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Arterial stiffness in children with and without probable developmental coordination disorder

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ABSTRACT

Background: Children with cardiovascular disease risk factors demonstrate adverse arterial alterations that are predictive of cardiovascular morbidity and mortality in adults. Children with developmental coordination disorder (DCD) are at cardiovascular risk as they are more likely to be obese and inactive.
Aim: The purpose of this study was to assess arterial structure and function in children with and without probable DCD (p-DCD).
Methods: A cross-sectional study of 33 children with p-DCD (22 male) and 53 without (30 male). The Movement Assessment Battery for Children was used to classify those with p-DCD. Adiposity was assessed using the BOD POD. Compliance, distensibility, and intima-media thickness were measured at the common carotid artery (CCA). ECG R-wave-to-toe pulse wave velocity (PWV) was also measured.
Results: Compared to controls, males with p-DCD had lower CCA distensibility ($p = 0.034$) and higher PWV ($p = 0.001$). No differences were evident in females. Body fat percent was a significant predictor of CCA distensibility and removed the effect of p-DCD on PWV in males.
Conclusions: The present study demonstrates augmented arterial stiffness in males with p-DCD, likely attributed to body fat. These findings underscore the importance of targeted interventions in children with p-DCD, specifically males, in order to prevent future cardiovascular risk.

What this paper adds

Children with cardiovascular disease risk factors demonstrate adverse arterial alterations that are predictive of cardiovascular morbidity and mortality in adults. Children with developmental coordination disorder (DCD) are less likely to participate in physical activity and are more likely to be obese than their peers. Consequently, these children are at an increased risk of early arterial changes. However, no study has examined the link between DCD and arterial health in children. As a result, this study was the first to show that males with probable DCD (p-DCD) exhibit increased arterial stiffness

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compared to controls; a finding that was attributed to excess adiposity in this population. In addition, this is the first study to show sex differences with respect to arterial health in children with p-DCD. No differences were seen in arterial health between females with and without p-DCD. As a result, males with p-DCD are at an increased risk for cardiovascular complications later in life. The results of this study highlight the importance of targeted interventions in children with p-DCD, specifically males with excess adiposity, in order to prevent future cardiovascular risk.

1. Introduction

Developmental coordination disorder (DCD) is a neurological disorder with a global prevalence of approximately 1.8% of children, and is reported more often in boys (Lingam, Hunt, Golding, Jongmans, & Emond, 2009). Children with DCD exhibit poor motor skills and coordination, which adversely affects their participation in physical activity (Batey et al., 2014). Children with DCD also exhibit a greater prevalence of cardiovascular disease risk factors. Substantial research has illustrated that compared to their typically developing peers, children with DCD have greater body mass index (BMI) and waist circumference (Joshi et al., 2015), higher percent body fat (PBF) (Cairney, Hay, Veldhuizen, & Faught, 2011), greater prevalence of overweight/obesity (Cairney, Hay, Faught, & Hawes, 2005), lower cardiorespiratory fitness (Wu, Lin, Li, Tsai, & Cairney, 2010), and decreased physical fitness (Schott, Alof, Hultsch, & Meermann, 2007). Likewise, we have demonstrated that children with probable DCD (p-DCD), in comparison to their typically developing peers, have reduced autonomic regulation of blood pressure (BP) and atypical left ventricular structure and function, two supplementary markers of cardiovascular health (Chirico et al., 2011; Coverdale et al., 2012). Consequently, children with DCD are at an increased risk of developing cardiovascular disease.

Noninvasive measures of arterial stiffness, such as reduced arterial distensibility and compliance, and increased pulse-wave velocity (PWV) and arterial thickness (i.e., intima-media thickness [IMT]) are established predictors of cardiovascular morbidity and mortality in adults (Hodis et al., 1998; van Sloten et al., 2014; Vlachopoulos, Aznaouridis, & Stefanadis, 2010). These measures also demonstrate utility in identifying adverse arterial alterations in children who are less physically active, hypertensive or pre-hypertensive, and overweight. (Banach et al., 2010; Edwards et al., 2012; Urbina et al., 2011). Early arterial alterations in childhood may translate into accelerated cardiovascular risk in adulthood. Therefore, identification of children with heightened cardiovascular risk is critical. However, there are no studies evaluating arterial stiffness in children with DCD to our knowledge.

The purpose of this investigation was to determine whether children diagnosed with p-DCD demonstrate increased arterial stiffness and thickness as measured by PWV, compliance, distensibility, and IMT of the common carotid artery (CCA) compared to age, sex and school matched controls.

2. Methods

2.1. Study population

The sample was drawn from a larger population-based study known as the Physical Health Activity Study Team (PHAST) study, the details of which have been described previously (Cairney, Hay, Veldhuizen, & Faught, 2010). The Brock University Research Ethics Board and the District School Board of Niagara approved this study and consent/assent was provided by all parents/participants. There were 198 participants identified with p-DCD, scoring below the 10th percentile on the Bruininks-Oseretsky Test of Motor Proficiency-Short Form (BOTMP-SF) during a health assessment in school. These individuals were invited by telephone to participate in annual lab-based assessments for three consecutive years, and a total of 63 agreed to participate. Healthy controls (63) were selected randomly from consenting students who scored above the 10th percentile on the BOTMP-SF and were matched for sex, school, and age within 6-months. All participants assessed in the lab were administered the Movement Assessment Battery for Children-2 (M-ABC2) to verify clinically significant motor coordination difficulties. The analyses reported are data collected from year three, and only includes those who completed all three years of the lab assessment. A total of 40 participants declined the invitation to return for the second and third years of assessment, resulting in a final sample size of 86 participants, of which, 33 had M-ABC2 scores $\leq$16th (p-DCD) and 53 controls scoring above the 16th percentile.

2.2. Experimental procedure

Participants were scheduled for an appointment at the Applied Physiology Laboratories at Brock University. They were instructed to avoid strenuous physical activity/exercise twenty-four hours prior, as well as caffeine and food intake at least four hours prior to their assessment. Standing height, body mass and adiposity were assessed. Participants then entered the Human Hemodynamic Laboratory for cardiovascular measures.

Once in the lab, participants were asked to lie supine for a period of 15 min to allow BP and heart rate (HR) to reach resting levels. Following this rest period, three manual BP measurements were taken with each measure separated by one minute. Participants then underwent five minutes of beat-by-beat HR, BP and PWV data collection. At the end of five minutes, right CCA ultrasound images were taken. Once data collection was complete, another three manual BP measurements were taken to ensure participants were still at rest.