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Physical fitness assessment tools for children with developmental coordination disorder and their feasibility for low-income settings: A systematic review

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ABSTRACT

Background: This study systematically reviewed the literature on physical fitness assessment tools for children with developmental coordination disorder compared with typically developing children aged 7 to 10 and analyzed the feasibility of these tools for use in low-income settings.
Methods: Searches were conducted in the PubMed, Scopus, Web of Science, and EBSCO/RIC databases. The Newcastle - Ottawa Quality Assessment Scale assessed the methodological quality of the studies, and a checklist adapted from COSMIN assessed the feasibility of the instruments.
Results: From 8470 studies initially retrieved, 21 were included in this systematic review. The most assessed physical fitness components in children with developmental coordination disorder compared with typically developing children were cardiorespiratory fitness and muscle strength. Most studies had high methodological quality. The shuttle run (cardiorespiratory fitness) and handgrip dynamometer (muscle strength) were the most used tools. The PERF-FIT, long jump, and 6-min walk test were considered the most feasible tools for low-income settings, while the incremental treadmill test was deemed the least feasible.
Conclusion: The findings evidenced several viable tools for testing physical fitness in children with DCD compared to typically developing peers from low-income countries. The most viable, as PERF-FIT, long jump and 6-min walk test should be used on large scale in low-income settings.

1. Introduction

The World Health Organization recommends that school-aged children and young people (5–17 years old) engage in an average of 60 min of moderate to vigorous intensity aerobic physical activity daily, incorporating strengthen exercises for a minimum of three times a week for health benefits.[1] Although this activity level is important for developing adequate motor coordination and physical fitness,[2–4] children with developmental coordination disorder (DCD) face challenges in achieving these conditions due to significant difficulties in acquiring and refining motor skills.[5]

Children with DCD often have low motor skills, leading to reduced

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physical activity compared with typically developing (TD) peers.[6,7] They tend to spend more time in sedentary activities[8] and less time in active play,[9,10] which may contribute to health issues, such as obesity[11,12] and cardiovascular alterations.[13] These children often avoid physical activities at school due to impaired coordination, especially in fundamental motor skills (e.g., ball skills),[14] resulting in poor general physical fitness.[9]

Access to diagnosis, physical fitness assessments, and early interventions are crucial to promote greater physical activity and prevent obesity and cardiovascular diseases in children with DCD. Despite the significant impact of DCD, many health and education professionals remain unfamiliar with the disorder.[15] In low-income countries, where approximately 80 % of the global disabled population lives,[16] children often face additional challenges related to poverty, limited healthcare access, and inadequate facilities. These issues further restrict their opportunities for sports and physical activities, leading to increased sedentary behavior and associated health risks.[17] Early diagnosis and appropriate assessment tools can support the development of interventions to help children with DCD engage in physical activities and improve their physical fitness and socialization.[18,19]

Reliable assessment tools for diagnosing and evaluating DCD are essential in this context, especially tools suitable for low-income populations and specific age groups. A recent systematic review detailed the main tools and protocols for assessing motor skills and physical fitness in children with DCD, such as manual dexterity, balance, coordination, and ball control, along with their psychometric properties.[20]However, no systematic literature reviews have identified the feasibility of the main physical fitness assessment tools for children with DCD in low-income settings. This study aimed to fill this gap by systematically reviewing the literature on physical fitness assessment tools for children with DCD compared with TD children aged 7 to 10 and evaluating the feasibility of these tools in low-income settings.

2. Materials and methods

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[21] The protocol was registered in the PROSPERO database, number CRD42021294035.

2.1. Eligibility criteria

Relevant studies were identified using predefined selection criteria based on the PECOS acronym: Population consisted of children with DCD aged 7 to 10; Exposure included suspicion or diagnosis of DCD or similar terminologies, such as at-risk for DCD, probable DCD, moderate DCD, and severe DCD; Comparison comprised children with TD; Outcome focused on physical fitness components assessed by tests, assessment tools, or other specific instruments; and Study design included cross-sectional, case-control, or cohort studies published in English or Portuguese.

Reviews, experimental, or other observational studies were excluded if they involved children with DCD and additional conditions (e.g., autism spectrum disorder, cerebral palsy, intellectual disability, or attention deficit hyperactivity disorder). The search was limited to articles published from January 1, 2001, to July 1, 2024.

