularly when it is targeted and intensive [28–32, 34]. The effectiveness of these short-term programmes might also be modulated by the developmental stage of the children. Literature suggests that around the age of 9-10, children, especially girls, enhance neuro-motor maturity which facilitates more efficient motor units' recruitment and supports skills acquisition, maximizing the impact of even brief intervention periods [52].

The differential response to task-oriented interventions in children with DCD may also be explained through the physiological principles of physical adaptation [53]. Physiological and motor adaptations occur when the mechanical load exceeds the child's habitual strain loading: children with lower baseline daily activity tend to demonstrate greater improvements in response to relatively low-intensity interventions, whereas children who are already more active may require higher intensity or greater mechanical load [54, 55]. The studies included in this review demonstrated different perspectives of this relationship. Fong *et al.* [28] and Hiller *et al.* [32], by excluding participants receiving regular or intensive training in sports and swimming respectively, targeted inactive cohorts, where even modest mechanical loads elicited neuro-motor adaptations. In contrast, Jahanbakshsh *et al.* [33] excluded children who did not regularly participated in physical activity. In this study, the efficacy of the task-oriented intervention suggests that for more active children, motor performance improvements depend on qualitative complexity and specificity of the task that exceed their habitual level of motor engagement.

Five of the reviewed studies included follow-up assessments at two, three or six months after the completion of intervention [17, 30, 31, 33, 35]. While the findings of these studies indicate that improvements in balance and overall motor performance may persist beyond the intervention period, evidence for long-term sustainability remains limited. Therefore, these findings should be interpreted with caution. In addition, the sustainability of the positive results and the integration into everyday life's activities greatly depend on the consistency and the quality of the intervention programme [56].

In the present systematic review, the PEDro scores of the 10 included studies ranged from 5/10 to 8/10, indicating an overall good methodological quality. Most studies exhibited satisfactory internal validity; however, concealed allocation and blinding of therapists and subjects were the items most frequently not met on the scale. Although blinding is not always feasible in physiotherapy interventions, its absence increases the risk of performance bias, especially when subjective outcomes are assessed [57]. Similarly, the absence of concealed allocation may lead to selection bias and potentially misleading conclusions about the treatment's effect [58]. Therefore, due to these methodological limitations, the results regarding the effectiveness of task-oriented intervention on motor performance of children with DCD, should be interpreted with caution

Stratification based on the PEDro scores (≥ 7 versus 5–6) revealed a distinct pattern of results. Randomized controlled trials with higher methodological

quality (score ≥ 7) demonstrated more consistent improvements in balance, sensory organization, and muscle strength; however, their effects on overall motor performance were less consistent. Conversely, studies of fair quality (score 5–6) more frequently reported statistically significant improvements in overall motor performance, often accompanied by large effect sizes. These discrepancies may suggest potential overestimation of treatment effects in lower-quality studies. In conclusion, there is greater confidence in outcomes related to balance when compared to those pertaining to overall motor performance.

Strengths and limitations

A key strength of this systematic review lies in its provision of the most up-to-date and comprehensive evidence on task-specific interventions in children with DCD by using rigorous methodology in accordance with the PRISMA guidelines. Furthermore, it exclusively includes randomized controlled trials (RCTs), thus offering evidence from studies with a high level of methodological rigour.

Nevertheless, the authors of this systematic review acknowledge several specific limitations that merit consideration when interpreting the findings. First, a limited number of studies met the eligibility criteria and were included in the synthesis of evidence. This likely constrains the generalizability of the findings to some extent and precludes subgroup analysis. Secondly, the relatively small sample sizes across most of the studies is another limitation. An additional significant limitation is the heterogeneity of the task-oriented interventions in the type, intensity, and duration, which probably influences the outcomes of the interventions. Finally, the majority of the studies did not include follow-up evaluations, thereby constraining conclusions regarding the long-term impact of these interventions.

Clinical implications and future research

The findings of this systematic review have significant implications for physiotherapists and other healthcare professionals working with children with DCD. Clinicians incorporating task-oriented or task-specific interventions into rehabilitation programs may enhance the patients' motor performance, balance, and ultimately, participation in daily activities. Nonetheless, clinicians should consider the variability in protocols of task-oriented interventions and individual characteristics when applying these findings in clinical practice. Additionally, given contemporary trends toward increased screen time and sedentary behaviour among school-aged children [59, 60], targeted task-oriented interventions could potentially facilitate active motor engagement.

