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Health-related quality of life of children with Developmental Coordination Disorder

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ABSTRACT

Background: Although Developmental Coordination Disorder (DCD) is primarily a motor disorder, it can also impact emotional and psychosocial functioning of children with this condition. Evidence suggests that children with DCD experience lower quality of life than their peers, but few studies have explicitly examined the health-related quality of life (HRQOL) of these children.
Aims: To: (1) describe HRQOL of children with DCD compared to typically-developing children; (2) compare HRQOL from the perspectives of children with DCD and their parents; and (3) explore predictors of HRQOL for children with DCD.
Methods: Data from the KidScreen-52 and Strength and Difficulties Questionnaire were collected from 50 children with DCD [Mean(SD) age: 9.8 (1.2) years] and their parents and compared to normative data.
Results: Children with DCD and their parents report significantly lower HRQOL compared to published norms. Caregivers have a significantly lower perception of their child's HRQOL than their child's self-report in many domains. Parents of children with DCD report that their children experience significantly more emotional and behavioral disturbances compared to norms. Poor motor function and attentional difficulties predict HRQOL.
Conclusion and implications: DCD appears to contribute to lower perceived HRQOL. Findings inform therapeutic targets for children with DCD, beyond motor skill intervention.

What this paper adds?

Since Developmental Coordination Disorder (DCD) is a condition directly affecting fine and gross motor functioning, traditional treatments generally focus on improving specific motor outcomes (Blank, Smits-Engelsman, Polatajko, & Wilson, 2012). However, as these motor difficulties have also been shown to significantly impact psychosocial and emotional functioning in children with this disorder, it was hypothesized that children with DCD are at higher risk than their typically developing peers for experiencing a lower health-related quality of life (HRQOL) (Zwicker, Harris, & Klassen, 2013). The present study provides a holistic analysis of the HRQOL of children with DCD, using the Kidscreen-52, from the perspectives of the children themselves as well as their parents. Our

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results show that children with DCD experience a lower HRQOL than their typically developing peers, both from their self-reported perspective and that of their parents. Furthermore, when compared to normative data of same-aged peers, our investigation found that children with DCD have lower psychosocial and emotional functioning outcomes. Level of motor functioning abilities and degree of attentional difficulties were determined to be predictors of HRQOL in children with DCD. These findings suggest that therapies to support children with DCD should consider intervention protocols holistically, including goals that specifically address psychosocial and emotional outcomes. Furthermore, implementing a family-centered approach is likely to benefit therapeutic outcomes for children with DCD, as it may bridge the gap between child and parent perceptions of the disorder.

1. Introduction

Throughout development, engagement in motor activities is important for healthy physical, emotional, and social functioning (Piek, Baynam, & Barrett, 2006). For children and adolescents with Developmental Coordination Disorder (DCD), significant difficulties with motor functioning interfere with numerous aspects of their lives, including academic achievements and leisure pursuits (Zwicker, Missiuna, Harris, & Boyd, 2012). Subsequently, recent evidence suggests that children with DCD are at risk for experiencing a lower quality of life than their typically developing peers (Flapper & Schoemaker, 2008; Wuang, Wang, & Huang, 2012; Zwicker et al., 2013).

DCD is a neurodevelopmental condition affecting approximately 5–6% of school-aged children (5th ed., DSM-V, American Psychiatric Association, 2013; Harris, Mickelson, & Zwicker, 2015). Children with this disorder characteristically present with motor coordination abilities below what is expected at their chronological age and difficulties with motor learning of fine and/or gross motor skills, not attributable to any other chronic or neurological condition affecting movement, such as cerebral palsy (Harris et al., 2015). Consequently, children with DCD often have lower performance outcomes in activities of daily living (such as tying shoes or using a knife and fork) and school activities (such as handwriting and team sports participation) (Flapper & Schoemaker, 2013; Zwicker et al., 2012). However, children with DCD typically are of average to high average intelligence (Zwicker et al., 2012).

Children diagnosed with DCD often have other co-occurring conditions (Zwicker et al., 2012). Approximately 50% of children with DCD also meet diagnostic criteria for Attention Deficit Hyperactivity Disorder (ADHD) (Blank et al., 2012; Martin, Piek, & Hay, 2006; Missiuna et al., 2011; Watemberg, Waiserberg, Zuk, & Lerman-Sagie, 2007). Other common comorbidities include specific learning disabilities, speech/language impairment, and obesity (Cairney et al., 2010; Flapper & Schoemaker, 2013; Jongmans, Smits-Engelsman, & Schoemaker, 2003; Zwicker et al., 2012). Contrary to previous beliefs that children with DCD will simply outgrow the condition, it is now understood that the motor deficits extend into adulthood (Cousins & Smyth, 2003; Kirby, Edwards, & Sugden, 2011; Tal-Saban, Ornoy, & Parush, 2014). Furthermore, a growing body of literature suggests motor implications of DCD also negatively impact the psychosocial and emotional functioning of children with this disorder, with potential for long-term mental health consequences (Engel-Yeger & Hanna Kasis, 2010; Kirby, Williams, Thomas, & Hill, 2013; Zwicker et al., 2013).

