Research in Developmental Disabilities 32 (2011) 2993–3002

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Motor coordination and health-related physical fitness of children with developmental coordination disorder: A three-year follow-up study

Yao-Chuen Li [a], Sheng K. Wu [b,*], John Cairney [c], Chiu-Yun Hsieh [d]

[a] Department of Physical Medicine and Rehabilitation, Cathay General Hospital, Taiwan
[b] Institute of Sport Performance, National Taiwan College of Physical Education, Taiwan
[c] CanChild Centre for Childhood Disability Research, Departments of Family Medicine, Psychiatry and Behavioural Neurosciences, and Kinesiology, McMaster University, Hamilton, ON, Canada
[d] Taichung Tung-Xing Elementary School, Taiwan

ARTICLE INFO

Article history:
Received 28 March 2011
Accepted 21 April 2011
Available online 31 May 2011

Keywords:
Developmental coordination disorder
Physical fitness
Physical activity
Longitudinal study
Children
Motor proficiency

ABSTRACT

Health-related physical fitness is an important risk factor of cardiovascular disease. While previous studies have identified children with developmental coordination disorder (DCD) to be less physically fit than typically developing (TD) peers, there is limited longitudinal research in this area. This study was undertaken to evaluate concomitant changes in motor coordination and health-related physical fitness of Taiwanese children with and without DCD over a three-year period. The Movement Assessment Battery for Children (Movement ABC) test was used to evaluate motor coordination, while health-related physical fitness included several core components: (1) body mass index (BMI), (2) sit and reach forward, (3) long jump, (4) sit-ups, and (5) 800-m run. Both the Movement ABC and fitness tests were implemented once each a year for three years. Twenty-five children with DCD and 25 TD children, matched by age and gender participated in this study. The TD group showed significant long-term changes in BMI and long jump while the DCD group showed significant increases in BMI values and decreases in flexibility, measured by the sit and reach task. In general, children with DCD performed worse on the items of flexibility, muscle strength and muscle endurance after the first year. Compared to age- and gender-matched norms, children with DCD not only were less physically fit, but showed a significant long-term decline in flexibility and abdominal or core strength (sit-ups). In years two and three, there was a significant negative correlation between poor fitness and motor coordination. Based on the results of this longitudinal study, greater attention should be paid to monitoring and improving physical fitness of children with DCD to prevent further health-related problems while intervention.

1. Introduction

According to the definition provided in the DSM-IV-TR (American Psychiatric Association, 2000), developmental coordination disorder (DCD) is characterized by poor motor proficiencies that result in significant impairment to activities of daily living or academic performance. In the absence of existing neurological conditions or intellectual impairments, DCD is the preferred diagnosis for healthy children with impairments of motor skills. Difficulties in motor

* Corresponding author. Tel.: +886 4 22213108x2226; fax: +886 4 22250756.
E-mail address: skwu@ntcpe.edu.tw (S.K. Wu).

0891-4222/$ – see front matter © 2011 Elsevier LtdElsevier Ltd. All rights reserved.
doi:10.1016/j.ridd.2011.04.009

skills and abilities may subsequently impact on daily or school activities and even later health (Barnett, van Beurden, Morgan, Brooks, & Bread, 2008; Cairney, Hay, Faught, & Hawes, 2005; Faught, Hay, Cairney, & Flouris, 2005; Zhu, Wu, & Cairney, 2011). While the prevalence of DCD has been estimated to be between 5% and 9% in children between the ages of 9 and 11 (Barnhart, Davenport, Epps, & Nordquist, 2003; Kadesjo & Gillberg, 1999), a previous study has found the prevalence of DCD in Taiwan to be 12% in 7–10-year-old population (Lin & Wu, 2002). The apparently higher prevalence of DCD in Taiwanese children may mean children from this country are particularly high risk for the development of secondary consequences from DCD.

Several research studies have shown that children with DCD have lower levels of participation in physical activities than their peers without DCD in recess, and are less likely to engage in both structured and unstructured activities when compared to typically developing (TD) children (Cairney, Hay, Faught, Mandigo, & Flouris, 2005; Watkinson et al., 2001). Cairney, Hay, Faught, Mandigo, et al. (2005) have found that children with DCD might frequently withdraw from physical activities due to poor motor coordination and low perceived competence in sports. Children with DCD often face frustration engaging in self-care activities (e.g., dressing), school-based activities (e.g., writing), and have less confidence in their ability to play with other children, mainly due to their motor coordination problems (Rodger & Mandich, 2005). As a result of repeatedly being unable to master daily activities, many children with DCD experience a chronic sense of failure that reduces their willingness to participate in physical activities and trying novel tasks (Mandich, Polatajko, & Rodger, 2003). Many children with DCD also report lower levels of enjoyment in free play activities, physical education classes, or organized sports (Bouffard, Watkinson, Thompson, Causgrove Dunn, & Romanow, 1996; Cairney, Hay, Faught, Mandigo, et al., 2005; Cairney, Hay, Veldhuizen, Missiuna, & Faught, 2010).

