



Management of Developmental Coordination Disorder

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Introduction

This document contains a brief overview of evidence regarding assessment, diagnosis, intervention, and service delivery for children and youth with developmental coordination disorder (DCD).

How was the literature review completed?

An electronic search was performed in November 2017 and February 2018 of the following databases: TRIP, Cochrane, OT Seeker, Rehabilitation Reference Centre, UpToDate, CINAHL, and MEDLINE (PubMed). Keywords used in the search included: developmental coordination disorder, DCD, child*, intervention, systematic review, and therapy. Summaries (e.g., clinical practice guidelines) and evidence syntheses (e.g., systematic reviews) were gathered to summarize research findings. Publications with the highest levels of evidence that were published since the most recent clinical practice guideline, as well as relevant qualitative research, were also included in this summary.

The American Academy for Cerebral Palsy and Developmental Medicine (AAPCPDM) Levels of Evidence¹ were assigned to relevant studies (see Table 1). The AMSTAR² scale was used to rate quality of included systematic reviews. The Appraisal of Guidelines for REsearch & Evaluation II (AGREE II) Instrument³ was used to assess the quality of any guidelines (see Tables 1 and 2). The International Classification for Functioning, Disability and Health (ICF) was used to describe study outcomes.⁴

What is Developmental Coordination Disorder (DCD)?

DCD is a chronic motor skill disorder seen in children and youth that significantly affects activities of daily living, school performance, and leisure activities.^{5,6} The motor deficits must not be attributable to any other known medical or neurological condition (e.g., cerebral palsy or a neurodegenerative disorder).⁵

Although DCD can occur on its own, there is a high co-occurrence with other neurodevelopmental or neurobehavioural disorders, such as attention deficit hyperactivity disorder (ADHD) and/or specific learning and/or language disabilities. DCD also co-occurs with autism spectrum disorder (ASD) and is more prevalent in children born preterm and/or low-birth weight.^{5,7}

What is the incidence of DCD?

DCD is a prevalent disorder, typically affecting 5% to 6% of school-aged children and youth (i.e., one to two children in every Canadian classroom).⁸ Males are more often diagnosed with DCD than females, with the male: female ratio varying from 2:1 to 7:1.⁵ However, population-based studies have found the ratio to be more similar between the sexes, leading to the possibility that girls may be under-diagnosed, perhaps because parents place less importance on poor motor coordination in girls.^{9,10}

What are the consequences of DCD?

As a long-standing chronic disorder, the consequences of the motor deficits associated with DCD typically affect not only body fitness, activities of daily living, and academic functioning, but also social relationships and participation.^{5,6,11-14} Children with DCD also report psychological issues, including



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significantly higher levels of depression and anxiety.¹⁴ Consequently, the quality of life of children and youth with DCD can be considerably compromised compared to typically developing peers.^{13,14}

Despite being one of the most common disorders in childhood, DCD is often under-recognized, under-diagnosed, and under-treated by the health care community.⁵

How is DCD assessed and diagnosed?

DCD is assessed and diagnosed by a health care professional, typically a medical doctor or pediatrician, who is qualified to examine the specific criteria (see below).⁵ Ideally, this process involves a multidisciplinary team approach for the most comprehensive assessment.^{5,6} Assessment should include a thorough medical and developmental history, as well as the use of questionnaires, clinical examination, and motor test(s), as well as a discussion with the child and key individuals in their lives regarding the impact of the child's motor functioning on daily living skills, school, leisure, and participation.^{5,6}

DCD is defined in the DSM-5¹⁵ by the following four criteria:⁵

- A. Acquisition and execution of coordinated motor skills are substantially below what would be expected given the child's age and opportunity for skill learning and use. Difficulties may be seen as clumsiness, inaccuracy, or slowness of performance of motor skills (e.g., catching a ball, using scissors, printing or handwriting, riding a bicycle, or participating in sports).
- B. The motor skills deficit significantly and persistently interferes with activities of daily living and impacts school productivity, vocational skills, leisure activities, and play.
- C. The onset of symptoms is in the early developmental period.
- D. The motor skills deficit is not better explained by intellectual disability, visual impairment, or a neurological or medical condition affecting movement.