When compared to typically-developing peers, children with DCD demonstrate more restricted and socially isolated patterns of participation (Jarus, Lourie-Gelberg, Engel-Yeger, & Bart, 2011; Mandich, Polatajko, & Rodger, 2003; Poulsen, Ziviani, Cuskelly, & Smith, 2007). Furthermore, children with DCD are more likely to be excluded from group play activities and report lower perceived self-efficacy outcomes, which has been linked to restricted activity preferences for these children (Jarus et al., 2011; Smyth & Anderson, 2000). These children have also been found to report lower self-perceptions of their health, physical abilities, peer relationships, and self-confidence than children who do not have a DCD diagnosis (Cocks, Barton, & Donelly, 2009; Dunford, Missiuna, Street, & Sibert, 2005; Piek et al., 2006; Watson & Knott, 2006; Yu et al., 2016; Zwicker et al., 2013). Due to their motor difficulties in daily life, children with DCD are at higher risk for experiencing lower self-worth and developing secondary emotional difficulties (Cocks et al., 2009; Engel-Yeger & Hanna Kasis, 2010; Skinner & Piek, 2001; Zwicker, Suto, Harris, Vlasakova, & Missiuna, 2018).

Unfortunately, these challenges are often trivialized by parents, teachers, and health professionals, and thus may be left unaddressed (Mandich et al., 2003). This is problematic, as children with limited ability to participate in everyday activities are at a higher risk of social isolation, loneliness, and being bullied (Mandich et al., 2003; Poulsen et al., 2007). Accordingly, many studies have consistently shown that children with DCD have an increased risk of experiencing symptoms of depression and anxiety and are vulnerable to both current and long-term mental health challenges (Green, Baird, & Sugden, 2006; Missiuna et al., 2014; Piek et al., 2006; Pratt & Hill, 2011; van den Heuvel, Jansen, Reijneveld, Flapper, & Smits-Engelsman, 2016; Zwicker et al., 2013). Furthermore, beyond a child's personal capacities, caregivers of school-aged children with DCD have been found to experience lower physical and psychological health outcomes, affecting dynamics of the family context and the support these children receive to manage their motor deficits and psychosocial experience (Wuang et al., 2012). Considering the subsequent psychosocial and emotional impacts of DCD-related motor difficulties, children and youth with DCD are at risk for a lower quality of life than typically developing peers (Zwicker et al., 2013).

Karimi and Brazier (2016) describe quality of life as a self-evaluation of life satisfaction in areas of physical, social, and emotional functioning, influenced by personal values and worldview. Similarly, the World Health Organization defines quality of life as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (Kuyken, 1995, pp. 1405). Uniquely, the quality of life of children is also significantly influenced by caregiver and family environment factors (Wuang et al., 2012). In the concept of health-related quality of life (HRQOL), quality of life is viewed through the lens of an individual's self-perceived health status (Craig, Greiner, Brown, & Reeve, 2016; Institute of Health Economics, 2008). Measuring HRQOL is both subjective and multidimensional, generating a holistic profile of an individual's perception of personal well-being at one point in time (Ravens-Sieberer et al., 2005; Wuang et al., 2012). As the motor deficits of DCD and associated psychosocial difficulties significantly interfere with everyday functioning, this condition is

thought to affect multiple domains associated with quality of life in children with this disorder (Flapper & Schoemaker, 2008; Zwicker et al., 2013, 2018).

Currently, few studies have directly examined the relationship between DCD and HRQOL. Further evidence is needed to more thoroughly describe the impact of DCD on the quality of life of these children and how to better support engagement in the activities they need and want to do that make their lives meaningful. Thus, the purpose of our study was to better understand which aspects of HRQOL are most affected for children with DCD to further inform interventions to support these children. Specifically, we aimed to: (1) describe health-related quality of life (HRQOL) of children with DCD compared to typically-developing children; (2) compare HRQOL from the perspectives of children with DCD and their parents; and (3) explore predictors of HRQOL for children with DCD. We hypothesized that children with DCD would show lower HRQOL across all domains of HRQOL, particularly psychological well-being. As such, our secondary aim was to further describe aspects of psychological well-being, including emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior. We also expected that parents would rate their child's quality of life lower than their child and that clinical measures of motor function and attention and socio-economic status (SES) would be potential predictors of HRQOL in children with DCD.

