



THE IMPACT OF A SCHOOL-BASED ACTIVE VIDEO GAME PLAY INTERVENTION ON CHILDREN'S PHYSICAL ACTIVITY DURING RECESS

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ABSTRACT

Purpose. To assess physical activity levels during active video game play over time and compare this to 'free play' associated with recess activity in a sample of British primary school children over a 6-week period. **Basic procedures.** Thirty children (ages 10–11, 12 boys, 18 girls) from central England were randomly selected to participate in a 6 week, recess based, active video gaming intervention ($n = 15$) or act as controls ($n = 15$). Repeated measures analysis of covariance (controlling for body fatness) was used to examine any differences in physical activity, determined by pedometry and heart rate monitoring over time and between intervention and control groups. **Main Findings.** Children in the intervention accumulated significantly greater steps/day than the control group during the first week of the intervention. This pattern was reversed at the mid and end points of the intervention ($p = .03$). Irrespective of time point, children engaging in active video game play spent a lesser percentage of time engaged in MVPA than the controls undertaking 'traditional' recess activity ($p = .0001$). **Conclusions.** Active video game play does not appear to be a sustainable means to enhance children's physical activity. Although physical activity (steps/min) was greater on initial presentation of active video games compared to 'traditional' recess activity, this appears to be an acute effect.

Key words: pedometer, heart rate monitoring, recess, steps, exergaming

Introduction

It has been accepted by scientists and health practitioners alike that media-based sedentary behaviours such as TV viewing and leisure time computer use compete for time that might otherwise be spent in physical activity, which might lead to obesity [1, 2]. One particular influence on children's health related behaviour that has received substantial media attention is computer and video game play. Moreover, children today have not only been described as fatter than previous generations, but also less active, less athletically skilled, less interested in physical activity, less self-disciplined (and therefore more likely to choose the 'easy' or 'soft' option, be it with respect to physical activity or food) and more addicted to technology [3]. This has subsequently led researchers to suggest that children's computer/video game behaviour should be the subject of further scrutiny when examining health behaviours [2].

Recently, technological advances have led to the development of active video gaming such as the Nintendo Wii, partly in an attempt to convert sedentary screen

time to active screen time and to promote children's physical activity. However, evidence supporting this idea is scant and that which is available has tended to be laboratory based. Lanningham-Foster et al. [4] reported that active video game play was associated with increased energy expenditure (EE) compared to resting energy expenditure (REE) and EE during seated gaming. Active gaming, using the Sony eye toy, increased EE by 273 kJ/h above REE whereas active gaming using a dance mat game increased EE 382 kJ/h above REE in 25, 9 year old children. They concluded that activity promoting video games more than doubled the energy expenditure compared with chair-based equivalents and offer a potential approach for reversing sedentariness and reducing pediatric obesity. Likewise, a further laboratory study by Graves et al. [5] examined energy expenditure during active and sedentary game play in 11, 13–15 year old adolescents. They concluded, similar to Lanningham-Foster et al. [4] that, active video games use significantly greater energy than sedentary game play but are not of sufficient intensity to contribute towards the recommended daily amount of exercise in children. However, both these studies were laboratory based and examined the acute impact of active video game play on

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physical activity. Both authors have highlighted further research examining this issue in other settings and with varied age ranges as a priority.

More recently, McDougall and Duncan [6] reported that, in a sample of 12, 8–11 year old children who engaged in active video game play during school recess over one week, children accumulated approximately 10% of the recommended number of steps/day for health. They however, highlighted the short duration of their study as a limitation and suggested that future research examine the potential of active video game play as a means to enhance children's physical activity at recess over a longer period. Therefore, the purpose of this study was to assess physical activity levels during active video game play over time and compare this to 'free play' associated with recess activity in a sample of British primary school children over a 6-week period.

Material and methods

Participants

Following ethics approval and parental informed consent, 30 children (12 boys, 18 girls) from 2 primary schools in central England were randomly selected to participate in a 6 week, recess based, active video gaming intervention. Children were from school year 6 (ages 10–11) and the mean age (SD) of the children was 10.4 (0.5) years. Fifteen children from each school undertook twice weekly sessions of active video gaming during school lunch breaks with 15 children acting as controls. There was an equal gender split between groups and across schools with 6 boys and 9 girls in both the intervention and control groups. The schools were located in the same geographical area of England and did not differ in regard to indices of deprivation.

Procedures

The intervention group undertook twice weekly active video game play sessions instead of their regular recess activity for 6 weeks. The control group took part in their normal recess activity only. Active video game play sessions used the Nintendo Wii console and employed 3 game titles, Wii Sports (Tennis), Sonic and Mario at the Olympics (100 m, 110 m hurdles) and Celebrity Sports Showdown (Horse Racing). Game titles were rotated during each session in order to avoid children becoming bored by playing the same game. This

ensured that the children played all of the active video games during each active game play session. The playground provision across both schools that participated in the study was similar in terms of area and equipment provided during recess ($p < .05$). In addition, the duration of school recess periods was identical across schools.