Further evidence is needed in this field, while future studies should implement larger sample, controlled trials with homogenous participant samples. Future research should incorporate age- and gender-stratified data to clarify the complex interaction between biological maturation and task-oriented training outcomes. Moreover, the sustainability of the effects should further be explored through extended follow up assessments.

Conclusions

The findings of the present systematic review indicate that task-oriented interventions might be effective in areas of motor performance such as balance, sensory organization, and muscle strength, especially in children exhibiting more severe impairments in fine and gross motor skills. Nonetheless, the strength of evidence regarding overall motor performance remains limited owing to the diversity in the methodological quality of the studies.

Ethical approval

The conducted research is not related to either human or animal use.

Conflicts of interest

The authors state no conflict of interest.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Funding

This research was funded by the Special Account for Research Grants of the University of West Attica.

References

[1] Blank R, Barnett AL, Cairney J, Green D, Kirby A, Polatajko H, Rosenblum S, Smits-Engelsman B, Sugden D, Wilson P, Vinçon S. International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. Dev Med Child Neurol. 2019;61(3):242–85; doi: 10.1111/dmcn.14132.

[2] Ferracioli-Gama MC, Tamplain P. Infographic: developmental coordination disorder (part I) – char-

acteristics, diagnosis, and consequences. Braz J Motor Behav. 2023;17(4):73–4; doi: 10.20338/bjmb.v17i2.349.

[3] Pergantis P, Drigas A. Developmental Coordination Disorder (DCD) and the role of ICTS and Neurofeedback (NF) for training and intervention. J Health Technol. 2023;2(2):e2238; doi: 10.47820/jht.v2i2.38.

[4] Biotteau M, Albaret JM, Chaix Y. Developmental coordination disorder. Handb Clin Neurol. 2020; 174:3–20; doi: 10.1016/B978-0-444-64148-9.00001-6.

[5] Zwicker JG, Harris SR, Klassen AF. Quality of life domains affected in children with developmental coordination disorder: a systematic review. Child Care Health Dev. 2012;39(4):562–80; doi: 10.1111/j.1365-2214.2012.01379.x.

[6] Yu JJ, Burnett AF, Sit CH. Motor skill interventions in children with developmental coordination disorder: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2018;99(10):2076–99; doi: 10.1016/j.apmr.2017.12.009.

[7] Martini G, Beani E, Filogna S, Menici V, Cioni G, Battini R, Sgandurra G. New technological approach for the evaluation of postural control abilities in children with developmental coordination disorder. Children. 2022; 9(7):957; doi: 10.3390/children9070957.

[8] Lee EJ, Zwicker JG. Early identification of children with/at risk of developmental coordination disorder: a scoping review. Dev Med Child Neurol. 2021;63(6):649–58; doi: 10.1111/dmcn.14803.

[9] Li YC, Tseng YT, Hsu FY, Chao HC, Wu SK. Developmental coordination disorder and unhealthy weight status in Taiwanese children: the roles of sex and age. Children. 2023;10(7):1171; doi: 10.3390/children10071171.

[10] Galea MP. Is task-oriented training effective for children with developmental coordination disorder? A Cochrane Review summary with commentary. Dev Med Child Neurol. 2020;62(2):160–2; doi: 10.1111/dmcn.14432.

[11] Kumar G, Barhoun P, Fuelscher I, Zwicker JG, Bianco K, Singh M, Mukherjee M, Williams J. Quality of life in children with developmental coordination disorder (DCD): a systematic review and meta-analysis. Res Dev Disabil. 2025;160: 104981; doi: 10.1016/j.ridd.2025.104981.

[12] Smits-Engelsman BCM, Blank R, Van Der Kaay AC, Mosterd-Van Der Meijs R, Vlugt-Van Den Brand E, Polatajko HJ, Wilson PH. Efficacy of interventions to improve motor performance in children with developmental coordination disorder: a combined systematic review and meta-analysis. Dev Med Child Neurol. 2013;55(3):229–37; doi: 10.1111/dmcn.12008.

[13] Offor N, Ossom Williamson P, Caçola P. Effectiveness of interventions for children with developmental coordination disorder in physical therapy contexts: a systematic literature review and meta-analysis. J Mot Learn Dev. 2016;4(2):169–96; doi: 10.1123/jmld.2015-0018.

[14] Smits-Engelsman B, Vinçon S, Blank R, Quadrado VH, Polatajko H, Wilson PH. Evaluating the evidence for motor-based interventions in developmental coordination disorder: a systematic review and meta-analysis. Res Dev Disabil. 2018; 74:72–102; doi: 10.1016/j.ridd.2018.01.002.

