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Young Children's School Day Sedentary Behavior and Physical Activity in Interactive Versus Non-interactive Active Video Games

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Abstract Differences between interactive active video games (AVGs) and non-interactive AVGs on sedentary behavior, light physical activity, and moderate-to-vigorous physical activity has never been compared. Therefore, the purpose of this study to compare differences between two AVGs modalities on sedentary behavior, light physical activity, and moderate-to-vigorous physical activity implemented within an academic classroom setting in children. Participants were 44 children (20 girls; mean age = 7.68 ± 1.49 years) from two elementary schools. Over 3 weeks, children in the non-interactive AVGs group completed three 10-minute classroom-based AVGs sessions daily (Monday-Friday). Children in the interactive video gaming group spent an identical amount of time daily in classroom-based AVGs. Participants' school day sedentary behavior and physical activity were assessed across 3 weeks using accelerometers. Linear mixed effects models were employed to compare differences between AVGs modalities across 3 weeks on sedentary behavior and physical activity controlling for the potential confounding of age and sex. Children participating in the interactive video gaming had a 14.4% greater increase in sedentary behavior, a 2.4% greater increase in light physical activity, and a 7.4% greater decrease in moderate-to-vigorous physical activity from Week 1 to Week 3 relative to non-interactive AVGs ($p < 0.001$). After adjusting for age and sex, across all time-points, children who participated in interactive gaming had lower sedentary behavior (mean difference = -45.8%, $p < 0.001$), lower light physical activity (mean difference = -5.1%, $p = 0.034$), and higher moderate-to-vigorous physical activity (mean difference = 24.7%, $p < 0.001$) compared to children participating in non-interactive AVGs. Although children participating in the 3-week interactive video gaming had lower sedentary behavior, lower light physical activity, and higher moderate-to-vigorous physical activity compared to non-interactive gaming, the magnitude of the differences were not sustained across the intervention.

Keywords*: Exergaming, schoolchildren, physical activity, sedentary behavior*

1. Introduction

Active video games (AVGs) represent a variety of video games that require bodily movement and physical activity (PA) while playing (Gao, 2017). Literature has suggested AVGs could improve children's health behaviors and its correlates (Chen & Sun, 2017; Fu & Burns, 2018; Fu, Burns, Constantino, & Zhang, 2018; Gao & Chen, 2014; Gao, Chen, Pasco, & Pope, 2015; Pasco, Roure, Kermarrec, Pope, & Gao, 2017), and AVGs have also been successfully used as a classroom-based active program (Fu et al., 2018). Interactive and non-interactive are two modalities of AVGs that have been frequently examined in the literature. Interactive AVGs (e.g., Nintendo Wii, Nintendo Switch, Microsoft's Xbox 360/One Kinect, and Sony's PlayStation 4, etc.) rely on a camera or a sensor that enables tracking and captures body movements or reactions for the game to progress. Players interact with the video games by receiving instant feedback as they move. Non-interactive AVGs (e.g., GoNoodle, Adventure to Fitness, Cosmic Kids Yoga, etc.) are the electronic or computerized screen-based games that require players to manipulate and imitate images, movements, and activities on a video display. Players demonstrate increased motivation and interests in interactive AVGs due to the interactions, which in turn they are more likely to achieve continuous physical activity participation. Non-interactive AVGs stations tend to be easier to set up, with no bulky cords in the space, and all players will have the opportunity to play the game at the same time. Although both types have been documented to improve children's PA level and other

health benefits (Baranowski et al., 2016; Gao et al., 2014), research in the AVGs field have been conducted primarily in school physical education or laboratory settings, and comparisons between these gaming modalities on such effects still remain unexamined. Therefore, this study aimed to compare differences between interactive and non-interactive AVGs on children's school day sedentary behavior, light PA, and moderate to vigorous PA within an academic classroom setting. It is hypothesized that children in the interactive AVGs group would demonstrate lower sedentary behavior and higher moderate to vigorous PA than non-interactive AVGs children over the three-week intervention period.

