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# Motor ability and weight status are determinants of out-of-school activity participation for children with developmental coordination disorder

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**Abstract**
According to the International Classification of Functioning, Disability and Health model endorsed by the World Health Organization, participation in everyday activities is integral to normal child development. However, little is known about the influence of motor ability and weight status on physical activity participation in children with developmental coordination disorder (DCD). This study aimed to (1) compare motor performance, weight status and pattern of out-of-school activity participation between children with DCD and those without; and (2) identify whether motor ability and weight status were determinants of participation patterns among children with DCD. We enrolled 81 children with DCD (boys, n=63; girls, n=18; mean age, 8.07±1.5 years) and 67 typically developing children (boys, n=48; girls, n=19; mean age, 8.25±1.6 years). Participation patterns (diversity, intensity, companionship, location, and enjoyment) were evaluated with the Children Assessment of Participation and Enjoyment. Motor ability was evaluated with the Movement Assessment Battery for Children, second edition (MABC-2). Other factors that may influence participation such as age, gender, and body weight were also recorded. Analysis of variance was used to compare outcome variables of the two groups, and significant determinants of activity participation were identified by multiple regression analysis. Children with DCD participated in fewer activities (i.e., limited participation diversity) and participated less frequently (i.e., limited participation intensity) than their typically developing peers; however, companionship, location of participation, and enjoyment level did not differ between the two groups. Children in the DCD group demonstrated significantly worse motor ability as assessed by the MABC-2. Further, a greater proportion of children in the DCD group were in the overweight/obese category compared with their typically developing peers. After accounting for the effects of age and gender, motor ability and weight category explained 7.6% and 5.0% of the variance in participation diversity, respectively, for children with DCD. Children with DCD showed less diverse and less intense out-of-school activity participation than typically developing children. Motor impairment and weight status were independently associated with the lower participation diversity. Interventions aiming at improving participation for children with DCD should target weight control and training in motor proficiency. Further study is needed to identify other factors that may hinder participation in this group of children.

**Keywords:**
Developmental Coordination Disorder
Participation
Motor ability
Overweight
Rehabilitation

## 1. Introduction

Based on the International Classification of Functioning, Disability and Health (ICF) model, participation in everyday activities and a variety of life situations is integral to normal child development and positively influences health, quality of life, and future life outcomes (Mandich, Polatajko, & Rodger, 2003; WHO, 2001). However, children with developmental coordination disorder (DCD) have motor difficulties that often restrict their ability to participate in typical activities of daily living (Jarus, Lourie-Gelberg, Engel-Yeger, & Bart, 2011).

DCD is a well-known motor-based problem that affects approximately 6% of children of primary school age (APA, 2000). Common symptoms include marked delays in achieving motor milestones, clumsiness, and poor balance, coordination, and handwriting (APA, 2000; Cermak & Larkin, 2002). These motor impairments also significantly interfere with the child's academic achievements and activities of daily living. DCD is diagnosed when these impairments cannot be explained by any medical or intellectual conditions (APA, 2000). Although enrolled in regular classrooms, children with DCD often experience difficulty participating in typical childhood activities and thus are more sedentary (Mandich et al., 2003).

A number of studies have examined participation patterns of children with DCD, but important domains such as skill-based and recreational activities have not been assessed (Cairney, Hay, Faught, Wade, et al., 2005; Cermak & Larkin, 2002; Chen & Cohn, 2003; Green et al., 2011; Mandich et al., 2003; Poulsen, Ziviani, & Cuskelly, 2006; Poulsen, Ziviani, & Cuskelly, 2007). Moreover, only one recent study by Jarus et al. (2011) used standardized measures to assess participation in a wide range of out-of-school activities among school-age children with and without DCD. In their study, children with DCD showed limited participation diversity, in which they participated less frequently and chose activities that were quieter and more socially isolating compared with children without DCD (Jarus et al., 2011). However, this study included only children aged 5 to 7 years old. Studies with larger sample sizes and a wider age range are needed to more accurately detect differences in participation patterns between primary school-aged children with and without DCD.

According to the ICF model, many factors influence the participation level of an individual. These include personal factors (e.g. age, gender), environmental factors (e.g. family support), and physiologic impairments (e.g. motor deficits). To develop effective interventions for children with DCD, a better understanding of their participation patterns and the determinants of participation are needed. Previous studies have attempted to identify the clinical correlates of participation in children with DCD. Jarus et al. (2011) identified a positive relationship between motor ability and participation patterns in children with DCD; however, multivariate analysis could not be performed because of the relatively small sample size (n=25). Therefore, the effects of potentially confounding variables (e.g. gender) were not taken into account. Previous research demonstrated that boys and girls tend to participate in different types of activities (Bult, Verschuren, Jongmans, Lindeman, & Ketelaar, 2001); therefore, it is important to use a larger sample size and take covariates into account when evaluating the relationship between motor ability and participation patterns in children with DCD.

