DCD Assessment Information Sheet

Developmental Coordination Disorder

Toolkit for Pediatricians

What is Developmental Coordination Disorder (DCD)?

DCD is a chronic motor skill disorder seen in children and youth, which significantly affects activities of daily living, school performance, and leisure activities.[1,2] The motor deficits must not be attributable to any other known medical or neurological condition (e.g., cerebral palsy or a neurodegenerative disorder).[2] Although DCD can occur on its own, there is a high co-occurrence with other neurodevelopmental disorders, such as attention deficit hyperactivity disorder (ADHD) and/or specific learning and/or language disabilities.[1] DCD also co-exists with autism spectrum disorder (ASD) and is more prevalent in children born preterm and/or low-birth weight.[2-4]

How is the disorder diagnosed?

DCD is typically diagnosed by a medical doctor or pediatrician who is qualified to examine the specific DSM-5 criteria.[1] Comprehensive assessment leading to diagnosis ideally involves a multidisciplinary health professional team.[1,5] Typically, an occupational or physical therapist assesses criteria A and B, and provides this information to the physician. The physician uses this information and assesses criteria C and D to inform diagnosis.[1,5]

The disorder is diagnosed using DSM-5 criteria:[3]
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.

Why is assessment and diagnosis important?

DCD is a prevalent disorder, affecting 5% to 6% of school-aged children and youth.[2] This means that in British Columbia, ~40,000 students or [1-2] in every classroom are affected.[6] All children with DCD have a history of motor difficulties but do not necessarily report delayed milestones.[5] DCD affects fitness, activities of daily living, academic functioning, social relationships, and participation in meaningful life activities.[1,7-10] Children with DCD find it hard to learn motor skills and perform everyday activities such as doing up buttons and zippers, tying shoelaces, cutting food with a knife, printing, riding a bicycle, and playing sports. Children with DCD also report

psychological issues, including significantly higher levels of depression and anxiety, and lower quality of life than their typically developing peers.[11-13] They may have poor self-esteem and challenges in relationships with peers, resulting in loneliness.[11] In the past the medical community assumed that children would outgrow DCD, but long-term studies have now confirmed that functional difficulties can persist into adulthood.[14,15]

Even though DCD is quite common, many children go undiagnosed and untreated.[1] Recent surveys have found that a majority of primary care physicians, family physicians, and community pediatricians are unaware of the condition and only a minority felt comfortable diagnosing the disorder.[16,17] The majority of both family physicians and pediatricians indicated the need for more education about the disorder.[17] Hence, the need for information sheets such as this one and other similar resources that can be found in the DCD Advocacy Toolkit at: http://www.childdevelopment.ca/DCDAdvocacyToolkit/DCDAdvocacyToolkitResources.aspx

At what age is a DCD diagnosis appropriate?

DCD is usually evident early on in a child's life but not typically diagnosed before age 5.[1] Preschoolers (aged 3 to 5 years) who show significant motor impairments (despite having had ample opportunities for learning and with other causes of motor delay ruled out) can receive a DCD diagnosis based on the findings from at least two longitudinal assessments (e.g., repeated administration of the MABC-2 at least 3 months apart).[1] Please also refer to the accompanying document, Early Identification and Early Intervention for DCD (http://bit.ly/2D8lDEY).

How to determine if DSM-5 diagnostic criteria have been met:

There are four diagnostic criteria for DCD. These are summarized in the attached Figure 1 but are explained in more detail below:

Criterion 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.

- This criterion is often assessed by an occupational or physical therapist using a standardized motor assessment.
- The most commonly used assessments are the **Movement Assessment Battery for Children-2 (MABC-2)**[18] and the **Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2)**.[19]
- MABC-2 total scores ≤ 16th percentile may be indicative of DCD (ages 6 years and older); however, a child of this age scoring ≤ 5th percentile on one of the sub-domains (e.g., manual dexterity, balance), regardless of the total score, also meets this criterion.[1]
- For children ages 3-5 years, an MABC-2 total score of ≤5th percentile is required to meet this criterion. Two assessments administered at least 3 months apart is recommended for this younger age group.[1]
- Cut-off scores for the BOT-2 (and other standardized motor assessments) are 1SD below the mean for children aged ≥ 6 years and 2SD below the mean for children aged 3-5 years.[1]
- Below average scores on psycho-educational testing (e.g., Beery-Buktenica Test of Visual Motor Integration, Coding subtest of the Weschler Intelligence Scale for Children, tests of written expression) may also meet this criterion.

