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The Effect of Active Video Game (Xbox Kinect) on Static and Dynamic Balance in Children with Autism Spectrum Disorders

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Original Article

Abstract

Introduction: Autism spectrum disorders are of neuro-developmental conditions with the most prevalence among the children during recent years. Children with autism spectrum disorders usually have mobility problems in balance. The purpose of this study was to investigate the effect of active video game on static and dynamic balance in children with autism spectrum disorders.

Materials and Methods: This was a semi-experimental research with pretest-posttest design and control group. 16 children with autism spectrum disorders, aged 6-10 years, were selected and after pretest of static and dynamic balance, randomly assigned to two equal groups of experimental and control. Experimental group received its respective intervention program [athletics, bowling, and boxing as video game (Xbox Kinect)] 2 sessions a week, lasting 45 minutes, over an 8-week period. Control group performed their daily activities. Modified stork test to measure static balance and walking heel to toe test were used to measure dynamic balance. Data were analyzed using one-way analysis of variance test with significance level of less than 0.05.

Results: Significant differences were found between control and experimental groups in static (P = 0.001) and dynamic (P = 0.001) balance.

Conclusion: Based on the results of this study, it can be stated that active video game may bring benefits on static and dynamic balance in children with autism spectrum disorders. Therefore, in order to develop balance in children with autism spectrum disorders, the use of active video game is suggested.

Keywords: Active video games, Static balance, Dynamic balance, Autism

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Introduction

Autism spectrum disorder (ASD) is defined as a neurodevelopmental disorder, a disorder in social interactions and communicational problems, a delay in language development, a change in motor patterns, and the presence of repetitive or stereotypical behaviors (1). The growing number of children with ASD as well as the lack of normal development of their motor skills have made this a major issue in today's society and educational environment (2). Children with ASD have limited opportunities to successfully participate in physical activities due to sedentary lifestyle, putting them at risk for diseases related to sedentary lifestyle and movement disorders (3). 50-70% of children with autism have significant delays in basic motor skills (4-6). These movement disorders include difficulty controlling basic movements (walking, posture, coordination, and balance). Parents and professionals frequently observe that children with ASD exhibit clumsy gait and imbalance (7). Children and adolescents with this disorder show poor coordination in the upper limbs to perform visual-motor tasks, as well as in the lower limbs to perform tasks requiring balance (8).

The growing prevalence of ASD and impairment in motor skills in these children has led to many studies carried out on the impact of a variety of motor interventions on the skills of these children. Over the

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past two decades, various exergames [virtual reality (VR) exercises] have been introduced. In 2010, Microsoft released Kinect using an optical sensor to track the movements of the entire body (9). Kinect Xbox games are a new technology with an interactive environment that requires gestures and body movements to simulate on the game screen (10,11). This system is an added mirror in which children with autism can see themselves as virtual dolls or virtual characters who behave in accordance with the children's movements (12). The current exergame console has been specifically designed to support the training of motor activities or rehabilitation (13). Given the advantages such as portability, this device is rarely used to evaluate balance skills. Research to date has reported a positive effect of VR on the individuals' motor function. The results of investigations conducted on the use of exergames in the area of rehabilitation of children with motor disorders in the field of object control, cognitive skills, executive functions, stereotyped movements, and eye and body coordination, have shown a positive effect of these games on children with mobility problems (14-18).

Taking into account the growing trend of the individuals with developmental disabilities, especially autism, which is a lesser-known and increasing disorder in societies, and the incidence of motor problems, especially balance problems in these children, and the importance of balance in daily life, as well as the lack of studies on the role and effect of using active video games on the balance and stability of children with autism, the present study is conducted with the objective to investigate the effectiveness of active video games on the static and dynamic balance of children with autism. New treatments, such as active video games (Kinect Xbox), could be a new step and an effective way to improve the performance of these children.

Materials and Methods

This was a quasi-experimental study conducted with a pre-test and post-test design in two groups. The statistical population of the study consisted of children aged 6-10 years (19) with ASD in Sari City, Iran, who had been registered at Nikandishan Center for Autism in 2018. Of the 24 samples available, 16 children were selected according to the inclusion criteria. It should be noted that the test power was considered to be 80%.

