

## A Comparison of Energy Expenditure During “Wii Boxing” Versus Heavy Bag Boxing in Young Adults

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### Abstract

Traditional computer videogames are sedentary, whereas new computer videogames, such as the Nintendo® (Redmond, WA) “Wii™ Sports” games, allow users to physically interact while playing the sport. Energy expenditure (EE), heart rate (HR), and rating of perceived exertion (RPE) during heavy bag boxing versus the Nintendo “Wii Boxing” game were compared. Fifteen males and 14 females (mean age, 25.6 years; height, 171.3 cm; weight, 71.8 kg) randomly selected (by a coin toss) heavy bag boxing or “Wii Boxing” for their first test session and completed the other protocol at their second session at least 2 days later. Each session lasted for a total duration of 30 minutes and consisted of 10 3-minute exercise bouts with measurements of HR, RPE, and EE obtained from indirect calorimetry. A paired-samples *t* test was used to analyze the results. Significant differences were found for HR (bag, 156 beats per minute; Wii, 138 beats per minute;  $P=0.001$ ) and RPE (bag, 13.8; Wii, 11.4;  $P=0.0001$ ) but not for EE (bag, 8.0 kcal/minute; Wii, 7.1 kcal/minute; bag, 241 total kcal; Wii, 213 total kcal;  $P=0.078$ ). The results suggest that computer active videogames, such as the Nintendo Wii, have the potential to provide similar EE as their traditional forms of exercise and may be a sufficient replacement for traditional target HR zone activities, especially in less fit individuals. Further research is needed to compare EE for different “Wii Sports” games with those for their traditional forms of exercise.

### Introduction

**O**BESITY IS AN ONGOING health concern in the United States. The 2012 U.S. Department of Health and Human Services National Health and Nutrition Examination Survey stated that 35.7 percent of adults and 17 percent of children and adolescents are obese.<sup>1</sup> It has been well documented that videogaming, television, and computer usage have contributed to the obesity crisis because of their sedentary nature and lack of physical interaction.<sup>2,3</sup> Research suggests that the majority of U.S. youth get 2 hours or less of screen time a day.<sup>3,4</sup> Obese and overweight children, however, logged more screen time hours than their healthy-weight counterparts.<sup>2-6</sup> National organizations such as the American Heart Association,<sup>7</sup> American Academy of Pediatrics,<sup>8</sup> and National Association for Sport and Physical Education<sup>9</sup> have issued recommendations limiting sedentary behaviors. In 2011, the American College of Sports Medicine revised its recommendations for adult physical activity.<sup>10</sup> These revised guidelines recommend a minimum of 30 minutes of moderate-intensity (3–6 metabolic equivalents [METs]) physical

activity, 5 days a week, resulting in an increased heart rate (HR) (i.e., brisk walking).<sup>10</sup> New active videogames may potentially change sedentary lifestyles into active lifestyles meeting the recommended standards of moderate-intensity physical activity.

New computer gaming systems are now active, which allows participants to become more physically active.<sup>11</sup> Unlike traditional, hand-held gaming systems, the Nintendo® (Redmond, WA) Wii™ requires the user to physically interact with the system, thus coining the terms “new-generation games” and “exergaming.”<sup>11</sup> The popularity of exergaming has led to increased investigation of its potential health benefits. In 2008, Graves et al.<sup>12</sup> estimated that users of active new-generation games expended 51 percent more energy than traditional videogame players. Results of numerous additional studies found “Wii Boxing” to have the highest energy expenditure (EE) and increased HR compared with other exergames.<sup>11,13-15</sup> Miyachi et al.<sup>16</sup> used a metabolic chamber to determine METs for adults participating in “Wii Sports” games and found that “Wii Boxing” yielded 4.2 METs. One study compared “Wii Boxing,” “Wii

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Tennis,” “Wii Bowling,” “Wii Step,” and “Wii Ski” in boys 10–12 years of age.<sup>17</sup> The “Wii Boxing” average HR was 140 beats per minute (bpm), and EE increased 190 percent from rest.<sup>17</sup> “Wii Boxing” yielded significantly higher results than any other “Wii Sports” game; however, all EEs were higher than those for traditional gaming and watching television.<sup>17</sup> Graf et al.<sup>13</sup> concluded that the intensity of the “Wii Sports” games in 11–13-year-old children was equivalent to moderate-intensity walking. Results of exergaming studies suggest that physically active videogame systems are positive alternatives to both traditional gaming systems and traditional moderate-intensity activities.