Criterion B: The motor skills deficit significantly and persistently interferes with activities of daily living and impacts school productivity, vocational skills, leisure activities, and play.

- This criterion is often assessed by an occupational or physical therapist.
- The OT or PT report will outline functional difficulties experienced by the child. Common problems include difficulty learning to tie shoelaces, manage buttons or zippers, use a knife and fork, print or handwrite, ride a bicycle, or play sports. The need to repeat the same level of swimming lessons multiple times is commonly reported.
- The OT or PT report may include results of the **Developmental Coordination Disorder Questionnaire (DCDQ)**,[20] a parent questionnaire for children 5-15 years that asks parents to rate their child's ability for

various motor tasks compared to children of the same age. Scores in the "indicative" or "suspected" DCD range may meet this criterion. The **Little DCDQ**[21] is a parent questionnaire for children 3-4 years; scores in the "suspected" range may meet this criterion for younger children.

- If a report of functional difficulties is not available, you can complete the **Listening for DCD Parent Interview Guide**[22], freely available from http://bit.ly/2Ca1qDw
- You can also have the parent complete the DCDQ,[20] freely available from http://www.dcdq.ca. It takes ~5 min to complete. For younger children, Little DCDQ[21] is available from https://www.dcdq.ca/little-dcdq-ca.html for a one-time fee of $50. Both of these questionnaires are also available in French.

Criterion C: The onset of symptoms is in the early developmental period.

- As part of your **developmental history**, listen for difficulty in learning motor tasks early in life, such as feeding as an infant (e.g., poor suck/swallow),[23] throwing/catching a ball, jumping, skipping, riding a tricycle/bicycle, dressing, tying shoelaces, using a knife and fork, or printing.[24] Avoidance or frustration with motor tasks and sports are commonly reported.[24]
- While some children with DCD may have delayed motor milestones, the majority attain gross motor milestones within the average range.[5,25]
- Early speech and/or language delays are often reported.[26,27]

Criterion D: The motor skills deficit is not better explained by intellectual disability, visual impairment, or a neurological or medical condition affecting movement (Figure 1).

- IQ testing is not necessary if there is a history of normal school achievement;[1] however, psycho-educational testing may be warranted if an intellectual disability or severe learning disability is suspected.
- It is possible to have a mild intellectual disability and DCD if the motor difficulties are greater than expected for the child's IQ.
- Ensure the child has normal sensory functioning, i.e., no major visual impairment or hearing impairment that impacts the vestibular system or other medical conditions affecting balance[28].
- Physical exam findings that may suggest DCD:[29]
  - soft neurological signs (e.g., mirror movements, motor overflow, finger agnosia)
  - absence of any hard neurological signs (e.g., normal reflexes, normal strength, normal to low normal tone)
  - MSK exam may show joint hypermobility[30]
- Medical conditions that **exclude a DCD diagnosis** include:
  - Neurological conditions (e.g., cerebral palsy, muscular dystrophy, peripheral neuropathy)
  - Musculoskeletal conditions (e.g., Ehlers-Danlos syndrome, joint hypermobility syndrome)
  - Genetic conditions affecting motor skills (e.g., Down's syndrome, Sotos syndrome, 22q11 deletion syndrome)
  - Moderate to severe intellectual disability
  - Traumatic brain injury
  - Conditions related to pregnancy and birth* (e.g., in utero stroke, periventricular leukomalacia, congenital infections)
- Common **co-occurring developmental conditions**:[5,31]
  - Attention deficit hyperactivity disorder (ADHD)
  - Learning disabilities
  - Speech and/or language delay or disorders (e.g., difficulty with speech articulation, phonological awareness, receptive and/or expressive language)
  - Autism spectrum disorder (ASD)

* Children who were born very preterm are 6-8 times more likely to develop DCD compared to children born full-term.[3] A history of grade I or II intraventricular hemorrhage (IVH) is generally acceptable for DCD diagnosis, but Grade III or IV IVH may be more reflective of perinatal brain injury, which could preclude a DCD diagnosis.