Another important correlate of activity participation may be related to weight status. Because of deficits in physical functioning (Cairney, Hay, Faught, Wade, et al., 2005; Poulsen, Ziviani, & Cuskelly, 2008) and psychosocial functioning (i.e., low self-esteem, perceived competency) (Cermak & Larkin, 2002), children with DCD may be less inclined to

participate in physical activities (Cairney, Hay, Faught, Wade, et al., 2005; Cermak & Larkin, 2002; Poulsen et al. 2008). This lower activity level may predispose children with DCD to obesity and cardiovascular disease. Indeed, children with DCD were found to have increased body fat and poor cardiorespiratory fitness (Cairney et al., 2007; Cairney, Hay, Faught, & Hawes 2005; Cairney, Hay, Veldhuizen, & Faught, 2010a; Cermak & Larkin, 2002; Faught, Hay, Cairney, & Flouris, 2005). A vicious circle of further physical deconditioning, increased body weight, and motor deficits may ensue. However, no study has yet examined the association between activity participation and weight status in children with DCD.

The objectives of this study were to (1) compare motor performance, weight status, and pattern of out-of-school activity participation between children with and without DCD; and (2) determine whether motor ability and weight status are associated with activity participation diversity among children with DCD.

## 2. Methods

### *2.1. Study design*

This was a cross-sectional exploratory study.

### *2.2. Participants*

Sample size calculations were based on a statistical power of 0.80 and alpha of 0.05 (two-tailed). According to Jarus et al. (2011), the Movement Assessment Battery for Children, second edition (MABC-2) percentile rank was 2.6 (standard deviation [SD]=1.84) for the DCD group (n=25) and 49.96 (SD=26.63) for the control group (n=25), which translates into a large effect size (2.51). For the Children's Assessment of Participation and Enjoyment (CAPE) total activity diversity and intensity scores, the effect sizes were medium to large (0.74–0.80). Therefore, assuming a medium to large effect size (0.74) and power of 0.80, the minimum sample size needed to detect a significant between-group difference in outcomes (objective 1) is 30 for each group (children with DCD and controls) (Portney & Watkins, 2009). Regarding the regression analysis (objective 2), Jarus et al. (2011) reported that the MABC-2 percentile showed fair to good correlation with various activity participation scores (r=0.29–0.64) among children with DCD. Therefore, a minimum sample size of 65 for the DCD group would be required for multiple regression analysis with four predictors and an effect size of 0.20 (medium to large) (Portney & Watkins, 2009).

Children with DCD were recruited from a local hospital and the Child Assessment Centre, which is a major institution that provides assessment services for children in Hong Kong, by convenience sampling. A formal diagnosis of DCD was made by an interdisciplinary team at the Child Assessment Centre according to criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) (APA, 2000). To warrant a DCD diagnosis, the child had to demonstrate motor coordination substantially below that of the child's age (i.e., gross motor composite score <42 as measured by the Bruininks-Oseretsky Test of Motor Proficiency) (Bruininks, 1978) that interfered with the child's academic performance and ability to carry out activities of daily living. Other inclusion criteria were neurological screening performed by a paediatrician to rule out other causes of motor deficits; age 6 to 12 years; enrolled in a regular classroom; and no intellectual impairment. Exclusion criteria were a formal diagnosis of emotional, neurologic, or other movement disorders; and significant musculoskeletal or cardiopulmonary conditions that could influence motor performance. As controls, children with normal development were recruited from the

community on a volunteer basis. They were subject to the same inclusion and exclusion criteria set for the DCD group, except that they did not have any history of DCD.

*2.3. Procedures*

Approval was obtained from the human subjects ethics review subcommittee of the Hong Kong Polytechnic University and the Hospital Authority. The study was explained to all children and their guardians, and written informed consent was obtained. All data collection was performed by two experienced paediatric physical therapists. The procedures were conducted in accordance with the Declaration of Helsinki.

*2.3.1. Demographic information*

Basic demographic information was obtained by interviewing the children and their guardians. Relevant information such as medical history was also obtained. Height and weight of the participants were measured, and body mass index (BMI, $kg/m^2$) was calculated. The percentile value of BMI was used to define overweight and obesity using results of a local study conducted by Ng, Lam, Kwok, & Chow (2004), which set the cut-off values for obesity and overweight as the 97th and 90th percentiles, respectively, for Hong Kong children.

*2.3.2. Motor ability*

The MABC-2 is a standardized tool used to measure motor performance of children in three age ranges: 3 to 6 years, 7 to 10 years, and 11 to 16 years. The assessment consists of eight tasks that are divided into three domains: manual dexterity, aiming and catching, and balance. The raw score of each item was converted into the item standard score, and the component score, standard score, and percentile of each domain were derived from the item standard scores. In addition, the total test score, standard score, and percentile rank were derived. The percentile rank, which indicates the percentage of children in the standardization sample who obtained a score less than or equal to a given raw score, was used for analysis in this study (Henderson, Sugden, & Barnett, 2007). A score at or below the 5th percentile indicates significant motor difficulty; a score between the 6th to 15th percentiles indicates borderline motor difficulty that requires monitoring; and a score at or above the 16th percentile is regarded as normal (Henderson et al., 2007). MABC-2, which is commonly used to identify children with DCD, has demonstrated good test-retest reliability, inter-rater reliability, and criterion-related validity (Henderson et al., 2007).