To address the above criteria, the assessment should encompass activities of daily living (e.g., self-care, academic abilities, prevocational and vocational activities, leisure participation and play) and the views of the child, parents, teachers, and relevant others.⁵ Cultural differences should be considered to ensure that the child has had appropriate opportunities to practice and acquire motor skills.⁵

Can a dual diagnosis be given?

A dual diagnosis of DCD and other neurodevelopmental disabilities (e.g., ASD, learning disorders, ADHD) should be given if appropriate, and treated according to established clinical guidelines. Treatment of co-occurring conditions can improve outcomes.⁵

What assessment measures should be used for Criterion A?

Motor abilities should be assessed using objective, reliable, validated, and norm-referenced tests and measures.^{5,6} The following motor function assessment tools are recommended as the primary evaluation measures for the assessment of DCD:⁵

1. Movement Assessment Battery for Children, 2nd edition (MABC-2)¹⁶

The MABC-2 is a norm-referenced test for children 3 years 0 months to 16 years 11 months.¹⁶ The measure contains 8 tasks in each of the 3 age ranges (3-6 years, 7-10 years, 11-16 years). Tasks relate to 3 specific areas: manual dexterity, ball skills, and balance (static and dynamic). Total standard scores are calculated and then converted into percentiles to determine how a child's motor coordination compares to typically developing children of the same age. A cut-off score at or below the 16th percentile is recommended for children 6 years and older. However, if a child scores below the 5th percentile in one domain (e.g., fine motor, balance) but scores above the 16th percentile in other domains, a DCD diagnosis could be made if other diagnostic criteria are met.⁵ For children under the age of 6 years, a cut-off score at or below the 5th percentile on the total motor score is recommended.⁵

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The MABC-2 has demonstrated good to excellent inter-rater and test-retest reliability ($r=0.72-0.95$),¹⁷ good specificity, and fair to good construct validity and concurrent validity with the Bruininks-Oseretsky Test of Motor Proficiency (1st edition: BOTMP and 2nd edition: BOT-2).⁵ Sensitivity compared to the BOTMP is fair to good, with higher sensitivity demonstrated when using the 15th percentile cut-off.⁵ Overall, the level of evidence on the quality and suitability of the MABC-2 for the diagnosis of DCD is moderate to good.^{5,17}

2. Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition (BOT-2)¹⁸

The BOT-2 is a norm-referenced motor function test for individuals aged 4 to 21 years, which assesses running ability, agility, balance, bilateral coordination, upper limb speed and dexterity, and visual motor control.¹⁸ The BOT-2 has good to excellent test-retest and inter-rater reliability correlations ($r=0.80$),¹⁷ with good specificity, construct validity, and concurrent validity with the MABC-2. Sensitivity is reported to be lower than that of the MABC-2, although this information is based on weak evidence.⁵ In general, the quality and suitability of the BOT-2 is rated moderate for this population.

Clinicians are advised that if any uncertainty exists in interpretation, administration of the alternate standardized motor test may be warranted.

What assessment measures should be used for Criteria B, C and D?

A validated parent or teacher questionnaire should be used to support criterion B.⁵ The parent-report Developmental Coordination Disorder Questionnaire (DCDQ)¹⁹ is reported to be the best evaluated and validated questionnaire; use of the MABC-2 checklist¹⁶ is also recommended.⁵ Questionnaires and checklists should not, however, be used for population-based screening because of low sensitivity.⁵ A history of motor learning challenges should be evident from early in life; parent interview and/or tools such as the Listening for DCD Checklist²⁰ or clinical interview guidelines²¹ may be used to assist in determining Criteria B & C. Standardized testing for criterion D (e.g., IQ testing) is not required if a normal history of school functioning and academic achievements is reported and no uncertainty exists regarding the child's cognitive functioning level.⁵

Can DCD be diagnosed before the age of 5?