[15] Gao J, Song W, Zhong Y, Huang D, Wang J, Zhang A, Ke X. Children with developmental coordination disorders: a review of approaches to assessment and intervention. Front Neurol. 2024;15: 1359955; doi: 10.3389/fneur.2024.1359955.

[16] Lucas BR, Elliott EJ, Coggan S, Pinto RZ, Jirikowic T, McCoy SW, Latimer J. Interventions to improve gross motor performance in children with neurodevelopmental disorders: a meta-analysis. BMC Pediatr. 2016;16(1):193; doi: 10.1186/s12887-016-0731-6.

[17] Au MK, Chan WM, Lee L, Chen TM, Chau RM, Pang MY. Core stability exercise is as effective as task-oriented motor training in improving motor proficiency in children with developmental coordination disorder: a randomized controlled pilot study. Clin Rehabil. 2014;28(10):992–3; doi: 10.1177/0269215514527596.

[18] Miyahara M, Hillier SL, Pridham L, Nakagawa S. Task-oriented interventions for children with developmental co-ordination disorder. Cochrane Database Syst Rev. 2017;7(7): CD010914; doi: 10.1002/14651858.CD010914.pub2.

[19] Rameckers EAA, Crafford R, Ferguson G, Smits Engelsman BCM. Efficacy of a task-oriented intervention for children with a dual diagnosis of specific learning disabilities and developmental coordination disorder: a pilot study. Children. 2023; 10(3):415; doi: 10.3390/children10030415.

[20] Preston N, Magallón S, Hill LJ, Andrews E, Ahern SM, Mon-Williams M. A systematic review of high quality randomized controlled trials investigating motor skill programmes for children with developmental coordination disorder. Clin Rehabil. 2017;31(7):857–70; doi: 10.1177/0269215516661014.

[21] Gao J, Yang Y, Xu X, Huang D, Wu Y, Ren H, Zhang A, Ke X, Song W. Motor-based interventions in children with developmental coordination disorder: a systematic review and meta-analysis of randomised controlled trials. Sports Med Open. 2025;11(1):59; doi: 10.1186/s40798-025-00833-w.
[22] Hubbard IJ, Parsons MW, Neilson C, Carey LM. Task-specific training: evidence for and translation to clinical practice. Occupational Ther Int. 2009;16(3–4):175–89; doi: 10.1002/oti.275.
[23] Peng C, He J, Xu K, Wu X, Wang D, Zhang L. Effects of exercise interventions on motor coordination in children with developmental coordination disorder (DCD): a systematic review and meta-analysis. Res Dev Disabil. 2025;168:105184; doi: 10.1016/j.ridd.2025.105184.
[24] Izadi-Najafabadi S, Gunton C, Dureno Z, Zwicker JG. Effectiveness of Cognitive Orientation to Occupational Performance intervention in improving motor skills of children with developmental coordination disorder: a randomized waitlist-control trial. Clin Rehabil. 2022;36(6):776–88; doi: 10.1177/02692155221086188.
[25] Moseley AM, Elkins MR, Van der Wees PJ, Pinheiro MB. Using research to guide practice: The Physiotherapy Evidence Database (PEDro). Braz J Phys Ther. 2019;24(5):384–91; doi: 10.1016/j.bjpt.2019.11.002.
[26] Cashin AG, McAuley JH. Clinimetrics: Physiotherapy Evidence Database (PEDro) Scale. J Physiother. 2020;66(1):59; doi: 10.1016/j.jphys.2019.08.005.
[27] Farhat F, Hsairi I, Baati H, Smits-Engelsman BCM, Masmoudi K, Mchirgui R, Triki C, Moalla W. The effect of a motor skills training program in the improvement of practiced and non-practiced tasks performance in children with developmental coordination disorder (DCD). Hum Mov Sci. 2016;46:10–22; doi: 10.1016/j.humov.2015.12.001.
[28] Fong SSM, Tsang WWN, Ng GYF. Taekwondo training improves sensory organization and balance control in children with developmental coordination disorder: a randomized controlled trial. Res Dev Disabil. 2012;33(1):85–95; doi: 10.1016/j.ridd.2011.08.023.
[29] Fong SSM, Chung JWY, Chow LPY, Ma AWW, Tsang WWN. 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. Res Dev Disabil. 2013;34(5):1446–55; doi: 10.1016/j.ridd.2013.01.025.
[30] Fong SSM, Guo X, Liu KPY, Ki WY, Louie LHT, Chung RCK, Macfarlane DJ. Task-specific balance training improves the sensory organisation of balance control in children with developmental coordination disorder: a randomised controlled trial. Sci Rep. 2016;6(1):20945; doi: 10.1038/srep20945.
[31] Fong SSM, Guo X, Cheng YTY, Liu KPY, Tsang WWN, Yam TTT, Chung LMY, Macfarlane DJ. A novel balance training program for children with developmental coordination disorder. Medicine. 2016;95(16):e3492; doi: 10.1097/MD.0000000000003492.
[32] Hillier S, McIntyre A, Plummer L. Aquatic physical therapy for children with developmental coordination disorder: a pilot randomized controlled trial. Phys Occup Ther Pediatr. 2010;30(2):111–24; doi: 10.3109/01942630903543575.
[33] Jahanbakhsh H, Sohrabi M, Saberi Kakhki A, Khodashenas E. The effect of task-specific balance training program in dual-task and single-task conditions on balance performance in children with developmental coordination disorder. Acta Gymnica. 2020;50(1):28–37; doi: 10.5507/ag.2020.003.
[34] Saidmamatov O, Raximov Q, Rodrigues P, Vasconcelos O. A ten-week motor skills training program increases motor competence in children with developmental coordination disorder. Children. 2021;8(12):1147; doi: 10.3390/children8121147.
[35] Yasunaga M, Miyaguchi H, Ishizuki C, Kita Y, Nakai A. Cognitive orientation to daily occupational performance: a randomized controlled trial examining intervention effects on children with developmental coordination disorder traits. Brain Sci. 2023;13(5):721; doi: 10.3390/brainsci13050721.
[36] Alghadier M, Alhusayni AI. Evaluating the efficacy of gross-motor-based interventions for children with developmental coordination disorder: a systematic review. J Clin Med. 2024;13(16):4609; doi: 10.3390/jcm13164609.
[37] Smits-Engelsman B, Verbecque E. Pediatric care for children with developmental coordination disorder, can we do better? Biomedical J. 2021;45(2):250–64; doi: 10.1016/j.bj.2021.08.008.
[38] Ganapathy Sankar U, Monisha R. Effectiveness of two task-oriented interventions over cardiorespiratory fitness and motor performance in children with developmental coordination disorder (dcd) – a pilot study. Int J Res Pharm Sci. 2020;11(4):6399–403; doi: 10.26452/ijrps.v11i4.3400.