*2.3.3. Out-of-School time activity participation*

The Children's Assessment of Participation and Enjoyment (CAPE) is a reliable and valid self-report measure of participation in outside school activities for children and youth aged 6 to 21 years (Imms, 2008). This tool was validated with 427 children (6–15 years old) with physical disabilities. Results demonstrated sufficient internal consistency, content validity, construct validity, and good test-retest reliability (King et al., 2006). This questionnaire includes both formal domains (more structured activities that require planning) and informal domains (less structured activities that require less planning), and five activity types, namely recreational, physical, social, skill-based, and self-improvement activities. The physical and skill-based activities generally require specific physical abilities, whereas the recreational, skill-based, and self-improvement activities involve skills that are transferable across the lifespan and are more important for lifelong participation. The 55 specific activities

assessed with CAPE are presented in Appendix. CAPE quantifies the level of participation according to five dimensions: diversity, intensity, location, companionship, and enjoyment. The participation diversity score is a count of the activities in which the child has participated over the previous 4 months. Participation intensity is calculated by dividing the sum of item frequency by the number of possible activities in each activity type. The intensity score indicates participation frequency for a set of activities. Location of participation is scored on a 6-point scale: 1=at home, 2=at a relative's home, 3=in the neighbourhood, 4=at school but not during class, 5=in the community and 6=beyond the community. Median scores were determined for each activity type, with low scores indicating participation closer to home and higher scores indicating more community-based participation. Companionship (participation with others) was scored on a 5-point scale (1=alone, 2=with family members, 3=with other relatives, 4=with friends, and 5=with other types or multiple types of people). Median scores were calculated, with lower scores indicating more solitary activities, and higher scores indicating more social engagement. Enjoyment was also measured on a 5-point scale ranging from 1 (not at all) to 5 (love it) (King et al., 2004).

An interview was conducted with each subject and guardian (face to face or by telephone) to complete the CAPE assessment. Participation in each of the 55 activities during the previous 4 months was recorded. The children were also given the opportunity to add other activities not specified in the CAPE.

*2.4. Statistical analysis*

Data analysis was performed using SPSS 17.0 (SPSS Inc., Chicago, IL, USA). A significance level of 0.05 (2-tailed) was adopted for all statistical tests. Descriptive statistics were used to describe all relevant variables. Normality of data was checked using the Kolmogorov-Smirnov test. Continuous variables (i.e., age, height, weight, BMI) were compared by independent *t*-test, and categorical demographic variables (i.e., gender, weight category) were compared by chi-square test.

Multivariate analysis of covariance (MANCOVA) was used to compare MABC-2 total percentile rank and CAPE scores of the seven types of activity (i.e., informal, formal, recreational, physical, social, skill-based, and self-improvement) between groups, with BMI as the covariate. The total diversity, intensity, companionship, location, and enjoyment scores were also compared by MANCOVA. These analyses were repeated after separating data collected from boys from that of girls. Results from these analyses showed the effects of group on all corresponding outcomes simultaneously and Bonferroni adjusted p-values to avoid an inflated type I error rates associated with multiple comparisons.

Pearson's correlation coefficients (for continuous variables) or Spearman's rho (for ordinal variables) were used to examine bivariate relationships between CAPE and MABC-2 scores and other variables among children with DCD. Multiple regression analyses were then performed to identify physical parameters that were predictors of CAPE total diversity score. Selection of predictor variables for regression analysis was based on both biological relevance and results of the bivariate correlation analysis. Age and gender were first entered into the regression model, as these factors may influence activity participation (Bult et al., 2011; Cairney, Hay, Veldhuizen, Missiuna, & Faught, 2010; Green et al., 2011). MABC-2 total percentile rank or weight category (ideal weight vs. overweight/obese) was then entered into the regression model. To avoid multicollinearity, the degree of association among the potential independent variables was checked.

## 3. Results

### *3.1. Demographic characteristics and motor performance*

Demographic characteristics and motor abilities of the DCD group (n=81) and control group (n=67) are outlined in Table 1. The mean age and gender ratios of the two groups did not differ ($p>0.30$); however, significant between-group differences were found in BMI, weight, and motor performance (MABC-2 percentile rank) ($p<0.05$). Gender-specific analysis also revealed significant between-group differences in weight category and motor performance (Table 1).