2. Methods

2.1. Participants

We used a cross-sectional design to explore the perceptions of children with DCD on their own HRQOL and that of their caregivers. A convenience sample of 50 children (8–12 years) diagnosed with DCD was recruited through the DCD Research Clinic at Sunny Hill Health Centre in Vancouver, Canada from January 2014 to September 2016. Children were included if they had a diagnosis of DCD in accordance with the 5th Edition of the Diagnostic and Statistical Manual of Mental Disorder (DSM-5) criteria (American Psychiatric Association, 2013) and European Academy of Childhood Disability guidelines (Blank et al., 2012), as assessed by a developmental pediatrician and an occupational therapist. We used a score of $\leq$16th percentile on the Movement Assessment Battery for Children-2 Test (MABC-2; Henderson, Sugden, & Barnett, 2007) and a score in the indicative or suspected range on the Developmental Coordination Disorder Questionnaire (DCDQ; Wilson, Kaplan, Crawford, & Roberts, 2007) to inform diagnosis. MABC-2 is a standardized assessment to identify motor impairments of children and adolescents from 3 to 16 years of age. It consists of three components of to assess manual dexterity (3 tasks), aiming & catching (2 tasks), and balance (3 tasks); a total score is derived from the result from all three components and was used in this study (Henderson et al., 2007). DCDQ is a parent-report questionnaire which requires parents to compare their child's motor coordination with their peers in order to identify motor problems (Wilson, Kaplan, Crawford, & Roberts, 2007). Participants were excluded if they had another medical condition affecting movement, such as cerebral palsy or a history of a moderate to severe intellectual disability. Children with common co-occurring conditions, such as attention deficit hyperactivity disorder or learning disabilities, were not excluded. We assessed children's attention using the parent form of the Conner's ADHD Index (Conners, 2009) and estimated IQ using the Kaufman Brief Intelligence Test-2nd edition (KBIT-2; Kaufman & Kaufman, 2004) to better describe our clinical sample.

Parents provided consent and children assented to be a part of the study. This study was approved by the Children's and Women's Health Centre/University of British Columbia Clinical Research Ethics Board.

2.2. Procedure

Participants attending the DCD Clinic were assessed by a developmental pediatrician as well as an occupational therapist, who administered the MABC-2 Test (Henderson et al., 2007) and DCDQ (Wilson et al., 2007). Parents and children were invited to participate in the study if they had sufficient English to complete questionnaires. If parents (children) provided written consent (assent) to take part in this study, the KBIT-2 was also administered and the Conner's ADHD Index was completed by parents. While at the clinic appointment, a research assistant provided the children (self-report) and parents (proxy report) with a paper copy of the KidScreen-52 (KidScreen Group Europe, 2006) to complete. Parents also completed the Strengths and Difficulties Questionnaire (Goodman, 1997). Data were also collected on family demographics, including partial postal code and maternal education, which were used as proxies for socioeconomic status. The first three digits of the participants' postal codes and then further categorized into average household income categories using 2011 Statistics Canada Census data.

2.3. Measures

For this study, Kidscreen-52 (KidScreen Group Europe, 2006) was our primary outcome to measure HRQOL in children living with DCD, both from the self-reported perspective of these children and that their caregivers. To gain further insights into the psychosocial and emotional functioning of children with DCD, the Strengths and Difficulties Questionnaire (Goodman, 1997) was also used.

2.3.1. Kidscreen-52

The Kidscreen-52 is a questionnaire designed to measure HRQOL of children and adolescents between ages 8–18 years (Ravens-Sieberer et al., 2008, 2014). This questionnaire, which can be administered via proxy or child self-report, consists of 52 items describing 10 different dimensions of HRQOL: *physical well-being, psychological well-being, moods and emotions, self-perception, autonomy, parent relations and home life, social support and peers, school environment, bullying, and financial resources* (Ravens-Sieberer

et al., 2005). Items on the questionnaire fulfill the assumptions of the Rasch model; thus, for each dimension, raw scores are totalled and scored as Rasch scales using the authors' provided syntax (KidScreen Group Europe, 2006). Scores are then translated into T-scores (scale mean = 50, SD = 10) for interpretation (KidScreen Group Europe, 2006). Higher scores in each domain indicate higher reported QOL (KidScreen Group Europe, 2006).

Internal consistency of this measure has been considered acceptable with Cronbach's Alpha scores measuring between 0.77–0.89 for the child self-report version and 0.77–0.90 for the proxy version (KidScreen Group Europe, 2006). Furthermore, convergent validity has been calculated by comparing the Kidscreen-52 with the KINDL^{R}, a similar, validated tool (Ravens-Sieberer et al., 2005). On average, correlation coefficients calculated between these two measures fell within the moderate range (r = 0.3–0.5), thus deeming this measure acceptable for clinical use (Ravens-Sieberer et al., 2005). Furthermore, the Kidscreen-52 is able to distinguish significant differences between healthy individuals and populations with atypical development with small to moderate effect sizes (r = 0.17–0.41) (KidScreen Group Europe, 2006).