[39] de Hóra N, Larkin L, Connell A. Is group-based or individual-based intervention more effective for quality of life outcomes in children with developmental coordination disorder? A systematic review. Phys Occup Ther Pediatr. 2019;39(4):353–72; doi: 10.1080/01942638.2018.1490847.

[40] Caçola PM, Ibana M, Romero M, Chuang J. The effectiveness of a group motor skill intervention program in children with developmental coordination disorder: program frequency matters. Internet J Allied Health Sci Pract. 2016;14(1):1–8; doi: 10.46743/1540-580X/2016.1567.

[41] Ward EJ, Hillier S, Raynor A, Petkov J. A range of service delivery modes for children with developmental coordination disorder are effective: a randomized controlled trial. Pediatr Phys Ther. 2017; 29(3):230–36; doi: 10.1097/PEP.0000000000000423.

[42] Shariat A, Najafabadi MG, dos Santos IK, Anastasio AT, Milajerdi HR, Hassanzadeh G, Nouri E. The effectiveness of aquatic therapy on motor and social skill as well as executive function in children with neurodevelopmental disorder: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2024;105(5):1000–7; doi: 10.1016/j.apmr.2023.08.025.

[43] Vasile L, Stănescu M. The aquatic therapy in balance coordination disorders. Procedia Soc Behav Sci. 2013;92:997–1002; doi: 10.1016/j.sbspro.2013.08.790.

[44] Ruban A, Radovenchyk A, Semal N, Bilohur B, Chkhailo M, Dzhym V. Sports games in the context of developing children's coordination ability as a component of physical development. Rev Rom Pentru Educ Multidimens. 2024;16(3):415–29; doi: 10.18662/rrem/16.3/901.

[45] Jelsma LD, Geuze RH, Fuermaier ABM, Tucha O, Smits-Engelsman BCM. Effect of dual tasking on a dynamic balance task in children with and without DCD. Hum Mov Sci. 2021;79:102859; doi: 10.1016/j.humov.2021.102859.

[46] Cherng RJ, Liang LY, Chen YJ, Chen JY. The effects of a motor and a cognitive concurrent task on walking in children with developmental coordination disorder. Gait Posture. 2009;29(2):204–7; doi: 10.1016/j.gaitpost.2008.08.003.

