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What Can We Do to Promote Mental Health Among Individuals With Developmental Coordination Disorder?

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Abstract

Purpose of the Review—It is well-documented that individuals with DCD experience mental health problems, in both psychosocial and psychiatric domains. In this review, we propose a series of diverse options to improve mental health among individuals with DCD.

Recent Findings—Despite recognition of mental health problems in DCD, relatively little work has been done to develop effective interventions. There is an urgent need for action in this matter. We present and discuss options based on a societal perspective (awareness and understanding), parental perspective (access to services and resources), and child perspective (participation).

Summary—In order to improve mental health, interventions must take into account multiple levels in a complex framework that includes community, family, and the individual. While more research on intervention effectiveness is necessary, researchers, practitioners, and community advocates can use existing initiatives as a starting point to address the urgent need for improving mental health in DCD.

Keywords

Mental health; Developmental coordination disorder; DCD; Developmental disorder; Interventions; Motor skills

Introduction

Developmental coordination disorder (DCD) is a disorder where motor skills are compromised. In general, it presents as coordination difficulties in manual dexterity, balance, and visuomotor skills, which interfere with daily living activities and academic/professional success. The disorder is highly prevalent, affecting 5–6% of school-aged children [1], and frequently co-occurs with other developmental disorders [2•]. Overall, individuals with DCD are clumsy, showing less accuracy and speed when performing motor

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skills and having to put in a larger effort than the typically developing (TD) population to move. Even skills that are relatively simple for a TD individual (such as using cutlery and cutting paper with scissors) can be very challenging for a person with DCD. These severe motor skill difficulties—combined with several associated problems (e.g., executive function difficulties) [3] and consequences such as depression and anxiety [4••]—may contribute to mental health difficulties in individuals with DCD.

The combination of motor skill difficulties and associated difficulties creates a complex puzzle for many researchers and practitioners. It is a disorder with heterogeneity in symptom presentation and severity, in part due to the frequency and impact of co-occurring conditions [5••, 6]. The diagnostic process is still lengthy, and many individuals go undiagnosed well beyond middle childhood. Lack of awareness and knowledge on the condition, lack of understanding of the potential causes, and the number and complexity of difficulties observed make DCD a challenging disorder to study and understand. Although much work has been done to investigate mechanisms underlying DCD, to better understand this disorder, we need to look at the broader picture and the relationships among the various problems associated with this condition. While the quantity and quality of DCD research has significantly increased over the years, translation to practice in medical, rehabilitation, and educational settings has been slow. Therefore, a very important next step in the field of DCD research is to promote translation and application of research findings. Further, best-practice guidelines are still not implemented in many parts of the world, and the availability of resources and services varies widely based on the level of community awareness and infrastructure.

Mental Health in DCD

A series of mental health issues have been documented in individuals with DCD. It has been stated that “without question, the literature has clearly established that many children with DCD are struggling and experiencing negative mental health outcomes” [7••]. These mental health problems have been assessed through two sets of indicators: (1) general *psychological/psychosocial* indicators and (2) more specific *psychiatric* indicators such as depression and anxiety. Psychosocial indicators—including self-concept, self-efficacy, social support, and negative peer interactions—are important in their own right not only because of their relationship to participation and quality of life but also because of their potential to be precursors of a psychiatric disorder [8••]. Both psychosocial and psychiatric indicators of mental health problems have been documented in prior studies of DCD [9]. As previously mentioned, the next critical steps in research and practice are to understand how these indicators relate to mental health and, most importantly, how we can prevent or minimize the downstream consequences of mental health problems.

In general, children with DCD display more emotional, psychosocial, and mental health concerns compared with their TD peers [10]. General psychological/psychosocial indicators as well as other physical and social factors may exacerbate mental health problems in this population by increasing isolation and creating barriers to prosocial behaviors and supportive peer relationships. For example, boys with DCD reported significantly higher loneliness and lower participation rates in group physical activities, whether in structured

(e.g., team sports) or unstructured (e.g., informal outdoor play) environments than boys without DCD [11]. Teachers also report that school-aged children with DCD have fewer friends and are more socially isolated than their peers [12]. It is possible that reduced social contact and friendships observed among children with DCD may lead to lower self-esteem [13].