### *3.2. Diversity of participation*

MANCOVA results revealed a significant overall difference between the two groups in participation diversity, as reflected by the CAPE total diversity score (Table 2). Significant between-group differences were still detected when the data for boys and girls were analyzed separately. Analysis of activity categories showed that children with DCD participated in fewer informal, physical, social, skill-based, and self-improvement activities than their peers with normal development ($p<0.05$), but participation in formal and recreational activities did not differ between groups (Table 2).

### *3.3. Intensity of participation*

Children with DCD had significantly lower CAPE total participation intensity scores compared with children in the control group; however, results were similar when gender was taken into account. Further analysis revealed that children with DCD participated less frequently in all categories (i.e., informal, formal, recreational, physical, social, skill-based, and self-improvement activities) (Table 2).

### *3.4. Companionship during participation*

Companionship measures did not differ significantly between the two groups (Table 2).

### *3.5. Location of participation*

Location of participation differed between the two groups for recreational activities only. Children with DCD were more likely than children in the control group to participate in recreational activities that were far away from their home ($p<0.05$) (Table 2).

### *3.6. Enjoyment of participation*

Enjoyment measure scores did not differ significantly between the two groups. Both groups of children enjoyed “pretty much” or “very much” the activities in which they participated (Table 2).

### *3.7. Relationships among demographic characteristics, motor ability, and participation pattern in children with DCD*

Because only the total diversity and intensity scores differed significantly between groups, we focused on these two aspects of participation in the subsequent correlation and regression analysis. We did not split the DCD and control groups into gender subgroups in this analysis because the MANCOVA results revealed that boys and girls had similar patterns of participation (total diversity and intensity scores) (Table 2). We found that motor ability (MABC-2 percentile rank) was positively correlated with CAPE total diversity score in

children with DCD (r=0.264, p=0.017). Specifically, motor ability was fairly correlated with participation diversity in formal (r=0.291, p=0.008), recreational (r=0.249, p=0.025), and skill-based activities (r=0.235, p=0.035), suggesting that the children with DCD who had higher motor competence participated in a greater variety of formal, recreational, and skill-based activities. Motor ability was not associated with the CAPE total intensity score (p>0.05).

We also found that weight status category correlated with total CAPE diversity score (ρ=-0.227, p=0.041) and recreational activity diversity score (ρ=-0.224, p=0.044), indicating that overweight children tended to participate in fewer activities, particularly recreational activities. In contrast, weight category did not correlate with intensity of participation.

*3.8. Determinants of diversity of activity participation in children with DCD*

The variables that were significantly associated with diversity of activity participation in bivariate correlation analysis were used in subsequent multiple regression analyses for predicting CAPE total diversity score. Hierarchical multiple regression analysis was performed to identify the determinants of the total CAPE diversity score. After adjusting for age and gender, adding motor ability to the regression model accounted for 7.6% of the variance in the total CAPE diversity score ($F_{change1,77}$=6.326, p=0.014) (Table 3). Addition of weight status category explained another 5.0% of the variance in activity participation diversity ($F_{change1,76}$=4.344, p=0.040). The regression model overall explained a total of 12.8% of the variance in activity participation diversity, with motor ability and weight status category being significant determinants ($F_{(4,76)}$=2.793, p=0.032,) (p<0.05).

## 4. Discussion

*4.1. Differential participation patterns of children with and without DCD*

This study revealed that children with DCD participated in fewer activities than their typically developing peers. This difference was observed regardless of gender, particularly in informal, physical, social, skill-based, and self-improvement activities, which is consistent with findings from previous studies (Cairney, Hay, Faught, Wade, et al., 2005b; Chen & Cohn, 2003; Jarus et al., 2011; Mandich et al., 2003; Poulsen et al., 2006 & Poulsen, Ziviani, & Cuskelly, 2007). For example, Jarus et al. (2011) reported that children with DCD (n=25) participated in fewer physical, skill-based, informal, and total activities, as assessed by CAPE, compared with children without DCD (n=25). Although the participation diversity of social and self-improvement activities did not differ significantly between the two groups, the partial eta square ($\eta^2_p$) values were 0.06 to 0.08, which indicate moderate effect sizes. The nonsignificant between-group differences in these activity categories was likely due to the reduced statistical power related to the smaller sample size in their study compared with ours (81 and 67 children in DCD and control groups, respectively).

Consistent with the results reported by Jarus et al. (2011), we found that participation diversity in formal and recreational activities was similar between children with DCD and typically developing children, perhaps because these structured, nonphysical activities do not expose the children's motor deficits (Engel-Yeger & Kasis, 2010). However, the participation intensity of children with DCD was far lower than typically developing children. In fact, children with DCD participated less intensely in all activities (informal, formal, recreational, physical, social, skill-based and self-improvement activities) compared with children without DCD. Jarus et al. (2011) also reported that children with DCD showed lower intensity of participation in most types of CAPE activity (p<0.05 or $\eta^2_p$ ranging from 0.05 to 0.16). A

possible explanation for this finding may be that children with less efficient movement patterns expend more energy and therefore fatigue faster (Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006).

