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Psychometric Properties of the Canadian Little Developmental Coordination Disorder Questionnaire for Preschool Children

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ABSTRACT. *Aims*: Test the psychometric properties and cut-off scores for the Canadian Little Developmental Coordination Disorder Questionnaire (Little DCDQ), which screens for coordination difficulties in children aged 3 to 4 years. *Methods*: Parents of children with typical development ($n = 108$) and children at risk for motor problems ($n = 245$) completed the questionnaire. A subgroup ($n = 119$) of children was tested with the Movement Assessment Battery for Children-2 (MABC-2) and the Beery–Buktenica Developmental Test of visual-motor integration (VMI) to determine motor impairment (MI). *Results*: Test-retest reliability ($r = 0.956, p < .001$) and internal consistency (Cronbach's alpha = 0.94) were high. Construct validity was supported by a factor analysis and significant difference in scores of children who were typically developing and were at risk. Concurrent validity was evaluated for the children who received standardized motor testing, with significant difference between children with and without MI. Discriminant function analysis showed that all 15 items were able to distinguish the two groups. The questionnaire correlated well with the MABC-2 and VMI. Validity as a screening tool was assessed using logistic regression modeling ($X^2(5) = 25.87$, $p < .001$) and receiver operating curves, establishing optimal cut-off values with adequate sensitivity. *Conclusions*: The Little DCDQ is a reliable, valid instrument for early identification of children with motor difficulties.

KEYWORDS. Developmental coordination disorder, DCD, daily living skills, health systems, motor development, self-care, psychometric testing, service delivery

Developmental Coordination Disorder (DCD) is a common childhood condition (Kirby and Sugden, 2010), with prevalence estimates ranging from 1.8% (Lingam et al., 2009) to 5–6% in all school-aged children (American Psychiatric Association

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(APA), 2013). DCD is characterized by motor in-coordination, delayed gross and/or fine motor skills, and difficulty learning new motor tasks (Cantin et al., 2007; Sugden, 2006). Motor impairments (MI) observed in DCD significantly interfere with an individual's ability to engage in activities of daily living and/or gain academic achievement. These impairments commonly persist into adolescence and adulthood (Cantell et al., 1994; Kirby et al., 2008; Losse et al., 1991).

A systematic review investigating various quality of life domains in children and youth with DCD found that physical, social, and psychological functioning are all negatively affected (Zwicker et al., 2012). Studies have indicated that social and emotional problems associated with DCD may be evident as early as in preschool (Kennedy-Behr et al., 2011; Piek et al., 2008), with higher incidences of aggressive behavior and negative effect during play interactions. These behaviors may result in restricted opportunities for development of motor and social play skills for children who are at risk of DCD (Kennedy-Behr et al., 2011).

Children with DCD experience delays in achieving early gross and fine motor milestones (Chambers and Sugden, 2002). However, since motor milestones are eventually reached, the possibility of DCD may not be considered in these young children (Rihtman et al., 2011). With the marked increase in motor demands at formal school entry, the difficulties experienced by children with coordination problems become more apparent (Chambers and Sugden, 2002; Wall, 2004). The disorder is generally diagnosed after the age of 5 years (Blank et al., 2012; Sugden, 2006), and as a result opportunities for early intervention become limited or are lost (Majnemer, 1998).

Delayed motor skills are known to negatively impact physical, social, and emotional development, signifying the need for a reliable and valid screening tool that will identify young children at risk of DCD (Giagazoglou et al., 2011; Rihtman et al., 2011). Earlier recognition will facilitate the development and implementation of targeted interventions aimed at promoting skill development and participation in age-appropriate activities. Such interventions may reduce the gap in abilities between affected children and their typically developing (TD) peers, thus minimizing the secondary consequences associated with DCD (Kennedy-Behr et al., 2011; Missiuna et al., 2003).

Although MI is often quantified by standardized assessments, there are fewer measures available to determine the functional impact that movement coordination problems have at home and school (Wilson et al., 2009). In recent years, several DCD screening tools have been developed (Chambers and Sugden, 2006; Rosenblum, 2006), including the Developmental Coordination Disorder Questionnaire (DCDQ'07; Wilson et al., 2009). Although a variety of DCD screening and diagnostic measures are available, currently there is no accepted "gold standard" instrument (Blank et al., 2012), and most are not appropriate for use with children under 5 years of age (Rihtman et al., 2011; Schoemaker and Wilson, 2014).