2.3.2. Strengths and Difficulties Questionnaire

The Strengths and Difficulties Questionnaire (SDQ) is a screening tool that measures psychosocial strengths and weaknesses in children and youth between the ages of 4–16 years (Goodman, 1997, 2001). The SDQ is completed by a primary caregiver and includes 25 items, equally divided between five scales: *emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior* (Goodman, 1997). Each of the five scales generates an individual score and, with the exception of the prosocial scale, the summation of these scales produces a total Difficulties Score ("Scoring the Strengths & Difficulties", 2015; Goodman, 1997). Five additional questions in the questionnaire explore the effect of a child's psychosocial difficulties on participation in activities of daily living and family functioning, which derive an impact score ("Scoring the Strengths & Difficulties", 2015). For the four difficulties domains and impact score, higher values indicate greater psychosocial difficulties, while higher prosocial scores suggest a strength in this area ("Scoring the Strengths & Difficulties", 2015). The SDQ and scoring guides can be accessed free of charge online (http://www.sdqinfo.org/).

A review of the extensive psychometric testing completed on the SDQ determined that the questionnaire exhibits suitable reliability and validity (Stone, Otten, Engels, Vermulst, & Janssens, 2010). The test-retest reliability of each separate domain range between r = 0.66–0.71 for the parent version, with higher reliability for the Total Difficulties score (r = 0.76) (Stone et al., 2010). The SDQ also yields a satisfactory internal consistency (alpha-0.73) (Goodman, 2001). Construct validity for the five scales is acceptable (r = 0.40-0.70), with good concurrent validity for the Total Difficulties score (r = 0.76) (Stone et al., 2010).

2.4. Statistical analyses

Analyses were conducted using SPSS version 24 for Macintosh (IBM SPSS Statistics, IBM Corporation). Descriptive statistics, reported as mean, standard deviation, range, and frequency values, were used to summarize clinical characteristic data of the sample, including participant age, sex, clinical measure scores (MABC-2, DCDQ, KBIT-2, and Conners ADHD Index), and presence of comorbidities. To evaluate socioeconomic status, the first three digits of participants' postal codes were organized into five categories of SES neighborhoods, based on average household income: Low ($0-$38,754), Lower-middle ($38,755-$61,928), Middle ($61,929-$88,074), Upper-middle ($88,075-$125,009), Highest ($125,010 and up) (Statistics Canada, 2011).

KidScreen-52 scores for each domain were transformed to T-values according to the authors recommended syntax (KidScreen Group Europe, 2006). Independent t-tests were conducted to compare means of HRQOL domain scores of children with DCD and published norms of children age 8–11 years and proxy report (KidScreen Group Europe, 2006), and for child versus caregiver report comparisons (Mezgebe et al., 2015); where variances were unequal between groups, Welch's *t*-test was used. Independent *t*-tests were also used to explore for significance differences between the SDQ scores of children with DCD and American normative data of children age 4–17 years (Biel et al., 2015; Youthinmind, 2013). Linear Regression Models were conducted to determine associations between clinical characteristics (e.g., motor and attention scores) and income category with the KidScreen-52 HRQOL domain outcomes for children with DCD. These predictors were chosen because previous research has shown that motor function (Raz-Silbiger et al., 2015), ADHD symptoms (Klassen, Miller, & Fine, 2006), and socioeconomic status (Otto et al., 2017) predicted health-related quality of life of children. Alpha was set to $p < 0.05$ and all analyses were corrected for multiple comparisons using Bonferroni correction.

3. Results

3.1. Clinical characteristics

Analysis of sociodemographic and clinical measure data are presented in Table 1. Consistent with the literature of clinical samples of children with DCD, our sample was primarily male (84%) (Harris et al., 2015). Although the inclusion criteria for this study required a mean MABC-2 percentile score of 16 or below, the mean percentile score of our sample was 3.7 (range 0.1st to 16th percentile). The mean standard IQ score for the sample was within the average range (Full scale IQ 104, range 75–134); 4/50 (8%) children had mild intellectual disability. The mean Conners ADHD Index t-score was 86 (range 54–90), which falls within the 'very elevated' or clinically significant range (t-score > 70) (Conners, 2009). Attention Deficit Hyperactivity Disorder was the most common comorbidity in the sample (70%), which is consistent with literature on common comorbidities of children with DCD (Zwicker et al., 2012). Of the participants, 26% had only one confirmed or probable comorbidity, while 70% had or were suspected of having at least two comorbidities.

Table 1
Description of participants (N = 50).