Self-perception of enjoyment is important because it is associated with decisions concerning whether to continue to participate in activities (Cairney et al. 2007). We found that both group of children "pretty much" or "very much" enjoyed the activities in which they participated. Although children with DCD participated in fewer activities and the level of engagement was lower, they still enjoyed participating in the activities they selected. This finding is consistent with that of Jarus et al. (2011). In contrast, younger children with DCD (4–6 years old) and their parents reported a lower level of enjoyment while participating in play, leisure, social, and educational activities (Bart, Jarus, Erez, & Rosenberg, 2011). These findings suggest that older children with DCD (6–12 years old in our study and 5–7 years old in the study of Jarus et al.) may choose activities in which they have a higher likelihood of success and enjoyment based on their past experience. It is therefore important to encourage children's enjoyment of a variety of activities starting at a very young age.

Although previous studies (Jarus et al., 2011; Poulsen, Ziviani, Cuskelly, & Smith, 2007) reported that children with DCD felt a sense of loneliness and tended to engage in solitary activities, we found that children with and without DCD demonstrated similar patterns of companionship or participation with other people. In contrast, the children in our DCD group tended to participate in activities with family members or relatives, similar to the controls. The discrepancy in results between studies might be explained by cultural and parental influences. Since western cultures emphasize on independence of the child while Asian cultures emphasize on parental warmth (Kim & Wong, 2002; Rubin & Stewart, 1996). The parents in this study may thus be more inclined to accompany their children in the outside school activities. Further research should consider the role of culture and parenting style in determining participation companions.

We found that activity locations were also similar between the two groups. Children with DCD might even travel further to participate in recreational activities that are suited to their needs and interests. This information is encouraging because it suggests that children with DCD do not experience limited community access.

*4.2. Determinants of participation diversity in children with DCD*

Consistent with the findings of Jarus et al. (2011), who reported that motor ability (MABC-2 percentile) was positively correlated with CAPE participation diversity, our study confirmed that motor proficiency was a significant determinant of activity participation diversity in children with DCD. This factor accounted for 7.6% of the variance in activity participation diversity after controlling for age and gender. Children with lower MABC-2 percentile ranks participate in fewer types of activities. Previous studies in children aged 8 to 10 years also found that motor proficiency, as determined by the Bruininks-Oseretsky Test of Motor Proficiency Short Form, explained 8.7% of the variance in physical activity (Wrotniak et al., 2006). A possible explanation for these findings is that children with greater motor proficiency (close to 15th percentile in MABC-2) are better at activating and sequencing movement patterns in formal, recreational, and skill-based tasks and may therefore have more opportunities to participate in varied activities (Wrotniak et al., 2006). In addition, children with higher motor proficiency may have higher self-efficacy (Cairney, Hay, Faught, Wade, et al., 2005), perceived freedom in leisure activity (Poulsen, Ziviani, & Cuskelly, 2007), and enjoyment during activities (Cairney et al., 2007). They may therefore choose to participate

in a wider range of activities compared with other children with DCD. In contrast, children with DCD with very low motor ability may participate in fewer activities, including physical activities (Cairney, Hay, Faught, Wade, et al., 2005; Cairney, Hay, Veldhuizen, Missiuna, et al., 2010; Chen & Cohn 2003; Engel-Yeger & Kasis 2010; Green et al., 2011; Jarus et al., 2011; Mandich et al., 2003; Poulsen et al., 2008; Wrotniak et al., 2006), further decreasing opportunities to practise skills and leading to activity deficits and a developmental skill-learning gap (Wall, 2004).

Similar to previous studies (Cairney et al., 2007; Cairney, Hay, Faught, & Hawes, 2005; Faught et al., 2005), we found that a higher proportion of children with DCD tended to be overweight/obese than children without the disorder. Further, weight status category was a significant determinant of activity participation diversity in this group of children. Being overweight or obese may make it more difficult for children with DCD to participate in activities (especially recreational activities), due to reduced physical fitness and the social stigma associated with obesity (Puhl & Latner, 2007). Reduced activity, in turn, may further increase body fat and increase the risk of coronary vascular disease, thus triggering a vicious cycle of inactivity and deterioration of health (Faught et al., 2005). Thus inclusion of various activities, including physical activities, is necessary to prevent disease and enhance overall health in children with DCD. However, motivating overweight children with DCD to participate in different types of activity may be a challenge. Previous studies have provided insight into psychological factors affecting activity participation in this group of children. Cairney and colleagues (2005 & 2007) suggested that lower self-efficacy largely (28%) accounts for inactivity in children with DCD, whereas body fat explained only a small proportion (5.7%) of the variance in participation in the present study. Clinicians may consider developing separate exercise classes for children with DCD (e.g. aerobic exercise classes) to avoid ridicule from typically developing children, improve self-efficacy, provide motivation to participate in other activities (Cermak & Larkin, 2002), and improve physical fitness.