A downward age extension of the DCDQ'07 was recently made in Israel, which modified the questions and reflected the motor coordination skills of 3- and 4-year-old children (Rihtman et al., 2011). Named the Little DCDQ, its purpose is to identify motor coordination difficulties that may be consistent with risk of DCD in preschool children. As recommended by the European Academy of Childhood Disability (EACD) consensus (Blank, et al., 2012), parent report of coordination difficulties indicates the need for further standardized assessment. The DCDQ'07 has been translated to English and is referred to as the Canadian version of Little DCDQ. The aims of this study were to examine the following psychometric properties of the Canadian Little DCDQ: (1) Item consistency and test-retest reliability; (2) construct validity and concurrent validity with the Movement Assessment Battery for Children-2 (MABC-2) and the Beery–Buktenica Developmental Test of visual-motor integration (VMI); (3) sensitivity and specificity; and (4) determine cut-off scores indicating risk of coordination problems.

METHODS

Participants

Ethics approval was received from the Conjoint Health Research Ethics Board of the University of Calgary. Children/families were recruited from both universal and specialized preschool programs (private and public), a hospital-based clinic following preterm children, and a speech therapy service in Calgary and area. Eight programs at 17 locations agreed to participate. Sites with children at higher risk for developmental problems were intentionally over-sampled to achieve a clinical sample for an accurate examination of sensitivity and specificity.

Inclusion criteria were (1) children aged 3 years 0 months to 4 years 11 months, and (2) parents who had sufficient proficiency in written English to be able to complete the questionnaires. Exclusion criteria for the children were a diagnosis of (1) intellectual disability, (2) autism spectrum disorder, (3) neuromotor disorder, or (4) sensory loss.

Over 1,000 questionnaires were distributed to eight programs at 17 locations; 517 were returned (35.4%). A sample of 353 children (202 boys and 151 girls) met inclusion criteria (Table 1). In order to stratify the participants by baseline risk, as required for assessment of construct validity, the children were divided into two groups. Children were included in the at-risk (AR) group if they were in treatment for a motor development or speech/language concern, or if they were in a follow-up clinic for children born prematurely, since previous research has shown these groups to be at an increased risk for having DCD (DSM 5th ed.; American Psychiatric Association, 2013). The remainder was part of the TD group. One hundred and eight children were categorized in the TD group and 245 children in the AR group.

Measures

Little Developmental Coordination Disorder Questionnaire (Little DCDQ)

The Little DCDQ includes 15 items describing specific motor abilities. Parents are asked to compare their child's skills with those of other children of the same age and gender. The development of this questionnaire, its items, and its psychometric properties are described fully in Rihtman et al. (2011).

Face validity of the Canadian version of Little DCDQ was established by consensus agreement of 11 Canadian child development experts invited for their extensive experience with children (averaged 17.7 years of experience) and interest in the development of screening tools. They all had a minimum of bachelor's level

TABLE 1. Mean Scores on Descriptive Data for Children Categorized as At Risk and Typically Developing (n = 353)

	At risk		Typically developing		Total	
Variable	Number	Age M (SD)	Number	Age M (SD)	Number	Age M (SD)
3-year-old children						
Boys	80	3.4 (0.3)	23	3.5 (0.3)	103	3.4 (0.3)
Girls	48	3.3 (0.3)	30	3.4 (0.2)	78	3.4 (0.3)
Total	128	3.4 (0.3)	53	3.5 (0.3)	181	3.4 (0.3)
4-year-old children						
Boys	70	4.3 (0.3)	29	4.4 (0.3)	99	4.3 (0.3)
Girls	47	4.3 (0.3)	26	4.4 (0.3)	73	4.3 (0.3)
Total	117	4.3 (0.3)	55	4.4 (0.3)	172	4.3 (0.3)
All children						
Boys	150	3.8 (0.6)	52	4.0 (0.5)	202	3.9 (0.6)
Girls	95	3.8 (0.6)	56	3.9 (0.6)	151	3.8 (0.6)
Total	245	3.8 (0.6)	108	3.9 (0.5)	353	3.8 (0.6)

education and professional backgrounds in occupational therapy, speech-language pathology, physiotherapy, and psychology. Experts rated the relevance of each item on a 4-point Likert scale (1 = "not at all relevant" to 4 = "extremely relevant") for five populations: 3-year-old children, 4-year-old children, Canadian children, children with non-neurological motor delays, and parent rating. Ratings ranged from highly relevant to extremely relevant for all items for 4-year-old children, Canadian children, children with non-neurological motor delays, and parent rating. For 3-year-old children, three items (2, 7, and 10) scored in the slightly relevant to highly relevant range and the wordings were changed to increase the applicability of these items for the youngest group.