2.2. Information sources and searches

Data were extracted from PubMed (https://pubmed.ncbi.nlm.nih.gov/), Web of Science (https://www-webofscience-com.ez86.periodicos.capes.gov.br/), Scopus (https://www-scopus-com.ez86.periodicos.capes.gov.br/), and ERIC (https://eric.ed.gov/) databases. References from the included articles were also reviewed to increase the possibility of including articles of interest.

The search used the following descriptors: “motor skills disorders”, “developmental coordination disorder”, “psychomotor performance”, “physical fitness”, and “child”. Boolean operators (AND, OR), were applied to create search strings tailored to the structure of each database (Table 1).

2.3. Selection process

Three authors (first, third, and fifth) independently selected articles. Disagreements were resolved by consensus, and the results were recorded in an Excel spreadsheet. If a consensus could not be reached, another author (second) made the final decision. Duplicate articles were identified and removed using the CADIMA platform (https://www.cadima.info). The initial selection was based on reading titles and descriptors relevant to the aim of the review, followed by abstracts and full texts according to eligibility criteria. The final decision was made with 100 % agreement between the three authors.

2.4. Data analysis

Data were analyzed based on authorship, publication year, location, objective, sample size and characteristics, diagnostic procedures for DCD, physical fitness components assessed, and assessment tools used. Additionally, the feasibility of the assessment tools in low-income settings was evaluated using a checklist adapted from the Consensus-based Standards for the selection of health Measurement Instruments.[22,23] The checklist was consisted of the five criteria: (i) “Access and instrument costs”, (ii) “Training evaluators to use the tool”, (iii) “Application/tool usage”, (iv) “Cultural characteristics of the assessment tool”, and (v) “Possibility of adapting items/criteria”. Each feasibility criterion was scored from 1 (not applied) to 5 (very good), with a maximum total score of 25 (100 %). The higher the score, the better the feasibility.

2.5. Methodological quality

The risk of bias in the included studies was assessed using the Newcastle-Ottawa Quality Assessment Scale, which has different versions for case-control, cohort, and cross-sectional studies. Each version includes three categories with criteria addressing selection, comparison, and outcomes (for cohort and cross-sectional) or exposure (case-control). The maximum score was 10 for cross-sectional studies and 9 for case-control or cohort studies. The methodological quality of studies was classified as low (2–4 points), moderate (5–6 points), or high (7–10 or 7–9 points).[24,25]

3. Results

A total of 8470 records were identified from database searches, and 7540 records remained after duplicate removal. Based on the eligibility criteria, 21 articles were selected for the final sample of this systematic review (Fig. 1).

Table 1
Constructed strings.

Search string	Database or further sources
(((((Motor Skill Disorder [Mesh])) OR (developmental coordination disorder [Mesh])) AND (developmental coordination disorder [Mesh])) OR (Physical fitness [Mesh])) AND (child* [Mesh])	PubMed
"Motor Skill Disorder" OR "developmental coordination disorder" AND "Psychomotor Performance" OR "Physical Fitness" AND child*	Scopus
TS=(("Motor Skill Disorder" OR "developmental coordination disorder") AND ("Psychomotor Performance" OR "Physical Fitness") AND child*)	Web of Science
(("Motor Skill Disorder" OR "developmental coordination disorder") AND ("Psychomotor Performance" OR "Physical Fitness") AND "child*")	EBSCO – ERIC

