

*THE EFFECTS OF EXERGAMING ON PHYSICAL ACTIVITY IN A  
THIRD-GRADE PHYSICAL EDUCATION CLASS*

RACHEL K. SHAYNE, VICTORIA A. FOGEL, RAYMOND G. MILTENBERGER, AND  
SHANNON KOEHLER

UNIVERSITY OF SOUTH FLORIDA

We compared the effects of exergaming and traditional physical education on physical activity among 4 active children who were not overweight and who had experience with the exergaming activities prior to the study. Results showed that exergaming produced substantially higher percentages of physical activity and opportunity to engage in physical activity. In addition, an evaluation of the exergaming equipment showed that exergaming stations were associated with differential levels of physical activity across participants.

*Key words:* exercise, exergaming, physical activity, interactive fitness, physical education

Today, more than 17% of U.S. children are overweight (U.S. Centers for Disease Control and Prevention, 2010). The U.S. Department of Health and Human Services (2005) recommends that children engage in daily physical activity for a minimum of 60 min at a moderate to vigorous intensity to maintain a healthy weight. However, most children do not meet the national recommendations for daily physical activity (U.S. Centers for Disease Control and Prevention, 2010).

Interactive video-game technology called *exergaming* (Sanders & Hansen, 2008) has been created to increase physical activity by capitalizing on the reinforcing effectiveness of video games. Exergaming may be a useful intervention with children because it is easy to use, requires little effort from physical education (PE) teachers, and offers an indoor place for children to exercise before and after school so they are not hampered by bad weather and do not have to be outdoors in an unsafe neighborhood.

Little research has examined whether exergaming, compared to other opportunities for physical activity (e.g., a traditional PE class),

increases physical activity in school-age children. Fogel, Miltenberger, Graves, and Koehler (2010) investigated physical activity levels (PA) and opportunity to engage in physical activity (OPA) in exergaming and traditional PE environments with four inactive students in an elementary school PE class. The exergaming condition produced more PA and OPA; there was a mean of 9.2 min of PA per 30-min session in exergaming but only 1.6 min in the PE condition. In addition, the exergaming condition produced a mean of 11.6 min of OPA, whereas the PE condition produced a mean of 3.8 min of OPA.

This research suggests that exergaming is a promising intervention to increase PA levels and potentially to combat childhood obesity. However, more research is needed with different populations (e.g., different age groups, active vs. inactive children, children with behavioral difficulties) to establish the generality of the procedure. Furthermore, a systematic evaluation of exergaming equipment is needed to determine the machines that produce the greatest duration of PA, the most intense forms of exercise, and the most OPA.

The purpose of this study was to replicate and extend the findings of Fogel et al. (2010) by evaluating exergaming with active children who already had a history with exergaming. Furthermore, we included a more extensive evaluation

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Correspondence concerning this article should be addressed to Raymond G. Miltenberger, Department of Child and Family Studies, MHC2113A, University of South Florida, Tampa, Florida 33612 (e-mail: miltenbe@usf.edu).

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of the exergaming equipment to identify the machines associated with the lowest and highest levels of PA.

## METHOD

### *Participants and Setting*

Four third-grade boys from a PE class in a public elementary school in Florida participated in the study. Two of the participants came from a regular education class and two from an exceptional student education class. The PE teachers reported that these participants were active (i.e., they did not sit around but rather played actively during PE and recess time) and that they were not overweight. All participants had utilized the exergaming equipment during PE class in the prior year.

The study was conducted during the regularly scheduled PE class that occurred 2 mornings per week. Although we collected data on the four participants, all students in this PE class engaged in both conditions of the study.