The study inclusion were lack of vision impairment and lack of medical prohibition to perform exercises (including epilepsy and orthopedic and cardiovascular problems) in the children that were examined by a pediatrician (20).

Participating in other regular sports activities, having an exercise program concurrent with the study (to control the confounding factors of the results in groups) that was followed by the center manager and parents, and lack of attending the training sessions were considered as the exclusion criteria.

Ethical standards, including the completion of the consent form by the parents of the children, confidentiality, care of the subjects during the training sessions and tests, and awareness of the implementation process of the project were fully observed. The ethical permission of the study was given by Tarbiat Modares University (TMU), Tehran, Iran, affiliated to the Ministry of Science, Research and Technology with the code IR.MODARES.REC.1398.051 and the code of Iranian Registry of Clinical Trials (IRCT) IRCT2019100904505039N1.

The tools used in the study included the parent consent form and the researcher-made demographic characteristics form. The Kinect Xbox 360 (Microsoft, USA) system, a video game console with motion sensitivity technology, as well as Kinect Sports 1 game (Microsoft, USA), were used to run the active video games. The gaming environment was a 4 × 4 safe place and a 32-inch television with a flat screen (SAMSUNG, South Korea) was used. In order to measure the static balance, the timer (Q&Q, HS45 model, Japan) was utilized.

The working method was as follows: after correspondence with the General Department of Welfare of Mazandaran Province, the official permit to work in the autism center was obtained from the department and after entering the center and expressing the study objectives to the parents of children and explaining the steps of study and obtaining their favorable opinion for participation in the study, consent was obtained from the parents of the subjects. The cardiovascular and musculoskeletal conditions of the subjects were then collected based on their medical records examined by the pediatrician. Before the study and based on the medical records available in the center, the subjects were diagnosed with high-functioning autism (HFA) by the psychiatrist based on the Gilliam Autism Rating Scale-Second Edition (GARS-2), the validity and reliability of which on the Iranian population have been reported acceptable (21).

GARS-2 is a reference tool for diagnosing and classifying the severity of disorder in individuals with ASD, which consists of 4 subscales with each subscale including 14 options and the score of each

item being between 0 and 3 (never to very much). These subscales include stereotypical behaviors, communication, social interactions, and developmental disorders (22).

In order to measure static balance, the modified stork balance test was employed (23). The test was performed in which the subject stood with one foot on a flat surface and raised his free leg to the level of the ankle of the support leg, with both hands placed next to the body and they could move their hands freely. The tester measured the maximum time the subject stood on his or her foot with the timer, and stopped when he or she placed his or her foot on the ground. This test was performed twice for both legs and the best time was recorded.

In order to measure dynamic balance, the heel-to-toe walking test was used (23). The test was performed in such a way that the subject walked as heel-to-toe on a specified path for 15 steps. The maximum test score was 15. If the subject deviated before completing the 15 steps, the test would be stopped and the number of steps would be recorded. This test was performed twice and the best score was recorded as the test record.

It should be noted that two weeks before the start of the study, the examiner was present at the center to get more familiar with the children as much as possible. Given the low level of attention, concentration, accuracy, and motivation in these children, which in some cases was associated with poor eye contact, as well as the lack of participation and vibrancy of some people, the process of measurement required more time compared to the healthy counterparts and the tester tried to control and overcome these conditions and prepare the subject for the test and provide the appropriate response. To determine the dominant leg, the subject was asked to shoot the ball in front of his foot.

After participating in the static and dynamic balance test, the subjects were homogenized in the two experimental (n = 8) and control (n = 8) groups, and then the groups' labels were specified by random assignment (Figure 1). In addition to the daily practice at the autism center, the experimental team performed Kinect Xbox games that included athletics, bowling, and boxing. These programs ran for 8 weeks, two sessions per week, and a total of 16 sessions (17). Each session lasted 45 minutes. The subjects of the control group also performed the routine occupational therapy exercises individually with the same number as the experimental group sessions. These programs, including play therapy, physical-motor occupational therapy, etc., were performed by the occupational therapists during official hours at the autism center.