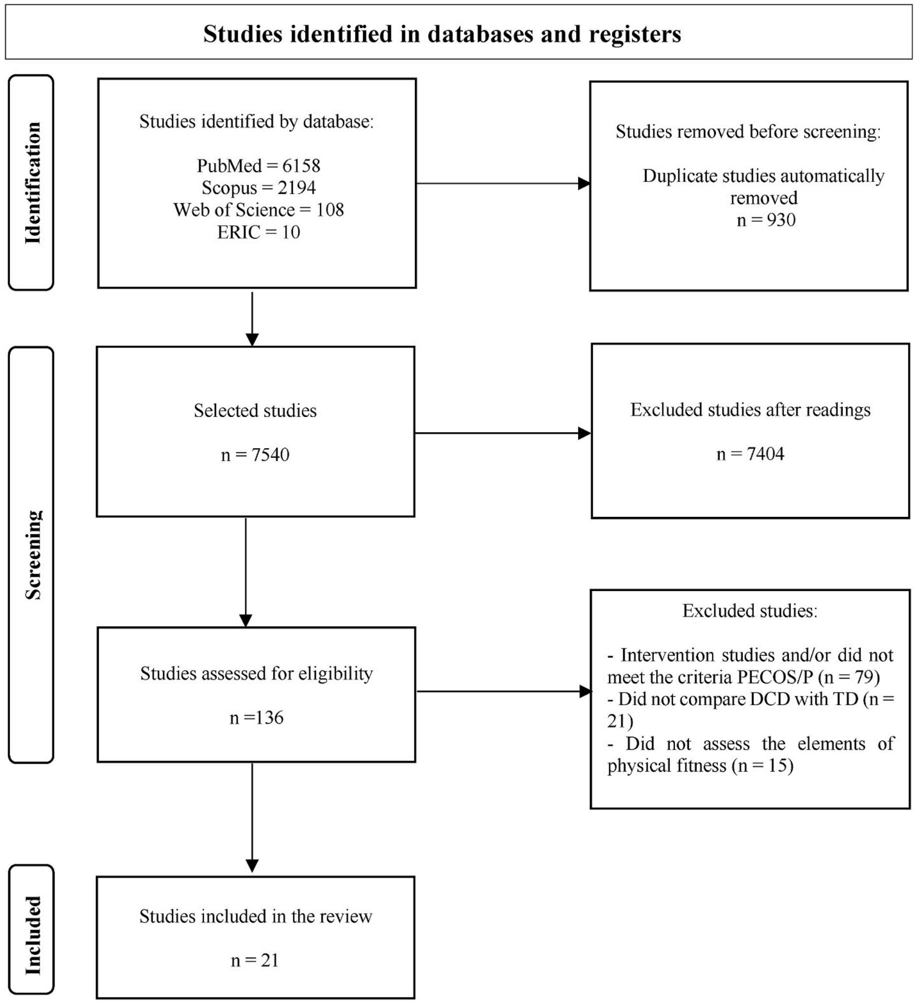

Fig. 1. Flowchart of article search and selection. Adapted from Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Page et al., 2021). DCD: developmental coordination disorder; TD: typical development.

The sample included 5650 children (1101 diagnosed with DCD and 4549 with TD), and studies were conducted mainly in Brazil (5/21), Canada (3/21), and Tunisia (3/21). The Movement Assessment Battery for Children was the most used tool for diagnosing DCD (14/21). Aerobic capacity (14/21) and muscle strength (11/21) were the most frequent physical fitness components assessed. The shuttle run (4/14) and the 6-min walk test (3/14) were the most used tools for assessing aerobic capacity, whereas handgrip dynamometer (4/11) and long jump (4/11) were the main tools for assessing muscle strength (Table 2).

Most studies (12/21) presented high methodological quality.[6,11,27,28,30,32,36–38,40,41,43] Eight studies were of moderate quality,[9,26,29,32,34,35,39,42] while only one study[31] was of low methodological quality (Table 3).

Table 4 outlines the feasibility of the assessment tools for use in low-income settings. The Performance and Fitness test battery (PERF-FIT) and long jump were the most feasible, scoring 92 % of the maximum points. In addition, the 6-min walk test, Muscle Power Sprint Test (MPST), and Functional Strength Measurement (FSM) scored 88 %. In contrast, the least feasible was the incremental treadmill test, scoring only 36 %.

PERF-FIT: Performance and Fitness test battery; BOT-2: Bruininks–Oseretsky Test of Motor Proficiency – Second edition; VO_2: oxygen uptake. 5 – very good; 4 – adequate; 3 – doubtful; 2 – inadequate; 1 – not applicable.

4. Discussion

This study systematically reviewed the literature on physical fitness assessment tools for children with DCD aged 7 to 10 compared with TD children and analyzed the feasibility of these tools in low-income settings. Cardiorespiratory fitness was the most frequently assessed component, while the shuttle run was the most used tool (score of 68 % on the feasibility checklist). The 6-min walk test was also widely used for assessing cardiorespiratory fitness and scored 88 % in the feasibility checklist.

A recent review[44] found cardiorespiratory fitness to be the most impaired component in children with DCD compared with TD, highlighting the need for proper assessment tools. Although the shuttle run is common and holistically estimates health indicators of children,[45] proper evaluator training is essential for accurate application and the low feasibility score found may limit its use in low-income settings. In this sense, the 6-min walk test is recommended for its practicality and safety in this population.