Physical activity was assessed at recess during the first, third and sixth weeks of the 6-week period for both groups using pedometry and heart rate monitoring. Physical activity was assessed using a sealed, piezo-electric pedometer (New Lifestyles, NL2000, Montana, USA) which was worn throughout the game play and recess periods. The physical activity monitoring/game play periods were set at 30 minutes across schools and across intervention and control groups. However, step counts were converted to steps/min in order to account for minor variations in the time engaged in recess activity between groups across the monitoring period and in accordance with recommended guidelines [7]. In addition, heart rate data was collected using Polar RS400 heart rate monitors (Polar Electro, OY, Finland), covered with a purpose built shield to prevent children gaining feedback during recess periods. Heart rate was recorded every 5 s. Resting heart rate was determined a priori by averaging the 5 lowest heart rate values recorded for each child [8] lying supine for a 10 minute period in a darkened room. These were determined 24 hours prior to the intervention beginning but following familiarisation sessions described below. Heart rate reserve (HRR) values of 50 (HRR_{50}) and 75 (HRR_{75}) percent were used as threshold values to represent moderate-to-vigorous physical activity (MVPA) and in agreement with prior studies of children's recess based activity [9]. In all cases monitors/pedometers were placed on the children prior to the start of their lunch recess period and the children consumed their lunches at the end of the recess period in order to ensure that heart rate measurements were not affected by dietary induced thermogenesis following lunch.

Prior to commencing the intervention or control periods measurement of stature (to the nearest 0.1 cm) was recorded using a Leicester Height Measure (Seca Ltd., Birmingham, UK). Body mass was assessed using calibrated scales (Seca Ltd., Birmingham, UK) and percent body fatness was determined using bioelectrical impedance analysis (Tanita BF305, Tanita Inc, Japan). This form of bioelectrical impedance analysis has previously been validated with pediatric populations and shows

Table 1. Mean (SD) of children's anthropometric characteristics

	Age (years)	Body Mass (kg)	Stature (m)	Body Fatness (%)
Group ($n = 30$)	10.4 (.50)	38.6 (8.2)	1.44 (.06)	20.1 (4.3)
Intervention ($n = 15$)	10.4 (.50)	38.7 (7.8)	1.44 (.07)	20.2 (4.6)
Control ($n = 15$)	10.4 (.51)	38.5 (8.9)	1.43 (.06)	19.9 (4.2)

Table 2. Mean (SD) of steps/min and percentage of recess time spent in MVPA across the monitoring period

	Steps/Min Week 1	Steps/Min Week 3	Steps/Min Week 6	MVPA Week 1 (% recess time)	MVPA Week 6 (% recess time)
Intervention ($n = 15$)	28.9 (8.6)	18.9 (8.5)	19.3 (5.6)	15.9 (8.3)	12.1 (6.0)
Control ($n = 15$)	27.0 (4.2)	25.1 (6.9)	25.1 (3.7)	23.1 (8.9)	25.2 (11.2)

good reliability and validity [10, 11]. The mean (SD) values for the children's anthropometric characteristics are shown in Tab. 1. In addition, children were familiarised with the physical activity monitoring equipment to be used in the study. The children undertaking the active video game play sessions were also familiarised with the Nintendo system to be used as part of the study. Brief focus group interviews ($n = 6$ approx per group) were also employed prior to any physical activity assessment/video game sessions in order to ascertain children's prior experience with video games in general and the Nintendo Wii specifically. These indicated that all the children possessed at least 1 video game console, 60% owned the same console that was used in the current study and 100% had experience of using/playing the same console that was used in the current study. Children who missed 2 scheduled sessions or more of the monitoring period were excluded from the data set. This resulted in 2 exclusions, both of whom were boys.

Statistical Analysis

Any differences in physical activity across the 6-week period and between intervention and control groups were examined using 3 (measurement period) by 2 (group) repeated measures Analysis of Covariance (ANCOVA) controlling for body fatness. The dependent variables were the percentage of time spent in MVPA and the steps/min taken at each measurement point. The statistical package for social sciences (Version 16) was used for all analysis and the alpha level was set at $p < 0.05$.