2. Methods

2.1. Participants

Participants included 44 children (M_{age} = 7.68 ± 1.49 years; 20 girls) recruited from two elementary schools located within the same school district. Two schools were assigned into an interactive (n = 28) or a non-interactive (n = 16) AVGs group. The inclusion criteria were children who were (1) aged 6-7 years; (2) without a diagnosed physical or mental disability according to school records; and (3) able to provide parental consent and child assent. Upon the approval from the University of Nevada, Reno IRB and the school district, informed parental consent forms and child assent forms were obtained before date collection.

2.2. Procedures

AVGs were offered daily for three weeks in both groups. In the interactive AVGs group, two stations were installed in one classroom, which offered Just Dance and Fitness Boxing using Nintendo Switch (Nintendo Co., Ltd., Kyoto, Japan), and Zumba Kids and Kinect Sports using Xbox 360 (Microsoft Corp., Redmond, WA, USA). Each station allowed two children to play at a time, and all the children took turns to play to ensure 30 minutes of daily playing.

In the non-interactive AVGs group, several games (e.g., Adventure to Fitness; GoNoodle; Cosmic Kids Yoga) were offered with three separate 10-minute sessions daily and supervised by a trained classroom teacher. One AVG station included a computer, a projector, and a screen, and was set up in the classroom for all the children to play at the same time.

2.3. Measures

Children's school day (9am-3pm) sedentary behavior, light PA and moderate to vigorous PA were assessed weekly over three consecutive weeks using ActiGraph wGT3X-BT accelerometers (ActiGraph, FL, USA), which were attached on children's right waist. Activity counts were collected at 15s epochs at 100 Hz processed using counts per minute (CPM) cut-points (sedentary behavior = 0-100 CPM; light PA: 101-2295 CPM; moderate to vigorous PA: 2296-4011 CPM) (Evenson, Catellier, Gill, Ondrak, McMurray, 2008). Outcome variables were the weekly means of the time percentage in sedentary behavior, light PA, and moderate to vigorous PA.

2.4. Analysis

Participating Parameter estimates of interest were the gaming modality main effect and the game modality (group) × time. General linear mixed effects models were employed to compare differences between AVGs modalities (interactive vs. non-interactive) across three weeks on sedentary behavior, light PA, and moderate to vigorous PA controlling for age and sex. Alpha level was set at $p < 0.05$ and all analyses were conducted using STATA v15.0 statistical software package (College Station, TX, USA).

3. Results

There were statistically significant group × time interactions for each outcome ($p < 0.001$). Specifically, children in interactive AVGs had a 14.4% greater increase in sedentary behavior, a 2.4% greater increase in light PA,

Table 1. Parameter estimates from the general linear mixed effects models

Outcome	Predictor	b-coefficient	95% C.I.	p-value
Sedentary Time (% of school day)	Interactive AVGs	**-45.8%**†	-58.3% – -33.4%	< 0.001
	Non-interactive AVGs×Time	1.1%	-3.4% – 5.3%	0.673
	Interactive AVGs×Time	**14.4%**†	10.8% –17.9%	< 0.001
Light PA (% of school day)	Interactive AVGs	**-5.1%**†	-9.8% – -0.4%	0.034
	Non-interactive AVGs×Time	-0.2%	-1.8% – 1.5%	0.859
	Interactive AVGs×Time	**2.4%**†	1.1% – 3.8%	< 0.001
MVPA (% of school day)	Interactive AVGs	**24.7%**†	18.3% – 31.0%	< 0.001
	Non-interactive AVGs×Time	-0.1%	-3.0% – 1.4%	0.479
	Interactive AVGs×Time	**-7.4%**†	-9.2% – -5.6%	< 0.001

Note: AVGs stands for active video games; MVPA stands for moderate-to-vigorous physical activity; 95% C.I. stands for 95% Confidence Interval; referent for gaming modality main effect was traditional gaming; models adjusted for age and sex; bold and † denotes statistical significance, $p < 0.05$.

and a 7.4% greater decrease in moderate to vigorous PA from Week 1 to Week 3 relative to non-interactive AVGs children ($p < 0.001$). Results from the generalized linear mixed effects models are reported in Table 1. After adjusting for age and sex, across all time-points, children in interactive AVGs group had lower sedentary behavior (mean difference = -45.8%, $p < 0.001$), lower light PA (mean difference = -5.1%, $p = 0.034$), and higher moderate to vigorous PA (mean difference = 24.7%, $p < 0.001$) compared to the non-interactive AVGs group. Raw trends in the outcomes are displayed within Figures 1-3. As compared to the non-interactive AVGs group, interactive AVGs children demonstrated greater increases in sedentary behavior and light PA, and a greater decrease in moderate to vigorous PA over the intervention period.