Clinical Characteristics	Mean (SD) or N (%)
Male sex	42 (84)
Age (years)	9.8 (1.22)
MABC-2 (percentile)	3.7 (4.73)
DCDQ (number in suspected or indicative range)[a]	50 (100)
Kaufman Brief Intelligence Test-2 (standard score)	104 (15.2)
Conners ADHD Index (t-score)	86 (9.6)
Co-occurring Conditions (definitive or probable):	
Attention Deficit Hyperactivity Disorder	35 (70)
Autism Spectrum Disorder	6 (12)
Learning Disabilities	32 (64)
Anxiety	28 (58)
Neighborhood Categories (average household income):	
Low ($0–$38,754)	2 (4)
Lower-middle ($38,755–$61,928)	29 (58)
Middle ($61,929–$88,074)	19 (38)
Upper-middle ($88,075–$125,009)	0
Highest ($125,010 and up)	0
Maternal Education:	
High school or less	7 (14)
Apprenticeship or trades certificate or diploma	4 (8)
Diploma, below Bachelor's level	21 (42)
Bachelor's degree	14 (28)
Graduate degree	4 (8)

[a] Scores in the suspected and indicative range for DCD range from 15 to 55 (out of 75) for ages 8 years 0 months to 9 years 11 months and 15 to 57 for children ages 10 years 0 months to 15 years.

3.2. Self-perception of HRQOL in children with DCD

Table 2 compares mean t-scores of the children with DCD in our sample to Kidscreen-52 published population normative t-scores of children ages 8–11 years (KidScreen Group Europe, 2006). Compared to normative data, children with DCD reported significantly lower scores in four out of 10 domains: psychological well-being ($p < 0.004$), moods and emotions ($p < 0.0002$), parent relations and home life ($p < 0.0001$), and school environment ($p < 0.005$).

3.3. Caregivers' perception of their children's HRQOL

Mean t-score results from the responses of caregivers of children with DCD are compared to the mean t-scores of the KidScreen-52 proxy published normative data in Table 3. Compared to normative data from caregivers of 8–11 year old typically developing children, caregivers of children with DCD reported significantly lower perceptions of their children's HRQOL in eight out of 10 domains: physical well-being, psychological well-being, moods and emotions, autonomy, parent relations and home life, school environment, bullying (all $p < 0.0001$), and self-perception ($p = 0.002$). Caregivers in our sample rated their financial resources significantly higher than the normative group ($p = 0.002$).

Table 2
Comparison of HRQOL outcomes on the KidScreen-52 between the self-report of children diagnosed with developmental coordination disorder in our sample and the published normative data of same-aged children (KidScreen Group Europe, 2006).

KidScreen-52 Domain	Children with DCD Mean (SD)	Published norms Mean (SD)	p-value*
Physical Well-being	50.1 (9.28)	53.7 (9.96)	0.01
Psychological Well-being	50.5 (6.64)	53.4 (9.40)	**0.004**
Moods & Emotions	46.8 (10.15)	52.2 (9.97)	**0.0002**
Self-Perception	55.3 (8.46)	54.5 (9.74)	0.54
Autonomy	50.5 (10.44)	51.6 (9.67)	0.43
Parent Relation & Home Life	48.1 (6.37)	52.7 (9.18)	**< 0.0001**
Social Support & Peers	50.2 (10.66)	50.6 (10.05)	0.76
School Environment	50.2 (9.67)	54.5 (10.46)	**0.005**
Bullying	45.1 (11.34)	47.6 (10.54)	0.11
Financial Resources	47.8 (9.52)	48.9 (10.45)	0.52

Bold values are statistically significant after Bonferroni correction for multiple comparisons.

Table 3
Comparison of HRQOL outcomes on the KidScreen-52 between proxy report results of the primary caregivers of children with developmental coordination disorder in our sample and published proxy normative data (KidScreen Group Europe, 2006).

KidScreen-52 Domain	Parent Proxy DCD Mean (SD)	Published Proxy norms Mean (SD)	p-value
Physical Well-being	43.3 (9.28)	52.6 (9.49)	< **0.0001**
Psychological Well-being	46.3 (9.86)	51.9 (9.46)	< **0.0001**
Moods & Emotions	36.4 (8.31)	51.5 (9.62)	< **0.0001**
Self-Perception	49.4 (7.56)	52.9 (9.91)	**0.002**
Autonomy	46.5 (5.69)	50.3 (9.03)	< **0.0001**
Parent Relation & Home Life	45.9 (6.19)	51.5 (9.38)	< **0.0001**
Social Support & Peers	47.6 (8.48)	50.4 (9.42)	0.05
School Environment	43.8 (6.80)	53.5 (9.97)	< **0.0001**
Bullying	38.4 (10.86)	48.0 (10.33)	< **0.0001**
Financial Resources	54.1 (7.68)	50.3 (10.29)	**0.002**

Bold values are statistically significant after Bonferroni correction for multiple comparisons.