Results

In regard to pedometer data, repeated measures ANCOVA indicated significant steps by group interaction

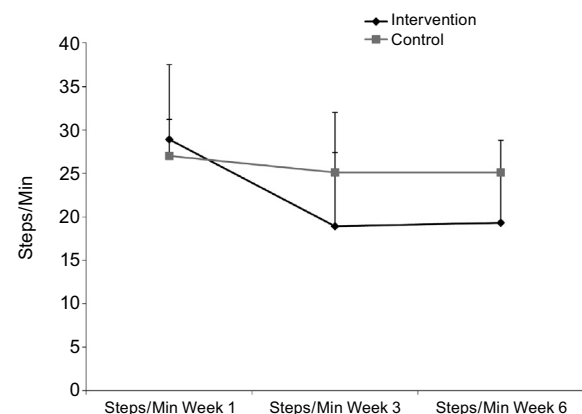


Figure 1. Mean (SD) of steps/min between intervention and control group during the first, third and final week of the intervention period

($F_{2, 54} = 3.74, p = .03$) with number of steps/min being greater for the intervention group in the first week of the intervention period but lower than the control group at the mid and end points of the 6-week period (see Fig. 1). Bonferroni post hoc pairwise comparisons indicated no significant differences between steps/min across the periods for the control group (all $p < .05$) but significant differences between steps/min taken in the first week of the intervention and the mid point of the intervention (Mean Diff = 9.95, $p = .01$) and between the first week of the intervention and the last week of the intervention (Mean Diff = 9.56, $p = .01$). In regard to heart rate, a significant main effect for the percentage of time spent in MVPA ($F_{1, 28} = 15.6, p = .0001$) was evident and indicated that the percentage of time spent in MVPA was significantly lower in the intervention group, compared to the control group, across the intervention period. There were no other significant interactions or main effects (all $p < .05$). Mean (SD) of steps/

day and percentage of recess time spent in MVPA for both groups and across the intervention period are presented in Tab. 2. Analysis also indicated that there were no significant differences in variables across the two schools that participated in the study (all $p < .05$), confirming the similarity of recess conditions across the two participating schools.

Discussion

The purpose of this study was to assess physical activity levels during active video game play over a 6-week period and to compare this to 'free play' associated with recess activity in a sample of British primary school children. The results from this exploratory study suggest that there is an acute effect of participating in active video game play whereby physical activity (steps/min) during recess was greater for children engaging in active video game play compared to those engaging in regular recess. However, this was not sustained and physical activity at weeks 3 and 6 was lower for the video game group compared to the control group. Heart rate data also support these assertions as the percentage of time spent in MVPA during traditional recess was greater than the percentage of time spent in MVPA when playing active video games. These results are novel but add support to laboratory based research which has suggested that active video game play may not be sufficient to contribute to children's recommended daily levels of physical activity [5]. Prior authors have also suggested that active video game play might provide a stimulus for obesity treatment and prevention due to increases in energy expenditure measured in comparison to sedentary game play [4]. Certainly, active video game play results in greater energy expenditure than sedentary game play but, in the context of this study and school recess, traditional recess activities appear to offer a more sustainable way for children to meet physical activity targets or recommendations during school time.

As this study was school-based, recess physical activity was employed in order to provide a comparison for the physical activity undertaken during active video game play sessions. Prior research has reported that children can accumulate substantial portions of their daily-recommended physical activity levels during the free-play associated with recess periods [12] and clearly, the benefit of traditional recess free play in terms of encouraging physical activity make this a particularly op-

portune period where children can be physically active. The current study was only 6 weeks in duration and suggests that there is an acute impact of active video games when used as a substitute for traditional school recess. This may be a form of novelty effect and physical activity levels decline after initial presentation with this mode of physical activity. In this context the introduction of active video game play may have actually suppressed children's physical activity levels rather than enhanced them.

Additionally, prior research conducted by McDougall and Duncan [6] also suggested that active video game play during school recess could provide a stimulus to increase children's physical activity and reported that a substantial part of the recommended level of children's physical activity could be achieved through recess based game play. However, this study was conducted over a 1 week period and used a limited number of participants and, although the authors noted this as a limitation and suggested further research was needed to verify their results, clearly the duration of their study has limited the conclusions they could make to the acute effects of a school based active video game intervention. This study has attempted to fill the gap in some of the previously published studies examining this topic by exploring active video game play outside the laboratory environment, by comparing this to a control group and by assessing children over a longer period than the majority of prior studies.

Despite this, the current study is not without its limitations. Active video game play was engaged in twice weekly as this was considered to be a realistic frequency for this form of activity in schools. It is possible that different weekly frequencies of game play may have provided different results. Expertise may also be an issue that future research needs to consider. Practice of using the Nintendo Wii games and controllers may change the level of energy expenditure required to be successful within these games. Prior studies have noted this to be an important consideration [13]. It is possible that the reductions in physical activity seen as the children progressed through the 6-week intervention may have arisen because they actually become more successful at the games they were playing. Anecdotally, in order to be successful in many of the active video games used in the present study dynamic, gross movements are not always required. To some extent this may then negate the premise on which these gaming platforms are based but further research is needed to verify this suggestion.

