

Can dance exergaming contribute to improving physical activity levels in elementary school children?

M. ADKINS¹, G.A. BROWN¹, K. HEELAN¹, C. ANSORGE², B.S. SHAW^{3,4} AND I. SHAW⁴

¹*HPERLS Department, University of Nebraska Kearney, Kearney, NE 68845, United States of America*

²*Teacher Education Department, University of Nebraska Lincoln, Lincoln, NE 68588, United States of America*

³*Department of Sport and Movement Studies, University of Johannesburg, PO Box 524, Auckland Park, Johannesburg, 2006, Republic of South Africa. E-mail: brandons@uj.ac.za*

⁴*Office of the Deputy Pro Vice-Chancellor: Research, Monash South Africa, P.O. Box X60, Ruimsig, 1725, Republic of South Africa*

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Abstract

Physically active video games that involve dancing are being marketed as possible forms of group physical activity (PA) in schools. However, the efficacy of a group video game dance intervention for reducing sedentary behaviour is unknown. The purpose of the present study was to compare before-school group video game dance interventions to a running club on changes in sedentary (SED) and moderate to vigorous physical activity (MVPA) time in 7 to 10-year-old children. For seven weeks, 88 subjects aged 7 to 10 years participated in a running club (RUN) twice weekly. For an additional seven weeks, subjects were randomly assigned to engage in a before school club and play WiiTM Just Dance (JD; n = 53) or Dance, Dance Revolution (DDR; n = 46). SED and MVPA time were assessed using accelerometry and compared to subjects with no intervention (NOPA; n = 45). Results indicated that MVPA time during the club meeting time was less in NOPA (5.2 ± 3.7 min.; $p \leq 0.05$) than RUN (12.7 ± 11.4 min.), JD (9.6 ± 6.5 min.) or DDR (9.3 ± 4.6 min.). Total daily MVPA was not different between JD (118.9 ± 43.8 min.), RUN (105.1 ± 39.4 min.), DDR (94.5 ± 48.9 min.) or NOPA (95.8 ± 35.6 min.). The present study suggests that before-school running and group video game dance clubs increased MVPA compared to those who had no before-school PA. However, it appears that the children compensated for the additional PA by increasing SED behaviour throughout the remainder of the day.

Keywords: Accelerometer, active play, exercise, exergaming.

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Introduction

The prevalence of children categorized as overweight or obese in the United States has increased from 15.5% in 1971 to 31.9% in 2007 (National Association for Sport and Physical Education: NASPE & American Heart Association: AHA, 2010; Wang & Beydoun, 2007). One of the major contributing factors to the

increasing incidence of childhood obesity is the increased time children spend in sedentary behaviours (Freddson, Poher & Janz, 2005; Maloney *et al.*, 2012; Rowlands, Pilgrim & Easton, 2008; Stone, Faulkner, Zeglen-Hunt & Bonne, 2012). In this regard, only one-half of children in the United States regularly participate in vigorous physical activity and only 34.7% of children meet the 60 minutes per day, five days per week physical activity recommendations of the NASPE and Centers for Disease Control (CDC) (CDC, 1999; CDC, 2010; Stone *et al.*, 2008).

In an attempt to increase childhood participation in physical activity, the Comprehensive School Physical Activity Program (CSPAP) was developed through the Child Nutrition and Women, Infants, and Children (WIC) Reauthorization Act of 2004 and included provisions for before-, during-, and after-school physical activity programming for children (Pate, Davis, Robinson, Stone, McKenzie & Young, 2006). In an effort to increase physical activity in children outside of the physical education class, public schools at the elementary and middle levels have begun to implement structured recess time, in-class physical activity sessions and before- and after-school physical activity programmes (Pate *et al.*, 2006; Reilly, 2005; Rideout, Foehr & Roberts, 2010).

