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The effect of exergames on functional strength, anaerobic fitness, balance and agility in children with and without motor coordination difficulties living in low-income communities



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ABSTRACT

Children with Developmental Coordination Disorder (DCD) are physically less active, preferring more sedentary behavior and are at risk of developing health problems or becoming overweight. 18 children (age 6–10 years) with lower levels of motor coordination attending a primary school in a low-income community in South Africa (score on Movement Assessment Battery for Children Second edition equal to or below the 5th percentile) were selected to participate in the study and were age-matched with typically developing peers (TD). Both groups of children engaged in 20 min of active Nintendo Wii Fit gaming on the balance board, twice a week for a period of five weeks. All children were tested before and after the intervention using the lower limb items of the Functional Strength Measurement, the 5 × 10 meter sprint test, the 5 × 10 meter slalom sprint test, and the Balance, Running speed and Agility subtest of the Bruininks Oseretsky Test of Motor Proficiency 2nd edition (BOT-2).

After intervention, both groups of children improved in functional strength and anaerobic fitness. The magnitude of these changes was not related to participant's motor coordination level. However, differences in change between the TD and DCD group were apparent on the motor performance tests; children with DCD seemed to benefit more in balance skills of the BOT-2, while the TD children improved more in the Running speed and Agility component of the BOT-2. Compliance to the study protocol over 5 weeks was high and the effect on physical functioning was shown on standardized measures of physical performance validated for children with and without DCD.

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1. Introduction

Until recently, the problem of low levels of physical activity and obesity has largely been limited to more developed, industrialized countries. However, this is no longer the case. Statistics indicate that 50% of learners from low- and middle-income settings in, South Africa, lack the required levels of physical activity (Reddy et al., 2008), with only 7% of girls said to be engaging in recommended levels of physical activity levels (Cole, Bellizzi, Flegal & Dietz, 2000). Moreover, South Africa has amongst the highest child obesity rates in Africa with a combined overweight/obesity prevalence of 17% (Warburton, Nicol, & Bredin, 2006; Gordon-Larsen, Nelson, & Popkin, 2004).

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Besides obesity being a major concern in typically developing (TD) children, this problem becomes even greater for children with disabilities, who are reported to have a higher prevalence of obesity (38%) compared to children without disabilities (CDC, 2014). Deficits in motor competence among children with Developmental Coordination Disorder (DCD) make them less likely to participate in active physical free play, in organized sport and physical activities, resulting in low fitness levels and higher levels of obesity in this group regardless of context (Cantell, Crawford, & Tish Doyle-Baker, 2008; Hands & Larkin, 2006; Yu et al., 2016). Poor motor development may result in children not taking part in physical activity, because they do not have the fundamental movement skills required to do so (Ferguson, Aertssen, Rameckers, Jelsma, & Smits-Engelsman, 2014). Many children with motor coordination difficulties also feel embarrassed by their poor performance and subsequently withdraw from physical activities leading to decreased fitness levels (e.g. cardiorespiratory fitness, body composition, muscular strength, muscular endurance, agility, coordination and flexibility). Ultimately, not participating in physical activity has a further negative impact on the motor skill development, resulting in a vicious cycle (Cairney, Hay, Faught, Wade et al., 2005; Cairney, Hay, Faught, & Hawes, 2005).

Engaging in regular physical activity is widely accepted as an effective preventative measure for a variety of health risk factors for children (Janssen & Leblanc, 2010; Pienaar, 2015). Numerous strategies have been designed to increase physical activity levels among children in South Africa (Kinsman et al., 2015; Villiers et al., 2015; Jemmott et al., 2011), however barriers to the promotion of physical activities in schools situated in low-income communities include resource constraints (limited physical education (PE) classes, no sports facilities) and environmental challenges (safety) (Puokane & Mchiza, 2009). Finding effective and fun interventions to increase physical activity levels and physical functioning is therefore warranted.

Historically, physical inactivity was considered as one of the primary predictors of low fitness levels. However, recent studies have cited motor competence and perceived motor competence (Castelli & Valley, 2007) as other possible compounding variables (McKenzie et al., 2002; Okely, Booth, & Chey, 2004; Stodden et al., 2008). Physical fitness of children is the ability of the body to function effectively and efficiently without becoming exhausted during daily activities, while performing skills such as running, climbing, jumping. Besides coordination, strength, power or endurance are needed in the development of fitness (Saakslahiti et al., 1999; Hands & Larkin, 2006).

Despite the evidence supporting the association between lower levels of motor coordination and physical fitness, there is limited research regarding interventions focusing on these relationships. Importantly, none have directly studied the effect of exergames on both coordination, strength and anaerobic fitness in groups of children with and without motor difficulties. Moreover, studies of this specific nature have not been conducted in low-income settings where opportunities for PE and sports to improve physical activity are limited.

The application of active computer games (exergames) that incorporate virtual reality in pediatric rehabilitation is relatively new. During exergaming, children use significantly more energy than during traditional sedentary computer activities. However, evidence is mixed on whether these games engage children in levels of activity that are consistent with public health recommendations for physical activity and improving cardiorespiratory fitness (Daley, 2009; Draper et al., 2010). In a recent review, Sween et al. (2014) reported that the majority of active videogames tested, were found to achieve physical activity levels of moderate intensity, which meet the American College of Sports Medicine guidelines for health and fitness (Sween et al., 2014). Therefore, exergaming could be attractive to help children with low levels of physical activity to displace sedentary behavior and their use could capitalize on children's motivation to play games.

Exergames may have an additional advantage for children with DCD. Active video games, such as the Wii Fit, which provides immediate feedback to the player, have been shown to improve motor skills and motivation to exercise in various populations including children with developmental coordination disorders (Jelsma, Geuze, Mombarg, & Smits-Engelsman, 2014; Ferguson, Jelsma, Jelsma, & Smits-Engelsman, 2013). These aspects are particularly important in the current context for poor motor control and compliance to exercise programs, since it has been recommended to combine the training of fundamental motor skills with training to increase levels of physical activity in children with DCD and to ensure that rehabilitation programs are enjoyable (Jelsma et al., 2014; Ferguson et al., 2013; Farhat et al., 2015). Everyday physical playground games, sport and other leisure activities require sufficient proficiency in motor control and fitness. Games such as tag, for example combine balance, agility and coordination with anaerobic fitness. If the skills needed to take part in these activities are not trained, the intervention, even if it showed gains in physical fitness, is likely to be ineffective after the training is stopped, since no transfer will take place to those activities. In addition, if the training is not fun and enjoyable, the likelihood that children will comply long enough to see changes in fitness levels will be poorer.

Exergaming provides a relatively low cost way to get children to move and be physically active. If the intended interventions are effective and safe, it would make it ideal for children living in situations where there are significant environmental barriers to exercise participation as the training programs can be set up in safe indoor spaces and no expensive supervision is needed. Exergaming may even increase compliance since many children have never played these types of computer games before. Although the Wii Fit has been shown to improve motor skills in South African children attending a low-income school with DCD and cerebral palsy, to date (Ferguson et al., 2013; Jelsma, Ferguson, Smits-Engelsman, & Geuze, 2015), there are limited published data comparing the impact of Wii Fit on physical fitness in typically developing children and children with DCD living in poor socioeconomic circumstances.

Therefore the primary purpose of this study was to establish if a 5-week training program using Wii Fit games has a positive impact on physical fitness (functional strength, anaerobic fitness, balance, and agility) in a group of children (age 6–10 years) attending school in a low-income community with fewer opportunities to participate in PE and sports. The second purpose was to determine whether the level of motor coordination had an impact on the training effect of physical

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