[47] Bardid F, Deconinck FJA, Descamps S, Verhoeven L, De Pooter G, Lenoir M, D'Hondt E. The effectiveness of a fundamental motor skill intervention in pre-schoolers with motor problems depends on gender but not environmental context. Res Dev Disabil. 2013;34(12):4571–81; doi: 10.1016/j.ridd.2013.09.035.

[48] Peens A, Pienaar AE. The effect of gender and ethnic differences on the success of intervention programmes for the motor proficiency and self-concept of 7–9 year old DCD children. S Afr J Res Sport Phys Educ Recreat. 2007;29(1):113–28; doi: 10.4314/sajrs.v29i1.25959.

[49] Krajenbrink H, Lust J, van Heeswijk J, Aarts P, Steenbergen B. Benefits of an intensive individual CO-OP intervention in a group setting for children with DCD. Occup Ther Int. 2022;2022:e8209128; doi: 10.1155/2022/8209128.

[50] Malik MA, Weber AM, Lang D, Vanderwal T, Zwicker JG. Changes in cortical grey matter volume with Cognitive Orientation to daily Occupational Performance intervention in children with developmental coordination disorder. Frontiers Hum Neurosci. 2024;18:1316117; doi: 10.3389/fnhum.2024.1316117.

[51] Araújo CRS, Cardoso AA, Magalhães L de C. Efficacy of the cognitive orientation to daily occupational performance with Brazilian children with developmental coordination disorder. Scand J Occup Ther. 2017;26(1):46–54; doi: 10.1080/11038128.2017.1417476.

[52] Solum M, Lorås H, Pedersen AV. A Golden age for motor skill learning? Learning of an unfamiliar motor task in 10-year-olds, young adults, and adults, when starting from similar baselines. Front Psychol. 2020;11:538; doi: 10.3389/fpsyg.2020.00538.

[53] Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, Nieman DC, Swain DP. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults. Med Sci Sports Exerc. 2011;43(7): 1334–59; doi: 10.1249/MSS.0b013e318213fefb.

[54] Faienza MF, Urbano F, Chiarito M, Lassandro G, Giordano P. Musculoskeletal health in children and adolescents. Front Pediatr. 2023;11:1226524; doi: 10.3389/fped.2023.1226524.

[55] Turner CH, Robling AG. Designing exercise regimens to increase bone strength. Exerc Sport Sci Rev. 2003;31(1):45–50; doi: 10.1097/00003677-200301000-00009.

[56] de Oliveira IS, Spessato BC, da Silva Oliveira D, Lins RJC, Sarinho SW. Long-term effects of a movement intervention program for children with probable developmental coordination disorder. J Teach Phys Educ. 2021;41(4):680–88; doi: 10.1123/jtpe.2021-0124.

[57] Phillips MR, Kaiser P, Thabane L, Bhandari M, Chaudhary V, Retina Evidence Trials InterNational Alliane (R.E.T.I.N.A.) Study Group. Risk of bias: why measure it, and how? Eye. 2022;36(2):346–8; doi: 10.1038/s41433-021-01759-9.
[58] Kahan BC, Rehal S, Cro S. Risk of selection bias in randomised trials. Trials. 2015;16:405; doi: 10.1186/s13063-015-0920-x.
[59] Piepiora P, Brojanowska A, Vveinhardt J. Polish pupils from the Alpha generation and their lifestyle. J Educ Health Sport. 2025;80:60014; doi: 10.12775/JEHS.2025.80.60014.
[60] Piepiora P. The Alpha Generation theoretical model of developmental disorders. Arch Budo. 2024;20:140–8.

Supplementary materials

DATABASE: PubMed (MEDLINE)
Date of last search: 21/05/25
Records Retrieved: 05
("Motor Skills Disorders"[MeSH Terms] OR "developmental coordination disorder"[Title/Abstract] OR "DCD"[Title/Abstract]) AND ("task-oriented"[Title/Abstract] OR "task specific"[Title/Abstract]) AND ("motor performance"[Title/Abstract] OR "Postural Balance"[MeSH Terms] OR "postural control"[Title/Abstract]) AND ("Child"[MeSH Terms] OR "Adolescent"[MeSH Terms] OR "child*"[Title/Abstract] OR "adolescent*"[Title/Abstract]) AND ("randomized controlled trial"[Publication Type] OR "controlled clinical trial"[Publication Type] OR "randomized"[Title/Abstract] OR "randomised"[Title/Abstract])

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND).