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Original research

Active video games and physical activity recommendations: A comparison of the Gamercize Stepper, XBOX Kinect and XaviX J-Mat

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ABSTRACT

Objectives: The current study was designed to evaluate the intensity levels of three exergames and determine the association with physical activity recommendations that correspond to specific outcomes. The variation in cardiovascular responses between the three exergames was also examined.
Design: We employed a cross-sectional laboratory design.
Methods: We recruited 18 girls to participate in a peak VO_2 test and to play Gamercize, Kinect River Rush, XaviX J-Mat at three separate exergaming sessions. Linear regression equations of heart rate and percentage of peak VO_2 were calculated for each participant to determine the intensity of exergame play. Differences in intensity between the three exergames and time spent in the recommended moderate (heart rate at ≥55% peak VO_2) and vigorous (heart rate at ≥75% peak VO_2) intensity levels were analyzed. We calculated the coefficient of variation for the mean heart rate to determine the difference in variance in heart rate values for the three exergames.
Results: When playing Gamercize and Kinect the girls did not play at recommended moderate or vigorous levels. Although the girls did not play at vigorous levels when playing XaviX J-Mat, our results showed that when playing XaviX J-Mat they did play at moderate intensity levels. No significant differences in the coefficient of variation between the three exergames were apparent.
Conclusions: If active gaming is to be used to increase physical activity levels then individual differences in levels of exertion and specific activity recommendations need to be taken into consideration.

1. Introduction

Video games have become an attractive form of entertainment and have surpassed television viewing as a preferred sedentary activity choice for children.[1] Media usage reports indicate that children are spending an average of 8 h playing sedentary video games a week [2] and the time spent playing video games has been implicated as factor in the rising prevalence of childhood obesity.[3] The addition of an active component to this popular form of entertainment has created the optimal tool to halt declining physical activity levels. Energy expenditure,[4,5] cardiovascular responses[4,6] and specific health outcomes[7–9] have been assessed highlighting some of the positive effects when engaging in active gaming activities.

Although promising, results are inconclusive as to whether active games result in energy levels that are commensurate with physical activity guidelines.[10] To ensure children participate in adequate amounts of physical activity for health it has been suggested that they engage in at least 60 min of moderate/vigorous intensity physical activity daily.[11] A recent study investigating the differences in energy cost of 6 different active gaming systems suggests that children engage in active video game play at moderate to vigorous intensity levels that correspond to physical activity recommendations for children.[12] This study used general activity guidelines and absolute intensities to determine whether the participants were meeting physical activity guidelines. Anchoring intensity to an absolute value does not account for differences in cardiorespiratory fitness between individuals, which may explain some of the intensity level discrepancies between active gaming studies. Cardiovascular effort during exercise or physical activity is commonly derived from predicted maximum heart rate values rather than individualized cardiovascular responses in relation to peak oxygen uptake. This may explain the differences noted in cardiovascular effort between studies, since use of predictions of maximum heart rate, rather than values relative to an individual's aerobic fitness are likely to reduce accuracy and lead to misrepresentation of physical effort.

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Differences in bodily movements required from various video games result in varied intensity levels and energy expenditure.[6] Body movements that incorporate all of the extremities produce higher intensity levels and elicit greater energy cost.[10] Active video games, which include sensor-based technologies, allow the user to control the game with body movements, move freely and engage all extremities when playing. Physiologic responses of Dance Central and Kinect Sports Boxing suggests that sensor based games result in significant increases in energy expenditure above rest.[13] When using MET values to equate these responses to generalized physical activity recommendations[14] Dance Central resulted in 2 METs whereas Kinect Sports Boxing elicited a MET value of 4.

Unlike sensor based systems that require an individual to use a controller, perform an activity on a dance mat or use body movements to control the game, contingent systems are connected to conventional exercise equipment. Contingent systems (game pauses when activity ceases) provide the active video game player with various game choices. Preference or choice of game increases the amount of time and intensity that children engage in physical activity.[15]

Active gaming (exergaming) is a promising physical activity alternative given that children are encouraged to move whilst engaging in an activity they enjoy. Limited evidence exists on whether active gaming will increase activity levels that meet recommendations commensurate with specific outcomes and the individual differences in intensity levels between active gaming systems.[16,17]

We aimed to determine differences in intensity between the three exergame conditions (Gamercize, Kinect River Rush, XaviX J-Mat) and the recommended moderate (heart rate at ≥55% peak VO_2) and vigorous (heart rate at ≥75% peak VO_2) intensity levels associated with body composition and cardiorespiratory fitness changes, respectively. Our hypothesis was two-fold. We expected (1) the three exergames would result in moderate levels of physical activity; (2) the three exergames would not increase intensity to vigorous levels.