The 6-min walk test is internationally recognized as a practical and safe assessment tool due to the intuitive nature of walking.[46,47] It is also suitable for children with DCD because it minimizes environmental restrictions and task complexities often required for this group.[48,49] The test scored high in accessibility, evaluator training, application, cultural relevance, and adaptability, highlighting its importance as a reliable and feasible assessment tool. Conversely, the incremental treadmill test, considered a gold standard for estimating maximum oxygen uptake,[50]

Table 2
Summary of objectives, sample characteristics, tools for diagnosing DCD, assessment tools, and physical fitness components assessed in the included studies.

Studies	Objective	Country	Sample characteristic			Assessment tools used to diagnose DCD	Assessment tools used to assess physical fitness	Physical fitness components assessed
			Total	DCD	TD			
Sujatha et al.[26]	Assess cardiorespiratory fitness in children with DCD.	India	24	12	12	DCDQ'07 BOT2 force test	20-m shuttle run test	Cardiorespiratory fitness
Smits-Engelsman et al.[27]	Identify attributes differentiating motor skills levels and anaerobic or musculoskeletal fitness.	Brazil	68	34	34	DCDQ MABC-2	I) PERF-FIT a) Jumping, hopping, running, stepping, side jump, long jump, and overhand throw b) Throwing and catching, bouncing and catching, and balance (static and dynamic)	I) Physical fitness related to motor skills a) Agility and power b) Motor skill performance
Nobre et al.[28]	Investigate if physical fitness test performance can distinguish children with pDCD and serve as a control parameter for motor coordination reliability.	Brazil	57	29	28	MABC-2	I) Adapted sit-and-reach test II) Push-up and modified pull-up tests III) Handgrip strength and horizontal jump	I) Flexibility II) Upper limb strength and resistance III) Lower limb strength
Hiraga et al.[9]	Examine physical fitness differences between children with pDCD and their TD peers.	Brazil	64	32	32	MABC	I) 9-min run II) Long jump III) Pull-ups and curl-ups IV) Sit-and-reach test	I) Cardiorespiratory fitness II) Explosive power III) Muscle strength and endurance IV) Flexibility
Schott et al.[29]	Analyze fitness, body composition, and physical activity differences between children with and without DCD.	Germany	261	71 52 (borderline/ moderate)	106 32 (mean)	MABC	Fitness Tests - protocol of the Allgemeiner Sportmotorischer Test für Kinder and the Münchner Fitness test I) 6-min run II) 1 kg medicine ball throw III) Jump-and-reach test IV) 20-m sprint test V) Standardized exercise measuring the spine in flexion	I) Cardiorespiratory fitness II) Explosive power III) Muscle strength IV) Anaerobic power V) Flexibility
Cairney et al.[30]	Determine if children with DCD have lower ACR than those without, considering age and sex variations.	Canada	549	44	505	BOTMP-SF	20-m shuttle run test	Cardiorespiratory fitness
Raynor[31]	Assess whether children with DCD exhibit lower levels of maximal strength and if this is due to increased coactivation levels.	Australia	40	20	20	MAND	Biodex dynamometer	Muscle strength and power
Lifshitz et al.[32]	Investigate correlations between physical fitness and overweight in Israeli children compared with TD children and examine sex differences.	Israel	69	22	47	MABC-2	I) BOT-2 strength test II) 6-min walk test	I) Muscle strength II) Cardiorespiratory fitness
Wu et al.[33]	Compare cardiopulmonary fitness and endurance in children with DCD and TD children aged nine to ten from Taiwan.	Taiwan	41	20	21	MABC	I) 800-m run test II) VO_2 test with Bruce treadmill protocol	I, II) Cardiorespiratory fitness
Li et al.[34]	Evaluate changes in motor coordination and health-related physical fitness in Taiwanese children over three years with and without DCD.	Taiwan	50	25	25	MABC	I) Sit-and-reach test II) Long jump III) Sit-ups IV) 800-m run test	I) Flexibility II) Muscle strength III) Muscle power IV) Cardiorespiratory fitness
Rivilis et al.[11]	Track cardiorespiratory fitness changes over 4.7 years in children with pDCD compared with TD controls.	Canada	2278	178	2100	BOTMP-SF	20-m shuttle run test	Cardiorespiratory fitness
Nascimento et al.[35]	Assess physical fitness among children with moderate and severe DCD and a control group in Manaus, Brazil.	Brazil	63	42	21	MABC-2	Fitnessgram	Muscle force Muscle strength Flexibility Cardiorespiratory fitness