How is DCD managed?

Timely, accurate physician assessment is critical to ensuring DCD diagnosis provision. Diagnosis provision allows for those involved in the child's life to advocate for more support and services. Diagnosis facilitates much needed treatment to improve physical, social, and psychological outcomes for these children. Treatment should be provided to all children with DCD and includes therapies such as occupational therapy and/or physical therapy.[1,32-35] In particular, a task-specific treatment approach known as the CO-OP approach (Cognitive Orientation to Occupational Performance) has strong evidence to support its use.[31,33] CO-OP is effective in helping children with DCD achieve functional motor goals.

Due to higher risk for becoming overweight or obese,[36] children with DCD should be encouraged to participate in healthy lifestyle activities, such as walking, hiking, swimming, and biking. Participation in individual-based sports, such as tae kwon do, instead of team sports is recommended. Given their high risk of anxiety and/or depression,[37] mental health should be evaluated at the time of assessment and thereafter be closely monitored.

Physician support to parents in seeking therapy and providing information about educational and community resources is critical for best outcomes. Lastly, encouraging families to participate in a provincial database (https://bit.ly/2LFs7EK) will advance practice and knowledge about children with DCD. Benefits to families included potential invitations to participate in research and intervention studies.

Where can I learn more?

- Evidence on DCD assessment/diagnosis and management (Evidence for Practice (E4P) Synthesis): https://bit.ly/2HcD1vM
- Advocating for a DCD diagnosis (information sheet): https://bit.ly/2D8IDEY
- Best practices in DCD treatment (information sheet): https://bit.ly/2D8IDEY
- Early Identification and Early Intervention for DCD (information sheet): http://bit.ly/2D8IDEY
- Listening for DCD Interview Guide (CanChild): http://bit.ly/2Ca1qDw
- DCDQ: http://www.dcdq.ca
- Why every office needs a tennis ball: a new approach to assessing the clumsy child: https://bit.ly/2S5UH1z
- Diagnosis and management of developmental coordination disorder: https://bit.ly/2FtzOvS
- CanChild Centre for Childhood Disability Research, McMaster University (many resources also available in French)
  - Educational materials and online workshops on causes, assessment, diagnosis and management (https://bit.ly/2suL9oG)
  - Educational materials for physicians and others (https://bit.ly/2qWIGjq)
  - DCD Physician Workshop (https://bit.ly/2FubkCo)

This document was prepared in November 2018 and will be updated as new evidence emerges.