### *Response Measurement and Definitions*

The dependent variables in this study were the percentage of the 30-min session engaged in PA and the percentage of the session in which there was OPA. We defined PA as any large motor movements associated with an activity assigned by the PE teacher such as running, biking, throwing, catching, punching, swinging arms, squatting, kicking, walking, jumping, stepping, or tapping. We did not count motor movements during transition time, waiting time, or the emission of problem behavior. OPA was defined as the total time in the PE or exergaming conditions during which the student had an opportunity to engage in physical activity. For example, there was no opportunity for physical activity while the PE teacher delivered instructions, if all exergaming activities were occupied, or if the teacher stopped the class to deal with problem behaviors.

We used personal digital assistants to collect duration data on PA and OPA. A research

assistant was assigned to each dependent variable and collected data on all participants' behavior by pressing the designated keys. Duration, in seconds, for PA and OPA was divided by the total seconds of the session to yield a percentage of the session with the target behaviors.

### *Interobserver Agreement*

To assess interobserver agreement on PA and OPA, data were collected by a second independent observer for 33% of the sessions across conditions. An agreement was scored when both observers indicated that PA or OPA was or was not occurring during each second of the observation. Agreement was calculated by dividing the seconds of agreement by the seconds of observation and then multiplying by 100%. Agreement averaged 82% across all students across all dependent variables; the average was 76% (range, 70% to 83%) for physical activity and 88% (range, 79% to 95%) for OPA.

### *Design and Procedure*

An alternating treatments design was used to compare the effects of regular PE class and exergaming on the duration of PA and OPA.

*Regular PE.* The PE teacher conducted class in the typical fashion according to her regular lesson plan (see Fogel *et al.*, 2010). PE activities observed during the course of the study included throwing and catching skills, basketball, baseball, balancing activities, and the governor's fitness challenge (a series of tests that included shuttle runs, standing long jump, push-ups, and the sit and reach).

*Exergaming.* The PE teacher also conducted the exergaming condition. The exergaming lab, with 10 activities in nine stations, was set up in an empty classroom. Before data collection started, the teacher described the use of the equipment and the rules for the exergaming session (see procedures outlined in Fogel *et al.*, 2010). The six types of exergaming equipment used in this study included Konomi Dance

Dance Revolution (DDR) with Sony Play Station; Fit Interactive 3 Kick; Gamercize with Sony Play Station Madden Football; Three Rivers Game Cycle with Sony Play Station Monster 4×4; Cateye Virtual Bike with Sony Play Station; Nintendo Wii Sports baseball, tennis, or boxing; and iTech Fitness XrBoard (see Fogel et al., 2010, for a description of the equipment).

## RESULTS AND DISCUSSION

Figure 1 (left) shows the percentage of PA for each participant during regular PE, exergaming, and exergaming in which a participant was assigned to a broken or malfunctioning machine for part of the period (and thus, had to wait for a rotation to a working machine). Extremely low percentages of PA were exhibited by all participants in the PE condition, with higher percentages in both exergaming conditions. Charlie had a mean of 6% PA for PE and 24% for exergaming. Hugo had a mean of 5% PA for PE and 33% for exergaming. Desmond engaged in a mean of 7% PA during PE and 31% during exergaming. Sawyer engaged in a mean of 6% PA during PE and 41% during exergaming.

Figure 1 (right) shows the percentage of OPA for each participant during PE and the two exergaming conditions. Both exergaming conditions were associated with higher percentages of OPA than PE for all participants. Charlie had a mean of 14% OPA for PE and 32% for exergaming. Hugo had a mean of 10% OPA for PE and 42% for exergaming. Desmond had a mean of 11% OPA during PE compared to 37% during exergaming. Sawyer had a mean of 14% OPA during PE compared to 47% during exergaming.

Table 1 shows the percentage of physical activity engaged in when given the opportunity (PA divided by OPA) for each station, by participant. The stations associated with the highest percentages of physical activities across participants were Monster 4×4 and DDR. The

station associated with low scores for each participant was Wii (baseball, tennis, and boxing). The Game Bikes were associated with low scores for three of the four participants. It is interesting to note that in exergaming, students engaged in physical activity 82.5% (range, 78% to 89%) of the time they had an opportunity to do so, whereas in PE, students engaged in physical activity 48.8% (range, 39% to 65%) of the time they had an opportunity to do so. Thus, students in exergaming not only engaged in more minutes of PA, but also used the time available to a greater degree than did students in PE.