Since diagnosis of DCD is not recommended before the age of 5 years, the aim of the Little DCDQ is to identify children who are at risk of being labeled DCD at school age. Therefore, a moderately stringent criterion of impaired performance below the 15th percentile for impairment was used (i.e., a coarse sieve to identify children at risk) rather than the 5th percentile. Preschool children are in the process of learning motor skills and their performance is dependent on their level of experience; our less stringent criterion was intended to more accurately identify children at risk of motor challenges who would benefit from being formally assessed.

Strengths and Difficulties Questionnaire (SDQ)

In order to support an international cross-cultural collaboration among many researchers around the world who have a common goal of developing an instrument to identify preschool children who may be at risk of DCD (Rihtman et. al., 2013), the SDQ parent report (Goodman, 1997; Goodman and Scott, 1999) was included. The SDQ covers 25 emotional and behavioral attributes of a child (10 strengths, 14 representing difficulties, and one being neutral) grouped into five scales: emotional symptoms, conduct problems, hyperactivity/inattentiveness, peer relationship problems, and pro-social behavior. The cut-off score of 1 standard deviation (SD) below the mean value (borderline) was chosen. In this study, the SDQ was not intended to be used as an outcome measure but rather a control for possible emotional and behavioral problems that may influence participation in movement activities and subsequent skill development. Reports of hyperactivity/inattentiveness problems and/or poor peer relationships were incorporated in the logistic regression analysis to adjust for these factors.

Demographic Questionnaire

Also to support the cross-cultural collaboration, parts of the demographic questionnaire developed by Rihtman and colleagues (2013) were included. These included variables that were known or thought to be related to DCD, such as birth history and weight, medical, pediatric, or neurological referral or intervention, and receipt of developmental, therapy, special education, or psychological services. Other variables related to our inclusion and exclusion criteria (see below) were included.

The Movement Assessment Battery for Children-2 (MABC-2)

The MABC-2 (Henderson et al., 2007) is a standardized, norm-referenced measure used to screen for deficits in motor skill development in children aged 3 through 16 years. The MABC-2 consists of eight gross and fine motor tasks, leading to a total impairment score and subscale scores in three domains: manual dexterity, aiming and catching, and balance. Scores less than the 5th percentile are indicative of a definite MI, between the 5th and 15th percentile a risk for MI, and above the 15th percentile typical motor skills.

Beery–Buktenica Developmental Test of Visual-Motor Integration (Beery VMI)

The Beery VMI (short form) is a 21-item standardized and norm-referenced measure, in which children (aged 2 through 7 years) use a pencil and paper to imitate or copy geometric forms ordered in a developmental sequence (Beery and Beery, 2010). The integration score and the motor coordination subtest, which assesses fine motor skills independent of visual perceptual abilities, were included. The visual perception score was not used as it is a motor-reduced measure.

Procedure

Teachers, therapists, nurses, and child care providers distributed a two-page package containing a letter, the Little DCDQ, the SDQ, and the short demographic survey, with an addressed and postage-paid envelope. Names and phone numbers were provided in case the parents had queries about the study or about how to answer the questionnaires. Return of this package indicated assent to participate in the questionnaire part of the study. Parents were asked to indicate on the form whether they would be willing to be contacted for further testing of their children. Written informed consent was obtained for children whose parents agreed to further questionnaires and/or motor testing.

Some of the parents who consented to further involvement were sent a second copy of Little DCDQ one to two weeks later to determine test-retest reliability. Although we aimed to have a two- to three-week interval, a wider range was unavoidable due to the volunteer nature of parent involvement and what we could practically achieve recruiting from 17 preschool locations. Nineteen parents completed the questionnaire twice within one month (mean = 19 days; median = 19.5 days; SD = 7.4 days; range of 5 to 30 days).