Mental health problems may extend beyond childhood, affecting adults with DCD as well. When evaluating quality of life (a broader measure that includes general psychological/ psychosocial indicators), 20 adults with DCD showed significantly lower quality of life satisfaction, as well as lower satisfaction across several more specific domains (e.g., subjective feelings, leisure time activities, social relationships, etc.) when compared with TD adults [14]. Another study involving a follow-up with young adults with DCD after 3–4 years found that significant life difficulties in this population may stem from reduced quality of life as well as from reduced participation and independence in various activities of daily living [15]. On all of the instruments used in that study, both the participants with DCD and those who were borderline DCD reported lower quality of life and level of participation in daily activities than those reported by the control participants [15].

Investigation of specific symptoms such as anxiety and depression also indicated higher problems in DCD as compared with the general population. Children identified on the basis of motor coordination problems through a population-based screening showed significantly more symptoms of depression and anxiety than TD children [16•]. In the same study, children who had both DCD and ADHD were at a heightened risk of psychological distress. Similarly, a study found that 83% of a group with DCD experienced anxiety [17]. A large study using prospectively collected data from a large UK birth cohort has also shown that children with probable DCD at 7 years have a 2-fold increased risk of self-reported depression and a 4-fold increased risk of parent-reported mental health and behavioral difficulties at 9 or 10 years [18••]. The results were similar for adults—after controlling for their reduced level of weekly physical activity, a group of adults with DCD reported significantly more symptoms of depression and state/trait anxiety than TD peers [19].

These findings provide evidence highlighting a potential compounding effect of DCD symptoms for children and adults, in which impaired motor skills are associated not only with limited physical skill achievements and academic problems but also with a range of mental health problems that can affect overall well-being. Notably, significant psychosocial issues have also been linked to reduced participation across a range of physical and social activities that can have a lifelong impact on physical as well as mental health. Psychosocial problems among children, including social isolation, may result in internalizing or externalizing behaviors [20], increased pain sensitivity or catastrophizing [21], and negative self-regard [22], all of which negatively impact quality of life [23, 24]. Further research is certainly required to understand the specific presentation of psychosocial problems in DCD and to design and validate DCD-specific interventions to offset the substantial negative consequences of these issues. However, many individuals with DCD and their families are dealing with urgent mental health problems now. While the community awaits more DCD-specific research on mental health, it may be beneficial to adopt existing evidence-based practices that have been shown to improve the mental health of children with special

healthcare needs and their caregivers [25, 26]. For example, it has been shown that family-centered models and coordination of care reduce the effects of stress and anxiety in caregivers of children with special healthcare needs [e.g., 7••, 8••, 9–28], as well as in children themselves [29]. These approaches may enable clinicians to address the urgent mental health needs of individuals with DCD and their families, who need support faster than the development and rigorous validation of DCD-specific mental health interventions will likely occur.

The current literature indicates that mental health should be a comprehensive part of a plan to treat DCD and that this population should be treated as “high-risk” [4••]. In fact, prevention and treatment of mental health difficulties should be a *key element* of intervention for children with DCD [18••]. When prioritizing areas for intervention, clinicians, educators, and loved ones must be mindful of what is most important for a child both immediately and across their lifespan. While clumsiness may undoubtedly be frustrating and stigmatizing across the lifespan for some, it may not be the most significant consequence of DCD compared with psychosocial and psychiatric issues. From a complementary perspective, building mental health (i.e., strong cognitive, emotional, and social skills) in children can make a significant difference in their ability to be resilient in the face of challenges [30–32].

While we may not fully understand the causal relationships and complex interactions among all indicators affecting mental health in DCD, we believe that there are some possibilities that can be considered to potentially minimize the impact of mental health difficulties in DCD. The complex nature of DCD and the mental health problems associated with this disorder suggest that there are various options that could lead to improved mental health in this population.

Options to Improve Mental Health in DCD

We need additional treatments and preventive methods that are readily accessible and acceptable to populations nationally and internationally [33]. However, it may take some time for the scientific community to determine which precursors and sequelae are most relevant to mental health in individuals with DCD. In the meantime, there are some perspectives in the DCD literature that could help to minimize mental health problems in this population. In this review, we discuss the possibility of implementing options based on three perspectives: a societal perspective (awareness and understanding), a parental perspective (access to services and resources), and the child’s perspective (participation).

Societal Perspective

As previously mentioned, DCD is underdiagnosed and not well-known as a neurodevelopmental disorder. Perhaps one of the most powerful tools to improve mental health in individuals with DCD is to improve societal awareness and understanding of the disorder, both within the DCD community and in the general population. For an individual with DCD and their loved ones, dealing with a condition that seems “invisible” and unclear to those around them may create additional stress and worry [34•].

