



Physical inactivity and motor skills in children with autism spectrum disorder: The role of exergames

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Abstract

There is growing literature on effects of physical activity on motor deficiency and sedentary life style in autism spectrum disorder (ASD). It appears there is however, little information on the positive effects of exergames on ASD. This study is aimed at reviewing the current studies on the role of exergames on improving sedentary lifestyle and motor skill in ASD. Scientific journals were searched for studies on ASD and benefits of exergames on motor skill and physical inactivity. These journals include pubmed, medline and google scholar. The results of this study confirm that Exergames are very effective interventions for improving motor skill and physical activity in ASD. In addition, exergames elicit maximum form of entertainment which could encourage active participation and consequently improve the conditions of the participants. Thus, exergames may provide alternative intervention to traditional exercise.

Keywords: autism spectrum disorder, exergames, motor skill, physical inactivity

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by impaired social interaction skill and odd behavioral pattern^[1]. The rate of ASD is fast on the increase globally^[2]. There is evidence that ASD is found in 1% to 2% of children population^[3, 4]. This condition is reportedly higher among male compared to their female counterpart^[4]. Investigations are currently on going to unravel the major cause of this condition.

However, genetic polymorphism and environmental factors have been linked to the development of ASD^[5, 6]. Pathogenesis of ASD has further been linked to the age of parent and inflammatory condition which could be caused by immune response and placental defection^[7]. This therefore suggests that different factors play a significant role in the development of ASD. It is difficult to diagnose ASD at early stage as a result of phenotypic and etiological heterogeneity which co-exists in people with neurodevelopment disorder^[8]. It is noted that ASD characteristics which are not detected at early stage may be noticed at puberty age^[9]. To this end, the positive effects of early interventions in people with ASD have been reported^[10]. Thus, the impact of not detecting ASD at early stage may have huge adverse consequences on health outcomes as required early intervention is obviously delayed as a result of this situation.

Motor deficiency is a major impairment reportedly found in people with ASD^[11]. As a result of the high prevalence of motor impairment in people with developmental disorder, there is an indication that their functionality may be compromised^[12]. There is evidence of high dysfunctional mirror neuron system (MNS) which impacts on motor ability in people with ASD^[13]. Given the prevalence of dysfunctional MNS in this population, both gross and fine motor skill may consequently suffer impairment. This deficiency, of course,

may have serious implication on the performance of daily activities that requires body movement. Therefore, it is important to understand the pathways which deficient MNS contribute the development of reported poor motor skills in ASD.

Further, it is alarming to note that sedentary behavior is reportedly higher in children with ASD compared with typically developing peers^[14, 16]. Low level of physical activity is a major indicator of poor health which could have negative impacts on health outcomes in this population. Children with ASD are faced with various barriers including exclusion by peers, lack of knowledge by adults to include and inadequate arrangement which have been reported to have significant correlation with physical activity participation and screen time including watching television, playing video game and computer^[17]. It is thus important to note that increased screen time as a result of these barriers may contribute to reduced physical activity level in children with ASD. Also, environmental feature is a major factor that may influence level of physical activity in this population^[18]. Suffice to suggest that this condition does not only pose serious burden to public health but also on economic budget thereby requiring adequate attention.

There is suggestive evidence that ASD population usually experience various comorbid medical conditions which are very difficult to detect through medical history and physical examination as a result of communication and behavioral impairment exhibited by this population which in turn interfere with the required detailed examination^[19]. It is alarming to note that prevalence of medical conditions in ASD population has been estimated to range from 10.7% of abnormal growth patterns to 77.4% of stereotypies^[20]. Apparently, these sets of disorders require effective

interventions with a view to improving the condition of people with ASD.

Method

For the purpose of this review, scientific journals were searched for studies on ASD and benefits of exergames. These journals include pubmed, medline, google scholar and cochrane central database. The words searched include: autism spectrum disorder, motor deficiency, exercise, physical activity and exergames. The search was limited to literatures in English language.

Inclusion Criteria

The studies included in this review involved exergames interventions. To be included, the studies must have been published not earlier than January 2011. The interventions must also be designed for patients with ASD. There is age restriction of 30 years and below for the intervention participants.

Results

Searches of journals identified 335 relevant papers to the study. From these papers, seven studies that met the inclusion criteria were critically examined in this review. As shown in table 1 below, the effects of exergames on physical inactivity and motor skills were analyzed.

Effects of exercise on motor skill

Physical exercise training is a very effective activity that could improve the perceptual-motor skill impairment in adolescent with autism [21]. It has been noted that psychomotor intervention activities targeting body awareness, space concept and time concept are valuable to general motor proficiency in children with ASD [22]. There is an indication that 12-week aquatic training, notably prompted by video instruction, is capable of increasing motor performance in children with ASD [23]. Similarly, simulated developmental horse-riding is a potential intervention for motor proficiency in autistic children [24]. To further understand the pathways which exercise could improve motor dysfunction, treadmill exercise has been confirmed to reduce Purkinje cell loss while it increases reelin expression as these protein expressions are related to gait impairment and motor preparation in autism [25]. In view of this, aerobic activity is a very effective exercise program that may contribute to reduction of gait deficiency in this population.

Given the huge positive benefits of exercise, tailoring the intervention program according to motor and social needs of children with ASD should be strictly followed to enhance their

interest in exercise and adherence to physical activity participation [26]. In fact, exercise program structured with participation of individuals as secondary outcome is known to contribute little effects [27]. Therefore, there is a need to give individual participation a priority when structuring exercise program.