References

1. Blank R, Smits-Engelsman B, Polatajko H, Wilson P. European Academy for Childhood Disability (EACD): Recommendations on the definition, diagnosis, and intervention of developmental coordination disorder (long version). Dev Med Child Neurol. 2012; 54:54-93.
2. American Psychiatric Association (APA). Diagnostic and statistical manual of mental disorders (5th ed.). 2013. Arlington, VA: APA.
3. Edwards J, Berube M, Erlandson K, Haug S, Johnstone H, Meagher M, Sarkodee-Adoo S, Zwicker JG. Developmental coordination disorder in school-aged children born very preterm and/or at very low birth weight: a systematic review. J Dev Beh Pediatr 2011; 32:678-87
4. Zwicker JG, Yoon SW, Mackay M, et al. Perinatal and neonatal predictors of developmental coordination disorder. Arch Dis Children – Fetal and Neonatal Ed, 2013;98:118-122.
5. Harris SR, Mickelson ECR, Zwicker JG. Diagnosis and management of developmental coordination disorder. Can Med Assoc J. 2015; 187:659-665.
6. Statistics Canada (2017). Table 17-10-0005-01 Population estimates on July 1st, by age and sex.
7. Callanen A. Clinical Review, Developmental Coordination Disorder (Physical Therapy). CINAHL Information Systems, Rehabilitation Reference Center, 2017.
8. Magalhaes LC, Cardoso AA, Missiuna C. Activities and participation in children with developmental coordination disorder: A systematic review. Res Dev Disabil. 2011;32(4):1309-16.
9. Gagnon-Roy M, Jasmin E, Camden C. Social participation of teenagers and young adults with developmental coordination disorder and strategies that could help them: Results from a scoping review. Child Care Health Dev. 2016;42(6):840-51.
10. Izadi-Najafabadi S, Ryan N, Ghafooripoor G, Gill K, Zwicker JG. Participation of children with developmental coordination disorder. Res Dev Disabil. 2018; doi: 10.1016/j.ridd.2018.05.011 [epub ahead of print]
11. Zwicker JG, Harris SR, Klassen AF. Quality of life domains affected in children with developmental coordination disorder: A systematic review. Child Care Health Dev. 2013;39(4):562-80.
12. Zwicker JG, Suto M, Harris SR, Vlasakova N, Missiuna C. Developmental coordination disorder is more than a motor problem: Children describe the impact of daily struggles on their quality of life. Br J Occup Ther. 2018; 81:65-73.
13. Karras HC, Morin DN, Gill K, Izadi-Najafabadi S, Zwicker JG. Health-related quality of life of children with developmental coordination disorder. Res Dev Disabil. 2018; doi:1016/j.ridd.2018.05.012 [epub ahead of print]
14. Cantell MH, Smyth MM, Ahonen TP. Two distinct pathways for developmental coordination disorder: Persistence and resolution. Human Movement Science. 2003 Nov 1;22(4-5):413-31
15. Cousins M, Smyth MM. Developmental coordination impairments in adulthood. Human Movement Science. 2003 Nov 1;22(4-5):433-59.
16. Gaines R, Missiuna C, Egan M, McLean J. Educational outreach and collaborative care enhances physician's perceived knowledge about Developmental Coordination Disorder. BMC Health Services Research. 2008 Dec;8(1):21.
17. Wilson BN, Neil K, Kamps PH, Babcock S. Awareness and knowledge of developmental co-ordination disorder among physicians, teachers and parents. Child: Care, Health Dev. 2013 Mar;39(2):296-300.
18. Henderson SE, Sugden DA, Barnett AL. Movement Assessment Battery for Children, 2nd ed. London: Pearson, 2007.
19. Bruininks R, Bruininks B. Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition. Minneapolis, MN: NCS, Pearson, 2005.
20. Wilson BN, Kaplan BJ, Crawford SG, Roberts G. Developmental Coordination Questionnaire 2007 (DCDQ'07). Available from: http://www.dcdq.ca.
21. Wilson BN, Creighton D, Crawford SG, Heath JA, Semple L, Tan B, Hansen S. Little DCDQ. Available from: https://www.dcdq.ca/little-dcdq-ca.html
22. Camden C, Rivard L, Pollock, Missiuna C. Listening for DCD Interview Guide. CanChild. 2013; Available from: http://bit.ly/2Ca1qDw
23. Zwicker JG, Rinat S, Mackay M., Synnes A. Poor feeding at four months corrected age is predictive of DCD and other neurodevelopmental impairments in infants born extremely preterm. In prep.
24. Missiuna C, Gaines R, Soucie H. Why every office needs a tennis ball: a new approach to assessing the clumsy child. Can Med Assoc J. 2006;175(5):417–73.
25. Lee J, Teo L, Gill K, Mickelson, ECR, Zwicker, JG. Is developmental coordination disorder associated with delayed gross motor milestones? In prep.
26. Copeland A, Rondeau C, Izadi-Najafabadi S, Mickelson ECR, Zwicker JG. Early speech and language delays: A risk factor for DCD? In prep.
27. Gaines R, Missiuna C. Early identification: Are speech/language-impaired toddlers at increased risk for developmental coordination disorder? Child: Care, Health Dev. 2007;33 325-332.
28. National Deaf Child Society (2008). Balance and balance disorders. Retrieved from: http://www.ndcs.org.uk/family_support/childhood_deafness/deaf_children_and_balance/index.html
29. Fletcher S, Mickelson ECR, Zwicker JG. Developmental coordination disorder: Using the neurological exam and parent interview to inform diagnosis. In prep.
30. Ehlers-Danlos Society (2018). Assessing joint hypermobility. Retrieved from: https://www.ehlers-danlos.com/assessing-joint-hypermobility/
31. Zwicker JG, Missiuna C, Boyd LA. Neural correlates of developmental coordination disorder: A review of hypotheses. J Child Neurol. 2009;24:1273-1281.
32. Hillier S. Interventions for children with developmental coordination disorder: a systematic review. Int J Allied Health Sci Prac. 2007;5:1–10.
33. Smits-Engelsman BCM, Blank R, Van der Kaay A C, 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;55:229-237.
34. Miyahara M, Lagisz M, Nakagawa S, Henderson S E. A narrative meta-review of a series of systematic and meta-analytic reviews on the intervention outcome for children with developmental co-ordination disorder. Child Care Health Dev. 2017; 43:733–742.
35. Smits-Engelsman B, Vinçon S, Blank R, Quadrado V H, 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.
36. Cairney J, Hay J, Veldhuizen S, Missiuna C, Mahlberg N, Faught BE. Trajectories of relative weight and waist circumference among children with and without developmental coordination disorder. Can Med Assoc J. 2010;182:1167-1172.
37. Missiuna C, Cairney J, Pollock N, Campbell W, Russell DJ, Macdonald K, et al. Psychological distress in children with developmental coordination disorder and attention-deficit hyperactivity disorder. Res Dev Disabil. 2014;35:1198-207.