For many neurodevelopmental disorders, community outreach initiatives often focus on awareness—that is, the knowledge that a given condition exists—with less attention paid to increasing public understanding of the functional impact of the condition for an individual and their family. Initiatives to improve both awareness and understanding of the condition could potentially lead to a drastic shift in how community leaders and healthcare/educational professionals view DCD and may alter the public vernacular and outlook regarding “clumsiness.” This could have a number of positive downstream consequences, including changes to public policy, physical education practices, community activities, and even how individuals with DCD see and feel about themselves. The most accessible entry point for this type of societal intervention is likely at the professional level. It seems obvious that DCD, as a condition clearly explained in the DSM-5 [1], would be part of the undergraduate and graduate curriculum for professions that may encounter the disorder (e.g., physicians, educators, rehabilitation professionals, psychologists, etc.). However, that does not appear to be the case, as shown in several studies described below.

One report shows that 67.3% of child and adolescent psychiatrists and 15.7% of pediatricians in a UK sample self-reported having poor or very poor knowledge of DCD. Twenty-eight percent of psychiatrists and 5.9% of pediatricians, respectively, reported that they never or only occasionally ask about motor difficulties in their clinical assessment protocols [35]. In Canada, there was also an overall lack of awareness of the diagnostic criteria for DCD among pediatricians and family physicians [36]. When investigating a specific region of Canada, occupational therapists reported that they were aware of the diagnostic criteria for the condition, although they were not as knowledgeable of the current guidelines for recommended assessments and cutoff scores used to inform and advocate for a diagnosis [37].

The good news is that studies have demonstrated that training and education can close these gaps in knowledge and clinical practice. One study demonstrated that at baseline, 91.1% of physicians were unaware of the diagnosis of DCD, and only 1.6% could diagnose the condition. After intervention involving educational outreach visits, 91% of participating physicians reported greater knowledge about DCD, and 29.2% were able to diagnose DCD compared with 0.5% of non-participating physicians [38]. All physicians who participated in collaborative care indicated that they would continue to use the project materials and resources, and 59.4% reported that they would recommend or share the materials with medical colleagues. Using an online delivery mode, it was demonstrated that education and training can be an effective knowledge translation strategy for physical therapists, who reported increased knowledge and skills [39]. In addition, these trainings, whether in person or online, can support evidence-informed practice by sharing and informing the community of research findings and recommendations supported by scientific evidence.

It is also important to acknowledge that international clinical practice recommendations for DCD have already been developed [40] and recently revised [8]. These guidelines are available open-access in pdf form (<https://onlinelibrary.wiley.com/doi/pdf/10.1111/dmcn.14132>). The development of the latest revision involved a formal expert consensus and review of research evidence, which led to 35 recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects associated with DCD. The authors

indicate that these recommendations reflect the state-of-art for clinicians and scientists of various disciplines and may serve as a basis for national guidelines. While it is possible that professionals may need some training or assistance understanding the nuances of the report, as the material is written in a largely formal and scientific format, it provides valuable foundational information that can be disseminated and translated.

Recent advances in our understanding, taxonomy, and treatment of DCD show great promise. However, there remains a critical need for developing resources and guidelines for *all* professional disciplines involved in DCD surveillance, assessment, diagnosis, and intervention. There is a high demand for online platforms that are easily accessible (such as the ones provided by the CanChild Center) and country-/region-specific, so that best practices can be followed. Effective knowledge translation, as well as future research on barriers to evidence-based practice among professionals working with individuals with DCD, can help determine the level of educational outreach and best delivery mechanisms. Awareness and understanding of DCD can lead to better prepared professionals and, consequently, better access to services and resources for families. Easy and timely access to high-quality services and resources can significantly reduce psychological, emotional, and logistical burdens for individuals with neurodevelopmental disorders—more specifically, parents and caregivers of children with DCD.

Parental Perspective

Parents that have support and knowledge may be better equipped to support their children's mental health. Most importantly, parents need knowledge in order to access services and resources, so they can better support their children. Parents and potentially other members of the family will be making decisions and looking for services and resources to improve and manage DCD. Little is known about access to services and resources in this specific population, but the existing literature leads us to believe that access is low and families' experiences are not optimal. For example, a study reporting experiences of parents of children with DCD described their experiences as a negotiation of a "maze of healthcare services" [41•]. Obviously, this may be more a burden for less privileged parents, but it still reflects the state of services for families caring for children with disorders such as DCD. However, this is not surprising, given that access to services and coordination of care have been established as key problems among other children with special healthcare needs [42].

