

Time Spent in MVPA during Exergaming with Xbox Kinect in Sedentary College Students

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ABSTRACT

International Journal of Exercise Science 7(4) : 286-294, 2014. The primary purpose of this study was to determine the amount of time spent in moderate-to-vigorous physical activity (MVPA) during a 30-minute bout of exergaming with the Xbox Kinect game console in sedentary college-aged students. A secondary purpose was to examine enjoyment level of participation in the selected exergame. Twenty college-aged students (14 females and 6 males) who self-reported being physically inactive and having no prior experience with the Xbox Kinect game "Your Shape Fitness Evolved 2012" Break a Sweat activity participated in the study. Participants came into the lab on two separate occasions. The first visit involved baseline testing and an 11 minute familiarization session with the game and physical activity (PA) assessment equipment. On the second visit, participants wore the same equipment and completed two 15 minute sessions of the full game. After the first 15 minute session, participants rested for 5 minutes before beginning the next 15 minute session. A 5 minute warm-up and cool-down was completed before and after the testing sessions on a treadmill. Time spent in MVPA was determined via portable indirect calorimetry and accelerometry worn at the wrist and waist. 30 minutes, 29.95±.22, and 27.90±1.37 minutes of the 30 minutes of exergaming were spent in MVPA according to activity monitors and indirect calorimetry, respectively. A majority of participants enjoyed the exergaming experience. The Xbox Kinect game "Your Shape Fitness Evolved 2012" Break a Sweat activity can be a viable mode of training to achieve the PA Guidelines for Americans in college-aged adults.

KEY WORDS: Video games, energy expenditure, behavior change, young adults, physical activity intervention

INTRODUCTION

The use of technology has had a tremendous impact on how we live our everyday lives and from a physical activity (PA) and public health point of view has resulted in a more sedentary lifestyle (25). Higher levels of sedentary time are adversely associated with several adverse

functional and clinical health outcomes in the general adult population (e.g., large waist circumferences; unhealthy levels of blood glucose, insulin, and blood fat; lower measures of physical functioning) (17). Fifty-eight percent of Americans play video games and 51% of U.S. households own a dedicated game console, and those that do own a dedicated game console, own an

average of two (6). Sedentary behaviors such as watching television and playing video games have been negatively associated with physical activity levels. Evidence reveals that this trend is heightened during the transition from secondary to postsecondary education and these rates have increased worldwide (3, 6, 13, and 22). Thirty – two percent of video game players are between the ages of 18 – 35 (6). One of the American College Health Association (2) Healthy Campus 2020 PA objectives is to increase the proportion of students (ages 18 – 24) who report meeting current federal guidelines for aerobic physical activity. As of spring 2010, only 48.7 percent of students met the current federal guidelines for aerobic physical activity. The current PA Guidelines for Americans (24) call for all healthy adults aged 18-65 years to engage in aerobic exercise at a moderate intensity for 150 minutes per week or at a vigorous intensity for 75 minutes per week.

In an attempt to increase physical activity behavior while accounting for the increased use of video games among young adults, the development of exergames (active video games) that stimulate greater activity during gaming through upper limb or total body movement may help to encourage physical activity (PA) during typically sedentary behaviors (5, 9). Exergaming has become a popular exercise modality while addressing several perceived barriers to exercise. Common obstacles for not participating in physical activity include not enjoying the particular physical activity, feeling incompetent in the activity, and lack of access to facilities to exercise or perform physical activity (8). Recently, video game platforms have been developed

to produce physical interaction during game play. Some of these platforms such as Dance Dance Revolution (DDR), Nintendo Wii, Xavix, Game Cycle, Play Station 2 Eye Toy, Play Station 3 (Move), and Xbox 360 (Kinect) are examples of exergaming specifically designed to promote physical activity during game play (7, 19). To date the majority of research that has examined whether these platforms are equivalent to moderate to vigorous physical activity (MVPA) or have the potential to promote healthy active behaviors has focused on the DDR and Nintendo Wii (5, 19). For adults, the results from these research studies have been mixed, indicating the intensity to be light to moderate and exergaming to be enjoyable (19).

