Original Article

Elementary students' physical activity and enjoyment during active video gaming and a modified tennis activity

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Abstract:

Problem Statement: Active video gaming (AVG) provides physical activity or exercise through interactive play and has been shown to promote physical activity in school age children. However, most studies have compared AVG tasks to sedentary behaviors or unrelated tasks/sports in lab-based settings. **Purpose:** The purpose of this study was to examine 132 second and third grade (mean age = 8.18 ± 0.76) physical education students' physical activity behavior and enjoyment during AVG and an equivalent traditional physical education striking activity. All students participated in two conditions during physical education classes: Wii[®] Tennis and a modified tennis activity. Step count was used to quantify physical activity and was measured with a Digiwalker SW 200 pedometer. A verbal questionnaire was administered to each participant immediately following participation in both conditions to assess enjoyment and preference. **Results:** Results indicated that participants accumulated significantly more steps in modified tennis compared to the Wii[®] Tennis ($t=34.15$, $df = 131$, $p < .001$). There were no significant sex differences in physical activity participation between the two conditions ($p = .243$). All of the students enjoyed Wii[®] Tennis and wanted to play again. **Conclusions:** Overall this study found that students' physical activity participation was significantly higher in the ecological relevant modified tennis activity compared to the AVG condition. All of the students enjoyed participated in the AVG condition and 89% would choose it as a future option in physical education.

Key words: Physical education, MVPA, sedentary activities, game knowledge, gender.

Introduction

Current recommendations suggest that children and adolescents should engage in 60 minutes or more of daily, moderate to vigorous physical activity (MVPA) to achieve optimal health, wellness, fitness, and performance benefits (Carlson, Fulton, Schoenborn, & Loustalot, 2010; Martinez-Gomez et al., 2011). Physical activity benefits include but are not limited to the prevention of chronic disease, support of a healthy immune system, improved glucose metabolism, improved strength, self-esteem, and body image (Sothorn, Loftin, Suskind, Udall, & Blecker, 1999). According to the World Health Organization (WHO), 2.6 million deaths are due to individuals being overweight or obese and approximately 1.9 million deaths can be attributed to lack of physical activity (Dobbins, Husson, DeCorby, & LaRocca, 2013). Therefore, it is extremely important for young children to participate in physical activity for both disease prevention and health promotion. Although benefits of physical activity have been established, data from the Health Behaviour in School-Aged Children (HBSC) International Report indicate sufficient physical activity is reached by fewer than two-thirds of children (Zanotti et al., 2012).

The school environment can play a critical role in physical activity promotion through physical education programs, recess periods, and other physical activity/wellness policies (Chotibang, Fongkaew, Mosuwan, Meininger, & Klunklin, 2013). Recommendations state that elementary school children should participate in at least 150 minutes per week of physical education (NASPE, 2011). Physical education can significantly increase activity during the school day and promote physical activity outside of school (Dale & Corbin, 2000; Morgan, Beighie, Pangrazi, 2007). Sallis, Prochaska, Taylor, Hill and Geraci (1999) examined potential determinants of physical activity in children grades 4-12 and found that enjoyment of physical activity and participation in physical education classes were among the strongest determinants for participation in physical activity. For decades Emmons (1986) and others have noted that the affect experienced during an activity is a good predictor of future physical activity involvement. Specifically, individuals are not likely to continue an activity that does not bring enjoyment or is not fun. Therefore an obvious dilemma in the effort to encourage children to be more physically active is that many sedentary activities are perceived as immediately reinforcing and enjoyable, whereas many physical activities capable of improving health and fitness are perceived as less enjoyable and less immediately reinforcing (Motl et al., 2001). Therefore, physical activities that provide reinforcement and