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Figure 1. Application of DSM-5 DCD Criteria

Criterion A: Motor skills substantially below age expectations.

Standardized Motor Assessment?

- Y
  - **Ages ≥ 5 years**: MABC-2 ≤ 16th percentile; however, if a child scores ≤ 5th percentile in one domain (e.g., fine motor, balance) but scores > 16th percentile overall, a DCD diagnosis could be made if other diagnostic criteria are met.
  - **Ages 3-4 years:** MABC-2 ≤ 5th percentile over two longitudinal assessments conducted > 3 months apart
- N
  - Refer to Occupational Therapist or Physical Therapist.

Criterion B: Motor skills significantly interfere with daily life.

Motor skills interfere with daily life documented?

- Y
  - *DCDQ/Little DCDQ* results in OT/PT report in suspected or indicative range for DCD; and/or functional difficulties reported.
- N
  - Give *DCDQ*l*Little DCDQ* (www.dcdq.ca) to parent.
  - Use *Listening for DCD* interview guide.

Criterion C: Onset of symptoms is in the early developmental period.

Developmental History

- May or may not have delayed motor milestones.
- Difficulty learning motor skills, such as breastfeeding, using cutlery, dressing, tying shoelaces, printing, riding a bicycle, swimming, etc.
- Infants born preterm are at much higher risk of DCD
- May have co-occurring conditions: ADHD, ASD, LD, mild ID, FASD

Criterion D: Motor skills deficit not better explained by visual impairments, intellectual disabilities, neurological or medical conditions.

Vision

- Significant visual impairment has been ruled out.

IQ

- IQ testing not required if there is no history of challenges with school functioning/academic achievement

Physical/neurological exam, other medical investigations as required

- No hard neurological signs; may have low-normal tone.
- Likely will show soft neurological signs (e.g., mirror movements, overflow movements, poor ball skills).
- Difficulty with tandem walking (accurately placing feet in heel-toe position walking a line).
- Neurological, muscular, and genetic conditions affecting movement have been ruled out.