

Original article

Impact of exergaming on young children's school day energy expenditure and moderate-to-vigorous physical activity levels

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Abstract

Background: Although emerging research is demonstrating the potential health impact of exergaming, investigations have primarily been conducted in laboratory settings among small samples with short-term interventions. Information on the effectiveness of exergaming in underserved children's objective physical activity (PA) in population-based settings is also scarce. Moreover, most empirical studies have only included 1 type of exergame in the intervention. Therefore, this study's purpose was to investigate the long-term impact of a multigame exergaming intervention among underserved children integrated within school curricula. Specifically, this study examined the effect of exergaming on children's accelerometer-determined sedentary behavior (SB), light PA, moderate-to-vigorous PA (MVPA), and energy expenditure (EE) over 2 years as compared with regular physical education (PE) classes.

Methods: A total of 261 second- and third-grade children (134 girls, 127 boys; mean age 8.27 years) were recruited from 2 Texas elementary schools. Children's pre-test 3-day SB, light PA, MVPA, and EE at school were assessed in the fall of 2012. Participants were assigned to 1 of 2 groups: (1) exergaming/PE group (125 min weekly of exergaming-based PA program) and (2) comparison group (125 min weekly of PE). PA (SB, light PA, and MVPA) and EE outcome variables were assessed again in 2013 (post-test) and 2014 (follow-up).

Results: Significant time effects were observed for SB ($F(1, 162) = 25.0, p < 0.01, \eta^2 = 0.14$), light PA ($F(1, 162) = 9.6, p < 0.01, \eta^2 = 0.06$), and MVPA ($F(1, 162) = 6.2, p = 0.01, \eta^2 = 0.04$) but not for EE ($F(1, 162) = 0.63, p > 0.05, \eta^2 = 0.004$). Subsequent pairwise comparisons revealed significant increases from pre- to post-test for light PA ($p < 0.01$), MVPA ($p < 0.01$), and EE ($p = 0.02$) with no changes in SB ($p > 0.05$). Conversely, significant decreases occurred in light PA ($p < 0.01$) from post-test to follow-up with no differences seen in MVPA ($p = 0.08$) and EE ($p = 0.06$) over the same time period. A significant increase was seen, however, for SB from post-test to follow-up.

Conclusion: Exergaming PE can have the same positive effect on children's light PA, MVPA, and EE as regular PE. More research is necessary to discern how to promote long-term PA participation after conclusion of the intervention.

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Keywords: Active video games; Childhood obesity; Light physical activity; Moderate-to-vigorous physical activity; Physical education; Sedentary behavior

1. Introduction

Low physical activity (PA) participation and increasing obesity trajectories of children from families of lower socioeco-

omic status continue to be a concern in the USA.^{1–3} In particular, underserved children have limited opportunities to engage in moderate-to-vigorous PA (MVPA), in large part because of limited availability of recreational programs and facilities, reduced quality of physical education (PE) time, and growth of sedentary leisure activities such as television viewing and playing sedentary video games.⁴ As a result, these children are more likely to be overweight and/or obese and develop

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cardiovascular disease, diabetes, and obesity as adults.⁵⁻⁷ Unfortunately, recent large-scale research indicated only 42% of U.S. children aged 6–11 years and 8% of adolescents participated in the recommended 60 min of MVPA per day.⁸ Schools reach nearly 95% of children in the USA and are important venues to promote weekday PA participation. A need exists to develop and promote novel approaches to improving children's PA and health through effective and innovative school-based PA programs.

Traditional sedentary video games have been criticized for promoting children's sedentary lifestyle because of its association with high rates of childhood obesity.⁹ Alternatively, exergaming, which refers to active video games that are also a form of exercise, has great potential to help children engage in a physically active lifestyle.¹⁰ In the past decade, the fast growth of exergaming has led to the development of new interactive exercise strategies, which in turn has had an impact on the implementation of school-based PA programs.^{11,12} Exergames have been increasingly used in public schools because they capitalize on children's interest in technology to promote PA. For example, Dance Dance Revolution (DDR) combines dancing, which involves agility, balance, and cardiorespiratory endurance, with energetic music and visuals, which capture children's interest and promote a health-enhancing level of PA for fitness.¹³⁻¹⁶