The effect of exergaming on HR and estimated EE has been researched in depth. However, according to a recent systematic review, only a few studies have actually measured EE during exergaming using indirect calorimetry.<sup>18</sup> In addition, comparison of a specific interactive videogame with its traditional physical activity counterpart has not been previously conducted. **The purpose of the current study was to compare actual EE, HR, and perceived exertion during heavy bag boxing versus the Nintendo “Wii Boxing” game.**

## Materials and Methods

A convenience sample of 30 young adults from Cleveland State University and the Cleveland community volunteered to participate in the study. However, one subject was physically unable to complete the exercise and was excluded from the study, resulting in a sample of 29 subjects (15 males, 14 females; mean age, 25.6 years; height, 171.3 cm; weight, 71.8 kg). The test protocol was approved by the Cleveland State University Institutional Review Board, and signed consents were obtained prior to participation in the study. Each subject completed the American Heart Association/American College of Sports Medicine Pre-Participation Screening Questionnaire, which was designed to assess an individual’s medical history, symptoms, and risk factors related to their safety for engaging in exercise.<sup>19</sup> All subjects who volunteered were classified as low risk and were subsequently enrolled in the study.

Using a crossover experimental design, subjects were randomly assigned (by a coin toss) to the heavy bag or “Wii Boxing” for their first test session and completed the other protocol at their second session, with a minimum of 2 days between each session (range, 2–14 days; mean, 4 days). During the first session, height was measured using a stadiometer (nearest 0.1 cm) and weight using a medical balance scale (nearest 0.1 kg). All subjects were familiarized with the two protocols with a 3-minute practice session on each. For the heavy bag boxing session, a 70-pound Century Black Max training bag was suspended from a rack (Title Boxing, Lenexa, KS). The subjects’ hands were wrapped for protection and fitted with Everlast Pro Style boxing gloves of appropriate size (small, 12 ounces; medium, 14 ounces; or large, 16 ounces) (Title Boxing). For the “Wii Boxing” session (“Original Wii Sports”; Nintendo), the game was projected onto a large screen, and the subjects boxed against a “virtual” opponent using the lightweight, hand-held control units provided with the game. **Both the heavy bag and “Wii Boxing” sessions consisted of 10 3-minute bouts, with a 10-second rest period every 2 minutes 50 seconds.** This protocol was in accordance with the “Wii Boxing” game

and simulated a typical boxing match as well. For both exercise sessions, all subjects were instructed to exercise at an intensity they could maintain for 30 minutes and during the “Wii Boxing” session to simulate actual heavy bag boxing as much as possible. All subjects were continuously observed and received verbal encouragement to comply with the protocol as described. For data acquisition, subjects were connected to an HR monitor (Polar, Lake Success, NY) and a portable indirect calorimeter (K4b<sup>2</sup>; Cosmed, Chicago, IL) to measure oxygen consumption (VO<sub>2</sub>). HR and VO<sub>2</sub> were continuously monitored and averaged for each minute with EE (in kcal) calculated from VO<sub>2</sub>. During the 10-second rest period at the end of each 3-minute exercise bout, subjects were asked to state their rating of perceived exertion (RPE) based on the original (6–20) Borg scale.<sup>20</sup> For each 30-minute exercise bout, average HR, RPE, VO<sub>2</sub>, and EE were obtained for data analysis. **After the completion of both exercise sessions, subjects were asked, “Which exercise session was harder?” and “Which exercise session did you find more enjoyable?”**

Descriptive statistics were obtained for all measures. A paired-samples *t* test was used to compare results for “Wii Boxing” versus heavy bag boxing. A repeated-measures analysis of variance was used to determine if there was any gender by protocol (Wii, Bag) interactions. SPSS software (version 18.0; SPSS, Inc., Chicago, IL) was used for all analyses with 0.05 used as the level of significance.

## Results

**All subjects (*n* = 29) indicated that the heavy bag boxing session was harder, while the “Wii Boxing” session was more enjoyable.** As shown in Table 1, **all measures were higher for the heavy bag compared with the Wii. However, the only significant differences were for HR (*P* = 0.001) and RPE (*P* = 0.0001), which were higher for the bag.** Average HR on the bag was 156 bpm, versus 138 bpm on the Wii.

TABLE 1. RESULTS FOR “WII BOXING” VERSUS HEAVY BAG BOXING

Condition	Mean	SD	P value (Wii versus bag)
HR (beats per minute)			0.001 <sup>a</sup>
Wii	138.0	23.7	
Bag	156.0	17.8	
RPE (6–20)			0.0001 <sup>a</sup>
Wii	11.4	2.0	
Bag	13.8	1.6	
VO <sub>2</sub> (mL/kg/minute)			0.197
Wii	19.6	5.7	
Bag	21.2	5.2	
EE (kcal/minute)			0.078
Wii	7.1	2.3	
Bag	8.0	2.8	
EE (total kcal)			0.077
Wii	213.0	68.4	
Bag	240.6	83.5	

<sup>a</sup>Significant difference (*P* < 0.05).