However, in spite of the possible benefits arising from school-based physical activity programmes, there is competition for children's attention from entertaining sedentary activities such as playing video games, watching television and/or using a computer. Although most time spent playing video games can be considered as sedentary, in the past few years, several physically active video games have been introduced (NASPE, 2008). For example, the Nintendo Wii™ uses hand-held motion sensing remote controls to control the on- screenplay, thus enabling a person to simulate activities such as boxing, swinging a baseball bat, walking a tight rope or throwing a ball. Initial research suggests that engaging in physically active screen time, such as the motion sensing remote controls used by Nintendo Wii™, increases physical activity in children and that physically active video games could be an effective tool to prevent obesity in children (McWha, Horst, Brown, Shaw & Shaw, 2009; NASPE, 2008). Other physically active video games, such as "Dance Dance Revolution®", use floor mats with arrows upon which a player steps left, right, up, or down to control game play. There are several variations of dancing video game systems (which include game consoles, speakers, and liquid-crystal display (LCD) projectors for use in a large group setting) being marketed to educators as novel and entertaining alternatives to more traditional physical activities (e.g. running or calisthenics, Nintendo Wii™ Group Fitness Mega Arcade Class Bundle®). However, the efficacy of using a dancing video game in a large group setting as a before-school physical activity programme has not been evaluated.

Methodology

Participants

Three hundred K-5th grade students from one elementary school in a rural Nebraska town with a population of approximately 30 000 were invited to participate in this project through announcements in their homeroom classes. Fifty-three females and forty-six males with an average age of 8.1 ± 1.7 years participated in the study (Table 1). All subjects provided assent and their parents provided written consent to participate in the study, which was approved by the Institutional Review Board at the University of Nebraska at Kearney and the University of Nebraska at Lincoln. All subjects were free from known exercise contra-indications to exercise.

Anthropometric Measurements

All measurements were collected during regular physical education class times. Body mass was measured to the nearest 0.1 kilogram (kg) using an electric digital scale (Model PS6600, Befour Inc., Suakville, WI) and body height was measured to the nearest 0.5 centimeters (cm) using a stadiometer (Model 707, Seca, Hamburg, Germany). Body mass index (BMI) was calculated by dividing body mass by stature squared (weight/stature^2) and expressed as kilograms per square meter (kg.m^{-2}). All measurements were taken with subjects wearing minimal clothing and no shoes

Intervention

Eighty-eight children (47 males and 41 females) (Table 1) participated in a running club (RUN) for seven weeks. The RUN group met on the school playground at 07:30 on Mondays and Wednesdays and the subjects followed a marked 400 meter (m) course with adult volunteers stationed at the corners to help guide the subjects through the course. The subjects were not given a specific pace to follow, but were encouraged to acquire as many laps around the track as possible in the 30 minute time frame. Laps were counted by an adult volunteer placing a dot on the hand of the subject each time a subject passed the starting line. At the conclusion of the activity, the adult volunteer counted the number of “dots” or laps the subject completed.

Table 1: Descriptive data for subjects who participated in before-school physical activity interventions that included a running club (RUN), Wii™ Dance Dance Revolution: Ultimate Party 2® (DDR) or Wii™ Just Dance® (JD)

	Running club (RUN) (n = 88)	Wii™ Dance Dance Revolution: Ultimate Party 2® (DDR) (n = 46)	Wii™ Just Dance® (JD) (n = 53)	No intervention (NOPA) (n = 45)
Age (years)	7.9 ± 1.7	8.3 ± 1.7	8.1 ± 1.9	8.1 ± 1.3
Stature (cm)	52.6 ± 4.3	53.1 ± 4.9	53.1 ± 5.01	53.0 ± 4.1
Body mass (kg)	70.2 ± 21.7	71.6 ± 23.7	74.6 ± 26.9	71.0 ± 19.6
BMI (kg.m ⁻²)	17.5 ± 3.3	17.4 ± 3.1	18.0 ± 3.4	17.46 ± 2.8

Values are means ± standard deviation (SD); cm: centimeters; kg: kilograms; BMI: body mass index; kg.m⁻²: kilograms per square meter

