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Performance on Functional Strength Measurement and Muscle Power Sprint Test confirm poor anaerobic capacity in children with Developmental Coordination Disorder

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ABSTRACT

Background: There is little and conflicting information about anaerobic performance and functional strength in children with Developmental Coordination Disorder (DCD).
Aims: To investigate anaerobic capacity and functional strength in children with a clinical diagnosis of DCD (clin-DCD) and if differences were larger in older (age 7–10 years) compared to younger children (age 4–6 years). Furthermore to determine the percentage of children with clin-DCD that scored <15th percentile on the norm-referenced *Functional Strength Measurement*.
Method: A clin-DCD group (36 boys, 11 girls, mean age: 7y 1mo, SD = 2y 1mo) and a typically developing group (TD) (57 boys, 53 girls, mean age: 7y 5mo, SD = 1y 10mo) were compared on *Muscle Power Sprint Test (MPST)* and *Functional Strength Measurement (FSM)*.
Results: Children with clin-DCD performed poorer on the *MPST* and *FSM*, especially on the muscle endurance items of the FSM. The differences were larger in the older children compared to the younger on the cluster *muscle endurance* and *the FSM total score*. Over 50% of clin-DCD group scored <15th percentile on the *FSM*.
Interpretation: Differences between children with clin-DCD and TD children are even more pronounced in the older children, especially when tested on items requiring fast repetitive movements.

What this paper adds

- Children with a clinical diagnosis of DCD (clin-DCD) have lower anaerobic capacity.
- Lower anaerobic capacity is more pronounced in tests involving fast repetitive movements.
- The differences between children with clin-DCD and their typically developing peers is larger in older children.
- Half the children with clin-DCD have functional strength items that are below age-related norms.

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1. Introduction

Although children with Developmental Coordination Disorder (DCD) are characterized as having impaired motor coordination, recent studies have focused on the reduced levels of physical fitness commonly seen in this group (Cantell, Crawford, & Doyle-Bakker, 2008; Ferguson, Aertssen, Rameckers, Jelsma, & Smits-Engelsman, 2014; Haga, 2009; Hands, 2008;; Hoek et al., 2012; Kanioglou, 2006; Li, Wu, Cairney, & Hsieh, 2011; Rivilis et al., 2011; Schott, Alof, Hultsch, & Meermann, 2007; O'Beirne, Larkin, & Cable, 1994; Hands & Larkin, 2006;; Farhat et al., 2015). Lower scores on several measures of physical fitness, including cardiorespiratory endurance and isometric muscle strength have been reported in several studies (Rivilis et al., 2011), but the number of studies examining anaerobic performance and functional strength in children with DCD are less extensive.

In everyday life, children tend to participate in short bursts of high intensity activity or play far more frequently than they do in games that require aerobic endurance (Bailey et al., 1995). Moreover, children's games seldom involve activities in which isolated muscles are engaged in prolonged isometric contraction. These important aspects regarding children's participation in everyday activities are of particular interest to rehabilitation professionals who treat children with motor impairments. Therefore, besides aerobic capacity, it is equally important to assess anaerobic and functional strength in children with DCD. To ensure that these assessments are ecologically valid, it would be preferable to use tests that closely resemble typical playground skills (e.g. throwing a ball, jumping, and sprinting) and everyday activities (e.g. getting up from a chair, going up and down stairs).

One aspect of anaerobic capacity concerns *muscular endurance;* which refers to the ability to repeat a series of muscle contractions or sustain a muscle contraction for a set period of time without fatiguing. In terms of assessment, the maximal number of repetitive movements to fatigue (RTF) is commonly used to evaluate anaerobic capacity. Importantly, repetitive movements require the ability to switch rapidly between different types of muscle contractions (e.g. eccentric and concentric) or to switch between contractions of different muscle groups (e.g. agonists and antagonists).

The few studies that have evaluated RTF in children with DCD included only one or two RTF items and predominantly assessed core muscles (Hands, 2008; Kanioglou, 2006; Li et al., 2011; Hands & Larkin, 2006). The results of those studies were equivocal and, taken together, suggested that anaerobic capacity was influenced by age. A three-year longitudinal study reported no differences in performing repeated *sit-ups* (Li et al., 2011) between children with DCD and TD children when the children were nine-years old. However, differences between groups became apparent at the age of 10 and 11 years, with TD children performing significantly more sit-ups than their counterparts with DCD. However, other studies found differences in *sit-up* performance between younger children (5–9 years) with and without DCD (Kanioglou, 2006; Hands, 2008). On examination of *curl-ups* or abdominal crunch performance in TD children and children with DCD, (Schott et al., 2007) found no differences in young children (4–9 years), but significant differences in the older age group (10–12 years). (Cantell et al., 2008) however, reported differences in performance of *curl-ups* among 9 year olds, while (Nascimento et al., 2013) found no differences in children over a larger age range (6–10 years old). Lastly, (Ferguson et al., 2014) used the *Functional Strength Measurement* to assess RTF of other muscle groups during functional tasks. Their results showed differences on four repetitive muscle endurance items (i.e. *lateral step-up, sit to stand, lifting a box* and *stair climbing*) between children with and without DCD aged 6–10 years old.

An additional aspect of anaerobic capacity is *explosive muscle power.* Power can be defined as the product of force and velocity per unit of time (Watts). By definition, explosive power tests require adequate force generation in a short period of time. Field tests commonly used to assess muscle power of the upper-body evaluate throwing distance (e.g. *medicine ball throwing, chest pass, overarm throwing, and underarm throwing*). Again, studies examining these aspects report conflicting results. (Schott et al., 2007) reported no significant differences in children aged 4–9 years old, but reported that children aged 10–12 years old were significantly different in medicine ball throwing. (Ferguson et al., 2014) found differences in *underarm throwing* but no significant differences between DCD and TD children (age 6–10 years) on the *chest pass and overarm throwing.* (Hands & Larkin, 2006) also found no significant differences in *chest pass* (5–8 years).

Assessing lower limb muscle power involves measuring whole body displacement in activities such as *vertical, squat or standing long jump.* Two studies, comparing DCD and TD, found that children aged 10–12 years were different in *jumping* but younger children (4–9 years) were not (Li et al., 2011; Schott et al., 2007). Other studies, however revealed differences between 5 and 10 year old TD children and children with DCD (Ferguson et al., 2014; Haga, 2009; Hands, 2008; Hands & Larkin, 2006). (Farhat et al., 2015), using the *5-jump test* and the *triple hop distance test,* reported that children with DCD, aged 7–10 years, covered less distance than TD children.

Sprinting tests are commonly used to assess *general anaerobic capacity* in children with DCD. Different studies reported poorer performance in DCD on anaerobic sprint test such as the *20* m *run* (O'Beirne et al., 1994), *10* × *5* m *sprint* (Haga, 2009), *50* m *run* (Hands, 2008;; Hands & Larkin, 2006) and *50 yards run* (Kanioglou, 2006). However, Ferguson at al. (2014) found no significant differences between children with and without DCD on the *Muscle Power Sprint test (MPST).* (Hands, 2008) and (O'Beirne et al., 1994) found an interaction between group and time meaning that children with motor coordination problems become worse over time.

In summary, the reason for these conflicting results on anaerobic muscle endurance and muscle power as discussed above, may be partly accounted by the age of the children in the study groups, the variety of measures used (Ferguson et al., 2014) and the extremities measured. Another, less considered reason could be due to the heterogeneity of the participating DCD groups used in the various studies in terms of their diagnosis. Reflecting on the studies mentioned before, only one (Hoek