The Xbox Kinect gaming console (Microsoft Corp, Redmond, WA) consists of the Xbox 360 video game console and a self-adjustable camera which acts as a sensor to detect whole body movements. This gaming system provides a controller-free type of gaming in which the individual controls the games using his or her body movements. Overall, exergames focusing on the lower body and the whole body expend more energy than those focusing on the upper body alone (18). There are very few published studies on the Xbox Kinect gaming console's impact on energy expenditure during exergaming or potential to promote healthy active behaviors (15, 16) and no published study that involved a game focused on fitness. Given the popularity of the Xbox Kinect, research is needed to evaluate the effects of this console and its specific exergames in order to accurately inform users of its potential contributions for meeting PA guidelines of exercise intensity. Therefore,

the primary purpose of this study was to determine the amount of time spent in MVPA during a 30-minute bout of exergaming with the Xbox Kinect game console in sedentary college-aged students. A secondary purpose was to examine the enjoyment level of participation in the selected exergame.

METHODS

Participants

Twenty university students (14 females & 6 males) aged 20.75 ± 1.8 who self-reported being physically inactive and having no prior experience with the Xbox Kinect game "Your Shape Fitness Evolved 2012" participated in the study. Participants self-reported being physical inactive via questionnaire. Physical inactivity was defined by accumulating less than 150 minutes of physical activity per week at moderate intensity or 75 minutes per week at vigorous intensity for 3 months. All participants completed a health history questionnaire and a Physical Activity Readiness Questionnaire (PAR-Q) to determine if there were any contraindications or physical limitations affecting their ability to participate in the exercise protocol. Participants were excluded if they were taking any medications affecting heart rate or had any physical limitations affecting exercise (pregnancy, injury, etc.). Prior to participation, all subjects had the research study and its potential risks and benefits explained fully before providing written informed consent. The Institutional Review Board approved all procedures. Recruitment methods included fliers posted in various campus academic buildings and residence halls, emails and messages (via

Facebook), classroom presentations by the researchers, and word of mouth contact. Data collection occurred between March and May, 2013. Characteristics of the study participants are provided in Table 1.

Table 1. Demographic characteristics of participants.

	All Participants (n=20)
Age (years)	20.75 ± 1.8
Height (cm)	167.4 ± 10.04
Weight (kg)	71.13 ± 15.33
BMI (kg/m ²)	25.35 ± 4.89
Systolic Blood Pressure	115 ± 7.77
Diastolic Blood Pressure	72 ± 10.36
Heart Rate @ Rest (bpm)	81 ± 8.51

Protocol

The Xbox Kinect game "Your Shape Fitness Evolved 2012" was implemented for this study because it was specifically designed to improve one's fitness level (23). From the game, "Break a Sweat" activity was chosen due to the set time duration allowing all participants to complete the same amount of game play and exercises. The Break a Sweat cardio activity focuses on short bursts of high intensity exercises. According to the PA guidelines for Americans, moderate-intensity aerobic exercise can be accumulated in 10 minute bouts to achieve the 150 minutes/week guideline. Some evidence suggests that shorter sessions are associated with greater adherence rates in sedentary individuals (7).

Additionally, after completing our pilot study, it was determined that 30 minutes of continuous exercise with the Break a Sweat activity would be too vigorous for our sedentary population. For this reason, it was decided to prescribe two 15 minute sessions of the game with a 5 minute rest period before beginning the next session to

appropriately match our targeted sedentary population. The Break a Sweat version G consisted of 2 sets of 9 exercises.

Table 2. Description of Break a Sweat (G) exercises and repetitions.

Exercises	Repetitions
Flying Jog	16
Oblique Swing	24
Oblique Swing	24
Jab Knee-up	8
Triple Run Punch	16
Slide Jump	8
Punch Side-Leap	16
Plyo Leg Curl	8
Shuffle Cross Punch	8

The selected exercises are provided in Table 2. Metabolic equivalent values (METs) were used to determine time spent in MVPA during the 30-minute exergaming session.