Although DCD is usually evident early on in a child's life, the disorder is not typically diagnosed before age five.⁵ However, if a preschooler (3 to 5 years of age) shows significant motor impairments (despite having had ample opportunities for learning and with other causes of motor delay have been ruled out), the diagnosis of DCD can be given, based on the findings from at least two longitudinal assessments (such as the repeated administration of the MABC-2) performed at sufficiently long intervals (at least 3 months apart).⁵ More specifically, a cut-off of no more than the 5th percentile is used for this age group.⁵

Which interventions are effective for children with DCD?

Children with DCD require treatment to remediate their motor challenges; strong (level II) evidence demonstrates physiotherapy and/or occupational therapy intervention are better than no treatment.^{5,22-24} Best practice dictates that intervention should begin with collaborative individualized client- and family-led goal setting, focused on functional and meaningful activities and participation outcomes.^{5,23} Recommended goal-setting and outcome measurement tools include the Canadian Occupational Performance Measure (COPM),^{5,25} the Goal Attainment Scale (GAS),^{5,26} the Perceived Efficacy and Goal Setting System(PEGS),²⁷ and the Pediatric Activity Card Sort (PACS).²⁸

Activity- or task-oriented approaches, such as Cognitive Orientation to Occupational Performance (CO-OP) and Neuromotor Task Training (NTT), focus on meaningful activities of daily living to help promote transfer of training, and are supported by strong evidence (level I and II) for improving task performance and satisfaction. This evidence is drawn from clinical practice guidelines⁵ and subsequent systematic



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reviews.^{23,31} Effectiveness findings for overall motor skill outcomes are inconclusive.³¹ Research syntheses report large effect sizes and strong treatment effects for task-oriented approaches.^{23,30,31}

To be most effective, the therapy process should be child-centred and include key stakeholders, such as parents and teachers.^{5,23,30} Inclusion of parents and teachers is needed to support task-specific practice, and to enable adequate practice time of home exercises/activities outside of professional treatment time.⁵ Professional instruction to educate and to coach the parents as a means to support the generalization and application of skills into daily life is recommended.^{5,23} Qualitative research suggests that incorporating the priorities of parents and children is crucial for optimising the outcomes of intervention.³² Parents report valuing the education and support provided by professionals, as it helps to mitigate the apprehension that is often associated with raising a child with DCD.³²

Compensatory and environmental supports, as well as the use of coping strategies, also need to be considered as part of intervention.^{5,13} Occupational therapy should include the modification of tasks and expectations to match abilities, and the adaptation of materials and the environment of the child.^{5,6,23}

Clinical practice guidelines and subsequent systematic reviews and meta-analyses (strong evidence; level II) do not recommend process-oriented approaches (e.g., sensory integrative, perceptual and kinaesthetic training^{5,23}), non-task specific interventions (e.g., use of the Wii Fit), and psychological approaches (e.g., self-concept training)²⁹ because of inconclusive, weak, or negligible effects on motor performance in this population. Some preliminary evidence exists for the effectiveness of motor imagery combined with task practice training²⁹ and for active video gaming as an adjunct to standard treatment.³¹ Despite the overwhelming support for task-specific interventions, a recent narrative meta-review²⁴ and evidence synthesis³³ convey weak to moderate confidence in previous systematic review findings. Clinicians are therefore encouraged to measure, monitor, and track motor skill outcomes, as well as activity- and participation-level outcomes that reflect families' goals.^{5,34}