3.4. Comparing the children's and caregivers' reports

Child-parent comparison, as is demonstrated in Table 4, found that caregivers of children with DCD reported significantly lower scores than their children regarding HRQOL in the domains of physical well-being, moods and emotions, self-perception, school environment (all $p < 0.001$), and bullying ($p = 0.004$). In the Financial Resources domain, children with DCD yielded a significantly lower mean t-score value than the mean t-score derived from the reports of their caregivers ($p = 0.001$). No significant differences were observed between child and caregiver reports in the areas of psychological well-being, autonomy, parent relations & home life, and social support and peers.

3.5. Psychosocial outcomes

Significant findings from analysis of the KidScreen-52 results, showing that children with DCD report significantly lower mean t-scores across holistic domains of HRQOL, warranted further investigation into the social and emotional impacts of the disorder. Table 5 displays the results of the Strengths and Difficulties Questionnaire, comparing mean scores of primary caregivers of children

Table 4
Comparison of perceptions of HRQOL between the self-report of children with developmental coordination disorder and that of their caregivers.

KidScreen-52 Domain	Child Score mean (SD)	Caregiver Score mean (SD)	p-value
Physical Well-being	50.1 (9.28)	43.3 (9.28)	< **0.001**
Psychological Well-being	50.5 (6.64)	46.3 (9.86)	0.014
Moods & Emotions	46.8 (10.15)	36.4 (8.31)	< **0.001**
Self-Perception	55.3 (8.46)	49.4 (7.56)	< **0.001**
Autonomy	50.5 (10.44)	46.5 (5.69)	0.021
Parent Relation & Home Life	48.1 (6.37)	45.9 (6.19)	0.084
Social Support & Peers	50.2 (10.66)	47.6 (8.48)	0.201
School Environment	50.2 (9.67)	43.8 (6.80)	< **0.001**
Bullying	45.1 (11.34)	38.4 (10.86)	**0.004**
Financial Resources	47.8 (9.52)	54.1 (7.68)	**0.001**

Bold values are statistically significant after Bonferroni correction for multiple comparisons.

Table 5
Comparison of the SDQ subscale outcomes between caregivers of children with developmental coordination disorder and proxy normative data (Goodman, 1997).

Strengths and Difficulties Questionnaire Domain	Caregiver Score mean (SD)	Norm Score mean (SD)	p-value*
Emotional Symptoms	5.0 (2.5)	1.6 (1.8)	< **0.001**
Conduct Problems	2.4 (1.9)	1.3 (1.6)	< **0.001**
Hyperactivity-inattention	7.1 (2.3)	2.8 (2.5)	< **0.001**
Peer Problems	3.8 (1.9)	1.4 (1.5)	< **0.001**
Prosocial Behavior	7.5 (2.1)	8.6 (1.8)	< **0.001**
Impact Score	4.0 (2.4)	0.4 (1.3)	< **0.001**
Total Difficulties Score	18.4 (6.2)	7.1 (5.7)	< **0.001**

Bold values are statistically significant after Bonferroni correction for multiple comparison.

with DCD to mean norm scores of caregivers of children and adolescents, 4–17 years of age, in the general population (Goodman, 1997). Across all areas of social/emotional functioning measured by the SDQ, primary caregivers of children with DCD reported significantly lower scores (all $p < 0.001$) than normative data.

3.6. Predictors of HRQOL

Linear Regression Models were conducted to explore predictive relationships between income category, maternal education, and clinical measure results of children with DCD, with each of the t-score outcomes on the KidScreen-52. Only two out of 10 comparisons were significant after correction for multiple comparisons. As shown in Table 6, motor function as measured by the DCDQ predicted physical well-being and inattention/hyperactivity as measured by the Conners ADHD Index predicted mood and emotions. Although our sample had significantly higher SES compared to norms, maternal education and family income were not associated with any HRQOL domain.

4. Discussion

This research adds to the growing body of knowledge around DCD and its impact on the HRQOL of children with the condition. Our findings demonstrate that both children with DCD and their parents report significantly lower HRQOL when compared to the published normative peer and proxy data. Moreover, our data suggests that caregivers have a significantly lower perception of their child's HRQOL when compared to the self-reported data from their children. Further inquiry also determined that parents of children with DCD report that their children experience significantly more emotional and behavioral disturbances than typically developing peers.

In keeping with existing literature, the present study supports the mounting evidence that children with DCD, with or without comorbid conditions, are at risk of experiencing significantly lower HRQOL when compared to their typically developing peer group. These findings particularly align with one study conducted by Wuang et al. (2012) where parents of children with DCD reported lower HRQOL in physical and psychosocial domains compared to reports from parents of typically developing children. Other existing literature also supports these findings through teacher reports, suggesting that children with DCD experience significantly more emotional and behavioural problems than their classmates (van den Heuvel et al., 2016). These findings are not surprising as children with DCD reportedly struggle in a variety of domains including ADL's, academic, and leisure pursuits (Flapper & Schoemaker, 2013; Zwicker et al., 2012). As such, if any episodes of particular clumsiness ensue in the presence of their peers, these children may be subject to undue ridicule. Consequently, this may spark peer conflict and psychological distress (Cairney, Rigoli, & Piek, 2013).