METs are numeric values equivalent to the number of times above resting energy expenditure that an activity requires. One MET is equal to the amount of energy that the body expends at rest and is fixed at 3.5 ml kg⁻¹ min⁻¹ (1). Moderate aerobic activities are classified as expending 3.0 to 5.9 METs, and vigorous intensity aerobic activities require expending 6.0 METs or more (1, 24). Indirect calorimetry was measured by the Cosmed K4b² (Cosmed Pulmonary Function Equipment, Rome, Italy). The Cosmed K4b² is a lightweight device, which has been shown to be valid for measuring VO₂ and VCO₂, compared to the Douglas Bag method, during cycle ergometry (14). Prior to each test the oxygen and carbon dioxide analyzers and the flow turbine were calibrated according to the manufacturer's instructions, which consisted of a room air calibration, gas calibration, volume calibration, and a delay calibration. The Cosmed was worn on the

torso and connected to a mask which was used to measure oxygen consumption by analyzing the concentration of gases inhaled and exhaled. Data from the Cosmed was stored in memory and downloaded to a computer at the completion of each test. Breath-by-breath data were collected by the Cosmed K4b², which were averaged over a 1-min period. For each minute of measurement, the VO₂ (ml min⁻¹) was converted to VO₂ (ml kg⁻¹ min⁻¹) and then to METs (1 MET = 3.5 ml kg⁻¹ min⁻¹) (4).

The dual mode Actical accelerometer (Respironics Inc., Bend, Oregon) is a small device that uses an omni-directional accelerometer. The Actical can measure accelerations in the range of 0.05–2.0 G and is sensitive to movements in the range of 0.35–3.5 Hz. Acticals were worn on the right waist level attached to a belt and on the dominant wrist attached to a band. At the conclusion of each test, the Actical data was downloaded to a laptop computer for subsequent analysis. In accordance with manufacturer's hardware and software, METs per minute were calculated for each accelerometer specific to placement. The Actical accelerometers used in this study were checked using manufacturer-recommended hardware and software, and calibrated if necessary.

Participants were asked to come into the lab on two separate sessions with at least 24 hours between each session. Subjects were instructed to refrain from eating 2 hours prior to exercise, drinking caffeine in beverages or other forms for 8 hours prior, drinking alcohol for 24 hours prior, and participating in strenuous exercise for 24 hours prior. Participants were asked to

arrive in work out attire and refrain from wearing excessively baggy clothing in order for the Xbox Kinect to analyze their movements accurately.

During their first visit, baseline testing was conducted and the participant completed an 11 minute Break a Sweat version C mini activity in order to become familiarized with the gaming system. The test was conducted in a quiet room to minimize distractions. The participant was instructed to mirror the Xbox Kinect trainer on the television screen and to play as if he or she would be at home. While the participant was playing, a Cosmed K4b², heart rate monitor, and accelerometers at the right hip and dominant wrist were worn so the participant could become accustomed to the equipment before data collection. Five minute warm-up and cool-down periods on a treadmill at 3.0 - 4.0 mph and 0% grade were completed before and after the completion of the Break the Sweat activity. On the second visit, the participant wore the same equipment and completed two 15 minute sessions of the Break a Sweat version G cardio activity. Five minute warm-up and cool-down periods on a treadmill at 3.0 - 4.0 mph and 0% grade were completed before and after the completion of the Break the Sweat activity. After the first 15 minute session, the participant was directed to walk out of the Kinect sensing area, where they stood in place and rested for 5 minutes before beginning the next session. Participants were not encouraged by the researchers during game play in order to minimize possible influences from the researchers. After the completion of the test, the equipment was taken off and participants were given a cup of water to drink. After

the participants finished the test and cool-down, the participants were asked to complete a short survey consisting of 3 questions on 1) their enjoyment level of the game, 2) if they would use it as a mode of exercise in the future, 3) and if they would use the game to meet the recommended guidelines for exercise. The questions were rated using a 5-point scale ranging from (1) strongly disagree to (5) strongly agree.