The children of families who agreed to motor testing provided written informed consent and were assessed by occupational therapists unaware of the child's history and questionnaire scores. These therapists were experienced in administering these tests and working with preschool children; in addition, to increase consistency between testers, they were provided with a detailed four-page outline of specific assessment and scoring procedures (beyond those provided in the administration manuals). Therapists with less than five years of experience were also provided at least one orientation session with a very experienced researcher clinician. Therapists scored the two tests according to the administration manuals; all scoring and calculations were then double-checked by a different therapist. Although participation was voluntary, children whose parents participated were not significantly different from those whose parents did not on the demographic characteristics measured, or mean total score on the Little DCDQ score ($p > .05$).

DATA ANALYSIS

Data were analyzed using the Statistical Package for the Social Sciences, Version 19 (SPSS Statistics; IBM Corp, 2010). Internal consistency was assessed calculating Cronbach's alpha. An overall alpha coefficient of 0.70 was used as the cut-off criterion to reach or possibly exceed for this study (Bland and Altman, 1997). Item-to-total correlations were calculated, which identified any single item that was not highly correlated with the total score and should be considered for deletion from the final version of the overall test. The Cronbach's alpha of the overall test when each item was deleted was also examined as a confirmation that all items should be kept in the final version of the overall test. In situations where the Cronbach's alpha does not increase significantly when an item is removed from the overall test, this means that the item should be retained in the final version of the questionnaire.

Test-retest reliability was examined by calculating the intra-class correlation (ICC) between total scores at the initial time point and total scores at the final time point. ICC values over 0.5 represent a high level of consistency in scores; values close to 1.0 are considered very high. Validity was examined in several ways.

To examine construct validity, factor analysis (principal component analysis with varimax rotation) was conducted to explore the relationship among items and groups of similar items on the Little DCDQ. It was expected that children would have similar scores on items related to gross motor, and that they would have similar scores on items related to fine motor skills; therefore, the factor analysis would be expected to show two factors. Analysis of variance was used to compare total scores of children grouped as at risk with scores of children considered to be typically developing. Validity of the questionnaire would be supported if significant differences in the total score on the Little DCDQ emerged between at risk children and typically developing children. Age group differences were also examined. Criterion-referenced, or concurrent, evidence of validity was evaluated for the sub-sample of children who received standardized motor testing by determining the differences between children with and without MI. Discriminant function analysis is used to predict a categorical dependent variable by one or more continuous independent variables, and in this case was used to determine the ability of questionnaire items to distinguish between children with and without MI. Relationship of the total score for Little DCDQ with other tests of motor coordination (MABC-2 and VMI) was assessed using a Pearson correlation.

To establish the validity of Little DCDQ as a screening tool, logistic regression modeling and receiver operating characteristic (ROC) curves were used to determine significant predictors of MI and optimal cut-off values. The Little DCDQ total score (a continuous variable) was used as the predictor in a logistic regression model that predicted a categorical status (MI vs. non-MI). Predicted probability scores were saved and plotted with MI/non-MI status to generate an ROC curve. The area under the ROC curve is best conceptualized as indicating test accuracy, since the closer the value to 1.0, the more accurate the test. The coordinate for the point on the ROC curve that maximizes sensitivity and specificity was then substituted back into the equation from the logistic regression model, and the equation was solved to obtain the best cut-off for Little DCDQ. Separate cut-offs were generated for boys and girls since gender was a significant predictor of the Little DCDQ total score.

RESULTS

Internal Consistency

Cronbach's alpha did not decrease significantly if any individual items were deleted, whether for the total sample (range 0.93 to 0.93), the AR group (range 0.93 to 0.94), or the TD group (range 0.90 to 0.91).

Test-retest Reliability

The ICC was 0.96 (95% Confidence Interval (CI): 0.82 to 0.98; $p < .001$), which indicates that the test-retest reliability was very high and statistically significant. Thus, parents rated their children very similarly on all items at each time point.

Construct Validity

Factor analysis using varimax rotation revealed two factors accounting for 61.4% of variance. Nine items which were clearly related to gross motor skills loaded on the first factor, while six items related to fine motor skills loaded on the second factor (Table 2).

To provide further evidence of construct validity, scores of children in the TD group were compared with those in the AR group. Significant group differences were found for total score on the Little DCDQ for full sample ($F_{(1, 351)} = 14.28$, $p < .001$, $\eta_p^2 = 0.04$), where η_p^2 is the effect size measured by partial η^2. Significant group differences were also found for 3-year-old ($F_{(1, 202)} = 10.39$, $p < .001$; $\eta_p^2 = 0.06$) and 4-year-old children ($F_{(1, 150)} = 4.23$, $p < .05$, $\eta_p^2 = 0.02$).