After examining the normal distribution of the data using the Shapiro-Wilk test and the equivalence of the variances using the Levene test ($P > 0.05$), the one-way analysis of variance (ANOVA) test was used in order to compare the scores of the two groups in each subscale in the posttest stage with the removal of the possible effect of the pretest scores. Data were analyzed using SPSS software (version 21, IBM Corporation, Armonk, NY, USA).

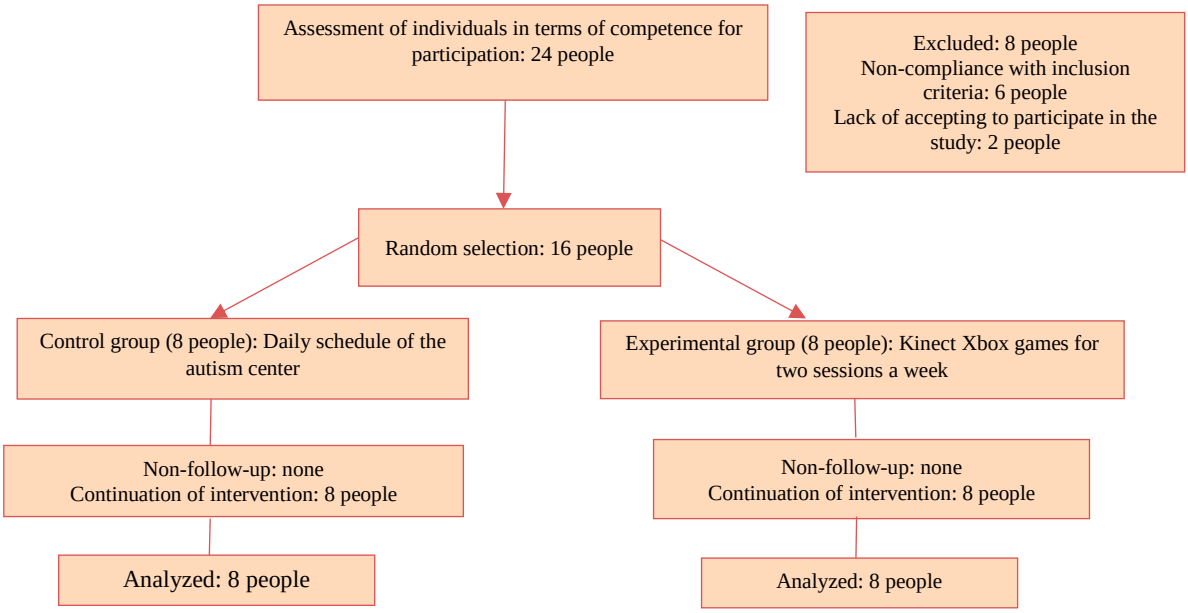

Figure 1. Study flow and process

Results

The demographic characteristics of the subjects are presented in table 1. Table 2 demonstrates the results of the descriptive statistics of the static and dynamic balance scores in the pre-test and post-test scales.

Table 1. Demographic characteristics of subjects (8 people in each group)

Variable	Group	
	Experimental	Control
Age (year)	8.60 ± 2.53	9.10 ± 2.01
Weight (kg)	35.98 ± 18.80	36.75 ± 17.90
Height (cm)	12.055 ± 19.66	121.55 ± 220.46
BMI (kg/m^2)	24.98 ± 1.60	25.10 ± 1.40
Gender		
Male	5	6
Female	3	2
Dominant side		
Right	5	5
Left	1	1
Parents' literacy level		
Diploma, lower	1	2
Associate and graduate	6	5
Master's and above	1	1

BMI: Body mass index
Data are reported based on mean ± standard deviation (SD).

One-way ANCOVA test was employed to assess the effect of active video game interventions on the static and dynamic balance in children with ASD. Accordingly, there was a significant difference between the experimental and control groups in terms of static balance (mean squares = 21.967, F = 8.710, P = 0.002) and dynamic balance (mean squares = 15.130, F = 10.293, P = 0.001) and it can be stated that active video games improved the static and dynamic balance of children with autism in the posttest stage.

Table 2. Mean static and dynamic balance scores in children with autism

Variable	Group	
	Experimental	Control
Static balance		
Pre-test	3.83 ± 1.47	43.58 ± 1.20
Post-test	6.33 ± 1.86	4.33 ± 1.37
Dynamic balance		
Pre-test	4.33 ± 1.16	4.67 ± 1.07
Post-test	6.17 ± 1.16	4.92 ± 1.31

Data are reported based on mean ± standard deviation (SD).

