



## Assessment of physical fitness and exercise tolerance in children with developmental coordination disorder



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### ABSTRACT

Children with developmental coordination disorder (DCD) have been shown to be less physically fit when compared to their typically developing peers. The purpose of the present study was to examine the relationships among body composition, physical fitness and exercise tolerance in children with and without DCD. Thirty-seven children between the ages of 7 and 9 years participated in this study. Participants were classified according to results obtained on the Movement Assessment Battery for Children (MABC) and were divided in 2 groups: 19 children with DCD and 18 children without DCD. All children performed the following physical fitness tests: The five-jump test (5JT), the triple-hop distance (THD) and the modified agility test (MAT). Walking distance was assessed using the 6-min walking test (6MWT). Children with DCD showed higher scores than children without DCD in all MABC subscale scores, as well as in the total score ( $p < 0.001$ ). Participants with DCD were found to perform significantly worse on the MAT ( $p < 0.001$ ), the THD ( $p < 0.001$ ) and 5JT ( $p < 0.05$ ). Moreover, children with DCD had poorer performance on the 6MWT than children without DCD ( $p < 0.01$ ). Our results found significant correlations among body mass index (BMI), THD ( $r = 0.553$ ,  $p < 0.05$ ), 5JT ( $r = 0.480$ ,  $p < 0.05$ ) and 6MWT ( $r = 0.544$ ,  $p < 0.05$ ) only in DCD group. A significant correlation between MAT and 5JT ( $r = -0.493$ ,  $p < 0.05$ ) was found. Similarly, THD and 5JT ( $r = 0.611$ ,  $p < 0.01$ ) was found to be correlated in children with DCD. We also found relationships among 6MWT and MAT ( $r = -0.522$ ,  $p < 0.05$ ) and the 6MWT and 5JT ( $r = 0.472$ ,  $p < 0.05$ ) in DCD group. In addition, we found gender specific patterns in the relationship between exercise tolerance, explosive strength, power, DCD, and BMI. In conclusion, the present study revealed that BMI was indicative of poorer explosive strength, power and exercise tolerance in children with DCD compared to children without DCD probably due to a limited coordination on motor control.

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## 1. Introduction

Children with developmental coordination disorder (DCD) are often described as having considerable difficulties coordinating and controlling their body movements, involving both fine and gross motor skills (Visser, 2003). Poor coordination and difficulty performing motor based activities leads to decreased motivation to participate in physical activity (Haga, 2009). Bouffard, Watkinson, Thompson, Dunn, and Romanow (1996) described the phenomenon of withdraw from physical activity as an 'activity deficit'. The links between motor coordination deficits and physical activity have been well documented in the extant literature. Moreover, the physical fitness of children with and without DCD has been explored in several research studies (Rivlis et al., 2011).

In the last decade, findings suggest that children with lower motor competence demonstrated significantly poorer performance on important components of physical fitness, such as aerobic and anaerobic endurance and muscular strength, when compared against developing typically peers (Ferguson, Aertssen, Rameckers, Jelsma, & Smits-Engelsman, 2014). Raynor (2001) found that children with DCD showed difficulties in tasks using explosive power due to poor motor coordination and ineffective motor patterns.

Van der Hoek et al. (2012) identified several factors that may contribute to poorer fitness in children with DCD such as, muscular strength, inability to exert maximal force, and variability in rate of power and timing in performing work. As such, the difficulties children with DCD have performing fundamental motor skills (Hands & Larkin, 2006) may be associated with both strength and power deficits.

Withdrawal from physical activity and poor physical fitness in these children is an important concern for later health outcomes (Hands & Larkin, 2006). Additional research is needed to identify how physical fitness in children with movement difficulties differs from other groups. Numerous standardized fitness tests, such as the EUROFIT (Adam, Klissouras, Ravazollo, Renson, & Tuxworth, 1998), the TPF (Fjørtoft, Pedersen, Sigmundsson, & Vereijken, 2003) and the functional strength measure (Smits-Engelsman & Verhoef-Aertssen, 2012), are available for assessment of pediatric physical fitness in both general and special populations. Most of these tests consist of activities that are part of children's everyday activities such as jumping, throwing, running and climbing. Descriptive studies using such tests may provide a more thorough understanding of the physical fitness profiles of children with poor motor coordination. Moreover, sub-maximal exercise testing provides a safe, practical means of evaluating functional status, monitoring treatment effectiveness and establishing prognosis in children with DCD. Indeed, several studies have examined physical fitness (cardiorespiratory fitness) in children with DCD using field-based running tests such as the 20 m shuttle run test (Rivlis et al., 2011).

Moreover, the development of field tests, such as the 6-min walking test (6MWT), can be used to measure the functional exercise capacities of healthy or unfit subjects. The 6MWT has emerged as a common sub-maximal test in clinical settings, and the provision of recent normative data for the test has extended its application in other settings (Li et al., 2005). The 6MWT has shown good validity and reliability in pediatric clinical populations, and is considered to be a clinically relevant test because it closely resembles common physical activities of daily living (walking), in healthy children and in children with various diseases (Solway, Brooks, Lacasse, & Thomas, 2001). The 6MWT may be a particularly useful sub-maximal test for children with DCD. For example, the 6MWT requires minimal coordination skills, especially when compared to submaximal tests such as the shuttle run, where aspects of the test such as line contact pivots, may prove very difficult for children with DCD. Compared to these other tasks, walking may be easier for children with motor coordination difficulties.

Likewise, because children with DCD have been found to be less likely to participate in physical activities, it has been hypothesized that this condition may be a risk factor for obesity and overweight (Cairney et al., 2010). Only a few studies have examined the associations among motor coordination problems, physical fitness and overweight or obesity in children. Several studies however have explored the relationship between weight status and gross motor skills, with some studies indicating that overweight and obese children showed poorer locomotor skills such as jumping and poor performance on the shuttle run and 30-m sprint when compared to their normal-weight peers (Graf et al., 2004; Okely, Booth, & Chey, 2004).

According to the results of field tests, such as 6MWT, researchers have found that children with DCD were poor in exercise tolerance (Farhat et al., 2014). However, no empirical study has investigated the relationships among body composition, exercise tolerance and physical ability such as anaerobic power, explosive strength and agility. Therefore, the purpose of the present study was to examine, through a cross-sectional study, body composition, exercise tolerance and physical fitness in children with and without DCD (DCD).

## 2. Methods

### 2.1. Participants

The study has been approved by the Ethical local Committee of the University Hospital of Sfax. Prior to testing, the protocol was explained in detail to the participants and their parents. After this, all participants signed a written informed consent in accordance with the principals outlined in the Declaration of Helsinki in 1975.

A total of fifty-one children were recruited from three primary schools from a middle-class region in Tunisia; all children were administered the movement assessment battery for children (MABC) to assess motor coordination. Five children (three boys and two girls) were excluded because they had intellectual impairment. In addition, nine children (six boys and three girls) did not attend the assessment session. In total, nineteen children with DCD and eighteen children without DCD aged

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