Age group differences were analyzed only for the TD group because children who are at risk may not function at an age-appropriate level and their data may therefore distort results. Since parents are asked to compare their children's motor function with other children of the same age/gender, it was expected that the child's age would not affect their scores on the Little DCDQ. As predicted, Pearson correlations ($n = 108$) between the child's age and scores were non-significant: fine

TABLE 2. Factor Loadings by Item

Item	Gross motor factor	Fine motor factor
1. Throw	0.8	
2. Catch	0.6	
3. Kick	0.7	
4. Run	0.8	
5. Move place	0.8	
6. Drinks		0.6
7. Cutlery		0.6
8. Pencil		0.7
9. Thread		0.8
10. Stickers		0.8
11. Building		0.8
12. Imitate	0.6	
13. Playground equipment	0.7	
14. Coordination	0.8	
15. Sits upright	0.6	

motor factor ($r = 0.01$; $p = .83$), gross motor factor ($r = 0.02$; $p = .76$), and total score ($r = 0.02$; $p = .69$).

Concurrent Validity

Assessment with a standardized motor test with a subgroup of children allowed full criterion referenced examination of concurrent validity. The MI group had significantly lower total Little DCDQ scores than the non-MI group ($F_{(1, 117)} = 25.60$, $p < .001$, with an effect size of $\eta_p^2 = 0.16$). Similarly, results showed significant group differences overall for the gross motor factor ($F_{(1, 114)} = 30.27$, $p < .001$, $\eta_p^2 = 0.18$), and for the fine motor factor ($F_{(1, 116)} = 21.02$, $p < .001$, $\eta_p^2 = 0.16$), with the MI group having higher scores (Table 3).

Results of discriminant function analysis with the sample that received motor testing ($n = 119$) indicated an overall significant model ($X^2_{(15)} = 38.02$, $p = .001$). The Little DCDQ item scores were significant predictors of the categorical group classification (MI and non-MI). All 15 items showed fair to good discrimination between children with and without MI, with structural coefficients > 0.3 (Table 4).

The Little DCDQ scores were significantly correlated with the scores for MABC-2 and Beery VMI with two exceptions (Table 5). Scores for the fine motor factor were not correlated with scores for aiming and catching, and scores for the gross motor factor were not correlated with the scores for VMI.

Cut-off Scores

Results of logistic regression revealed a significant overall model ($X^2_{(5)} = 25.87$, $p < .001$); lower total scores on the Little DCDQ significantly predicted MI ($p < .001$), as did being a boy ($p = .022$). Child's age was not a significant predictor ($p = .96$), and neither were peer problems ($p = .94$) nor hyperactivity/inattention ($p = .34$) as measured with the SDQ.

Receiver Operating Characteristic curves are presented in Figures 1 and 2. The *x*-axis represents the false positive rate (1-specificity) and the *y*-axis the true positive rate (sensitivity). Choosing a cut-off score of ≤67 for boys, the area under the

TABLE 3. Mean Little DCDQ Scores by Group, Age, and Gender ($n = 119$)

	Motor impairment				Non-motor impairment			
Variable	*n*	Little DCDQ total M (SD)	Gross motor factor M (SD)	Fine motor factor M (SD)	*n*	Little DCDQ total M (SD)	Gross motor factor M (SD)	Fine motor factor M (SD)
3-year-old children								
Boys	11	53.2 (8.9)	31.9 (5.8)	21.2 (4.8)	20	66.6 (6.8)	40.6 (3.9)	25.4 (3.3)
Girls	6	55.4 (10.7)	30.0 (7.1)	22.3 (3.6)	26	65.8 (9.9)	38.3 (7.5)	26.7 (4.1)
Total	17	53.9 (9.2)	31.4 (5.9)	21.5 (4.4)	46	66.2 (8.6)	39.3 (5.0)	26.5 (5.5)
4-year-old children								
Boys	10	56.1 (13.4)	32.2 (8.5)	21.2 (6.9)	18	68.6 (9.0)	39.7 (6.2)	26.2 (5.5)
Girls	5	56.8 (16.4)	35.0 (2.8)	23.7 (7.8)	23	64.3 (13.2)	39.2 (7.5)	26.2 (5.5)
Total	15	56.3 (13.9)	33.0 (7.2)	22.1 (6.8)	41	66.2 (11.6)	39.4 (6.9)	26.3 (5.1)
All children								
Boys	21	54.6 (11.1)	32.0 (6.5)	21.2 (5.4)	38	67.5 (7.9)	40.2 (5.0)	25.9 (3.9)
Girls	11	56.1 (13.1)	31.7 (6.2)	22.9 (5.2)	49	65.1 (11.5)	38.7 (6.5)	26.4 (4.8)
Total	32	55.1 (11.6)	31.9 (6.3)	21.7 (5.3)	87	66.2 (10.1)	39.3 (5.9)	26.2 (4.4)