Treatment frequency and duration

Optimal treatment frequency and duration have not been determined conclusively because of the non-uniformity of variables across studies.^{5,23} However, the majority of effective treatment interventions lasted longer than 10 weeks.²³ Reported treatment frequency ranged from every school day (including home exercises) to weekly, with once per week being most common.²³ Training programs with more frequent practicing schedules (e.g., 3-5 times/week) demonstrated the most significant effects on motor performance.^{30,35}

Group versus individual intervention

Small group intervention settings (4-6 children with one therapist and optional assistant) offer promise,³¹ particularly those that involve parents;^{23,36} however, this approach needs to be considered carefully for very young children and for those with severe DCD, both of whom may benefit more from individualized therapy.⁵ Intervention should be tailored to the individual needs and interests of participants.²⁹

Based on outcomes from the highest available level of evidence for each intervention approach for school-age children, grades of recommendation are offered in Table 1. Grades of recommendation are defined in Appendix II.³⁷ Evidence for early intervention for DCD is limited, but is summarized in the accompanying document, *Early Identification and Early Intervention for DCD* (<http://bit.ly/2D8IDEY>).

What is known about intervention for youth and young adults with DCD?

The persistent nature of DCD needs to be addressed as children transition to adolescence and adulthood. New demands develop during this transition, which lead to subsequent struggles with activities, such as driving and academic tasks.¹³ Mental health challenges, such as anxiety and depression, may emerge in early adolescence and continue into adulthood, leading to further reduced

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social participation.^{13,14} Little evidence exists for interventions specifically targeted toward social participation for youth and young adults with DCD.¹³ Current best practice recommendations include clinicians working with youth and young adults to address compensatory and coping strategies, to consider the impact of co-occurring conditions and secondary sequelae (and refer to other health care professionals, as necessary), to provide education, and to enhance functional abilities.¹³ While improving motor skills is critical, the prevention and treatment of mental health difficulties should be a significant component of DCD intervention.³⁸

What is the best service delivery method?

Service delivery recommendations centre around organizing services to meet the comprehensive needs of children with DCD at all stages throughout childhood and adolescence.³⁹ Key elements of program delivery include: (1) working collaboratively with the child and family; (2) providing best practice treatment that focuses on function, participation, and prevention; (3) advocacy to increase awareness of DCD; (4) coordination among all professionals and community groups; (5) establishing clear care pathways; and (6) using a graduated or staged approach for assessment and intervention.³⁹ Stakeholders at all levels are encouraged to work together in designing, implementing, and evaluating interventions.^{39,40} Two proposed models (Apollo and Partnering for Change) are described in the literature, and may hold promise for the provision of a continuum of services designed to build capacity,^{41,42} for decreasing wait times, and for increasing the number of service recipients without sacrificing quality of care.⁴¹

Table 1. Grades of Recommendation for Intervention with Children and Youth with DCD

ICF Dimension	Outcome of interest	Intervention	Recommendation
Body Structure/Function	Gross motor skills	No intervention	   Proven Ineffective ^{5,23,24,31}
		Activity- or task-oriented approach (e.g., CO-OP, NTT) - individual or group* intervention	   Insufficient Evidence ³¹
		Process-oriented approach (e.g., sensory integration, kinesthetic training)	   Conflicting Evidence ^{5,23}
	Gross motor functions, strength exercises, and weight-bearing	Gross motor functions, strength exercises, and weight-bearing	   Insufficient Evidence ⁵
		Virtual reality/active video gaming as an adjunct to standard treatment	   Insufficient Evidence ³¹
	Fine motor skills	Motor skills intervention	   Insufficient Evidence ³⁰
	Physical fitness (if targeted) (e.g., physical condition and strength)	Activity- or task-oriented training, (e.g., NTT and sport/play related skill training, and virtual reality)	   Proven Effective ³¹