A large number of children in our sample had co-occurring ADHD, which may confound the results; however, up to 50% of children with DCD have comorbid ADHD (Blank et al., 2012; Martin et al., 2006; Missiuna et al., 2011; Watemberg et al., 2007) so our sample may be considered reflective of a clinical population of children with DCD. Our findings are consistent with Flapper and Schoemaker (2008), who explored HRQOL for children with combined DCD and ADHD diagnoses; they found that both children with DCD and their primary caregivers reported lower HRQOL outcomes than healthy controls. While the introduction of stimulant medication showed some improvements in the children's ADHD symptoms and motor functioning, at reassessment, the children with DCD/ADHD again reported lower HRQOL of life outcomes than the typically developing control group, suggesting the pervasive impact of DCD on their HRQOL (Flapper & Schoemaker, 2008).

In the present study, parents reported significantly lower perceptions of their child's HRQOL than that expressed by their children in half of the HRQOL domains. This discrepancy is consistent with trends in the literature that examine proxy versus self-report data (Klassen et al., 2006). It has been suggested that parents of children with various chronic conditions tend to report lower HRQOL scores than their children, while parents of typically developing children will often overestimate HRQOL (Morrow, Hayen, Quine, Scheinberg, & Craig, 2012). Such a discrepancy may be related to parental anxiety towards a child's health condition, leading to an underestimation of the child's HRQOL (Baca, Vickrey, Hays, Vassar, & Berg, 2010). For example, research examining HRQOL in children with epilepsy suggests that parents may have a broader awareness of the challenges that their child might face such as difficulties in future employment, educational achievement, and socioeconomic status (Baca et al., 2010). The same theory could also be applied to parents of children with DCD as they may also feel uncertainty about their child's well-being as a consequence of their diagnosis.

There are several clinical implications of our study results. Of critical importance, children with DCD and their parents reported poorer quality of life and lower psychosocial and emotional well-being outcomes compared to peers; these results are consistent with reports that children with DCD are at higher risk to be socially isolated and experience depression and anxiety (Jarus et al., 2011; Piek et al., 2006; Pratt & Hill, 2011; Zwicker et al., 2013).

Most of the common interventions to support health outcomes in children with DCD are focused around motor skill development, classroom environment modifications, and pharmaceutical management of comorbid conditions, such as ADHD (Blank et al., 2012; Smits-Engelsman, Blank, Van Der Kaay, Mosterd-Van Der Meijs, & Wilson, 2013). While task-specific, evidence-based interventions such as the *Cognitive Orientation to daily Occupational Performance* (CO-OP) approach have demonstrated effective results for supporting improved motor functioning for children with DCD (Polatajko, Mandich, Miller, & Macnab, 2001; Smits-Engelsman et al., 2013), the present study sheds light on the need for support that transcends beyond such domains. Our findings suggest that children with DCD could also benefit from therapeutic support addressing psychosocial and emotional challenges that arise from the condition. Such interventions may focus on areas such as the development of self-esteem (Sin & Lyubomirsky, 2009), social skills training (Maag, 2006), problem solving (Cote, 2011), and positive coping strategies. One example of this may be through the use of age-

Table 6
Predictors of health-related quality of life domains in children with developmental coordination disorder.