(continued on next page)

Table 2 (*continued*)

Studies	Objective	Country	Sample characteristic			Assessment tools used to diagnose DCD	Assessment tools used to assess physical fitness	Physical fitness components assessed
			Total	DCD	TD			
Farhat et al.[36]	Evaluate neuromotor and cardiorespiratory fitness using laboratory tests during an incremental treadmill protocol in children with and without pDCD.	Tunisia	49	21	28	MABC	I) Cycle ergometer II) 6-min walk test	I, II) Cardiorespiratory fitness
Farhat et al.[37]	Explore relationships between body composition, physical fitness, and exercise tolerance in children with and without DCD.	Tunisia	37	19	18	MABC	I) Modified agility test II) Triple-hop distance test III) Five-jump test IV) 6-min walk test	I) Agility II, III) Explosive strength IV) Cardiorespiratory fitness
Aertssen, Ferguson, Smits-Engelsman[38]	Investigate anaerobic capacity and functional strength in children with clinical DCD, particularly differences in older (7–10 years) versus younger (4–6 years) children.	The Netherlands	157	47	110	MABC-2	I) Muscle Power Sprint Test II) Functional Strength Measurement	I) Explosive force II) Muscle strength
Wright et al.[39]	Compare physiological characteristics and perceptions of physical activity among children with varying levels of motor proficiency.	Australia	117	57	60	MABC	I) Incremental treadmill test II) Bench press, leg press, and pull-down (five maximum repetitions)	I) Cardiorespiratory fitness II) Muscle strength
Cairney et al.[6]	Examine if differences in aerobic fitness between children with and without DCD are due to the perceived adequacy of physical activity.	Canada	586	44	542	BOT-2 force test	20-m shuttle run	Cardiorespiratory fitness
Nobre et al.[40]	Compare physical and psychosocial factors and their associations with gross motor coordination in children with DCD and TD children.	Brazil	463	166	243	MABC-2	I) Long jump II) Handgrip dynamometer	I) Lower limb muscle strength II) Handgrip strength
Ito et al.[41]	Compare walking efficiency and its association with physical function in children with and without DCD traits.	Japan	286	45	241	DCDQ	2-min walk test	Cardiorespiratory fitness
Tsiotra et al.[42]	Investigate physical fitness levels in children with suspected DCD versus their TD peers.	Greece	177	12	165	BOTMP-SF	I) Sit-and-reach test II) Vertical jump III) Handgrip dynamometer IV) 40-m velocity test V) 40-m dash	I) Flexibility II) Explosive force III) Handgrip strength IV) Velocity V) Aerobic power
Farhat et al.[43]	Determine motor skills levels, daily living activities, and self-efficacy in children with severe and moderate DCD compared with TD children and report the relationships between physical fitness, motor skills, daily activities, and self-efficacy.	Tunisia	214	109	105	MABC-2	I) PERF-FIT a) Jumping, hopping, running, stepping, side jump, long jump, and overhand throw b) Throwing and catching, bouncing and catching, and balance (static and dynamic)	a) Physical fitness related to motor skills – agility and power b) Motor skill performance

MABC-2: Movement Assessment Battery for Children – Second edition; BOTMP-SF: Bruininks–Oseretsky Test of Motor Proficiency – Short form; MAND: McCarron Assessment of Neuromuscular Development; PERF-FIT: Performance and Fitness test battery; DCDQ: Developmental Coordination Disorder Questionnaire; MPST: Muscle Power Sprint Test; FSM: Functional Strength Measurement. DCD: developmental coordination disorder; pDCD: probable developmental coordination disorder; TD: typical development; VO_2: oxygen uptake.

presented the lowest score due to its complexity, high training requirements, and equipment costs, making it unsuitable for low-income settings.

Muscle strength was the second most assessed component in children with DCD compared with TD. This component was also the second most compromised in children with DCD, according to a recent systematic review.[44] Using validated and reliable assessment tools is essential for estimating the strength levels of children. The handgrip dynamometer was the most frequently used tool but had a low feasibility score of 56 %. More sophisticated models, such as the Biodex dynamometer, scored even lower (52 %). Despite its convenience and portability, the instrument is costly and offers limited customization options, making it also impractical for use in low-income settings.