HR, heart rate; RPE, rating of perceived exertion; VO<sub>2</sub>, oxygen consumption; EE, energy expenditure.

Perceived exertion on the bag was 13.8, versus 11.4 on the Wii. However,  $\text{VO}_2$  on the bag (21.2 mL/kg/minute) and Wii (19.6 mL/kg/minute) showed no significant difference ( $P=0.197$ ). Thus, EE (computed from  $\text{VO}_2$ ) on the bag (8.0 kcal/minute; 241 total kcal) versus the Wii (7.1 kcal/minute; 213 total kcal) also did not differ significantly ( $P=0.078$ ).

Analysis of the 10 3-minute exercise bouts showed only minor fluctuations in EE from the beginning to the end of the 30-minute session for both the Wii and the heavy bag. Average  $\text{VO}_2$  for the heavy bag was 22.5 mL/kg/minute for the first 15 minutes versus 21.4 mL/kg/minute for the second 15 minutes; for the Wii, it was 19.2 mL/kg/minute for the first 15 minutes versus 20.0 mL/kg/minute for the second 15 minutes. Thus, EE remained fairly consistent for both of the 30-minute exercise sessions.

As expected, there were significant ( $P<0.05$ ) gender differences for height, weight, and EE (total and kcal/min for both the heavy bag and the Wii), with the values for the males being significantly higher. Because of their larger size and muscle mass, males expended greater energy for a given exercise bout. However, there were no significant ( $P\geq 0.05$ ) gender by protocol (Wii, bag) interactions.

## Discussion

The results of this study suggest that computer active videogames, such as those for the Nintendo Wii, have the potential to provide similar EE as actual physical activity/sports participation. The average RPE during “Wii Boxing” was 11 (i.e., light), which is appropriate for novice and less physically fit exercisers. The average HR during “Wii Boxing” was 138 bpm, which is 71 percent of the age-predicted maximum HR for 26 year olds, the average age of the subjects in this study. The average MET level during “Wii Boxing” was 5.6, which equates to moderate intensity (i.e., 3.0–5.9 METs) according to the American College of Sports Medicine.<sup>10</sup> This is much higher than the range of 2–4 METs reported for active gaming, including “Wii Boxing,” in a systematic review of previous studies.<sup>18</sup> This suggests that the researchers were successful in encouraging the subjects to simulate heavy bag boxing as much as possible during the “Wii Boxing” session. Total EE for the 30-minute “Wii Boxing” session was 213 kcal, which is within the recommended range for an exercise session (i.e., 200–400 kcal). Thus, although “Wii Boxing” was perceived by the subjects in this study as more enjoyable than heavy bag boxing, as well as light in intensity, it fell within the American College of Sports Medicine’s recommended values for moderate-intensity exercise (i.e., 64–76 percent maximum HR; 3.0–5.9 METs; 200–400 kcal per session;  $\geq 30$  minutes/day).<sup>10</sup>

Recent studies have detailed the impact of television and videogames on physical activity and obesity rates,<sup>6,21,22</sup> but there is scant research on the actual EE of the new generation of active games such as those for the Wii.<sup>18</sup> Other studies have measured EE related to various physical activities in adolescents<sup>23,24</sup> and linked this with increased levels of obesity. Graves et al.<sup>12</sup> found that active gaming can increase EE by up to 172 percent. Sedentary individuals may benefit from regular use of active videogames. As was found in this study, the novelty of active gaming may be that the participant does not perceive it as being difficult or challenging

because of a high level of enjoyment. Sell et al.<sup>25</sup> found that more experienced active gaming players participated at a higher level of intensity and therefore had higher EE than inexperienced players. However, Bosch et al.<sup>26</sup> found the opposite, suggesting that inexperienced “Wii Boxing” participants played at a higher intensity level, resulting in a higher HR. The participants in the current study had no previous experience with heavy bag or “Wii Boxing,” and all were instructed to simulate the mechanics of heavy bag boxing while performing the “Wii Boxing” game. The results suggest that if gaming participants simulate the mechanics of the traditional activity, then active gaming may be an ideal alternative providing similar EE.

This study is the first to compare a new-generation active game with its traditional counterpart sport using indirect calorimetry. The results showed no significant difference in energy cost for “Wii Boxing” versus heavy bag boxing, which suggests that the Nintendo Wii may be a sufficient replacement for traditional target HR zone activities, especially in less fit individuals. Further research is needed to compare EE for different “Wii Sports” games with their traditional forms of exercise.

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## Author Disclosure Statement

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