Interestingly, parents of children with DCD display significantly lower quality of life than parents of TD children [43], potentially reflecting the lack of support and resources offered to families/parents of individuals with the condition. In fact, in one study, post-diagnostic provision was the area in which parents reported most dissatisfaction [44]. This is not surprising, given that 43% of parents surveyed had not been offered any practical help or support during the diagnostic process or in follow-up appointments. Previous research has indicated that referring parents to and ensuring that they have access to evidence-based education could be a way for physicians and health professionals to provide families with the information/resources they need to self-manage this condition [45]. Increased emphasis on health literacy, person-centered planning, and self-efficacy (e.g., via parent training) has been found to increase parental feelings of empowerment when choosing, acquiring, and

supporting appropriate services for their children [46]. Children with DCD also need access to appropriate services and resources in order to develop a strong sense of self-efficacy and a positive self-image, which in turn empowers them to engage in positive coping strategies and builds resilience [47]. One study suggests that researchers, managers, clinicians, community partners, and families should work together to design, implement, and evaluate interventions for children with DCD [48••]. This could ensure that families are involved and have access to services and resources needed in their community. Interventions that consider each family's unique lifestyle are likely to be most effective and long lasting [49].

In addition, lack of access to services and resources may be associated with a significant cost to the society and the individual/family. One study investigating access to services and resources and the financial costs of this disorder has reported that only half of children with DCD used healthcare services to manage their condition, primarily because of an access issue rather than a lack of demand for services [50]. Parents who need services for their children may feel unsupported and helpless towards their children, and without these appropriate services and interventions, children with DCD may be at higher risk for mental health problems. To minimize the social and economic costs of DCD, it is important to ensure that children and their families have access to appropriate services in an efficient manner.

Until further research is done, we cannot be certain that information, support, and services result in improved mental health among individuals with and affected by DCD. However, the extant data from both the DCD literature and that of other neurodevelopmental disorders suggests that dedicated programs and research that improve access to resources and services could make a meaningful difference. In other words, parents/families that have access to resources and services may feel more supported and may be able to provide better experiences for children with DCD, which could potentially minimize mental health problems in this population. Evidence supports the presence of family-centered services that view parents as experts in their children, promote partnerships between families and service providers, and support the family's role in making decisions about their child [51]. The type of support required for an individual with DCD may be complex, especially as the presentation of DCD can vary [52], and guiding parents through this process may require expert handling [41•, 42–53]. It appears that parents have more expectations than children when it comes to training and support for DCD [54], possibly because they are the decision-makers in this context. This finding is interesting because it reflects the need for offering indirect interventions, such as training, consulting, and supporting groups of parents in addition to intervention for children.

Child Perspective

Participation in everyday activities is considered to be a vital part of children's development and life experiences and is considered a key indicator of overall health and well-being across the lifespan [55]. Participation is defined as involvement in life situations [56]. Lack of motor coordination seems to be a barrier for participation in activities that require a level of motor and physical development. This includes activities of daily living, physical activity, and structured programs, such as sports. Improved understanding of the participation of

children with DCD in everyday activities may be essential to potentially support mental health in this population. For example, it has been shown that participation in sports is valuable for the well-being and health of children [57].

Children with DCD show lower levels of participation in physical activities during recess than their peers without DCD and are less likely to engage in both structured and unstructured activities compared with TD children [58, 59]. Children with DCD lack confidence to perform self-care activities and engage in school-based events due to their motor coordination problems [60]. These circumstances often result in a chronic sense of failure that reduces their willingness to continue participating in physical activities and trying novel tasks [61]. Many children with DCD also report lower levels of enjoyment in free-play activities, physical education classes, or organized sports [9, 58, 62]. They also frequently withdraw from activities involving movement, due to poor motor coordination and low perceived competence in sports [58].

Although this is a point that needs more research, it is possible that greater participation in school and community settings could result in improved mental health among individuals with DCD. For example, children with DCD show less diverse and less intense out-of-school activity participation than TD children [63]. Children with DCD also participated less frequently than TD children in school and community settings and had less overall environmental support in all home, school, and community settings [64••]. Regarding improvement in participation, children with DCD could benefit from motor interventions that also focus on modification of the environment to support their participation in home, school, and community settings [65]. Research has established that interventions focusing on enabling children to choose their functional goals in the area of physical activity have important implications for enabling participation and building social networks of children with DCD [61]. In addition, strategies to increase participation could include (1) promoting diverse activities that may spark the interest of children and focus on their strengths, (2) addressing environmental barriers [64••], (3) using cognitive strategies to improve children's understanding of the task, and (4) goal setting. Goal setting to identify important client-centered activities may be a key element that influences participation [55]. With that, it is important to understand that an assessment of the child's profile and needs will influence participation outcome. Participation is a complex multidimensional construct, and research has shown that participation needs are unique to each individual [54].