In view of the recent literature highlighting considerable individual variations in physical effort when playing active video games,[12] we investigated the variation in cardiovascular responses between the three exergames. We hypothesized that there would be significant variation in intensity of play between the three exergames.

2. Methods

We chose to recruit girls for this investigation with the knowledge that girls are less active than boys[18] and that exergaming may be a more suitable physical activity alternative for meeting physical activity recommendations in this subgroup of youth.[19] Twenty Hong Kong Chinese girls were recruited through a local government primary school and agreed to participate in this study. Two girls were absent during the maximal exercise testing protocol and were excluded from the final analysis. According to local age and sex specific BMI cut-offs, 11 (61%) of the girls were considered overweight and 7 (39%) were normal weight. Written informed consent was received by all the parents and the Institutional Review Board for human ethics granted ethical approval for this study.

The girls attended one session in our laboratory during which time anthropometric measures and peak oxygen uptake (peak VO_2) were assessed. Stature was measured barefoot with an accuracy of 0.1 cm with a fixed stadiometer (Invicta 2007246, Leicester, UK). Body mass and body fat were determined with an accuracy of 0.1 kg using electronic scales (Tanita Body Composition Analyzer, TBF-410, Japan). Following a 10-min seated resting period, submaximal and peak oxygen uptake, as well as cardiovascular responses were determined using an incremental treadmill protocol. The girls starting walking at 3.0 km h^{-1} and speed was increased every 4-minutes by 1.0 km h^{-1} (4, 5, 6, km h^{-1}). Speed was increased to 8 km h^{-1} for 1-min and once RER values of 0.90 were attained gradient was increased every minute by 2% until the child reached volitional maximum.

Peak VO_2 was determined when two of the following three conditions were reached: (i) a respiratory exchange ratio >1.0, (ii) heart rate >85% of age predicted maximum and (iii) the participant was exhausted and refused to carry on despite strong verbal encouragement.[20] We utilized a Medgraphics Ultima indirect calorimeter. Data were collected breath-by-breath and integrated to an eight-breath average. Prior to each test gases of known concentration were used to calibrate the oxygen and carbon dioxide sensors. Calibration of the volume sensor was performed using a 3-l syringe. The children wore a pediatric sized Hans Rudolph mask (Model 8950), which was assessed for proper fit and leakage. Heart rate was monitored continuously from heart rate telemetry (Polar E600). Linear regression equations of percentage of peak HR versus percentage of peak VO_2 were calculated for each participant to determine the level of exergame play at 55% and 75% of peak VO_2.

During the baseline assessment session the girls were given time to habituate to the three active gaming systems. Although none of the girls reported having any prior experience playing any of the three exergames, habituation (ability to operate the controller and game without disruption to the game or physical activity) to the three gaming systems was completed within 15-min.

Following the initial baseline assessments, the girls attended three active gaming sessions on separate days in the primary school. At the beginning of each active gaming session the girls were fitted with a Polar heart rate monitor (Polar E600). Heart rate was assessed continuously for 5-min and the average heart rate from the 5-min of active game play was used determine the cardiovascular effort for each session. We asked the girls to sit quietly for 5 min to ensure heart rates were at resting levels prior to the active video gaming sessions. Due to limited time period during lunch recess and to reduce the burden on the school the active video gaming sessions were limited to 5-min each.

The three exergames used in this study are commercial systems, which were available and affordable to the girls at the time of the study. The girls were allowed to play freely on the three exergames and were not given any feedback during the 5-min exergaming sessions. To maintain consistency all of the XBOX video games were set at beginner level. We also allowed the girls to choose one video game from a variety of E-rated adventure video games (Bee Movie and Surfs Up) when playing on the Gamercize Stepper since this is common practice when playing with this system in a home environment. When exergaming using the Gamercize Stepper, the girls stepped and played on contingent mode, which ceases video game play when stepping stops. The Kinect XBOX system is a sensor based active video game system, which requires body movements to control the game. We choose the Kinect River Rush video game to compliment the adventure video games used when playing the Gamercize Stepper. We set the Kinect system to single player and allowed the girls choose the River Rush adventure. The girls' walked/ran and dodged ninjas at their chosen pace when playing the Jackie Chan Challenge on the XaviX J-Mat, which comprises of a sensor port and a mat.

Means and standard deviations were computed for all key variables. A within group only repeated measures ANOVA was conducted to examine whether there were differences in heart rate between the three exergame conditions: Gamercize, XaviX J-Mat and Kinect River Rush. We used paired *t*-tests to determine differences in the heart rate achieved whilst playing the three exergames and the heart rate values at ≥55% peak VO_2 (moderate) and at ≥75% peak VO_2 (vigorous), which were obtained during the exercise test.