Following the seven-week running intervention, subjects were randomly divided into two groups playing either Wii™ “Just Dance®” (JD) (Nintendo of America Inc., Redmond, Washington) or Wii™ “Dance Dance Revolution: Ultimate Party 2®” (DDR) (Nintendo of America Inc., Redmond, Washington). Eleven additional children who were not part of the running club chose to participate in the interactive videogame portion and these subjects were also randomly assigned to either JD or DDR. The groups were not even in number due to several parents requesting their child be assigned to the alternative group due to transportation issues. This alternative assignment occurred after the first week of completing the programme and to avoid confusion no other subjects were asked to change days. The JD group met in the school gymnasium on Mondays and Wednesdays at 07:30 while the DDR group met in the school gymnasium on Tuesdays and Thursdays at 07:30. The JD and DDR were required to meet on different days due to a limited facility space. All subjects were provided a short instruction on how to play JD or DDR, depending on which group they were assigned to. All JD and DDR subjects commenced each session on the lowest level of difficulty as allowed by the Wii™ “Just Dance®” (Nintendo of America Inc., Redmond, Washington) or Wii™ “Dance Dance Revolution: Ultimate Party 2®” (Nintendo of America Inc., Redmond, Washington) gaming software.

While playing JD, for each song one subject was selected to hold the Wii™ remote in one hand, then positioned in front of the Wii™ console, while attempting to follow the dance routine projected by an LCD projector onto a wall in the facility. Determination of which subject would be holding the remote for each song was accomplished by moving down the roster list and after a subject’s name was called, their name was checked off the list of names listed alphabetically by last name. This process was repeated each day, starting from where the previous session had finished and progressing through the complete roster before starting once again at the beginning. The remainder of the subjects

not holding a remote were scattered around the facility and found their own personal space (roughly the length of their arms away from one another) to view and participate in JD. “Just Dance[®]” is a music and rhythm video game that allows an individual to emulate dance moves by practising eye-body coordination while engaging in whole body physical activity. When playing Wii[™] “Just Dance[®]”, the player uses the Wii[™] remote to follow the moves of a character shown on-screen completing a variety of dance moves. Scores earned by the subjects while playing JD were not recorded due to the variability in the beat and rhythm of the songs which would have greatly influenced the possible score earned as well as the difficulty of the movements to be emulated.

While playing DDR, four subjects were selected for each song to perform the activity on the “scoring dance platforms,” while the remaining subjects were scattered around the facility on non-scoring dance platforms. After each song, four new subjects would move onto the scoring dance platforms and those who had just used the scoring dance platforms would move onto non-scoring dance platforms based upon a randomly established participation order list posted on the facility wall and also verbally communicated to the subjects after each song. The scoring dance platforms were connected to the Wii[™] console and thus the subject using these platforms could earn a score, while the non-scoring platforms looked very similar but were not connected to the Wii[™] console. Each dance platform (scoring or non- scoring) was composed of a central standing point and of four arrows corresponding to stepping forward, backward, left or from the central space. The video game was projected onto a wall in the facility, and as the song was played, arrows would scroll along indicating in which direction the subjects should step from the central starting space. Scores earned by the subjects while playing DDR were not recorded due to the variability in the beat and rhythm of the songs which would have greatly influenced the possible score earned as well as the difficulty of the step to be followed.

Physical activity measurement

In order to assess the changes in physical activity due to the interventions, following the completion of the RUN, DDR and JD interventions, subjects were asked to volunteer for their physical activity assessments when no intervention was offered, and 45 (24 females, 21 males) subjects obliged.

Moderate to vigorous physical activity (MVPA) and sedentary (SED) time were assessed using accelerometry (#AM7164, Actigraph Inc., Pensacola, FL). Accelerometers were provided to the subjects on Mondays at 07:30 and the subjects were instructed to wear the accelerometer at hip level directly over the right knee for four consecutive days and to only remove the accelerometer when sleeping or bathing.

The accelerometers utilised were small (5.1 x 3.8 x 1.5 cm), light weight (45 grams) uniaxial calculators designed to detect vertical acceleration ranging in magnitude from 0.05 to 2.00 G with frequency response of 0.25 to 2.50 Hz. The accelerometer parameters allowed for a high detection of normal human movement and filtered out high frequency vibrations such as shaking of the monitor. The filtered acceleration signal is digitised and the magnitude is summed over a user-specified time interval. At the end of each interval, the summed value or activity “count” is stored in memory and the integrator is reset. The classification of each category (SED, light, moderate, vigorous, or hard activity) based on counts per minutes allowed the number of minutes of each type of physical activity or SED time to be assessed and the cut points established by Freddson, Pober and Janz (2005) were used for this purpose (Lanningham-Foster *et al.*, 2006; Pate *et al.*, 2006).