In this sense, the long jump and PERF-FIT were identified as the most viable tools for assessing muscle strength in low-income settings. The MPST and FSM also achieved high scores and are recommended for use in these contexts. These tools are cost-effective and easy to administer in playgrounds, courts, or sandy areas, which are commonly available in elementary schools, including in developing countries.[38,51] The PERF-FIT, MPST, and FSM are comprehensive test batteries that assess muscle strength, agility, power, and muscle endurance. Notably, the long jump is included in the PERF-FIT[27] and FSM.[52]

This review synthesized key information on the feasibility of physical fitness assessment tools for children with DCD in low-income settings. Therefore, we recommend the PERF-FIT, MPST, and FSM for muscle strength assessment and the 6-min walk test for cardiorespiratory fitness. A total of 95 % of studies presented an acceptable risk of bias (i.e., 57 % and 38 % of studies presented high and moderate

Table 3
Methodological quality of the included studies using the Newcastle-Ottawa Quality Assessment Scale.

NEWCASTLE-OTTAWA SCALE (NOS)											
Study (n)	**Design**	**Selection 1**	**Selection 2**	**Selection 3**	**Selection 4**	**Comparison 1a**	**Comparison 1b**	**Outcome 1/ Exposure 1**	**Outcome 2/ Exposure 2**	**Exposure 3**	**NOS total score**
Sujatha et al.[26]	Cross-sectional	-	-	-	**	-	*	**	-	-	5/10 (50%)
Smits-Engelsman et al.[27]	Cross-sectional	-	-	-	**	*	*	**	*	-	7/10 (70%)
Nobre et al.[28]	Case-control	*	-	*	**	*	-	-	*	*	7/9 (78%)
Hiraga et al.[9]	Case-control	*	-	-	*	*	*	-	*	-	5/9 (56%)
Schott et al.[29]	Cross-sectional	*	-	*	*	*	*	-	*	-	6/10 (60%)
Cairney et al.[30]	Cross-sectional	*	*	*	**	*	*	-	*	-	8/10 (80%)
Raynor[31]	Case-control	-	-	*	-	*	-	-	*	-	3/9 (33%)
Lifshitz et al.[32]	Cross-sectional	-	*	*	**	*	-	-	*	-	6/10 (60%)
Wu et al.[33]	Cross-sectional	*	*	*	**	*	-	-	-	*	7/10 (70%)
Li et al.[34]	Cohort	*	*	*	-	*	-	-	*	*	6/10 (60%)
Rivilis et al.[11]	Cohort	*	*	*	*	*	-	-	*	*	7/9 (78%)
Nascimento et al.[35]	Cross-sectional	-	-	*	**	*	-	-	*	-	6/10 (60%)
Farhat et al.[36]	Cross-sectional	*	*	*	**	*	-	-	*	-	7/10 (70%)
Farhat et al.[37]	Cross-sectional	-	*	*	**	**	-	-	*	--	7/10) (70%)
Aertssen et al.[38]	Case-control	*	*	*	*	*	-	*	*	-	7/9 (78%)
Wright et al.[39]	Cross-sectional	-	*	*	**	*	-	-	*	-	6/10 (60%)
Cairney et al.[6]	Cross-sectional	*	*	*	**	**	-	**	*	-	10/10 (100%)
Nobre et al.[40]	Cross-sectional	*	*	*	**	*	-	-	*	-	7/10 (70%)
Ito et al.[41]	Cross-sectional	-	*	*	**	*	-	**	*	-	8/10 (80%)
Tsiotra et al.[42]	Cross-sectional	-	*	*	**	*	-	-	*	-	6/10 (60%)
Farhat et al.[43]	Cross-sectional	-	*	*	**	**	-	-	*	-	7/10 (70%)

Methodological quality was classified as low (red), moderate (orange), or high (green).

methodological quality, respectively).

We should also highlight the importance of verifying the feasibility of physical fitness tools, particularly for children with DCD, a complex and heterogenous condition. For this reason, it is important to distinguish between laboratory and field-based tests and their relevance when accessing feasibility. Although laboratory tests represent the gold standard in estimating physical fitness, particularly for children with DCD, field-based tests such as the 6-min walk test, PERF-FIT, MPST, and FSM can be more ecologically valid, as they closely match common playground activities during childhood.[20]

However, many studies did not control for additional variables (e.g., sex, body weight, height, and body mass index) and focused only on age, which does not fully address bias despite being an important factor. Additionally, numerous studies lacked clear descriptions of test applications, influencing the validity and safety of results. Further research using the most feasible assessment tools for low-income settings is needed to strengthen the body of evidence.