This study replicated and extended the findings of Fogel et al. (2010) and found that even when the equipment was not novel and students were not overweight or obese, more physical activity occurred during exergaming than during PE. As in the study by Fogel et al., we recorded very low physical activity levels in the PE condition. It is possible that, because our study and that by Fogel et al. were conducted with the same PE teacher at the same school, the results of these two studies are not representative of PE classes nationwide. However, an earlier study by Sallis et al. (1997) also found low levels of physical activity in traditional PE classes. Sallis et al. found that children in 33 traditional PE classes averaged 17.8 min of physical activity per 90-min class (engaging in PA about 20% of the 90-min class), which is higher than the percentages of PA observed in the current study. Nevertheless, even if data from Sallis et al. were used as a comparison, the level of physical activity in the exergaming condition of the current study still would be higher than the level that occurs during traditional PE. Therefore, it is possible that children do not receive as much PA from PE class as parents may believe. Additional data are needed to verify these findings.

One limitation of the current study is that the overall interobserver agreement percentage was 82%, somewhat lower than we would like.

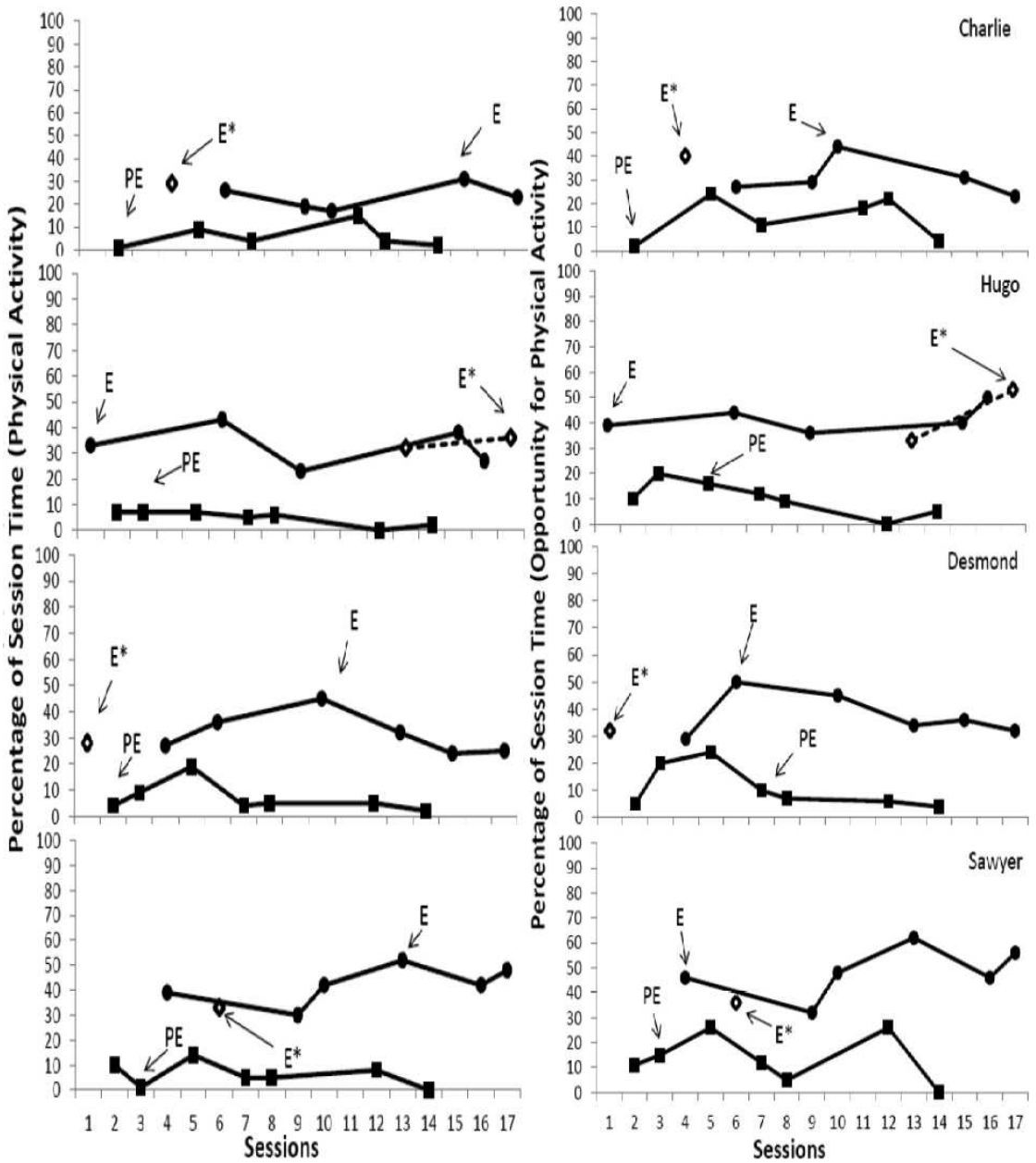


Figure 1. The left panel shows the percentage of session time with physical activity during the exergaming condition (E), the traditional physical education condition (PE), and the exergaming condition in which a machine was not functioning properly (E\*); the right panel shows the percentage of session time with the opportunity to engage in physical activity across sessions during each condition.

We believe this figure is attributable to the challenge of observing four individuals simultaneously as they engaged in physical activity, sometimes in a different area of the room, and calculating agreement on a stringent second-by-

second basis. Another factor might be the difficulty in discriminating behavior that fits the definition of physical activity from behavior that did not. Future research should carefully evaluate the definition of physical activity.