### *4.3. Clinical implication*

Motor impairments and overweight/obesity experienced by children with DCD limit activity participation, which in turn may affect the health and well being of these children (Mandich et al., 2003). Interventions should aim to prevent the vicious circle of activity avoidance, poor motor performance and physical fitness, and decreased participation in all activities. Interventions for children with poor motor ability and physical fitness should be made available in the community and after-school facilities along with more opportunities to participate in a variety of activities. In addition, the activity or training intensity must be sufficient to improve the children's health.

### *4.4. Limitations and consideration for future studies*

Some limitations of this study need to be addressed in future work. First, these data are cross-sectional and causal inferences based on the results can be made but not tested. Second, our regression model accounted for only 12.8% of the variance in activity participation. Many other personal, familial, and environmental factors are associated with children's activity participation diversity (e.g. children's communication skills and social competence, leisure interests and preferences, family circumstances, socioeconomic backgrounds, and environment setting) (Jarus et al., 2011; King et al., 2006). These factors should also be examined in future studies.

## 5. Conclusions

This study shows that out-of-school activity participation in primary school-aged children with DCD is less diverse and intense than that of typically developing children, regardless of gender. Motor impairment and weight status are significantly associated with the deficit in participation diversity in this group of children. Interventions directed at improving participation for children with DCD should target training on motor proficiency and weight control. Further study is needed to identify other factors that hinder participation in this group of children.

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**Table 1. Demographic characteristics and motor ability of the participants.**

| | DCD group [Mean (SD)] | | | Control group [Mean (SD)] | | |
|---|---|---|---|---|---|---|
| | **All (n=81)** | **Male (n=63)** | **Female (n=18)** | **All (n=67)** | **Male (n=48)** | **Female (n=19)** |
| **Age, years** | 8.07 (1.49) | 8.06 (1.52) | 8.11 (1.41) | 8.25 (1.60) | 8.38 (1.63) | 7.95 (1.51) |
| **Gender (boys/girls), n** | 63/18 | | | 48/19 | | |
| **Height, cm** | 130.53 (11.87) | 131.07 (12.11) | 128.64 (11.13) | 129.87 (10.41) | 130.82 (10.58) | 127.45 (9.81) |
| **Weight, kg** | 33.09 (11.55) | 33.23 (11.26) | 32.63 (12.87) | 30.33 (8.69) | 31.04 (9.21) | 28.53 (7.11) |
| **Body mass index, kg/m$^2$** | 18.85 (3.72)[a] | 18.76 (3.23) | 19.13 (5.21) | 17.65 (2.97) | 17.77 (3.15) | 17.35 (2.51) |
| **Overweight and obese, n** | 24[c] | 18[b] | 6[a] | 5 | 4 | 1 |
| **MABC-2 total percentile rank** | 11.55 (14.79) [c] | 10.85 (14.03)[c] | 14.03 (17.42)[c] | 46.36 (24.54) | 47.94 (26.04) | 42.37 (20.36) |
| **Co-morbidity:** | | | | | | |
| **Attention deficit hyperactivity disorder, n** | 9 | 7 | 2 | 0 | 0 | 0 |
| **Attention deficit disorder, n** | 9 | 7 | 2 | 0 | 0 | 0 |
| **Dyslexia, n** | 9 | 9 | 0 | 0 | 0 | 0 |
| **Asperger syndrome, n** | 5 | 5 | 0 | 0 | 0 | 0 |
| **Autism spectrum disorders, n** | 1 | 1 | 0 | 0 | 0 | 0 |

[a] $p \leq 0.05$.

[b] $p \leq 0.01$.

[c] $p \leq 0.001$.

