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Interactive Video Games are an Effective Supplementary to Pediatric Clinical Exercise Rehabilitation for Cerebral Palsy: Knowledge Translation of Video Game-Based Therapy

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Abstract

To increase physical activity participation in children with cerebral palsy, the concept of video game-therapy has been introduced as a supplementary to physical rehabilitation programs. Evidence suggests that video game-based therapy is a safe, enjoyable and feasible strategy to increase movement experiences in children with developmental disabilities. Commercial video game consoles provide a platform for users to participate in repetitive movement tasks, which have been suggested to drive neuroplastic changes towards motor development in children with cerebral palsy. This evidence-based review is a supplementary to a knowledge translation video designed to educate the general public on the health-related benefits that can be accrued from playing interactive video games as an adjunct therapy to clinical exercise rehabilitation for children with cerebral palsy. **Health & Fitness Journal of Canada 2017;10(1):17-22.**

Keywords: Cerebral Palsy, Video Game-Based Therapy, Clinical Exercise Rehabilitation, Movement Experience, Physical Activity, Health Promotion, Knowledge Translation, Kinesiology

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Introduction

Cerebral palsy (CP) is the most common physical developmental disability in childhood, occurring in approximately 3 out of every 1000 live births in the United States (Odding et al., 2006). CP is a non-progressive

developmental disorder caused by an injury to the immature brain, which compromises its ability to acquire the appropriate motor schemas for motor development (Bax et al., 2005; Zoccolillo et al., 2015). In a majority of children with CP, impairments in the learning of new motor skills lead to a group of disorders related to movement and posture, which limit physical activity participation (Carlberg and Hadders-Algra, 2005). When compounded with secondary complications related to physical inactivity and poor cardiorespiratory capacity, CP can lead to increasing disability and deterioration in quality of life with age (Robert et al., 2013; Warburton et al., 2006). Hence, increasing physical activity participation in children with CP has been a focus in clinical exercise rehabilitation.

Conventional physical rehabilitation for CP focuses on intensive, task-oriented and long-lasting training, which is suggested to drive neuroplastic changes towards motor development (Zoccolillo et al., 2015). However, despite the dose-response relationship between CP therapy and rehabilitation outcomes (Damiano, 2006), the repetitive and mundane nature of conventional training tasks may reduce children's motivation in adhering to a regular activity routine. To increase their motivation for physical

activity, interactive video games have been introduced as an adjunct strategy to conventional therapy. Based on the concept of play, interactive video games have been shown to be a significant motivator in optimizing therapeutic compliance (Chang et al., 2013; Crisco et al., 2015). The evidence suggests that a high level of participation in interactive video games is an effective strategy to increase movement experiences in children with CP (Sajan et al., 2016).

The primary purpose of this narrative review and commentary is to supplement an evidence-based knowledge translation video designed to educate the general public on the health-related benefits of playing interactive video games as an adjunct intervention to clinical exercise rehabilitation for CP.

Key Findings

Although conventional therapy has been shown to be more superior to video game-based therapy to improve rehabilitation outcomes in children with CP (Zoccolillo et al., 2015), evidence suggests that interactive video games provide significant therapeutic value as an adjunct intervention. In a systematic review of 126 articles, Bonnechère et al. (2016) revealed that rehabilitation programs that integrated video game-based therapy in treating neurological disorders achieved similar health-benefit results as observed in conventional therapy. In a majority of these studies, the authors reported that commercially-available consoles, including the Microsoft Xbox™, Nintendo Wii™ and Sony PlayStation™, were effective therapeutic tools to improve movement experiences in children with CP.

Recent advancements in research have provided insight on the use of

commercial-consoles in conjunction with motion capture devices (e.g., the Xbox 360 Kinect™, Nintendo Wii Fit™ and PlayStation EyeToy™) to improve movement experiences in children with CP. Kinect™ is a webcam-style, full-body 3D motion capture system that allows the user to interact with the virtual environment using gestures and body movements independent of a game controller (Luna-Oliva et al., 2013). PlayStation's EyeToy™ device operates in a similar manner, as it employs a webcam to capture body movements (Jannink et al., 2008). In contrast, the Nintendo Wii™ enables users to play a variety of virtual games through the use of a handheld, motion-sensing controller, or via a platform more commonly known as the Wii Fit™ (Robert et al., 2013). The versatility of the Wii™ console in providing diverse, interactive video games makes it an appealing choice for video game-based therapy.

To the best of our knowledge, the Xbox 360 Kinect™ motion capture device and the Nintendo Wii Fit™ system are the most actively investigated consoles for their use as video game-based therapy. Currently, the research shows that these commercial-consoles are effective, adjunct tools to improve movement experiences in children with CP.

In a pilot study, Luna-Oliva et al. (2013) demonstrated that the use of the Xbox 360 Kinect™ game console in conjunction with physiotherapy improved gross motor functions and activities of daily living in 11 children with CP. A follow-up evaluation revealed that the training effects were retained 8 months post-intervention (Luna-Oliva et al., 2013). These findings are consistent with the dose-response relationship between therapy and outcome: that more physical

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activity leads to greater rehabilitation benefits (Chang et al., 2013; Crisco et al., 2015). These implications were further supported by evidence presented by Zoccolillo et al. (2015).