In addition, participation patterns may differ based on season of the year and times of the week/weekend, which can determine children's engagement in leisure activities. Participation is also important in terms of activities of daily living and sport-related, recreational activities—children with DCD participate less frequently in those that can be avoided (e.g., the domain of gross motor play activities and, at an item level, kicking a ball, constructional play, and moving game pieces on a board game) as well as those that can be “taken over” by parents, such as cutting bread, pouring a drink, unwrapping packages, and drying after a shower [66]. Not being part of essential and leisure activities can make children feel left out and, consequently, negatively affect their mental health.

Final Remarks

While many studies need to be done to better understand the nature and the complexity of mental health problems in DCD, there seems to be sufficient data to call researchers, practitioners, and the community/government to action. It is clear that mental health should be a comprehensive part of a plan to treat DCD. Because this may take years to be implemented, we proposed several evidence-based solutions that may help improve mental health in this population from different perspectives: societal (awareness and understanding), parental (access to resources and services), and child (participation). Mental health is a complex, integrated set of processes with wide-reaching effects, and mental health problems in children and adolescents are a significant public health issue [27].

It is possible that addressing some of the specific psychosocial or psychiatric factors that influence overall mental health in DCD can lead to improvements in quality of life. A multi-faceted approach, engaging stakeholders and professionals from multiple perspectives and disciplines, is likely to hold the greatest promise for success. In DCD, mental health problems need to be fully acknowledged, recognized, and included in plans to support and treat the condition. Initiatives that address awareness and understanding, improve access to resources and services, and increase participation in different settings can positively impact mental health in this population and must be put in place now.

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References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
 - Of major importance
1. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Washington: American Psychiatric Association; 2013.
 - 2•. Lingam R, Golding J, Jongmans MJ, Hunt LP, Ellis M, Emond A. The association between developmental coordination disorder and other developmental traits. *Pediatrics*. 2010;126(5). This study demonstrates that children with probable DCD have an increased risk of difficulties in attention, social skills, reading, and spelling.
 3. Leonard HC, Bernardi M, Hill EL, Henry LA. Executive functioning, motor difficulties, and developmental coordination disorder. *Dev Neuropsychol*. 2015;40(4):201–15. [PubMed: 26179487]
 - 4••. Caçola P. Physical and mental health of children with developmental coordination disorder. *Front. Public Health* 2016; 4:224. [PubMed: 27822464] This review summarizes the existing evidence on physical and mental health consequences of DCD and makes a case for interventions focusing on improving these consequences.
 - 5••. Dewey D, Kaplan BJ, Crawford SG, Wilson BN. Developmental coordination disorder: associated problems in attention, learning, and psychosocial adjustment. *Hum Mov Sci*. 2002;21(5–6):905–18. [PubMed: 12620725] This study identified the association of movement problems with risk for attention and learning as well as risk for psychosocial adjustment – and calls for an examination of a wide range of functions in addition to motor functioning.

