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A prospective cohort study comparing workload in children with and without developmental coordination disorder

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ABSTRACT

The purpose of this prospective cohort study was to assess how cardiorespiratory fitness (CRF) of children with probable developmental coordination disorder (DCD) changes over a period of 4.7 years relative to a group of typically developing controls. A school-based sample of children in a large region of Ontario, Canada with 75 out of a possible 92 schools consented to participate. Children enrolled in Grade 4 (mean = 9.9 years, SD = 0.35) at baseline (n = 2278) were followed over the course of 56 months. A total of eight waves of data collection were carried out throughout the study period. The short form of the Bruininks–Oseretsky test of motor proficiency was used to identify children with probable DCD and the maximal speed attained on the Léger 20-m shuttle run to measure CRF. Mixed-effects modeling was used to estimate the change over time in maximal Leger run speed for both groups adjusting for relevant covariates (e.g., gender, BMI, school, activity level, predilection for activity). Children with pDCD had consistently lower maximal run speed relative to controls. The trajectories of run speed in children with probable DCD and those without the disorder differed by gender with pDCD females demonstrating the lowest scores over time. Both genders with probable DCD showed a greater rate of decline in CRF over time relative to the controls. In conclusion, the difference in CRF between children with and without probable DCD is substantial, and it tends to increase over time. This adds to the argument suggesting that interventions intended to improve CRF may be appropriate and necessary for children with motor difficulties.

1. Introduction

Developmental coordination disorder (DCD) is a prevalent childhood condition characterized by motor coordination difficulties that affect day-to-day activities such as dressing, feeding, and writing (Wilson, 2005). DCD is thought to affect approximately 5–9% of school-age children (APA, 2000; Cermak & Larkin, 2002; Gillberg & Kadesjo, 2003). The cause of DCD has not been established however it is generally believed to be a chronic impairment that persists into adulthood (Barnhart, Davenport, Epps, & Nordquist, 2003; Cantell, Smyth, & Ahonen, 1994).

Children with DCD are at risk for overweight/obesity, lower overall fitness levels, poor perceived physical competence, lower activity levels, and reduced motivation to participate in physical activity (Cairney, Hay, Faught, & Hawes, 2005;

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Cairney, Hay, Faught, Flouris, & Klentrou, 2007; Cantell, Smyth, & Ahonen, 2003; Poulsen, Zivinai, & Cuskelly, 2008; Schott, Alof, Hultsch, & Meermann, 2007).

In light of the increasing prevalence of cardiovascular disease risk factors observed in children and adolescents, those for whom compromised motor proficiency presents challenges for engaging in physical activity may be of particular concern. One of the many consequences of reduced physical activity is that health-related fitness components such as cardiorespiratory fitness (CRF) are compromised (Hands, 2008). Higher levels of CRF have been associated with numerous health benefits, whereas poor fitness is an independent risk factor for a variety of negative health outcomes, including cardiovascular disease, and premature mortality (Katzmarzyk, Church, & Blair, 2004). While previous work has shed light on these disconcerting patterns for children with poor motor proficiency, many gaps in the literature exist and large scale, prospective, longitudinal, studies that quantify disease risk in this population of children are still lacking (Rivilis et al., 2011a).

A widely used direct assessment of cardiorespiratory fitness is performed by measuring peak oxygen uptake (peak VO_2) during a maximal exercise test. This requires measurement of respiratory gas exchange by indirect calorimetry and is performed in a controlled laboratory environment. Field tests such as the 20-m shuttle run, that measure CRF responses, are frequently used as a proxy, particularly in large community-based samples where individual laboratory assessments are not feasible. A recent systematic review reported that children with DCD had on average 11–22% lower VO_2 peak using lab-based assessments, and 17–28% lower aerobic capacity in field-based tests (Rivilis et al., 2011a).

Very few prospective studies have been conducted that describe the long-term trajectories of cardiorespiratory fitness in children with DCD relative to children without motoric difficulties. In particular, differences in CRF as children progress into adolescence are not well understood. Considering the importance of CRF as a key determinant of future health status, we sought to assess how CRF changes over time, and to delineate factors that may have an impact on CRF in children with DCD. In order to isolate the independent effect of DCD, we consider gender, BMI, school, perceptions of self-efficacy (adequacy), and physical activity participation as covariates.

In a previous publication, we compared CRF differences between children with DCD and their peers in a 2.5 years prospective follow up study (Cairney, Hay, Veldhuizen, & Faught, 2010a). In the current investigation, we add to previous findings by following the same cohort of children into adolescence, for a total surveillance period of approximately 5 years. Given the longer follow up period in the current study and the increased number of observations, we now have the ability to see if the observed trend continues, to control for confounding factors (e.g., perceptions of adequacy), and to examine three way interactions (e.g., between DCD, gender, and time). The outcome we are using in the current study is maximum speed attained during the final stage of the 20-m shuttle run. The measure has not been transformed in any way, and therefore is less prone to bias that may be associated with using a formula to calculate peak VO_2 in children (Fairbrother, Jones, & Hitchen, 2005; Penry, Wilcox, & Yun, 2011; Ruiz et al., 2009; Stickland, Petersen, & Bouffard, 2003). Using the non-transformed shuttle run results also allows us to estimate the relative impact of factors such as BMI on overall test performance on the shuttle run. This is not possible when using the allometrically scaled transformation, which scales the test results to body composition (weight in kg).

2. Methods

2.1. Data collection

This study is part of a prospective cohort follow up designed by the Physical Health Activity Study Team (PHAST). The PHAST is a longitudinal investigation following a large cohort of children from Grade 4 to 9 in the District School Board of Niagara (DSBN). The project began in September 2004 with all students enrolled in Grade 4 (average age = 9.9 years at baseline). A total of 2278 children from an original sample of 2378 (representing 75 of 92 possible schools) agreed to participate in annual school-based health assessments (95.4% consent rate). In the autumn of 2004, the pilot phase of PHAST took place, where we established testing and training protocols, developed a cadre of trained assistants, and completed baseline testing. The first formal wave of data collection took place in the spring of 2005. Subsequent assessments were conducted bi-annually (i.e., autumn and spring of each school year) for 2005 through 2007. In 2008–2009, due to the addition of a laboratory-based component to the study (reported elsewhere) and pedagogic concerns of the school board, only one annual school-based assessment was possible. Overall, eight waves of data collection were carried out (not including the pilot phase in year 1) over the course of 56 months. The number of participants available for analysis for each wave of data collection, as well as subjects' characteristics are reported in Table 1. Research ethics approval was provided by Brock University and the DSBN.

2.2. Motor proficiency and case ascertainment

Children's motor proficiency was evaluated using the short form of the Bruininks–Oseretsky Test of Motor Proficiency (BOTMP-SF), using standardized procedures (Bruininks & Bruininks, 2005). The short form has been previously validated for school-age children against the full-scale test with high correlations (Bruininks, 1978). The short form contains 14 items that examine general motor skills including running speed and agility, balance, bilateral coordination, strength, upper-limb coordination and dexterity, and response speed. Sampling procedures are reported in detail elsewhere (Cairney et al., 2010a). In brief, motor assessments were conducted by a team of trained research assistants in each school's gymnasium. Children