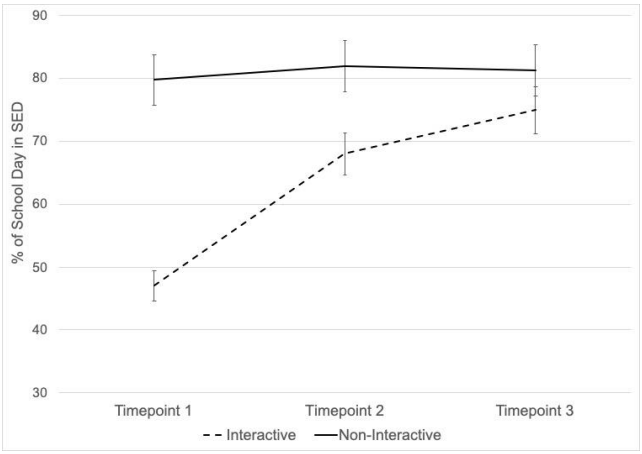

Figure 1. Percent of the school day spent in sedentary behavior between gaming modalities and across time points. *Note:* error bars are standard errors.

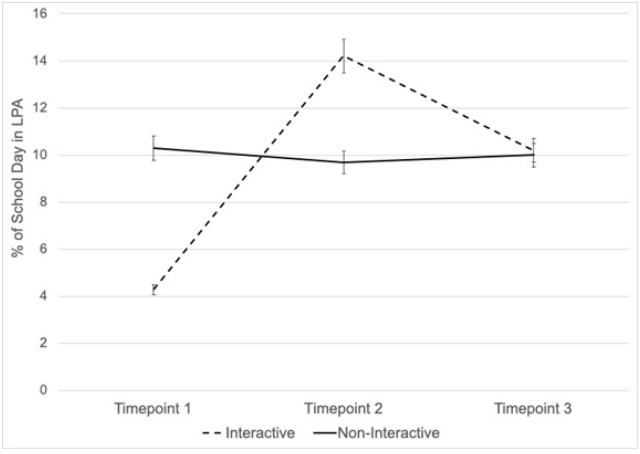

Figure 2. Percent of school day spent in light PA between gaming modalities and across time points. *Note:* error bars are standard errors.

4. Discussion

The results indicate that children who played interactive AVGs in the classroom for three weeks demonstrated lower sedentary behavior and light PA, while had higher school day moderate to vigorous PA compared to the non-interactive AVGs group. The mechanism to achieve these benefits is that interactive AVGs may improve motivation and capture interests with the addition of exercise facilities to maintain higher levels of energy expenditure (Gao, 2017). The findings are soundly echoed by previous research that interactive AVGs could reduce children's sedentary behavior, yield high energy expenditures (Gao, 2017), and can be as physically active as moderate to vigorous PA activities such as jogging or brisk walking (Zhang, Moore, Gu, Chu, & Gao, 2016). However, the lack of consistent improvement is concerning in that children in the interactive AVGs group had greater increases in sedentary behavior and light PA, and a greater decrease in moderate to vigorous PA from Week 1 to 3 relative to non-interactive AVGs children. A plausible explanation is that a limited variety of interactive AVGs offered in this study. Therefore, children may have experienced decreased interest and enjoyment by playing repetitive video games. Furthermore, children in the interactive AVGs group took turns to play. Thus, the prolonged transition period may also lead to increased sedentary behavior and decreased moderate to vigorous PA. There are many game choices in the non-interactive AVGs with all children playing the games at the same time, which may explain the constant stable trend on the outcomes across three weeks in the non-interactive AVGs group.