enjoyment will support optimal physical education environments, and potentially influence physical activity participation. Playing computer and video games are a very popular free time activity among children and adolescents. In fact, 63% of school-age children between ages 11 – 15 years reported a preference for playing computer or video games during free time (Nippold, Duthie, & Larsen, 2005). Recent reports from the Kaiser Family Foundation suggest that the typical American youth between 8 and 18 years of age spends approximately 2 hours a day playing video games (Roberts, Foehr, & Rideout, 2005). According to Nippold et al. (2005) traditional video game play is associated with sedentary activities; however the current generation of video gaming requires interactive movement and is called “Active Video Gaming” (AVG). Mears and Hansen (2009) define AVG as “video games that provide physical activity or exercise through interactive play, these games go beyond simple hand/finger movements” (p. 26). Graf, Pratt, Hester, and Short (2009) explain the purpose of AVG as getting players to directly interface their physical or sport-based movements so they control or coincide with movement activity within the video game, thereby eliciting physical activity from the gamer in a fun environment. Biddiss and Irwin (2010) and Barnett, Cerin and Baranowski (2011) completed a systematic review of 18 AVG studies. The reviews concluded that AVG has become very popular and could help some children increase their physical activity by integrating video play with exercise. AVG has been shown to enhance hand-eye coordination, agility, balance, and core strength (Trout & Christie, 2007). Maddison et al. (2012) found that AVG promoted a healthy body composition and reduced BMI in obese and overweight children over a 24 week time period. Furthermore, previous studies have shown that movement based AVG technology can also increase physical activity. Graves, Stratton, Ridgers, and Cable (2008) found 10-year olds exhibited an increase in energy expenditure to a level similar to low-to-moderate physical activity intensity (2.4 km/hour) walking while participating in Dance Dance Revolution™ (Konami Digital Entertainment, Redwood City, CA) a popular dance simulation game. The Nintendo Wii™ (Nintendo, Redmond, WA) allows individuals to play simulated sports games and other activities by using handheld motion sensors. Studies have shown that adolescents expend 50% more energy while playing the Wii sports-simulation games of tennis, boxing, and bowling than playing traditional video games (Graf et al., 2009; Leatherdale, Woodruff, & Manske, 2010). These studies suggest that AVG could be a feasible option toward promoting physical activity along with physical activity enjoyment.

With growing interest in technology based gaming systems and the need for children to be more active, physical educators are integrating AVG such as EyeToy™, Dance Dance Revolution™, Nintendo Wii™, and XBox Kinect™ into physical education programs (Trout & Christie, 2007). However, studies that examine the physical benefits of AVG have been conducted in lab-based settings and commonly compare differences between an AVG and sedentary (i.e. traditional video game play or watching television) conditions (Graves, Stratton, Ridgers, & Cable, 2008) or lab based equipment such as treadmill walking (Graves, Williams, Stratton, Atkinson, & Cable, 2008). Hansen and Sanders (2010) qualitatively examined the experiences of six elementary children participating in an 8-week AVG physical education unit. Results determined that children described AVG as fun, were motivated to stay engaged, and engaged frequently in interactions with peers. The authors suggest that AVG has the potential to increase children’s physical activity level, however these measures were not collected. To our knowledge, no studies, have examined the differences between an AVG task to its ecological equivalent task in a naturalistic setting. The purpose of this study was to compare physical activity, measured through step count, during an AVG (Wii® Tennis) and a traditional physical education striking game (i.e., modified tennis). This study also evaluated students’ preference as it relates to their enjoyment in the activities and future engagement in AVG as an option in their physical education program.

Material & Method

Participants

This study took place in a rural elementary school located in the southeast United States. Data were collected over six weeks during the students’ physical education class period. This project was approved by the Institutional Review Board and informed consent and participant assent was obtained. The elementary school is comprised of 360 2nd and 376 3rd graders. The school demographics consist of 55% boys with a racial/ethnic population of: 78% White, 18% Black, 3% Hispanic, and 1% Asian. At this school, students participated in Physical Education five days per week for 30 minutes, resulting in 150 minutes of Physical Education instruction per week. Instruction consisted of a motor skills based program and the students had participated in various striking games and activities twice previously during the school year. 132 students received parental consent to participate in the study (69 2nd graders; 63 3rd grade students). The sample consisted of 70 boys and 62 girls with a mean age of 8.18 ± 0.76 years.

Procedure

For this within-subject design study, students participated in two conditions: Wii® Tennis and modified tennis during a striking instructional unit in Physical Education. Participants were randomly assigned in pairs to each condition. Each pair participated in the two conditions for 10-minutes subsequently and the order of the conditions were counterbalanced. The conditions took place during regularly scheduled physical education and a researcher was present during each condition.