TABLE 4. Discriminant Function Analysis

Item	Structural coefficients
2. Catch	0.8
3. Kick	0.7
12. Imitate	0.7
4. Run	0.7
10. Stickers	0.7
1. Throw	0.6
9. Thread	0.6
14 Coordination	0.5
8. Pencil	0.5
11. Building	0.5
7. Cutlery	0.4
5. Move place	0.4
15. Sits upright	0.4
6. Drinks	0.3
13. Playground equipment	0.3

curve is 0.81. Sensitivity is calculated to be 86% and specificity is 63%. For girls, using a cut-off score of ≤68, the area under the curve is 0.72, with 80% sensitivity and 49% specificity.

DISCUSSION

The development of a valid screening tool for motor coordination problems in preschoolers has the potential to facilitate earlier intervention and thus prevent secondary consequences of DCD. This report demonstrates the validity, reliability, and some of the psychometric properties of the Canadian version of Little DCDQ. Although there are other translations of this questionnaire and some versions have preliminary validation data with small sample sizes, this study represents the most thorough research with the largest sample size. The design has allowed the development of cut-off scores for the instrument. The initial psychometric evidence for the Hebrew version of Little DCDQ was promising (Rihtman et al., 2011) and this version is now compared with standardized testing using the specified criteria of MABC-2, which is considered a gold standard (Blank et al., 2012).

TABLE 5. Correlations of Little DCDQ Total and Factor Scores with the MABC-2 and Beery VMI Scores

	MABC-2				Beery VMI	
	Total impairment	Manual dexterity	Aiming & catching	Balance	VMI Integration	Motor coordination
Little DCDQ						
Total	0.3[a]	0.4[a]	0.2[b]	0.3[a]	0.2[b]	0.4[a]
Gross motor factor	0.4[a]	0.4[b]	0.3[a]	0.3[a]	0.2	0.3[a]
Fine motor factor	0.4[a]	0.4[a]	0.1	0.3[a]	0.3[a]	0.5[a]

[a]$p < .01$ (2-tailed); [b]$p < .05$ (2-tailed).