Although emerging research is demonstrating the potential health impact of exergaming, investigations in the field have primarily been conducted in laboratory settings using small samples with short-term interventions.^{17,18} Information on the effectiveness of exergaming in underserved children's objective PA in population-based settings is also scarce. Moreover, most empirical studies have included only 1 type of exergame in the intervention.^{13,14,19} Because evidence suggests that children are more active on days when PE is held²⁰⁻²³ and do not compensate with increased PA on days devoid of PE,²¹ it is imperative to find novel intervention strategies capable of increasing children's PA. Notably, researchers have long highlighted the need for these activities to be fun and developmentally appropriate—promoting long-term maintenance of regular PA behavior among youth.^{7,24}

Therefore, the purpose of this study was to investigate the long-term impact of a multigame exergaming intervention among underserved children integrated within the children's school PE class. Specifically, this study examined the impact of exergaming on children's accelerometer-determined sedentary behavior (SB), light PA, MVPA, and energy expenditure (EE) over 2 years as compared with PE. It was hypothesized that exergaming in combination with PE would promote decreased SB and increased light PA, MVPA, and EE at least as well as traditional PE class.

2. Methods

2.1. Participants and research setting

A total of 261 second- and third-grade children (134 girls, 127 boys; 8.27 ± 0.70 years) from 2 suburban schools in Texas participated in this study. Both schools were Title I schools (i.e., greater than 50% of children receive free or reduced-price school

meals), with a majority of children from low-income families. The ethnicity breakdown was as follows: 192 whites (including Latino and non-Latino), 42 native Hawaiians or other Pacific Islanders, 16 Native Americans, 7 African Americans, and 4 Asian Americans. Both schools served grades K–5 with student populations ranging from 400 to 500 and had similar curricula, quality teachers, and sociocultural environments. The schools' policy required 125 min of weekly PA and a daily 20 min recess. Because randomization of individual students was not possible owing to class assignments, a quasi-experimental research design with repeated measures was used, with 1 school purposely assigned to the intervention group because of its ability to install exergaming on site and the other to the comparison group. In the intervention school, the exergaming program was integrated into the school's overall curriculum with the school administrators' support such that exergaming and PE alternated on a daily basis for a combined total of 125 min of weekly PA. That is, children had three 25 min PE classes plus two 25 min exergaming sessions in 1 week, followed by two 25 min PE classes plus three 25 min exergaming sessions the following week. PE was taught by a certified PE teacher, and the exergaming was supervised by a full-time teacher at school. In the comparison school, children had 125 min (25 min per day) of weekly PE classes taught by 2 certified teachers. Participants were recruited from 16 classes (average of 20 per class) at the schools, with 8 classes from each school site.

This age range (7–9 years) of participants was chosen because children aged 7 or older were able to understand, perform, and enjoy all the specific exergaming activities. The specific inclusion criteria for this study were children who were (1) enrolled in a public Title I elementary school; (2) aged 7–9 years; (3) from low socioeconomic status families; (4) without a diagnosed physical or mental disability according to school records; and (5) able to provide parental consent and child assent. Inclusion eligibility was verified through school records and the demographic information sheet. The study was approved by the Texas Tech University Institutional Review Board. Parental consent and child assent were obtained from each participant prior to data collection.

Children's pre-test 3-day SB, light PA, MVPA, and EE at school was assessed in September/October 2012. Children were purposely assigned to 1 of the 2 groups with the school as the experimental unit: (1) exergaming/PE group (125 min of weekly structured PA programs, with exergaming and PE alternating daily each week) and (2) comparison group (125 min of weekly traditional PE). All children underwent identical assessment of SB, light PA, MVPA, and EE in April/May 2013 (post-test) and follow-up in April/May 2014.

2.2. Procedures

In the intervention school, a total of 12 stations were set up in a large classroom with each station equipped with 2 exergaming systems (Wii (Nintendo Co., Ltd., Kyoto, Japan) and Xbox Kinect (Microsoft Corp., Redmond, WA, USA)) and a television. A number of exergames were offered, including but not limited to Kinect Ultimate Sports, Just Dance, Wii Sports, and Wii Fit, allowing a variety of choices and promoting

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