**Table 2. Differential participation patterns in children with and without DCD.**

| Outcome | DCD group [Mean (SD)] | | | Control group [Mean (SD)] | | |
|---|---|---|---|---|---|---|
| | **All (n=81)** | **Male (n=63)** | **Female (n=18)** | **All (n=67)** | **Male (n=48)** | **Female (n=19)** |
| **Total activities** | | | | | | |
| Total diversity score | 23.40 (6.74)[c] | 23.57 (7.05)[a] | 22.78 (5.64)[b] | 27.94 (4.99) | 27.23 (5.12) | 29.74 (4.25) |
| Total intensity score | 108.37 | 109.27 (30.10)[b] | 105.22 (23.49)[c] | 133.76 (26.61) | 129.10 (27.11) | 145.53 (21.74) |
| Total companionship score | 2.40 (0.37) | 2.39 (0.38) | 2.41 (0.35) | 2.45 (0.30) | 2.38 (0.27) | 2.64 (0.32) |
| Total location score | 2.90 (0.42) | 2.92 (0.43) | 2.83 (0.35) | 2.91 (0.52) | 2.91 (0.58) | 2.91 (0.30) |
| Total enjoyment score | 3.76 (0.36) | 3.72 (0.37) | 3.89 (0.33) | 3.78 (0.35) | 3.73 (0.36) | 3.92 (0.28) |
| **Informal activities** | | | | | | |
| Diversity score | 18.88 (5.23)[c] | 18.97 (5.38)[b] | 18.56 (4.82)[a] | 22.37 (4.06) | 22.13 (4.34) | 23.00 (3.28) |
| Intensity score | 2.17 (0.56)[c] | 2.18 (0.58)[a] | 2.13 (0.50)[c] | 2.64 (0.52) | 2.58 (0.55) | 2.78 (0.41) |
| Companionship score | 2.05 (0.31) | 2.04 (0.31) | 2.08 (0.32) | 2.11 (0.28) | 2.06 (0.25) | 2.22 (0.32) |
| Location score | 2.58 (0.43) | 2.61 (0.44) | 2.51 (0.39) | 2.54 (0.36) | 2.54 (0.34) | 2.54 (0.43) |
| Enjoyment score | 3.81 (0.38) | 3.77 (0.38) | 3.97 (0.35) | 3.83 (0.35) | 3.76 (0.36) | 3.98 (0.28) |
| **Formal activities** | | | | | | |
| Diversity score | 4.53 (2.23) | 4.62 (2.41) | 4.22 (1.44)[c] | 5.57 (1.92) | 5.13 (1.90) | 6.68 (1.53) |
| Intensity score | 1.42 (0.68)[b] | 1.45 (0.73) | 1.34 (0.48)[c] | 1.88 (0.71) | 1.72 (0.67) | 2.29 (0.65) |
| Companionship score | 3.77 (1.07) | 3.76 (1.07) | 3.79 (1.12) | 3.83 (0.74) | 3.73 (0.77) | 4.08 (0.63) |
| Location score | 4.18 (0.75) | 4.24 (0.76) | 3.97 (0.65) | 4.12 (0.57) | 4.13 (0.59) | 4.10 (0.50) |
| Enjoyment score | 3.59 (0.84) | 3.60 (0.91) | 3.58 (0.56) | 3.64 (0.57) | 3.60 (0.63) | 3.74 (0.38) |
| **Recreational activities** | | | | | | |
| Diversity score | 7.22 (2.25) | 7.29 (2.22) | 7.00 (2.40) | 8.01 (1.67) | 8.10 (1.77) | 7.79 (1.40) |
| Intensity score | 3.08 (0.98)[a] | 3.09 (1.00)[a] | 3.03 (0.90) | 3.55 (0.86) | 3.59 (0.92) | 3.48 (0.67) |
| Companionship score | 1.84 (0.42) | 1.84 (0.45) | 1.85 (0.29) | 1.86 (0.44) | 1.78 (0.36) | 2.08 (0.53) |
| Location score | 1.89 (0.65)[b] | 1.92 (0.69)[a] | 1.76 (0.47) | 1.72 (0.44) | 1.71 (0.47) | 1.74 (0.38) |
| Enjoyment score | 4.04 (0.46) | 3.99 (0.46) | 4.22 (0.43) | 4.01 (0.41) | 4.00 (0.42) | 4.04 (0.37) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Physical activities** | | | | | | |
| Diversity score | 3.20 (1.96)[a] | 3.32 (1.99) | 2.78 (1.86)[a] | 4.13 (1.61) | 3.92 (1.61) | 4.68 (1.53) |
| Intensity score | 1.05 (0.68)[a] | 1.09 (0.71) | 0.92 (0.59)[a] | 1.43 (0.68) | 1.37 (0.71) | 1.57 (0.59) |
| Companionship score | 3.13 (1.33) | 3.11 (1.29) | 3.19 (1.51) | 3.06 (0.85) | 3.01 (0.90) | 3.19 (0.72) |
| Location score | 4.17 (1.29) | 4.28 (1.21) | 3.74 (1.52) | 4.09 (0.76) | 4.14 (0.76) | 3.97 (0.75) |
| Enjoyment score | 3.64 (1.12) | 3.70 (1.02) | 3.45 (1.45) | 3.89 (0.61) | 3.90 (0.66) | 3.85 (0.48) |
| **Social activities** | | | | | | |
| Diversity score | 4.93 (2.14)[b] | 4.92 (2.19)[a] | 4.94 (2.04)[a] | 6.16 (1.64) | 6.06 (1.77) | 6.42 (1.26) |
| Intensity score | 1.74 (0.88)[b] | 1.75 (0.92) | 1.68 (0.79)[c] | 2.22 (0.77) | 2.06 (0.79) | 2.62 (0.56) |
| Companionship score | 2.46 (0.53) | 2.46 (0.52) | 2.49 (0.61) | 2.57 (0.41) | 2.55 (0.41) | 2.64 (0.43) |
| Location score | 3.10 (0.87) | 3.14 (0.91) | 2.96 (0.72) | 3.09 (0.63) | 3.10 (0.63) | 3.07 (0.65) |
| Enjoyment score | 3.80 (0.65) | 3.76 (0.66) | 3.99 (0.62) | 3.94 (0.49) | 3.86 (0.50) | 4.15 (0.40) |
| **Skill-based activities** | | | | | | |
| Diversity score | 2.64 (1.60)[a] | 2.59 (1.65) | 2.83 (1.42)[b] | 3.46 (1.60) | 3.02 (1.51) | 4.58 (1.26) |
| Intensity score | 1.20 (0.76)[b] | 1.17 (0.77) | 1.33 (0.74)[a] | 1.74 (0.88) | 1.49 (0.81) | 2.37 (0.71) |
| Companionship score | 3.25 (1.34) | 3.30 (1.38) | 3.09 (1.21) | 3.49 (1.10) | 3.28 (1.16) | 4.02 (0.71) |
| Location score | 3.68 (1.24) | 3.80 (1.27) | 3.24 (1.03) | 3.61 (1.43) | 3.48 (1.60) | 3.94 (0.81) |
| Enjoyment score | 3.60 (1.40) | 3.53 (1.55) | 3.86 (0.57) | 3.54 (0.90) | 3.44 (0.98) | 3.79 (0.62) |
| **Self improvement activities** | | | | | | |
| Diversity score | 5.42 (1.65)[a] | 5.48 (1.69) | 5.22 (1.52) | 6.16 (1.72) | 6.15 (1.68) | 6.21 (1.87) |
| Intensity score | 2.79 (0.76)[c] | 2.82 (0.75)[b] | 2.69 (0.80)[a] | 3.29 (0.80) | 3.27 (0.81) | 3.34 (0.79) |
| Companionship score | 2.13 (0.59) | 2.13 (0.54) | 2.13 (0.77) | 2.06 (0.45) | 2.11 (0.39) | 1.96 (0.58) |
| Location score | 2.81 (0.73) | 2.78 (0.63) | 2.91 (1.05) | 2.83 (0.63) | 2.90 (0.64) | 2.64 (0.56) |
| Enjoyment score | 3.36 (0.49) | 3.35 (0.47) | 3.38 (0.55) | 3.34 (0.60) | 3.21 (0.59) | 3.67 (0.48) |