Discussion

The present study was accomplished aiming to investigate the effect of active video games on the static and dynamic balance of children with ASD. Based on the results, it can be concluded that the use of active video games improves the balance in children with ASD. Kinect-based VR training is a new technology that is increasingly being used in the rehabilitation system for different individuals (24).

The results of the present study were consistent with the findings of the studies performed by Vernadakis et al. (17), Jelsma et al. (25), and Lotfi et al. (26). While no specific treatment has yet been found for autism, there are appropriate intervention methods that can be used to help these children develop more abilities (27). Since behaviors and disorders in children with ASD vary widely, several treatment programs have been developed for these subjects. In general, it seems that practicing in a virtual environment by playing an exergame can provide better learning opportunities. According to a study accomplished by Stanmore et al., enjoying physical activity is one of the most important elements in determining whether a person will maintain their commitment to the activity, and the virtual environment can create more pleasure among users compared to traditional exercises (9). Moreover, Putnam and Chong reported in their study that people with ASD consistently enjoy interactions with technologies such as computers and games (28). One of the reasons for the improved performance and balance in the VR environment is that Kinect does not require manual control. Therefore, the player uses his/her whole body to control the game and interact in the virtual environment (28).

The reason for the effectiveness of the exergames on the individuals' motor learning can be explained by the fact that the method used in teaching children with ASD is often a method that ensures the use of any visual, auditory, and tactile stimuli (29). When more than one sense is involved in performing a skill, children are allowed to learn more easily and quickly (30). Through visual, auditory, and tactile stimuli, these games enable people with ASD to acquire skills in less time and in a more sustainable manner (31).

Subjects with ASD have limited physical activity opportunities in the community and also the chance to participate in purposeful games with normal people and they are often rejected by these people. Therefore, using active video games in subjects with ASD can help them learn new motor skills in a safe and secure environment. Thus, coaches and athletes who work with people with ASD are recommended to use active video games in practical classes and in the areas of motor learning for these individuals for more productivity of training motor skills.

Limitations

Although the present study is one of the first research initiatives to use effective yet enjoyable technologies to perform balance skills in children with autism, there were some limitations, including the small number of samples. Therefore, it is recommended that future studies be conducted on a larger number of samples. Furthermore, four girls participated in the study, indicating that the effect of gender on the results was not controlled.

Recommendations

Based on the results of the present study on the effectiveness of exergames on the balance of children with autism, it is recommended that programs for the use of these games be included in the weekly program for children with autism. It is also suggested that the effect of these games on fine and gross motor skills, stereotyped behaviors, social behaviors, etc. of children with autism and other disorders be examined.

Conclusion

Overall, the use of active video games appears to affect the static and dynamic balance of children with autism.

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Authors' Contribution

Neda Ghobadi: Study design and ideation, attracting financial resources for the study, supportive, executive, and scientific services of the study, data collection, analysis and interpretation of results, specialized statistics services, manuscript preparation, specialized manuscript evaluation in scientific concepts, confirming the final manuscript to submit to the journal office, responsibility of maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments; Farhad Ghadiri: Study design and ideation, supportive, executive, and scientific services of the study, analysis and interpretation of results, specialized manuscript evaluation in scientific concepts, confirming the final manuscript to submit to the journal office, responsibility of maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments; Rasoul Yaali: Study design and ideation, supportive, executive, and scientific services of the study, analysis and interpretation of results, specialized manuscript evaluation in scientific concepts, confirming the final manuscript to submit to the journal office, responsibility of maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments; Ahmadreza Movahedi: Study design and ideation, supportive, executive, and scientific services of the study, analysis and interpretation of results, specialized manuscript evaluation in scientific concepts, confirming the final manuscript to submit to the journal office, responsibility of maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments.

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Conflict of Interest

The authors did not have a conflict of interest. Dr. Ghadiri and Dr. Yaali are working as assistant professors in the Department of Motor Behavior at Kharazmi University. Neda Ghobadi has been studying at the international campus of Kharazmi University since 2013 as a PhD student in motor behavior.

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