In the crossover randomized controlled study conducted by Zoccolillo et al. (2015), 22 children with CP were randomly assigned into one of two groups: 1) conventional therapy followed by video-game training; or 2) video-game training followed by conventional therapy. Their findings demonstrated that, within a one-year intervention period, the use of the Xbox 360 Kinect™ was sufficient to improve motor functions of the upper extremities in children with CP, and that the quantity of limb-performed movements was three times higher during video-game training than during conventional therapy. However, conventional therapy remained superior to video-game training in improving performance in manual activities of daily living (Zoccolillo et al., 2015).

The evidence provided by Luna-Oliva (2013) and Zoccolillo et al. (2015) provide support for the use of interactive video games as a supplementary therapy. This evidence-based recommendation is consistent with similar findings in studies that examined the role of the Nintendo Wii™ to improve rehabilitation outcomes in children with CP.

Winkels et al. (2013) showed that the Nintendo Wii™ console is also a feasible supplementary to conventional therapy. In this clinical trial, 15 children with CP participated in a 6-week intervention using the Wii™ console. Based on pre- and post-outcome assessments, it was observed that using the most affected arm to play virtual boxing and tennis games (twice a week) significantly increased the convenience in performing activities of

daily living, but did not significantly change the quality of upper extremity movements; we postulate that the latter may be improved by conventional therapy, as suggested by Zoccolillo and colleagues. Other aspects of motor performance measures, such as goal-directed arm movements, balance and jumping, have also been shown to benefit from using the Nintendo Wii™ in video game-based therapy for children with CP (AlSaif and Alsenany, 2015; Tarakci et al., 2013; Tarakci et al., 2016).

Collectively, the literature recommends that interactive video games should supplement, but not replace, conventional therapy. Several reasons explain why interactive video games can be effective adjunct tools to improve movement experiences in children with CP.

First, the use of interactive video games is a feasible strategy to integrate physical activities that are not only long in duration but also high in intensity. Based on the concept of play, video games provide motivational incentives to participate in physical activity (Harris and Reid, 2005). The mundane nature of repetitive tasks can be avoided by the ability to select for, and engage in, novel virtual environments in video games. Furthermore, it has been demonstrated that in interactive video games, children with CP can exert the same level of exercise intensity in comparison to age-matched controls (Robert et al., 2013), suggesting that children with CP can obtain similar exercise-related benefits from playing interactive video games. Hence, interactive video games can provide a platform to integrate intensive, task-oriented and long-lasting training, which is the essence of contemporary clinical exercise rehabilitation for CP. We postulate that interactive video games

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with a clinical focus can provide even greater rehabilitation outcomes.

Second, children with CP who are living with greater functional limitations may accrue greater health-related benefits through playing interactive video games (Winkels et al., 2013). A key finding in the study by Winkels and colleagues was that children with CP who were assessed lower baseline measures elicited greater improvements in performing activities of daily living. Consistent with the dose-response relationship between therapy and rehabilitation outcomes, this finding suggests that participating in repetitive movements in interactive video games can drive neuroplastic changes towards motor development in children with CP (Luna-Oliva, 2013; Snider et al., 2010; Zoccolillo et al., 2015).

To maximize its potential as a supplementary, video game-based therapy should be incorporated outside of clinical settings. A home-based approach is feasible because commercially-available consoles are relatively low in cost, as one in four children own a video game console at home (Riley, 2009).

The feasibility of home-based interventions has long been recommended but only recently investigated (Sandlund et al., 2011; Sandlund et al., 2013; Weightman et al., 2011). As reported by these authors, the effectiveness of home-based therapy provides additional support for the use of interactive video games as an adjunct strategy to conventional therapy. While future research is required to validate the efficacy of home-based training programs for children with CP, this concept has been well received by both therapists and parents (Sandlund et al., 2012; Tatla et al., 2015). For instance, a home-based

intervention can increase opportunities to engage in physical activity, reduce the geographic inconveniences of travelling to a rehabilitation centre, and enable children to foster safe, social connections with their peers (Tatla et al., 2015).

As a supplementary, interactive video games confer several advantages: 1) a variety of movement exercises can be integrated; 2) commercial availability of video game consoles enable home-based therapy; 3) movement exercises can be individualized and adapted based on the participants' needs; and 4) video games can motivate children to adhere to intensive, task-oriented and long-lasting training (Harris and Reid, 2005).

Conclusion

The evidence suggests that playing interactive video games can provide health-related benefits to supplement conventional physical rehabilitation programs for children with CP. Interactive video games have been shown to be effective tools to improve movement experiences in children, as the appeal in video games provides a significant motivational factor. By using a home-based approach, interactive video games can be utilized outside of clinical settings to provide additional opportunities for children with CP to engage in intensive, task-oriented and long-lasting exercises, which have been suggested to elicit neuroplastic changes towards motor development (Zoccolillo et al., 2015).

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