Another issue to be account is the influence of socioeconomic factors across low-income countries. We should be aware of how education levels, public health infrastructures and also cultural practices can determine the impact the use of the physical fitness tools. Mainly because those socioeconomic factors have been pointed out as moderators[53,54] of physical activity behaviors in children, probably the most feasible tool to access precisely physical fitness levels must be dependent of such factors as well. As the information regarding socioeconomic factors were lacking in the most part of the included studies, further studies should add the mentioned factors to enhance this discussion.

This study is not free of limitations. Only studies published in English and Portuguese were retrieved; thus, future reviews should incorporate studies in other languages to capture a broader range of information. Moreover, this review did not examine other physical fitness elements, such as flexibility and agility, because they were not a primary focus of the included studies. Another limitation was the lack of detailed socioeconomic information, which could have provided a clearer analysis of the feasibility of assessment tools in low-income settings.

5. Conclusion

Based on evidence from 21 primary observational studies (95 % of high to moderate methodological quality), the most frequently used physical fitness assessment tools for children with DCD compared with TD were the shuttle run, 6-min walk test, handgrip dynamometer, and long jump. However, the 6-min walk test was the most feasible tool for assessing cardiorespiratory fitness, while the long jump and PERF-FIT were feasible for assessing muscle strength in low-income settings. Further high-quality studies are recommended, especially using these feasible assessment tools in low-income settings.

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Table 4
Feasibility of the assessment tools included in the studies, considering the checklist adapted from the COSMIN.

Physical Fitness Assessment Tools (studies)	Criteria					
	Access and instrument costs	Training evaluators to use the tool	Application/ tool usage	Cultural characteristics of the assessment tool	Possibility of adapting items/ criteria	Total
20-m shuttle run[6,11,26,30]	5	1	4	4	3	17 (68 %)
PERF-FIT[27,43]	5	5	4	4	5	23 (92 %)
Adapted sit-and-reach test[28]	5	1	4	4	3	17 (68 %)
Push-up and modified pull-up tests[28]	4	1	3	3	3	14 (56 %)
9-min run[9]	5	1	3	3	4	16 (64 %)
Long Jump[9,28,34,40]	5	5	4	4	5	23 (92 %)
Pull-ups and curl-ups[9]	4	1	3	3	3	14 (56 %)
Sit-and-reach test[9,34]	3	3	4	4	4	18 (72 %)
Fitness Tests - protocol of the Allgemeiner Sportmotorischer Test für Kinder and the Münchner Fitness test[29]	4	3	3	4	3	17 (68 %)
Biodex dynamometer[31]	2	1	3	3	1	10 (40 %)
BOT-2 force test[32]	3	4	4	3	2	16 (64 %)
6-min walk test[32,37]	5	4	4	4	5	22 (88 %)
800-m run test[33,34]	5	3	3	4	4	19 (76 %)
VO_2 test with treadmill - Bruce protocol[33]	2	4	3	3	1	13 (52 %)
Sit-ups[34]	5	3	3	4	4	19 (76 %)
Fitnessgram[35]	5	3	3	3	3	17 (68 %)
Cycle ergometer[36]	2	3	4	3	3	15 (60 %)
Triple-hop distance test[37]	5	1	4	4	4	18 (72 %)
Five-jump test[37]	5	1	4	4	5	19 (76 %)
Modified agility test[37]	5	1	4	2	3	15 (60 %)
Muscle Power Sprint Test[38]	5	4	5	3	5	22 (88 %)
Functional Strength Measurement[38]	5	4	5	3	5	22 (88 %)
Incremental treadmill test[39]	1	1	2	2	3	9 (36 %)
Bench press, leg press, and pull-down five maximum repetitions[39]	3	1	3	2	2	11 (44 %)
Handgrip dynamometer[28,40,42]	3	3	3	4	1	14 (56 %)
2-min walk test[41]	2	3	4	1	4	14 (56 %)
Vertical jump[42]	5	3	3	4	4	19 (76 %)
40-m velocity test[42]	4	3	4	4	4	19 (76 %)
40-m dash[42]	4	3	3	3	4	17 (68 %)

Declaration of interest statement

The authors declare that they do not have conflict of interest to report.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesf.2024.12.005.

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