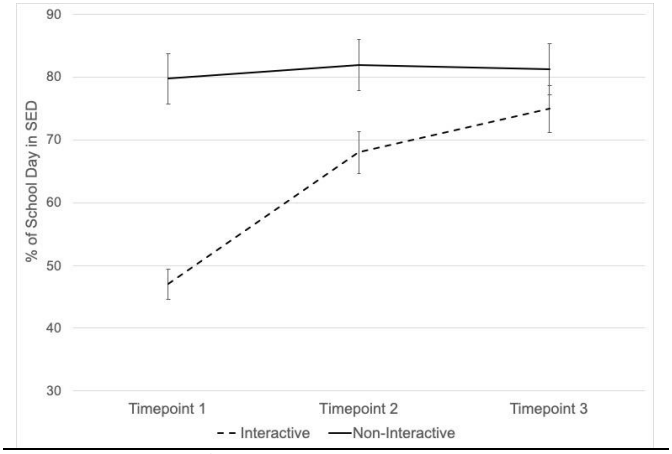

Figure 3. Percent of school day spent in moderate to vigorous PA between gaming modalities and across time points. Note: error bars are standard errors.

The current study is not without limitations. First, this study was conducted in one school district using a small sample, which limits the generalizability of the findings. In addition, although comparisons were made within two schools with similar settings in the same school district, the confounding variables (e.g., physical education class/teacher, recess, facilities, etc.) may influence participant's PA levels and the results of the study. Future research should be conducted within the same school/class, or within the laboratory settings, to control the confounding effects. Second, the intervention period was relatively short; additional data collection time points may have been helpful to confirm the outcome changes. Third, this study did not employ a true control or

comparison group, making it difficult to attribute any changes in sedentary behavior or moderate to vigorous PA to the AVGs. Finally, the lack of standardized teacher training could have significantly affected the results.

This is the first study to compare interactive and non-interactive AVGs on children's school day sedentary behavior and PA within an academic classroom setting. Overall, participation in classroom-based AVGs demonstrated a positive impact on children's PA. Classroom teachers may integrate both interactive and non-interactive AVGs to achieve the goals of establishing a physically active habit and helping reduce the sedentary lifestyle in school-aged children.

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Author Disclosure Statement

All authors report that no competing financial interests exist.

References

Baranowski, T., Blumberg, F., Buday, R., DeSmet, A., Fiellin, L. E., Green, C. S.,…Young, K. (2016). Games for health for children-current status and needed research. *Games for Health Journal, 5*(1), 1–12.

Chen, H., & Sun, H. C. (2017). Effects of active videogame and sports, play, and active recreation for kids physical education on children's health-related fitness and enjoyment. *Games for Health Journal*, *6*, 312–318.

Evenson, K. R., Catellier, D. J., Gill, K., Ondrak, K. S., McMurray, R. G. (2008). Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences, 26*, 1557–1565.

Fu, Y., & Burns, R. (2018). Effect of an active video gaming classroom curriculum on health-related fitness, school day step counts, and motivation in sixth graders. *Journal of Physical Activity and Health, 15*(9), 644–650.

Fu, Y., Burns, R., Constantino, N., & Zhang, P. (2018). Differences in step counts, motor competence, and enjoyment between an exergaming group and a non-exergaming group. *Games for Health Journal*, *7*(5), 335–340.

Gao, Z. (2017). Fight fire with fire? Promoting physical activity and health through active video games. *Journal of Sport & Health Science, 6*(1), 1–3.

Gao, Z., & Chen, S. (2014). Are field-based exergames useful in preventing childhood obesity? A systematic review. *Obesity Reviews, 5*, 1–16.

Gao, Z., Chen, S., Pasco, D., & Pope, Z. (2015). A meta-analysis of active video games on health outcomes among children and adolescents. *Obesity Reviews, 16*, 783–794.

Pasco, D., Roure, C., Kermarrec, G., Pope, Z., & Gao, Z. (2017). The effects of a bike active video game on players' physical activity and motivation. *Journal of Sport and Health Science, 6*, 25–32.

Zhang, T., Moore, W., Gu, X., Chu, T, L., & Gao, Z. (2016). Promoting children's physical activity in physical education: the role of active video gaming. *Journal of Teaching, Research, and Media in Kinesiology, 1*, 1–13.

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