6. Schoemaker MM, Lingam R, Jongmans MJ, van Heuvelen MJG, Emond A. Is severity of motor coordination difficulties related to co-morbidity in children at risk for developmental coordination disorder? *Res Dev Disabil.* 2013;34(10):3084–91. [PubMed: 23886753]
- 7••. Missiuna C, Campbell WN. Psychological aspects of developmental coordination disorder: can we establish causality? *Curr Dev Disord Rep.* 2014;(1):125–31. This review examines evidence suggesting that DCD may trigger several stressors including psychological distress and suggests future research to establish causal pathways.
- 8••. Blank R, Barnett AL, Cairney J, Green D, Kirby A, Polatajko H, et al. International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. *Dev Med Child Neurol.* 2019; (61):242–85. [PubMed: 30671947] This manuscript is a comprehensive overview of DCD and reflects the state of art for clinicians and scientists in the field.
9. Cairney J, Veldhuizen S, Szatmari P. Motor coordination and emotional-behavioral problems in children. *Curr Opin Psychiatry.* 2010;23:324–9. [PubMed: 20520549]
10. Zwicker JG, Missiuna C, Harris SR, Boyd LA. Developmental coordination disorder: a review and update. *Eur J Paediatr Neurol.* 2012;16:573–81. [PubMed: 22705270]
11. Poulsen AA, Ziviani JM, Johnson H, Cuskelly M. Loneliness and life satisfaction of boys with developmental coordination disorder: the impact of leisure participation and perceived freedom in leisure. *Hum Mov Sci.* 2008;27:325–43. [PubMed: 18353475]
12. Piek JP, Barrett NC, Allen LS, Jones A, Louise M. The relationship between bullying and self-worth in children with movement coordination problems. *Br J Educ Psychol.* 2005;75:453–63. [PubMed: 16238876]
13. Cairney J, Hay J, Mandigo J, Wade T, Faught BE, Flouris A. Developmental coordination disorder and reported enjoyment of physical education in children. *Eur Phys Educ Rev.* 2007;13:81–98.
14. Hill EL, Brown D, Sorgardt KS. A preliminary investigation of quality of life satisfaction reports in emerging adults with and without developmental coordination disorder. *J Adult Dev.* 2011;18:130–4.
15. Tal-Saban M, Ornoy A, Parush S. Young adults with developmental coordination disorder: a longitudinal study. *Am J Occup Ther.* 2014;68:307–16. [PubMed: 24797194]
- 16•. 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. [PubMed: 24559609] This study determined that children with motor problems showed significantly more symptoms of depression and anxiety than typically developing children, and that children with both DCD and ADHD are at a heightened risk of psychological distress.
17. Farmer M, Echenne B, Bentourkia M. Study of clinical characteristics in young subjects with developmental coordination disorder. *Brain and Development.* 2016;38(6):538–47. [PubMed: 26763621]
- 18••. Lingam R, Jongmans MJ, Ellis M, Hunt LP, Golding J, Emond A. Mental health difficulties in children with developmental coordination disorder. *Pediatrics.* 2012;129:e882–91. [PubMed: 22451706] This is a large study stating that children with probable DCD have an increased risk for mental health difficulties, suggesting that prevention of these difficulties should be a key element of intervention for children with DCD.
19. Hill EL, Brown D. Mood impairments in adults previously diagnosed with developmental coordination disorder. *J Ment Health.* 2013;22(4):334–40. [PubMed: 23323694]
20. Bornstein MH, Hahn CS, Haynes OM. Social competence, externalizing, and internalizing behavioral adjustment from early childhood through early adolescence: developmental cascades. *Dev Psychopathol.* 2010;22(4):717–35. [PubMed: 20883577]
21. Tsao JCI, Allen LB, Evans S, Lu Q, Myers CD, Zeltzer LK. Anxiety, sensitivity and catastrophizing: associations with pain and somatization in non-clinical children. *J Health Psychol.* 2009;14(8):1085–94. [PubMed: 19858329]
22. Rubin KH, Chen X, McDougall P, Bowker A, McKinnon J. The waterloo longitudinal project: predicting internalizing and externalizing problems in adolescence. *Dev Psychopathol.* 1995;7(4):71–764.