Statistical Analysis

The accumulated number of minutes with MET values ≥ 3.0 during the 30-minute exergaming session was recorded for each participant via indirect caloriometry and accelerometry measured at the waist and wrist. Chi-square analysis was used to examine the frequency data from the questionnaire to determine whether frequencies of the categories differ by amounts larger than would be expected by chance. Descriptive statistics were calculated to determine means and standard deviations for all variables. Statistical analyses were performed using SPSS 18.0 (Statistical Package for the Social Sciences, Inc, Chicago, IL). For all analyses, a p value 0.05 was used to indicate statistical significance.

RESULTS

Time spent in MVPA for the Actical worn at the waist was 29.95 ± 0.22 (99.9%) minutes of the 30-minute exergaming session with 5.91 ± 0.46 average METs per minute expended. Time spent in MVPA for the Actical worn at the wrist was 30 (100%) minutes of the 30-minute exergaming session with 7.04 ± 0.48 average METs per minute expended. Time spent in MVPA for the Cosmed was 27.90 ± 1.37 (93%) minutes

of the 30-minutes exergaming session with 5.48 ± 0.88 average METs per minute expended. Chi-square analysis revealed a significant relationship between level of enjoyment and participation in the Break a Sweat activity, $X^2 (2, N=20) = 9.1, p < .01$. A significant relationship also existed between game availability and utilization as a mode of exercise for future use, $X^2 (2, N=20) = 9.1, p < .01$. No relationship existed between game availability and meeting PA guidelines through exclusive game play, $X^2 (3, N=20) = 6, p = .11$. Figure 1 displays the complete results from the questionnaire.

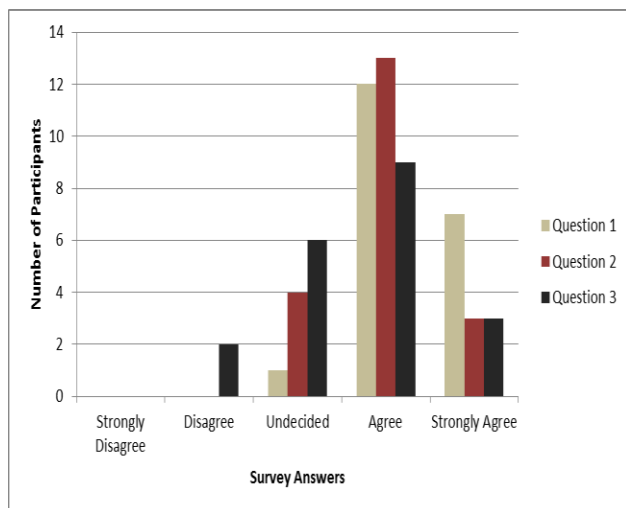


Figure 1. Frequency analysis of the post-exergame questionnaire. Question 1 “I enjoyed the Break a Sweat active video game”. Question 2 “If it were available, I would likely use this game as a mode of exercise in the future”. Question 3 “If it were available, I would likely meet the recommended guidelines for exercise by using this game”.

DISCUSSION

The purpose of this study was to determine the amount of time spent in MVPA during a 30-minute exergaming session with the Xbox Kinect gaming console in a group of sedentary college-aged students. Results from the study indicated that participation

in the Xbox Kinect game “Your Shape Fitness Evolved 2012” Break a Sweat activity allowed for 100%, 99% and 93% of the 30-minute exergaming session to be spent in MVPA when measured by accelerometry (wrist & waist) and indirect calorimetry, respectively. This is the first study, to our knowledge, to explore the impact on energy expenditure during exergaming using an Xbox Kinect game that focused exclusively on fitness rather than adventure (15, 16). The study also examined the enjoyment level of participation in the selected exergame as perceived by the sedentary college-aged students. The majority of participants reported enjoyment of the exergaming experience.

Using the Xbox Kinect gaming console in a group of young girls, Mellecker & McNamus (15) indicated that participation in the River Rush game did not allow for play at the recommended moderate or vigorous levels. This outcome could be attributed to the short duration of the gaming experience (5 minutes) and/or the selected game which was focused on adventure. O’Donovan et al. (16) examined energy expenditure using the Xbox Kinect and Wii gaming consoles in a group of young healthy adults using heart rate, VO_2 , and METs. The Reflex Ridge Collector Level game was used and participation lasted for 10 minutes with a 5 minute rest period in between. The authors concluded that mean METs (4.26 ± 1.09) from the gaming experience was of a light intensity (interpretation based on absolute age-relative MET guideline for moderate activity) but that playing on the Xbox Kinect elicited greater energy expenditure than playing on the Wii. Our results

support this finding especially when compared to published studies on Wii MET values across games. The differences in METs values reported by O'Donovan et al (16) and the present study could be attributed to the shorter duration of the gaming experience (10 minutes vs. 30 minutes), the selected game which was focused on adventure not fitness, and study population (healthy active vs. sedentary).