Role of exergames on autism spectrum disorder

There is evidence that exergames with high aerobic activity may improve repetitive behavior and executive function in children with ASD [28]. In addition to the significant contribution of exergames to motor memory and metacognition, it is found to be effective in improving motor deficiency in autistic children [29]. Given the relationship between executive function and motor proficiency, effective, interesting and motivating intervention such as exergames should be used to elicit maximum impact [30]. Also, perceptions of children with ASD about their motor skills could positively be influenced through exergame intervention [31]. Although with little movement, a virtual reality training which involves arm or body movement could significantly improve skills and cognition in young adult with high functioning ASD [32]. Therefore, exergame may present effective intervention towards improvement of motor skill in children with ASD either with high or low functioning status. It is important to note that intrinsic motivation and self-efficacy could significantly increase using exergame intervention [33]. Also, exergame is a novel intervention that increases physical activity and may contribute to improved health outcomes in children [33, 35]. More importantly, exergames could elevate energy expenditure to a moderate-vigorous intensity level [36]. To this effect, exergame may be an alternative intervention for reducing sedentary life style and promoting health outcomes in children and adolescents [36, 38]. It is amazing to note that exergame does not only positively contribute to physical rehabilitation but also provides maximum form of entertainment [39]. Another advantage of exergames is its inclusiveness which does not necessarily require modification and adjustment thereby providing social benefit, cost effectiveness and easy access [40]. With the use of exergames, typically developing children could obtain same exercise related-benefits as those children with disability [41]. Exergame is relatively emerging intervention that is attracting growing investigation on its benefits on the health outcomes in diverse population. However, there is little information on the benefit of exergames on motor skill in children with ASD. Further, there is no clear indication if exergames could improve habitual sedentary life style in the people at the low end of the spectrum.

Table 1: Summary of Exergames Study

Author	Design	Age	Sample	Intervention	Frequency	Functioning	Outcomes
Getchell <i>et al.</i> 2012	Randomized Trial	17.50±2.4 17.23±4.1	30	Dance dance Revolution, Wii Fit &Wii Sport	2 weeks	High Functioning	Increased moderate to vigorous PA
Edward <i>et al.</i> 2017	Randomized Trial	6-10	20	X Box Kinect	2 weeks 3times/week	N/A	Improved perception of skill
Hilton <i>et al.</i> 2015	Cross Sectional	8-18	17	Speed-based (Makoto Arena)	6-8 weeks 30 sessions	High Functioning	Increased motivation for physical activity Reduced motor skill deficiency

Daphne <i>et al.</i> 2017	Randomized Trial	8-11	17	X box Kinect	1-2 weeks	N/A	Increased physical activity
Arpita, <i>et al.</i> 2015	Cross Sectional	8-19	18	Kinect Game	3 months	High Functioning	Improved motor skill
Hilton <i>et al.</i> 2014	Cohort	6-14	8	Makoto Arena	30 session 3 times /week	N/A	Improved reaction speed and motor performance
Evans 2014	Cohort	12-21	15	Xbox Kinect Boxing and Nintendo wii Boxing	N/A	High and low functioning	Increased moderate to vigorous physical activity

Discussion

There is evidence that exergames are capable of improving the moderate to vigorous physical activity participation in children and adults with ASD [38, 42]. In a study conducted by Getchell *et al.* 2012, two weeks of participation in exergames was found to contribute to improved engagement in moderate to vigorous physical activity [38]. As a result of increased physical activity participation elicited by exergames, there appears that people with ASD could potentially benefit from active engagement in this game.

While investigating the effects of exergames on motor deficiency in ASD, Arpita, *et al.* 2015 found that exergame is an interesting activity which has positive effects on motor skill in this population [43]. This finding was corroborated by Hilton *et al.* 2014 and Edward *et al.* 2017 as they posited that exergame is an effective intervention capable of improving reaction speed and perception of skill [29, 31].

It is interesting to note that exergames intervention does not necessarily require supervision as most children with ASD can actively engage in this activity without been supervised [31]. Although there is a little evidence to suggest that children with ASD can actively participate in exergames without supervision, it is therefore important to further investigate if this assertion is applicable to children on the low end of the spectrum.

Apparently, exergames have been confirmed to be effective interventions for the treatment of ASD [30, 38, 42]. Although investigation on exergames is still at the infant stage, this intervention appears to elicit high motivation to actively engage in physical activity [30]. Similarly, exergames is a very unique intervention that comes with maximum form of entertainment for the participants [39]. Consequently, the great form of entertainment provided by exergames may contribute to the motivation to participate in physical activity.

Limitations

One of the limitations of this review is the inclusion of studies with low population which may affect better understanding of true effects of the intervention. Also, the inclusion of relatively short time intervention studies is another limitation of the review.

Recommendations

It will be worthwhile to compare the effectiveness of exergames with traditional physical exercise with a view to understanding the outstanding contributor that improves physical inactivity in ASD as primary effects of aerobic exercise and motivation in exergames are poorly understood [28]. Furthermore, there is need to investigate the role of exergames on health outcomes and behavior in children with low functioning autism as there is no current literature to

confirm if this intervention could actually motivate the people with ASD on the low end of the spectrum to actively engage in physical activity and consequently enhance their health.

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