23. Weitkamp K, Daniels JK, Romer G, Wiegand-Grefe S. Health-related quality of life of children and adolescents with mental disorders. *Health Qual Life Outcomes*. 2013;11:129. [PubMed: 23902824]
24. Martisen KD, Neumer SP, Holen S, Waaktaar T, Sund AM, Kendall PC. Self-reported quality of life and self-esteem in sad and anxious school children. *BMC Psychol*. 2016;4(1):45. [PubMed: 27624487]
25. Singer GHS, Ethridge BL, Aldana SI. Primary and secondary effects of parenting and stress management interventions for parents of children with developmental disabilities: a meta-analysis. *Ment Retard Dev Disabil Res Rev*. 2007;13(4):357–69. [PubMed: 17979202]
26. Kuhlthau KA, Bloom S, Van Cleave J, Knapp AA, Room D, Klatka K, et al. Evidence for family-centered care for children with special health care needs: a systematic review. *Acad Pediatr*. 2011;11(2):136–143.e8. [PubMed: 21396616]
27. Nolan KW, Orlando M, Liptak GS. Care coordination services for children with special health care needs: are we family-centered yet? *Fam Syst Health*. 2007;25(3):293–306.
28. Litt JS, McCormick MC. Care coordination, the family-centered medical home, and functional disability among children with special health care needs. *Acad Pediatr*. 2015;15(2):185–90. [PubMed: 25311760]
29. Roberts C, Mazzucchelli T, Studman L, Sanders MR. Behavioral family intervention for children with developmental disabilities and behavioral problems. *J Clin Child Adolesc Psychol*. 2010;35(2):180–93.
30. Gartland D, Riggs E, Muyeen S, Giallo R, TO A, MacMillan H, et al. What factors are associated with resilient outcomes in children exposed to social adversity? A systematic review. *BMJ Open*. 2019;9(4):e024870.
31. Dumont M, Provost MA. Resilience in adolescents: protective role of social support, coping strategies, self-esteem, and social activities on experience of stress and depression. *J Youth Adolesc*. 1999;28:343–63.
32. Hjemdal O, Friborg O, Stiles TC, Rosenvinge JH, Martinussen M. Resilience predicting psychiatric symptoms: a prospective study of protective factors and their role in adjustment to stressful life events. *Clin Psychol Psychother*. 2006;13(3):194–201.
33. DiGirolamo AM, Ramirez-Zea M. Role of zinc in maternal and child mental health. *Am J Clin Nutr*. 2009;89(suppl):940S–5S. [PubMed: 19176735]
- 34*. Cairney J, Rigoli D, Piek J. Developmental coordination disorder and internalizing problems in children: the environmental stress hypothesis elaborated. *Dev Rev*. 2013;33(3):224–38. This paper elaborates on a model that considers how different stressors affect internalizing symptoms in children with DCD, and adds the role that physical inactivity and obesity might play in this model.
- 35*. Kirby A, Salmon G, Edwards L. Attention-deficit hyperactivity and developmental coordination disorders: knowledge and practice among child and adolescent psychiatrists and paediatricians. *Psychiatr Bull*. 2007;31:336–8. This paper highlights the fact that there is little routine screening for movement difficulties when assessing for ADHD, and shows that child and adolescent psychiatrists need training on DCD.
36. Wilson BN, Neil K, Kamps PH, Babcock S. Awareness and knowledge of developmental coordination disorder among physicians, teachers and parents. *Child Care Health Dev*. 2013;39:296–300. [PubMed: 22823542]
37. Karkling M, Paul A, Zwicker JG. Occupational therapists' awareness of guidelines for assessment and diagnosis of developmental coordination disorder. *Can J Occup Ther*. 2017;84(3):148–57. [PubMed: 28730904]
- 38*. Gaines R, Missiuna C, Egan M, Gaines MLJ, et al. Educational outreach and collaborative care enhances physician's perceived knowledge about developmental coordination disorder. *BMC Health Serv Res*. 2008;8:21. [PubMed: 18218082] This study shows that providing educational outreach visits and collaboration among health professions improve knowledge of DCD and increase confidence in physicians.
39. Camden C, Rivard L, Pollock N, Missiuna C. Knowledge to practice in developmental coordination disorder: impact of an evidence-based online module on physical therapists' self-