Several studies have identified that children with DCD are physically inactive and less fit when compared to their TD peers (Cairney, Hay, Veldhuizen, & Faught, 2010a; Cairney, Hay, Veldhuizen, Missiuna, & Faught, 2010; Rivilis et al., 2011; Schott, Alof, Hultsch, & Meermann, 2007; Tsiotra, Nevill, Lane, & Koutedakis, 2009; Wu, Lin, Li, Tsai, & Cairney, 2010). Hands and Larkin (2002) presented a hypothetical model, the core of which is a continuous negative feedback loop incorporating low motor competence, hypoactivity and low physical fitness mediated by genetic predisposition, self-perception, social pressure and physical constrains. According to Hands and Larkin (2002), children mainly develop their physical fitness through play in casual (unstructured) activities. Thus, withdrawal or exclusion from regular play, sports and games in children could have negative consequences for their fitness and health both now and in the future (Cairney, Hay, Wade, Faught, & Flouris, 2006; Payne & Isaacs, 2002; Rivilis et al., 2011; Sallis, Patterson, Buono, & Nader, 1988). Cairney, Hay, Faught, and Hawes (2005) in Canada and Zhu et al. (2011) in Taiwan have found that children with DCD have higher prevalence in obesity and overweight comparing to their TD peers. In addition, children with DCD were found to have lower cardiopulmonary fitness than TD children, demonstrated by both field and lab-based studies (Cairney et al., 2010a; Wu et al., 2010). Although the above studies were cross-sectional, these findings support the concern that children with DCD may be at greater risk of developing cardiovascular disease (CVD) if nothing is done to intervene in this population (Cairney, Hay, Veldhuizen, Missiuna, Mahlberg, et al., 2010).

Physical fitness is a set of attributes that are health-related, skill-related, or both (Committee on Sports Medicine & Fitness, 1994). As defined then, health-related physical fitness is a multi-dimensional construct, including cardiopulmonary fitness, body composition, flexibility and muscular fitness, which itself includes muscle power and muscle endurance. Health-related fitness is a state characterized by an ability to perform vigorous activities of daily living, and represents traits and capacities that are associated with low risks of premature development of hypokinetic diseases (Dwyer & Davis, 2005; Stout, 2000). Chatrath, Shenoy, Serratto, and Thoele (2002) reported a "fitness crisis" in the urban U.S. pediatric population, showing that children and adolescents were less physically fit, accompanied by a dramatic increase in body mass index (BMI), when compared to children 25 years ago. Many clinical studies have claimed that the performance of health-related physical fitness, particularly cardiopulmonary fitness, would influence numerous risk factors of CVD, such as hypertension, type 2 diabetes, obesity, high serum lipid and hypercholesterolemia, and therefore, CVD itself. Poor physical fitness has been recognized as a pediatric problem, even though the consequences of poor fitness generally do not appear until much later in life (Andersen, Wedderkopp, Hansen, Cooper, & Froberg, 2003; Cantell, Crawford, & Doyle-Barker, 2008; Faught et al., 2005; Raitakari et al., 1997; Ribeiro et al., 2003). Targeting poor physical fitness in the early years of life should be a priority if we wish to prevent the onset of adult diseases such as CVD.

Although the association between physical activity and physical fitness in childhood has been examined in many studies and children with DCD have been shown to have lower levels of physical fitness and had a high risk in obesity and health problems, only three longitudinal studies have been conducted to examine long-term changes in physical fitness for children with DCD; one study conducted in Australia (Hands, 2008), one in Norway (Haga, 2009) and one in Canada (Cairney, Hay, Veldhuizen, & Faught, 2010b; Cairney, Hay, Veldhuizen, Missiuna, Mahlberg, et al., 2010). However, two of these studies are based on very small numbers of children with DCD (Haga, 2009; Hands, 2008). The other study, while having a much larger sample of children with DCD, focused on specific components of physical fitness, such as BMI (Cairney, Hay, Veldhuizen, Missiuna, Mahlberg, et al., 2010) or cardio-respiratory fitness (Cairney et al., 2010b). Currently, there are no longitudinal studies of children with DCD in Asia that have examined this issue. Thus, the purpose of this study was to investigate changes in health-related physical fitness and motor coordination of children with DCD for three consecutive years, to attempt to determine the longitudinal association between motor coordination and multiple components of health-related physical fitness.