Sample size is also an issue, these results are based on a relatively small sample of participants and further large scale studies are needed to verify these findings. Furthermore, as children were selected from one school year, resulting in a possible age difference between any two children in the study being 12 months. As prior authors [14] have reported that although children may be the same age chronologically, they may be a different age biologically which can then manifest itself in performance differences, this may be an issue future authors need to consider when examining physical activity in the school setting. The authors of the current study also acknowledge that the use of pedometry and heart rate monitoring to quantify physical activity in the current study may also be a limitation. In some cases, lower limb movement during the active video game play is not always needed but upper body movement is and therefore differences in pedometer counts between intervention and control groups may be a result of the games selected as part of the intervention. Accelerometers were not available for use in the current study but future researchers interested in this area may benefit from the use of accelerometry as a tool to quantify movement during active video gaming.

Conclusions

This study has added further data on children's physical activity responses to active video games. No study to date has examined the potential for active videogames to contribute to enhanced physical activity in the school setting. This study is novel in that it is the first to provide heart rate and step count data comparing a sustained period of active video game play to traditional recess physical activity in an ecologically valid setting (i.e. the school). In this case, physical activity was greater for active video games played during school recess compared to traditional recess during the first week of a 6-week intervention period. Thereafter, physical activity during active game play was significantly lower than physical activity during traditional recess. This suggests that although the premise of active video games has potential to enhance children's physical activity, this does not appear to be the case when applied to school recess over a 6-week period.

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References

1. Andersen R.E., Crespo C.J., Bartlett S.J., Cheskin L.J., Pratt M., Relationship of physical activity and television watching with body weight and level of fatness among children. *JAMA*, 1998, 279 (12), 938–942.
2. Mota J., Ribeiro J.C., Santos P.M., Gomes H., Obesity, physical activity, computer use and TV viewing in Portuguese adolescents. *Ped Exer Sci*, 2006, 18 (1), 113–121.
3. Gard M., Wright J., The Obesity Epidemic, Science, Morality and Ideology. Routledge, London 2005.
4. Lanningham-Foster L., Jensen T.B., Foster R.C., Redmond A.B., Walker B.A., Heinz D. et al., Energy Expenditure of sedentary screen time compared with active screen time for children. *Pediatrics*, 2006, 118 (6), e1831–e1835. DOI: 10.1542/peds.2006-1087.
5. Graves L., Stratton G., Ridgers N.D., Cable N.T., Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: cross sectional study. *BMJ*, 2007, 335 (7633), 1282–1284. DOI: 10.1136/bmj.39415.632951.80.
6. McDougall J., Duncan M.J., Children, Videogames and Physical Activity: An exploratory Study. *Int J Disability Hum Dev*, 2008, 7 (1), 89–94.
7. Jago R., Watson K., Baranowski T., Zakeri I., Yoo S., Baranowski J. et al., Pedometer reliability, validity and daily activity targets among 10- to 15-year-old boys. *J Sports Sci*, 2006, 24, 241–251. DOI: 10.1080/02640410500141661.
8. Janz K.F., Use of heart rate monitors to assess physical activity. In: Welk G.J. (ed.), Physical Activity Assessments for Health-Related Research. Human Kinetics, Champaign 2002, 143–161.
9. Ridgers N.D., Stratton G., Clark E., Fairclough S.J., Richardson D.J., Day-to-day and seasonal variability of physical activity during school recess. *Prev Med*, 2006, 42 (5), 372–374. DOI: 10.1016/j.ypmed.2006.01.017.
10. Jartti L., Hakanen M., Paakkunainen U., Raittinen P., Rönnemaa T., Comparison of hand-to-leg and leg-to-leg bioelectric impedance devices in the assessment of body adiposity in prepubertal children. The STRIP study. *Acta Paed*, 2000, 89 (7), 781–786. DOI: 10.1111/j.1651-2227.2000.tb00385.x.
11. Goss F., Robertson R., Williams A., Sward K., Abt K., Ladewig M. et al., A comparison of skinfolds and leg-to-leg bioelectrical impedance for the assessment of body composition in children. *Dyn Med*, 2003, 2, 5. DOI: 10.1186/1476-5918-2-5.
12. Verstraete S.J.M., Cardon G.M., De Clercq D.L.R., De Bourdeaudhuij I.M.M., Increasing children's physical activity levels during recess periods in elementary schools: The effects of providing game equipment. *Eur J Pub Health*, 2006, 16 (4), 415–419. DOI: 10.1093/eurpub/ckl008.
13. Sell K., Lillie T., Taylor J., Energy expenditure during physically interactive video game playing in male college students with different playing experience. *J Am Coll Health*, 2008, 56 (5), 505–511. DOI: 10.3200/JACH.56.5.505-512.
14. Gladwell M., Outliers: The Story of Success. Penguin, London 2009.

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