Condition

AVG Condition. Nintendo's Wii[®] Sport Tennis game was used for the AVG condition. Wii[®] is a home video system with a wireless motion-sensitive remote control that enables players to point to the television screen and interact with the game. The Wii[®] remote, which is similar in size to a television remote, uses a three-axis accelerometer to translate body movement into onscreen movement. The onscreen movement is visualized by an avatar called a Mii (pronounce "me") which is a figure representing movement of the player in the game. The Wii[®] remote also provides basic audio and vibration feedback. Prior to the AVG condition, participants received instruction on the Wii[®] Tennis gaming system and viewed a 5-minute instructional video. The instruction and video explained the interactive gaming system and basic operational questions for Wii[®] Tennis. Participants selected Miis from 20 preset Miis that ranged in sex, race, hair color, and body size and completed the gaming condition (10 minutes) with a partner.

Modified Tennis.

The traditional striking activity was a "modified tennis" activity. Children in pairs were given 2 tennis racquets, a tennis ball and were instructed to strike the ball back and forth over the net on an indoor court. Using tennis rules, boundary lines and scoring was optional during play because, although they had played striking activities in PE before, many participants did not have previous tennis knowledge. Children could also choose the level of difficulty of the game (e.g., volleying, one or two bounces) to accommodate for skill differences, as long as they continued to strike the ball over the net for 10 minutes during this condition.

Instrument

Physical activity participation was measured with New Lifestyles Yamax NL-200 pedometers. Prior to data collection, a 20-step field-based pedometer check was conducted to assess step count measurement accuracy for all pedometers (Bassett Jr. et al., 1996). The check demonstrated that the pedometers accurately counted steps for children (error = +/- 1 step). Previous reliability and validity testing for Yamaz NL-200 indicate that the pedometers accurately records the number of steps taken, has the most consistency among pedometer units, and is the most accurate at moderate activity levels (Bassett Jr. et al., 1996). Additionally, the device records steps within 1% of all steps taken under controlled conditions (Barfield, Rowe, & Michael, 2004; Tudor-Locke, Williams, Reis, & Pluto, 2002) and has shown a strong relationship ($r = 0.80-0.90$) under laboratory conditions with more expensive accelerometers including the CSA (Computer Science Applications Inc.). The pedometer was secured to a pedometer belt that was placed around the participants' waist and adjusted so that the pedometer was located on the right side in midline with the quadriceps. The pedometer was closed, thus students were unable to see their step count while engaging in the two conditions. At the end of each 10-minute experimental condition (i.e., AVG or modified tennis) a technician recorded the total count of accumulated steps. The pedometer was then reset to zero and participants engaged in the second experimental condition.

Student Evaluation Immediately following participation in both conditions, participants completed a verbal dichotomous (i.e., Yes/No) questionnaire about their experiences participating in Wii[®] Tennis and modified tennis. Participants were asked the following: 1) Have you played Wii[®] Tennis before today, 2) Have you played regular tennis before today, 3) Would you want to play Wii[®] again, and 4) Would you choose to play Wii[®] if you had the option in PE?

Statistical analysis Paired t-tests were utilized to examine differences between the two conditions (AVG or modified tennis). A 2(sex: male, female) X 2(condition: AVG or modified tennis) ANOVA examined differences in physical activity. Alpha level was set at .05 a priori. Overall percentages for each of the 4 questions from the student evaluation are reported.

Results

Participants on average accumulated 322.73 steps in a 10-min Wii[®] Tennis session and 965.67 steps while participating in modified tennis in Physical Education. Paired *t*-test revealed that participants accumulated significantly more ($t=34.15$, $df = 131$, $p < .001$) steps in modified tennis compared to the Wii[®] Tennis (see Figure 1).

Fig. 1. Step Count for Wii Tennis and Modified Tennis
*denotes significant differences, $p < .001$, between conditions

There were no significant sex differences in physical activity participation between the two conditions ($p = .243$). Participants evaluated the Wii[®] Tennis game more favorably than the modified tennis condition. Specifically, 100% of the students enjoyed Wii[®] Tennis and 100% of the students wanted to play Wii[®] again. Only 45% of the children had played Wii[®] Tennis prior to this experiment and 34% of the children had played traditional tennis. A majority (89%) of the students' stated that they would choose to play the Wii[®] during physical education if they were given the option (see Figure II).

Fig.2. Enjoyment survey responses by percentage.