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ICF Dimension	Outcome of interest	Intervention	Recommendation
		No intervention	 STOP  MEASURE  GO Proven Ineffective ^{5,23,24,31}
		Activity- or task-oriented Approach (e.g., CO-OP, NTT) - individual or group* intervention	 STOP  MEASURE  GO Proven Effective ^{5,23,31}
		Process-oriented approach (e.g., sensory integration, kinesthetic training)	 STOP  MEASURE  GO Insufficient Evidence ^{5,23}
Activity	Motor task performance	Non-task-specific interventions (e.g., Wii Fit, Tai Kwon Do)	 STOP  MEASURE  GO Proven Ineffective ²⁹
		Psychological approaches (e.g., self-concept training)	 STOP  MEASURE  GO Proven Ineffective ²⁹
		Motor imagery training combined with task practice training	 STOP  MEASURE  GO Conflicting Evidence ^{5,29}
		Active video gaming as an adjunct to standard treatment	 STOP  MEASURE  GO Insufficient Evidence ³¹
		Cognitive, emotional and other psychological factors (e.g., inhibition, self-esteem)	 STOP  MEASURE  GO Insufficient Evidence ³⁰
Participation	Satisfaction with motor task performance	Not specified	 STOP  MEASURE  GO Insufficient Evidence ³⁰
	Participation in physical activity, sports, or active play.	Activity- or task-oriented approach (e.g., CO-OP, NTT) - individual or group* intervention	 STOP  MEASURE  GO Insufficient Evidence ³¹

CO-OP, Cognitive Orientation to Daily Occupational Performance; NTT, Neuromotor Task Training

*Small group intervention recommended with parent involvement, for older children with milder DCD⁵

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Table 2: AMSTAR Conduct Rating²

Conduct Rating Questions	Articles								
	Zwicker ¹⁴	Slater ¹⁷	Pless ³⁵	Hillier ²²	Smits-Engelsman ²³	Miyahara ²⁴	Preston ²⁹	Yu ³⁰	Smits-Engelsman ³¹
1. Was an a priori design provided?	Yes	No	No	No	No	No	Yes	Yes	Yes
2. Was there duplicate study selection and data extraction?	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes
3. Was a comprehensive literature search performed?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
4. Was the status of publication (i.e., grey literature) used as an inclusion criterion?	Yes	Yes	Yes	No	No	No	No	Yes	No
5. Was a list of studies (included and excluded) provided?	No	No	No	No	No	No	Yes	No	No
6. Were the characteristics of the included studies provided?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Was the scientific quality of the included studies assessed and documented?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
8. Was the scientific quality of the included studies used appropriate in formulating conclusions?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
9. Were the methods used to combine the findings of studies appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10. Was the likelihood of publication bias assessed?	No	No	No	No	No	No	No	Yes	No
11. Was the conflict of interest included?	No	No	No	No	No	No	Yes	Yes	Yes
Total Rating	8/11	7/11	3/11	5/11	6/11	6/11	8/11	10/11	8/11
AACPDM Level of Evidence (see Appendix 2)	II	II	II	II	II	II	I	I	I

Note: AACPDM=American Academy for Cerebral Palsy and Developmental Medicine

Quality Rating for AACPDM levels of evidence I through III¹

High Quality	8 to 11
Moderate Quality	4 to 7
Low Quality	0 to 3

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Table 3: AGREE II Appraisal Instrument³ for Blank⁵ article