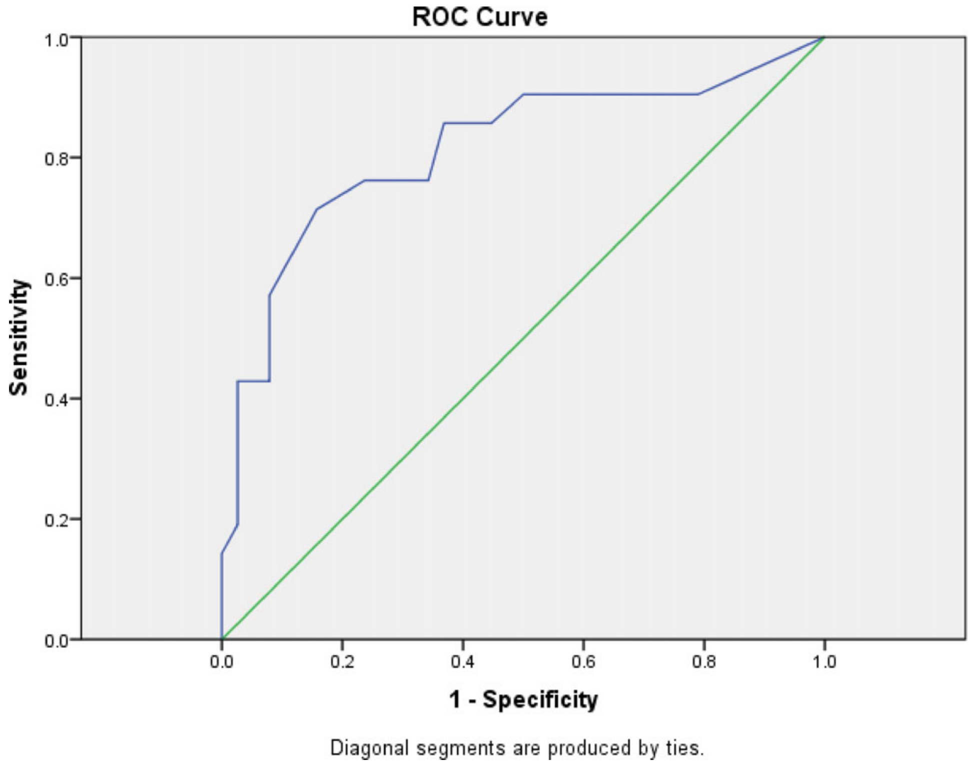

FIGURE 1. Canadian Little DCDQ: ROC curve for boys.

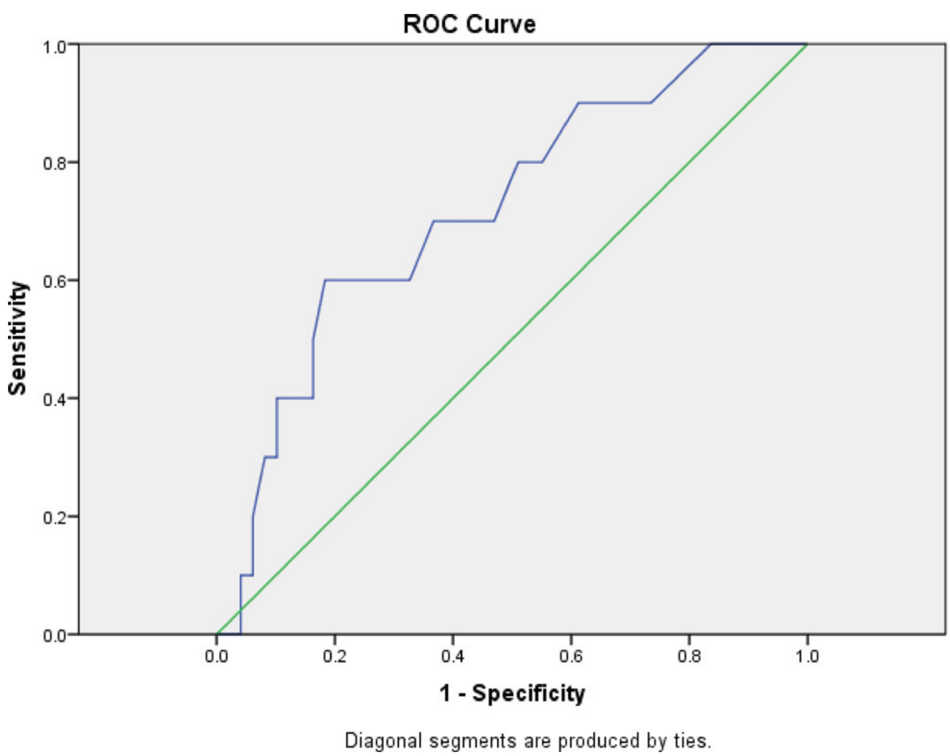

FIGURE 2. Canadian Little DCDQ ROC curve for girls.

Face validity of the Canadian version was carefully established by a large group of clinical experts. Homogeneity of items was confirmed by Cronbach's alpha, indicating that all of the items relate to one construct, motor coordination. Children's age did not affect their scores on the Little DCDQ, demonstrating that parents are able to report on their children's skills compared with other children of the same age. Test-retest reliability was very high and statistically significant, suggesting that the questionnaire is stable over time with children aged 3 and 4 years. Factor analysis revealed two factors: gross motor and fine motor, explaining over 60% of variance. All 15 items discriminated between groups of children who were typically developing or at risk of MI.

Validity was demonstrated in several ways, with the scores of children at risk for DCD differing significantly from the scores of children with typical development. There were also significant differences in the Little DCDQ scores between children who showed MI based on standardized testing and those who did not. This led to the creation of gender-specific cut-off scores which are good predictors of MI. Sensitivity ranged from 80% to 86% and specificity from 49% to 63%.