Discussion

There is a growing interest and popularity of AVG in fitness, physical education, and home settings as a means to promote physical activity participation. Many educators have already recognized that technology can be an important means of supporting general learning, particularly in physical education (Fiorentino & Castelli, 2005). The literature supports that AVG is an effective tool to enhance spatial abilities (DeLisi & Wolford, 2002), motor skills (Fery & Ponserre, 2001), knowledge structures and transfer (Day, Author, & Gettman, 2001; Gopher, Well, & Bareket, 2003), visual selective attention (Green & Bavelier, 2003), and problem solving skills (Ko, 2002) which are all skills learned within the physical education context.

In terms of physical activity, it is recommended that elementary students engage in moderate-to-vigorous physical activity lasting 10-15 minutes (i.e. 33-50% of a 30-minute class) during physical education (NASPE, 2011). Ten minutes of moderate-to-vigorous physical activity can be quantified as 61-63 steps per minute for second grade children and 58-61 steps per minute for third grade children (Scruggs, Beveridge, Watson, & Clocksin, 2005). During the modified tennis condition participants achieved 96 steps per minute and aligns with the recommendation for this age group, however, this threshold was not met in the Wii[®] Tennis condition. According to White, Kilding, and Schofield (2009) and Graves et al. (2010) Wii[®] interactive gaming provides more activity than traditional sedentary video games, however the most active Wii[®] game was similar to the child/adolescent walking at a moderate or leisurely pace. Our findings were similar in that modified tennis activities resulted in greater accumulation of steps compared to the AVG condition. The difference between the conditions could be due to the inherent nature of the two striking conditions. For example, modified tennis required changes in directions, and random movements of limbs and retrieval of balls, whereas, some children did not exhibit these behaviors in AVG.

One hundred percent of the participants enjoyed playing Wii[®] tennis. The incorporation of a gaming system into physical education was new for the children and the novel effect may wear off over time. A few participants expressed they would rather participate in a modified tennis activity during physical education rather than the AVG activity. Thus, we speculate that these individuals in the AVG condition did not receive the same social interaction with their peers compared to the modified tennis activity. A study by Cherney and London (2006) found similar findings, specifically suggesting that some children still enjoy traditional activities within the physical education setting.

Other aspects of the AVG condition observed during the study were the evidence of a clear "winner" and "loser" and incorporation of sport specific language. If participants completed a set of 5 tennis games during the 10-minute condition the screen portrayed an image of the winning avatar celebrating on the screen and the losing avatar looking sad and downtrodden. Whereas, in the modified tennis activity a score was not officially, displayed, or verbalized. Although this did not seem to curb enjoyment of the game, outcome goals focused solely on winning should be considered when incorporating AVG. In the AVG condition there were some observed positive outcomes concerning game knowledge, such as the use of tennis language, for example "love" and "deuce" during the interactive gaming condition, which prompted sport specific questions from participants.

Limitations

A few limitations were present in this study. Specifically, the participants' were predominantly White and of middle socioeconomic status, according to the questions from the student evaluation; 45% of the children have been exposed to Wii[®] Tennis and 34% to traditional tennis. However, all participants received formalized instruction and a 5-minute instructional video regarding the Wii[®] Tennis condition. This study also only examined second and third graders providing a narrow view of elementary school physical activity levels and skills. Furthermore, this study only examined a snapshot of game play, previous research has shown that players' efficiency in movement based games increase through practice (Sell, Little, & Taylor, 2008), and therefore these results may change over repeated exposure.

Conclusions

In conclusion, AVG are being marketed as techniques to increase physical activity rather than promote sedentary behaviors (Daley, 2009). AVG requires interactive physical activity that can help some children increase their physical activity by integrating play with exercise (Graf et al., 2009). This study found that students' physical activity participation was significantly higher in the ecologically relevant modified tennis activity compared to the AVG condition, but all of the students enjoyed participated in the AVG condition.

Although not investigated in this study, video games can offer considerable potential for tailoring the level of instruction to individual or group levels of proficiency. This potential benefit may help children who are more likely to be inactive or overweight, or that are not motivated to participate in traditional methods of sports and physical education (Hayes & Silberman, 2007). There is a paucity of research examining the effect of AVG on physical activity and additional outcomes associated with quality physical education instruction. Further empirical investigation is needed that incorporates longitudinal research designs and larger diverse samples. Focus on populations in the greatest need of exercise and physical activity participation, such as children who are overweight, obese, children with disabilities or developmental coordination disorder, and children who exhibit low fitness levels and/or an aversion towards physical activity is needed. In addition, changes in physical activity motivation from engaging in AVG should also be examined.

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