Rating Questions	Reviewer 1	Reviewer 2	Domain Score
1. The overall objective(s) of the guideline is (are) specifically described.	7	7	14
2. The health question(s) covered by the guideline is(are) specifically described.	6	6	12
3. The population (patients, public, etc.) to whom the guideline is meant to apply are specifically described.	5	7	12
Scope and Purpose Domain Total Score	18	20	38 (89%)
4. The guideline development group includes individuals from all the relevant professional groups.	5	4	9
5. The views and preferences of the target population (patients, public, etc.) have been sought.	4	6	10
6. The target users of the guideline are clearly defined.	6	5	11
Stakeholder Involvement Domain Total Score	15	15	30 (67%)
7. Systematic methods were used to search for evidence.	7	7	14
8. The criteria for selecting the evidence are clearly described.	6	6	12
9. The strengths and limitations of the body of evidence are clearly described.	7	7	14
10. The methods for formulating the recommendations are clearly described.	4	5	9
11. The health benefits, side effects and risks have been considered in formulating the recommendations.	3	4	7
12. There is an explicit link between the recommendations and the supporting evidence.	6	6	12
13. The guideline has been externally reviewed by experts prior to its publication.	4	3	7
14. A procedure for updating the guideline is provided.	1	1	2
Rigour of Development Domain Total Score	38	39	77 (64%)
15. The recommendations are specific and unambiguous.	6	6	12
16. The different options for management of the condition or health issue are clearly presented.	6	6	12
17. Key recommendations are easily identifiable.	7	7	14
Clarity and Presentation Domain Total Score	19	19	38 (89%)
18. The guideline describes facilitators and barriers to its application.	2	2	4
19. The guideline provides advice and/or tools on how the recommendations can be put into practice.	4	2	6
20. The potential resource implications of applying the recommendations have been considered.	3	3	6
21. The guideline presents monitoring and/or auditing criteria.	5	5	10
Applicability Domain Total Score	14	12	26 (38%)
22. The views of the funding body have not influenced the content of the guideline.	4	3	7
23. Competing interests of guideline development group members have been recorded and addressed.	1	1	2
Editorial Independence Total Score^a	5	4	9 (21%)
Overall Guideline Assessment Quality^b	5	5	
Overall Guideline Assessment Recommendation for Use^c	Yes	Yes	

Domain scaled score (in brackets)=(Domain score – minimum possible score)/(maximum possible score – minimum possible score) x 100

^aAGREE Score: 1 to 7 (1=strongly disagree, 7=strongly agree)

^bOverall guideline assessment: 1 to 7 (1=lowest possible quality, 7=highest possible quality)

^cI would recommend use of this guideline: Yes, Yes with modifications, No; Strongly recommend' or 'recommend' or 'would not recommend' or 'unsure'



Management of Developmental Coordination Disorder

Appendix I: AACPDM - Levels of Evidence for Group Intervention Studies (December 2008)¹

Level of Evidence	Group Intervention Study Designs
I	Systematic review of randomized controlled trials (RCTs) Large RCTs (with narrow confidence intervals) (n>100)
II	Smaller RCTs (with wider confidence intervals) (n<100) Systematic reviews of cohort studies "Outcomes research" (very large ecologic studies)
III	Cohort studies (must have concurrent control group) Systematic reviews of case-control studies
IV	Case series Cohort study without concurrent control group (e.g., with historical control group) Case-control study
V	Expert opinion Case study or report Bench research Expert opinion based on theory or physiologic research Common sense/anecdotes

AACPDM, American Academy for Cerebral Palsy and Developmental Medicine; RCT, randomized controlled trial

Appendix II: Traffic Lighting Classification Scale³⁴

Colour Code	Criteria	State of the Evidence
	Group design Level I or II evidence of good* quality demonstrating negative outcomes (e.g., absence of change compared to no treatment)	Proven Ineffective
	Group design Level I or II evidence of poor [∞] quality regardless of outcome Group design Level III-V evidence of any quality regardless of outcome Single study research design Level I-V of any quality regardless of outcome Inconclusive results	Insufficient Evidence
	No evidence about the intervention's effectiveness Group design of either Level I or II evidence, where both studies of the same level of evidence show conflicting results	No Evidence Conflicting Evidence
	Group design Level I or II evidence of good* quality, demonstrating statistically significant positive outcomes	Proven Effective

*=Moderate or Strong quality (Group Design AACPDM Conduct Rating Scale¹ score 4-7 or AMSTAR² score 4-11)

∞=Weak quality (Group Design AACPDM Conduct Rating Scale¹ or AMSTAR² score of 1-3)