- reported knowledge, skills, and practice. *Phys Occup Ther Pediatr*. 2015;35(2):195–210. [PubMed: 25790193]
40. 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(1):54–93. [PubMed: 22171930]
 41. Missiuna C, Moll S, Law M, King S, King G. Mysteries and mazes: parents' experiences of children with developmental coordination disorder. *Can J Occup Ther*. 2006;73(1):7–17. [PubMed: 16570837] This study highlights the difficult experiences of parents as they attempted to understand and get help for their child with DCD.
 42. Ngui EM, Flores G. Satisfaction with care and ease of using health care services among parents of children with special health care needs: the roles of race/ethnicity, insurance, language, and adequacy of family-centered care. *Pediatr*. 2006;117(4):1184–96.
 43. Wang YP, Wang CC, Huang MH. Health-related quality of life in children with developmental coordination disorder and their parents. *OTJR*. 2012;32(4):142–50.
 44. Soriano CA, Hill EL, Crane L. Surveying parental experiences of receiving a diagnosis of developmental coordination disorder (DCD). *Res Dev Disabil*. 2015;43–44:11–20.
 45. Camden C, Foley V, Anaby D, Shikako-Thomas K, Gauthier-Boudreault C, Berbari J, et al. Using an evidence-based online module to improve parents' ability to support their child with developmental coordination disorder. *Disabil Health J*. 2016;9(3):406–15. [PubMed: 27155793]
 46. Nachshen JS. Empowerment and families: building bridges between parents and professionals, theory and research. *J Dev Disabil*. 2005;11(1):67–75.
 47. Lingam RP, Novak C, Edmond A, Coad JE. The importance of identity and empowerment to teenagers with developmental coordination disorder. *Child Care Health Dev*. 2014;40:309–18. [PubMed: 23781846]
 48. Camden C, Wilson B, Kirby A, Sugden D, Missiuna C. Best practice principles for management of children with developmental co-ordination disorder (DCD): results of a scoping review. *Child Care Health Dev*. 2014;41(1):147–159. [PubMed: 24387638] This study presents five principles to guide best practice and service delivery for children with DCD.
 49. Sugden D, Kirby A, Dunford C. Issues surrounding children with developmental coordination disorder. *Intl J Disabil Dev Educ*. 2008;55(2):173–87.
 50. Cleaton MAM, Lorgelly PK, Kirby A. Developmental coordination disorder in UK children aged 6–18 years: estimating the cost. *Br J Occup Ther*. 2020;83(1):29–40.
 51. Law M, Teplicky R, King S, King G, Kertoy M, Moning T, et al. Family-centred service: moving ideas into practice. *Child Care Health Dev*. 2005;31:633–42. [PubMed: 16207220]
 52. Kirby A, Edwards L, Sugden D. Emerging adulthood in developmental co-ordination disorder: parent and young adult perspectives. *Res Dev Disabil*. 2011;32:1351–60. [PubMed: 21334175]
 53. Glidden LM, Jobe BM. Measuring parental daily rewards and worries in the transition to adulthood. *Am J Ment Retard*. 2007;112:275–88. [PubMed: 17559294]
 54. Jasmin E, Tetreault S, Lariviere N, Joly J. Participation and needs of children with developmental coordination disorder at home and in the community: perceptions of children and parents. *Res Dev Disabil*. 2018;73:1–13. [PubMed: 29245043]
 55. O'Dea A, Robinson K, Coote S. Effectiveness of interventions to improve participation outcomes for children with developmental coordination disorder: a systematic review. *Br J Occup Ther*. 2020;83(4):256–73.
 56. Liberman L, Ratzon N, Bart O. The profile of performance skills and emotional factors in the context of participation among young children with developmental coordination disorder. *Res Dev Disabil*. 2013;34:87–94. [PubMed: 22940162]
 57. Adams ILJ, Broekkamp W, Wilson PH, Imms C, Overvelde A, Steenbergen B. Role of pediatric physical therapists in promoting sports participation in developmental coordination disorder. *Pediatr Phys Ther*. 2018;30(2):106–11. [PubMed: 29578996]
 58. Cairney J, Hay JA, Faught BE, Mandigo J, Flouris A. Developmental coordination disorder, self-efficacy toward physical activity and participation in free play and organized activities: does gender matter? *Adapt Phys Act Q*. 2005;22:67–82.

59. Watkinson EJ, Dunn JC, Cavaliere N, Calzonetti K, Wilhelm L, Dwyer S. Engagement in playground activities as a criterion for diagnosing developmental coordination disorder. *Adapt Phys Act Q.* 2001;18:18–34.
60. Rodger S, Mandich A. Getting the run around: accessing services for children with developmental co-ordination disorder. *Child Care Health Dev.* 2005;31:449–57. [PubMed: 15948882]
61. Mandich A, Polatajko H, Rodger S. Rites of passage: understanding participation of children with developmental coordination disorder. *Hum Mov Sci.* 2003;22:583–95. [PubMed: 14624835]
62. Bouffard M, Watkinson JE, Thompson LP, Dunn JLC, Romanow SK. A test of the activity deficit hypothesis with children with movement difficulties. *Adapt Phys Act Q.* 1996;13:61–73.
63. Fong SMS, Lee VYL, Chan NNC, Chan RSH, Chak WK, Pang MYC. Motor ability and weight status are determinants of out-of-school activity participation for children with developmental coordination disorder. *Res Dev Disabil.* 2011;32:2614–23. [PubMed: 21767931]
- 64••. Izadi-Najafabadi S, Ryan N, Ghafooripoor G, Gill K, Zwicker JG. Participation of children with developmental coordination disorder. *Res Dev Disabil.* 2019;84:75–84. [PubMed: 30041931]
This review establishes that children with DCD participate less overall, and suggests that intervention needs to address environmental barriers to improve participation.
65. Coussens M, Van Driessen E, De Baets S, Van Regenmortel J, Desoete A, Oostra A, et al. Parents' perspectives on participation of young children with attention deficit hyperactivity disorder, developmental coordination disorder, and/or autism spectrum disorder: a systematic scoping review. *Child Care Health Dev.* 2020;46:232–43. [PubMed: 31867727]
66. Van der Linde BW, van Netten JJ, Otten B, Postema K, Geuze RH, Schoemaker MM. Activities of daily living in children with developmental coordination disorder: performance, learning, and participation. *Phys Ther.* 2015;95(11):1496–506. [PubMed: 26045605]