Sensitivity, or the ability of a questionnaire to identify true cases of DCD, has a required standard of 80% (American Psychiatric Association, 2013). For a screening test in which early diagnosis is beneficial, and when it is more desirable to identify all those at risk of having DCD, high sensitivity is preferable to higher specificity (Schoemaker et al., 2003). This is especially true for a condition such as DCD where the psychological consequences of a false positive result may be less than for a condition that carries a risk of mortality. The potential distress of false positives is minimized by confirmatory testing (Schoemaker and Wilson, 2014). Application of all DSM diagnostic criteria is required to make a proper diagnosis of DCD, and the Little DCDQ has a role in fulfilling some of these diagnostic criteria.

Use of the SDQ allowed examination of potential confounders related to known associations with DCD. Peer problems and hyperactivity/inattention, as measured by the SDQ, did not impact scores on the Little DCDQ, resulting in greater confidence in using the questionnaire as part of the diagnostic criteria for DCD.

The gender differences seen with the Little DCDQ are consistent with Rivard and colleagues' (2012) findings with DCDQ'07. In both population-based sample and clinical sample, they found that girls tended to score higher. This further supports the development of gender-specific scores for the Little DCDQ.

As the secondary consequences of DCD are significant if left untreated, the development of reliable and valid assessment tools has important clinical implications for the provision of adequate services for these children. Although parents identify problems at ages as young as 3 and 4 years (Chambers and Sugden, 2002), the condition is not commonly diagnosed prior the age of 5 years, which limits possibilities for providing essential early intervention (Majnemer, 1998) and for preventing unwanted secondary difficulties resulting from DCD (Missiuna et al., 2003). The instrument may be used for the screening of populations of children in multiple settings. The Little DCDQ offers valuable information about the performance of motor skills within the child's daily environment and takes into account performance across a period of time. The use of parent report also assists in parental education and can facilitate the family's acceptance of motor differences.

Limitations and Future Research

The sample size of 353 children was adequate to test psychometric attributes and to perform factor analysis; however, the sub-group whose motor skills were confirmed by testing comprised only 119 children. Although this is currently the largest study using standardized testing compared with the Little DCDQ, a larger sample size would strengthen the psychometric properties. It would be especially helpful to increase the sample size of girls with MI, where numbers were low.

The sample was recruited from only one city of Canada. Although 17 preschool sites were involved, a normative stratified sample was not recruited. This may limit the generalizability of results. Although specificity did not reach the standard 80% (American Psychiatric Association, 2013), values are comparable with other studies of questionnaires in clinical DCD populations. Schoemaker and Wilson (2014) found that in the five studies of parent reports, sensitivity ranged from 38% to 86% and specificity from 71% to 90%. In the three studies of teacher-based reports, the range of sensitivity was 62% to 81%, and specificity ranged from 62% to 93%. The predictive values of the Little DCDQ are comparable. Future research may examine the utility of teacher observations in comparison with parent report.

Notwithstanding these limitations, the Little DCDQ provides important information about functional motor abilities of children at home, play, and preschool. It complements the identification process to ascertain that the diagnostic criteria have been met. Future longitudinal studies will provide important insight into the relationship between the Little DCDQ and the actual diagnosis of DCD at school age.

Implications of Therapy Practice

Early identification of children at risk of DCD has important clinical implications for provision of adequate services and prevention of secondary consequences for preschool children. However, administering motor tests is time-consuming, costly, and not suitable for screening large numbers of children. Questionnaires can be a first step in the identification process, as they are relatively inexpensive, fast, and easy to administer. Questionnaires are also useful to obtain information about performance of day-to-day motor skills across a longer timeframe. The Little DCDQ measures functional skills in several contextual areas across home and preschool environments and during play activities. The Little DCDQ is a reliable and valid instrument with a potential to aid in the early identification of children with motor coordination difficulties.

CONCLUSIONS

The development of a parent questionnaire for use with preschool children will provide clinicians and researchers with a means to screen younger children at risk of DCD and facilitate earlier identification, which may lead to more timely intervention and better support for these children. The results indicate that the Little DCDQ meets many of the standards for reliability and validity. In addition to the clinical benefits of a sound screening tool to identify the risk of DCD in young preschoolers, there is also research potential for a wider scope of longitudinal studies in this population. The questionnaire with cut-off scores will be available in 2014 at www.dcdq.ca.

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