[a] $p \leq 0.05$.

[b] $p \leq 0.01$.

[c] $p \leq 0.001$.

**Table 3. Multiple regression analysis of participation diversity in children with DCD.**

| Independent variables | $R^2$ change | Unstandardized Regression Coefficient (B) | 95% Confidence interval | Standardized Regression Coefficient (β) | p |
|---|---|---|---|---|---|
| Age (year) | | 0.697 | -0.367, 1.760 | 0.057 | 0.609 |
| Gender (boys=1, girls=2) | 0.03 | -1.042 | -4.498, 2.414 | -0.075 | 0.496 |
| **MABC-2 total percentile rank** | **0.076** | **0.121** | **0.022, 0.220** | **0.280** | **0.014[a]** |
| **Weight status category (ideal weight=1, overweight/obese=2)** | **0.050** | **-3.592** | **-7.025, -0.160** | **-0.245** | **0.040[a]** |

[a] $p \leq 0.05$.

## Appendix

### Activities assessed by The Children's Assessment of Participation and Enjoyment.

| Recreational (12 items) | Physical (13 items) | Social (10 items) | Skill-based (10 items) | Self-improvement (10 items) |
|---|---|---|---|---|
| 1. Doing puzzles | 1. Doing martial arts | 1. Talking on the phone | 1. Swimming | 1. Writing letters |
| 2. Playing board or card games | 2. Racing or track and field | 2. Going to a party | 2. Doing gymnastics | 2. Writing a story |
| 3. Doing crafts, drawing or coloring | 3. Doing team sports | 3. Hanging out | 3. Horseback riding | 3. Getting extra help for schoolwork from a tutor |
| 4. Collecting things | 4. Participating in school clubs | 4. Visiting | 4. Learning to sing (choir or individual lessons) | 4. Doing a religious activity |
| 5. Playing computer or video games | 5. Bicycling, in-line skating or skateboarding | 5. Entertaining others | 5. Taking art lessons | 5. Going to the public library |
| 6. Playing with pets | 6. Doing water sports | 6. Going to the movies | 6. Learning to dance | 6. Reading |
| 7. Doing pretend or imaginary play | 7. Doing snow sports | 7. Going to a live event | 7. Playing a musical instrument | 7. Doing volunteer work |
| 8. Playing with things or toys | 8. Playing games | 8. Going on a full-day outing | 8. Taking music lessons | 8. Doing a chore |
| 9. Going for a walk or a hike | 9. Gardening | 9. Listening to music | 9. Participating in community organizations | 9. Doing homework |
| 10. Playing on equipment | 10. Fishing | 10. Making food | 10. Dancing | 10. Shopping |
| 11. Watching TV or a rented movie | 11. Doing individual physical activities | | | |
| 12. Taking care of a pet | 12. Playing non-team sports | | | |
| | 13. Doing a paid job | | | |