Garn et al. (7) examined time spent in MVPA in college-aged students participating in select Nintendo Wii Fit exergames using Actigraph accelerometers worn at the waist. The Basic Run exergame generated MVPA during 90% of the 10 minute bouts. The Basic Step, Table Tilt, Balance Bubble, and Ski Slalom exergames did not produce time spent in MVPA. Graves et al. (9) examined the physiological cost of Nintendo Wii Fit in adolescence, young adults, and older adults. They indicated that the time spent participating in the Wii Fit aerobics exercises was of moderate intensity for all age groups for the 10-minute exergaming session. Another study, conducted by Grieser et al. (10), examined the intensity levels generated by Nintendo Wii Fit in college-aged adults using a TrueMax metabolic cart in exergame sessions lasting between 3 – 7 minutes. The two aerobic games tested in the study elicited the highest MET levels compared to the strength and yoga games. These were the Basic Run (short) (4.98 ± 1.22 METs) and the Basic Run (long) (5.73 ± 1.36 METs). In addition to the two aerobic games, the Lunges (3.18 ± 0.62 METs) and Single Leg Extension (3.29 ± 0.71 METs) strength games averaged MET levels in accordance to with the guidelines for moderate physical activity. The results from

these studies support the current study outcomes, indicating the ability of specific exergames to provide moderate physical activity, especially those focused on aerobic activity. Also, Sell et al. (21) showed energy expenditure to be greater among experienced players than inexperienced players, which would suggest possibly higher energy expenditure outcomes if participants in our study had previous experience with the exergame.

When comparing the results of our study to those that have examined energy expenditure during exergaming using the Nintendo Wii gaming console, caution must be used due to gaming consoles being equipped with different hardware. The movement focus of the various exergames also has to be considered when comparing results between studies (i.e. upper body, lower body, combination of upper & lower body) (19). The inconsistencies among various gaming consoles and games in producing MVPA show that further research should be done with various gaming consoles and exergames to more accurately portray which types tend to produce MVPA.

Our study outcomes support previous research that has indicated enjoyment while participating in exergames from other gaming consoles (7, 9, 19, and 20). Our results differ from Lyons et al. (12), who found that exergames with greater energy expenditure were perceived by adults to be less enjoyable than exergames with less energy expenditure. Research has shown that incorporating enjoyable exercise into a program may contribute to adherence and a higher probability of performing the activity (7, 11). Eighty percent of the

participants in our study responded that if they had access to this gaming console and game, they would use the game as a mode of exercise in the future. Sixty percent of the participants responded that if they had access to this gaming console and game, they would use exergaming to achieve the PA guidelines for Americans. It appears that this Xbox Kinect exergame may be a viable option for sedentary individuals in this age group to achieve higher levels of physical activity. Further research should be done to investigate the dependability of these intentions.

In conclusion, the Xbox Kinect game console and game “Your Shape Fitness Evolved 2012” Break a Sweat activity was successful in maximizing time spent in MVPA in sedentary college-aged individuals who had no prior experience with this specific game. This Xbox Kinect game may be used effectively as a mode of exercise to meet the Physical Activity Guidelines for Americans for this segment of the population, especially for those who are just beginning a physical activity program. High levels of enjoyment were reported by participants, which suggest an increased likelihood of adherence to this form of activity. The convenience of having the Xbox Kinect at home may aid in eliminating barriers to exercise, such as transportation, cost, access of facility, and time constraints. The combination of enjoyment and decreased barriers may result in motivation for this population to become more physically active and thus, decrease the health risks associated with a sedentary lifestyle (9, 25).

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