Sedentary time was defined as activity equal to one Metabolic Equivalent for Activity (MET) or less or less than 100 ActiGraph™ counts per minute (counts·min⁻¹). Light activity was defined as activity equal to or greater than 1 MET and less than 4 METs, or between 100 and 2999 ActiGraph™ counts·min⁻¹. Moderate activity (equal to or greater than a brisk walk) levels equaled 4 METS or thresholds greater than 3000 to 3600 ActiGraph™ counts·min⁻¹, vigorous activity (equal or greater than a light jog) was greater than or equal to 7 METS or thresholds greater than 3600 to 9630 ActiGraph™ counts·min⁻¹ and hard activity (equal or greater than fast run) was greater than or equal to 10 METS or 9630 ActiGraph™ counts·min⁻¹. However, of these, only moderate, vigorous, and hard PA are considered to be health promoting PA (Lanningham-Foster *et al.*, 2006; Trost, McIver & Pate, 2005; Tudor-Locke, Lee, Morgan, Belghle & Pangrazi, 2006; Wang & Beydoun, 2007). Following the four days of wearing the accelerometer, the data from each accelerometer were downloaded to a computer and Actilife software (v 6.0, Actigraph Inc., Pensacola, FL) was used to convert the counts per minute to minutes of SED and MVPA. The minutes of SED and MVPA between 07:15 and 08:15 were used to determine the amount of physical activity induced by RUN, JD, DDR, and NOPA. The minutes of total daily SED and MVPA were used to compare the effects of RUN, JD, DDR and NOPA on total daily physical activity.

Statistical analysis

Data were presented as means ± standard deviations. Accelerometry data were analyzed using statistical software (SAS® version 9.1, Cary, N. C.) to compare the amount of total daily SED time, and total daily MVPA time in the RUN, JD, DDR and NOPA groups. A one-way ANOVA with repeated measures and Duncan *Post-Hoc* test with an alpha level set at 0.05 was used to identify differences in SED and MVPA as well as between total daily SED and MVPA between 07:15 and 08:15 caused by the RUN, JD, DDR and NOPA interventions. A one-way ANOVA with repeated measures and Duncan *Post-*

Hoc test set at an alpha level of 0.05 was used to identify differences in total daily SED and MVPA between the RUN, JD, DDR and NOPA groups.

Results

Attendance rates for the interventions were $68.6 \pm 11.7\%$ for the RUN, $75.5 \pm 10.9\%$ for the JD and $81.8 \pm 5\%$ for the DDR intervention. There was significantly ($p > 0.05$) more minutes of MVPA following the RUN, JD and DDR interventions when compared to the NOPA intervention (Table 2). In addition, there were no significant differences found in MVPA time between JD, DDR, and NOPA. The study also demonstrated that there were significantly more minutes of SED between 07:15 and 08:15 in the NOPA group when compared to the RUN, JD or DDR groups. No significant differences were found in SED time between the JD, DDR and NOPA groups.

Table 2: Minutes of sedentary (SED) and moderate- to vigorous-physical activity (MVPA) during a before-school fitness club for kindergarten-fifth grade students as measured by accelerometry

	Running club (RUN) (n = 88)	Wii™ Dance Dance Revolution: Ultimate Party 2® (DDR) (n = 46)	Wii™ Just Dance® (JD) (n = 53)	No intervention (NOPA) (n = 45)
SED (min)	29.2 ± 12.4	31.4 ± 13.0	31.7 ± 10.2	40.0 ± 10.5*
MVPA (min)	12.7 ± 11.4	9.3 ± 4.6	9.6 ± 6.5	5.2 ± 3.7*

Values are means ± standard deviation; *: Indicates significant difference from other groups ($p \leq 0.05$); SED: Minutes of sedentary behaviour; min: minutes; MVPA: minutes of moderate to vigorous physical activity

At the conclusion of the present study, it was found that there were no significant ($p \geq 0.05$) differences in total daily MVPA time between the NOPA, JD, DDR and RUN interventions (Table 3). Further, the present study did not find any significant difference in total daily SED time between the NOPA, JD, DDR and RUN groups.