	DCDQ		MABC-2		KBIT-2		Conner's ADHD Index		Income Category		Maternal Education	
Kidscreen-52 Domain	Co-efficient (SE)	p-value*	Co-efficient (SE)	p-value	Co-efficient (SE)	p-value	Co-efficient (SE)	p-value*	Co-efficient (SE)	p-value	Co-efficient (SE)	p-value
Physical Well-being	0.61 (0.18)	**0.001**	−0.51 (0.80)	0.52	0.001 (0.09)	0.99	0.11 (0.13)	0.40	−0.35 (2.36)	0.88	0.31 (0.83)	0.71
Psychological Well-being	0.26 (0.20)	0.19	−0.61 (0.91)	0.50	0.08 (0.10)	0.40	−0.16 (0.15)	0.31	2.65 (2.67)	0.33	0.98 (0.94)	0.30
Moods & Emotions	0.03 (0.15)	0.84	0.04 (0.70)	0.95	0.07 (0.08)	0.37	0.04 (0.12)	**0.003**	2.70 (2.06)	0.20	0.26 (0.73)	0.72
Self-Perception	0.04 (0.15)	0.79	0.23 (0.69)	0.74	0.07 (0.07)	0.30	0.08 (0.11)	0.46	4.10 (2.03)	0.05	−0.28 (0.71)	0.70
Autonomy	0.07 (0.12)	0.55	−0.20 (0.55)	0.72	−0.03 (0.06)	0.67	−0.06 (0.09)	0.51	0.05 (1.62)	0.97	−0.57 (0.57)	0.32
Parents & Home Life	0.06 (0.13)	0.62	−0.20 (0.58)	0.73	0.04 (0.06)	0.54	−0.09 (0.10)	0.35	2.09 (1.72)	0.23	0.44 (0.60)	0.47
Social Support and Peers	0.06 (0.18)	0.74	1.23 (0.85)	0.16	−0.06 (0.09)	0.46	−0.10 (0.16)	0.51	2.16 (2.48)	0.39	−0.12 (0.84)	0.88
School Environment	0.25 (0.14)	0.07	−0.60 (0.63)	0.34	0.07 (0.07)	0.30	−0.01 (0.10)	0.95	2.34 (1.85)	0.21	0.49 (0.66)	0.46
Bullying	−0.15 (0.22)	0.50	0.27 (0.99)	0.79	0.18 (0.11)	0.11	0.04 (0.17)	0.81	5.25 (2.91)	0.08	0.43 (1.04)	0.68
Financial Resources	−0.17 (0.16)	0.30	0.60 (0.74)	0.42	−0.06 (0.08)	0.46	−0.23 (0.12)	0.07	2.22 (2.15)	0.31	0.19 (0.75)	0.80

ADHD, Attention Deficit Hyperactivity Disorder; DCDQ, Developmental Coordination Disorder Questionnaire, KBIT-2, Kaufman Brief Intelligence Test – 2nd ed.; MABC-2, Movement Assessment Battery for Children – 2nd ed.
Bolded p-values indicate significant correlations (adjusted for multiple comparisons) between independent sociodemographic and clinical variables and HRQOL outcome variables.

appropriate Cognitive Behavioural Therapy (CBT) (Muñoz-Solomando, Kendall, & Whittington, 2008). Implementation of mindfulness principles is another intervention with emerging evidence demonstrating effectiveness in improving mental health and attentional outcomes in children and adolescents with difficulties in these areas (Thompson & Gauntlett-Gilbert, 2008). Additionally, integrating a strengths-based approach to care may also produce beneficial outcomes as the child's unique strengths and goals are accounted for and placed at the centre of therapy (Sabalauskas, Ortolani, & McCall, 2014). Furthermore, taking a family-centered approach to care may bridge the gap between parent and child perspectives, and thus contribute to an intervention program that is meaningful for the child and supportive of any differing parent concerns (Kuhlthau et al., 2011). Therefore, it is recommended that therapists working with children with a DCD diagnosis assess for needs beyond the physical domain and be prepared to integrate psychosocial and emotional lenses into goal setting and treatment planning.

When considering HRQOL, examining comorbid conditions is important, as children with various comorbidities have been shown to report lower QOL when compared to children with a single diagnosis (O'Hare, Helmes, Reece, Eapen, & McBain, 2016). More specifically, children diagnosed with both DCD and ADHD have been shown to be at greater risk of depression, anxiety and overall psychological distress when compared to children diagnosed with DCD alone (Missiuna et al., 2014). When looking at the data in the present study, only 4% of the sample reported no comorbid conditions, thus leaving the remainder of the sample with one or more comorbidities. As such, it is difficult to determine whether the study findings can be solely attributed to DCD or the compounding effect of multiple comorbidities. Despite this limitation, our findings tend to match up with other literature suggesting that children with DCD are often faced with one or more co-occurring conditions (Zwicker et al., 2012).

Other limitations to this study include a relatively small sample size originating from a single clinic as a means of obtaining data. As such, our sample may not be accurately representative of the larger DCD population. In addition, our clinically-based sample consisted predominantly of boys, suggesting a referral bias. Future work would benefit from population-based samples to balance the gender distribution and increase the generalizability of the findings. Our well-defined sample of children with DCD also included a high frequency of comorbidities; although co-morbidity with DCD is more the rule than the exception, it would be beneficial to explore the impact of comorbidities on HRQOL as they compare to DCD alone. While our study took advantage of published norms, future studies examining HRQOL of children with DCD should include recruitment of typically-developing children matched for age, gender, and SES. While we found few predictors of HRQOL domains, our results should be interpreted with caution as we may have been under-powered to detect significant predictors. Finally, the cross-sectional nature of this study limits the causal inferences that can be drawn; future studies would benefit from longitudinal work.

5. Conclusion

Children with DCD and their parents report significantly lower HRQOL across numerous domains, including physical well-being, psychological well-being, moods and emotions, self-perception, autonomy, parent relations and home life, social support and peers, school environment, and bullying. As the burden of psychosocial concerns is high in children with DCD, the target of intervention needs to extend beyond motor skills and include treatments to improve the mental health and quality of life of children with this common motor disorder.

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