Table 1

The Average Percentage of Physical Activity Engaged in When Given the Opportunity for Each Participant for Each Piece of Equipment in the Exergaming Condition, Overall in the Exergaming Condition, and Overall in the PE Condition

Exergaming machine	Charlie	Hugo	Desmond	Sawyer
Monster 4×4	100 <sup>a</sup>	94	100 <sup>a</sup>	100 <sup>a</sup>
DDR Station 2	100 <sup>a</sup>	91	100	92
3 Kick	100	88	100	88 <sup>a</sup>
Stepper	100 <sup>a</sup>	96	84	89
DDR Station 6	100	88	100	100
Wii (tennis, baseball, boxing)	62	35	58	78
XR board	25	87	100	85
Game bikes	68	56 <sup>a</sup>	76	94 <sup>a</sup>
Overall exergaming	78	79	84	89
Overall PE	39	44	65	47

<sup>a</sup> There was only one session of data for the participant at the corresponding equipment.

Although the results of this study are promising, the use of exergaming in schools warrants careful consideration. In addition to the costs associated with the exergaming equipment, equipment failure was experienced periodically throughout the study, which limited the number of exergaming stations available for students. Future research should identify the machines that are cost efficient, reasonably priced, require the least maintenance, and result in the greatest levels of physical activity.

Another extension of Fogel et al. (2010) was to identify the exergames that produced the highest levels of physical activity. This study revealed that the Monster 4×4 and DDR resulted in the highest percentages of physical activity and that the Wii resulted in the lowest. However, before drawing conclusions about which exergames should be used for a PE classroom or bought for the home environment, additional research must be conducted to assess the intensity of physical activity and effects on health factors and skill development for each exergame.

Childhood obesity is a growing health concern, and therefore it is important to find strategies for the masses that are sustainable, reinforce physical activity, and are easy to

employ. The current study extends previous research and provides further support for the use of exergaming in a PE environment as a way to increase physical activity among elementary school children.

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