Table 3: Minutes of total daily sedentary (SED) and moderate- to vigorous-physical activity (MVPA) for kindergarten-fifth grade students enrolled in a before school fitness club as measured by accelerometry

	Running club (RUN) (n = 88)	Wii™ Dance Dance Revolution: Ultimate Party 2® (DDR) (n = 46)	Wii™ Just Dance® (JD) (n = 53)	No intervention (NOPA) (n = 45)
SED (min)	1 080.1 ± 68.4	1 169.4 ± 335	1 062.9 ± 73.3	1 094.3 ± 83.2
MVPA (min)	105.1 ± 39.4	94.5 ± 48.9	118.9 ± 43.8	95.8 ± 35.6

Values are means ± standard deviation; SED: Minutes of sedentary behaviour; min: minutes; MVPA: minutes of moderate to vigorous physical activity

Discussion

The purpose of this study was to determine if the use of a physically active group dance video game in a before-school physical activity programme could increase the total amount of daily moderate to vigorous physical activity and decrease sedentary time in children. The present data indicate that there are similar increases in moderate to vigorous physical activity during before-school activity programmes using group dance video games and a running club. However, the study found no differences in total daily sedentary time or moderate to vigorous physical activity time among children when the before-school physical activity programmes were implemented and when no physical activity intervention was provided. These findings suggest that the children compensated for the increased morning physical activity by being more sedentary throughout the remainder of the day.

The NASPE recommends that children receive daily physical activity with a minimum of 60 minutes at MVPA levels (NASPE, 2008). However, in spite of the collaborative efforts of schools and states, most children do not meet the national recommendations (CDC, 2010). As such, “exergaming” activities such as the group dance video games are marketed to parents, teachers and schools as a form of physical activity to increase daily activity levels. To support these claims, research conducted on such active video games appear to provide satisfactory heart rate responses to facilitate improvement in cardiorespiratory fitness, an increase in moderate to vigorous physical activity and have the potential to meet the physical activity guidelines similar to other forms of exercise (Maloney *et al.*, 2012). In this regard, the findings of the present study are in agreement with the previous research in suggesting that group dance video games can be a viable alternative to a more traditional running programme to enhance physical activity in children.

The findings of the present study are also in agreement with previous findings of an increased physical activity and energy expenditure in children while playing “physically active” video games (Daley, 2009; Höysniemi, 2006; Maloney *et al.*, 2012). However, changes in total daily physical activity and sedentary time when using a before school physical activity programme using group dance video games has not been previously been investigated. The present study demonstrated that compared to no morning physical activity programming, there were no reductions in total daily sedentary time when children played the interactive games, or participated in a running programme before school. Similarly, compared to no exercise programming, there were no differences in total daily moderate to vigorous physical activity when children played interactive games or participated in a running programme before school. These findings suggest that although the children participated in a before-school physical activity that increased the moderate to vigorous physical activity during the structured activity time, the amount of total physical activity did not change. To date, no studies were found researching the relationship of daily physical activity and sedentary behaviour when a before-school physical activity programme was offered. Studies conducted on physical activity throughout the day and programme offering after-school physical activity, have shown a positive relationship between opportunities to be physically active throughout the school day and daily moderate to vigorous physical activity counts (Tudor-Locke *et al.*, 2006). However, the findings of the present study suggest that when children are involved in a before-school physical activity programme, there may be a compensatory reduction in physical activity throughout the remainder of the day that nullifies the increased physical activity of the exercise programme. According to Epstein, Paluch, Gordy and Dorn (2000), this finding has similarly been found in adults.

Conclusion

The findings of the present study indicate that a before-school physical activity programme that uses dance video games in a group setting, or a running club increases physical activity during the course of the intervention. However, a concomitant reduction in physical activity throughout the remainder of the day may nullify the physical activity benefits of the before school physical activity programme. As such, further research is needed to discern the benefits, or lack thereof, of before-school physical activity programmes.

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