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SYMPOSIUM

Novel Approaches to Obesity Prevention: Effects of Game Enjoyment and Game Type on Energy Expenditure in Active Video Games

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Abstract

Background:

Some active video games have been found to promote physical activity adherence because of enjoyment. However, many active games are exercise themed, which may interfere with the distracting properties that make game-based exercise more enjoyable than traditional exercise. This study compared exercise-themed and game-themed active games to investigate differences in energy expenditure and enjoyment.

Method:

Young adults (N = 100, 50 female, 55 overweight, aged 18–35 years) played two of four Wii Fit games (one aerobic game and one balance game per person) for 10 min each. Of the two aerobic games, one was exercise themed (jogging) and the other was game themed (hula hooping). Both balance games were game themed. Energy expenditure and enjoyment were measured.

Results:

After adjustment for gender and weight, aerobic games produced 2.70 $kcal/kg^{-1}/h^{-1}$ (95% confidence interval 2.41, 3.00) greater energy expenditure than balance games ($p < .001$), but balance games were more enjoyable ($p < .001$). In aerobic games, jogging produced greater energy expenditure than hula hooping in normal-weight and male participants ($p < .001$); in overweight and female participants, no differences were found ($p > .17$). Hula hooping was enjoyed more than jogging ($p = .008$). Enjoyment predicted energy expenditure in aerobic games ($B = 0.767$, $p = .010$).

Conclusions:

Aerobic games produced greater energy expenditure but lower enjoyment than balance games, and a game-themed aerobic game was found more enjoyable than an exercise-themed aerobic game. Integrating more strenuous activity into entertaining games instead of games that simply simulate exercise may be a fruitful avenue for active game development.

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Abbreviations: (BMI) body mass index, (CI) confidence interval, (M) mean, (MET) metabolic equivalent, (SD) standard deviation

Keywords: energy expenditure, gender, obesity, video game

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Introduction

Television viewing is a highly prevalent sedentary behavior that is associated with increased metabolic syndrome and mortality independent of physical activity.[1–3] However, interactive forms of media are now providing ways to be active instead of sedentary. Active video games (also called "exergames") that require physical activity in order to interface with the game have become popular.[4] Because these games offer physical activity within the context of a reinforcing video game, they may be a promising strategy for increasing physical activity during screen time, such as watching television. There is preliminary evidence that these games are capable of producing moderate–vigorous intensity-physical activity but that different types of active games may produce different levels of activity.[5–7]

According to behavioral choice theory, substituting one behavior for another works best if the alternative behavior is as enjoyable or more enjoyable than the original.[8] Additionally, self-determination theory suggests that intrinsic motivation, or the desire to engage in a behavior for its own sake, is a more powerful predictor of behavior than extrinsic motivation, which occurs in the context of receiving external rewards for a behavior.[9] Enjoyment is a powerful predictor of physical activity and video game play over time.[10–12] Affective judgments, including enjoyment and intrinsic motivation, have been found to have a similarly sized effect on physical activity as self-efficacy (confidence in one's ability to carry out a behavior successfully), one of the strongest predictors of physical activity.[13] Combining video game features with traditional forms of exercise increases exercise adherence and intensity,[14–16] and most likely, this is due to increases in enjoyment and positive affect.[17,18]

Fitness-themed games (i.e., Wii Fit, EA Sports Active) are active games that differ greatly from traditional video games. Fitness games are modeled after exercises and workouts; in other words, these games simulate exercise rather than behaviors that are more typical in video games (i.e., exploring, fighting). Games require a goal as well as rules that prevent efficient accomplishment of that goal.[19] Fitness-themed "games" such as jogging, calisthenics, and yoga are not true games under this definition. To distinguish between games that focus on fitness goals and games that focus on other game goals, we will use the terms "fitness-themed" or "exercise-themed" games for the former and "game-like," "game-themed," "traditional," or "typical" games for the latter. To distinguish between games that require cardio exertion to play and those that require balance, we will use "aerobic" games for the former and "balance" games for the latter.

It is unclear whether positive affective reactions found for typical video games would be produced by exercise-themed games. It has been hypothesized that active video games improve affective responses to exercise by distracting from bodily discomfort associated with exertion.[20] Theoretically, distraction from the real world while attention is paid to a virtual one is represented by the concept of presence, or the feeling of being in the game.[21] Presence, highly related to engagement and immersion, occurs when the mind fails to consciously realize that an experience is technology mediated. There is preliminary evidence that use of player movement as the input or interface to a video game may increase feelings of presence;[22,23] thus active games like Wii Fit may be more presence inducing than a sedentary game that uses a button-based controller. However, feeling present in a fitness-themed game that simulates running is unlikely to distract from the exercise being performed; in fact, the simulation directly draws the player's attention to his or her movements. It is not yet known whether the player's level of exertion in the physical activity simulated in an active game is associated with enjoyment of the game.

Wii Fit is one of the best-selling games of the 2000s.[4] Wii Fit contains a wide variety of games that players can choose, categorized by the game into aerobic, balance, yoga, and strength-training categories. Preliminary research has found that playing Wii Fit can sometimes be more enjoyable than traditional exercise, be equally enjoyable as some sedentary video games, and be less enjoyable than band-simulation games for certain populations.[24,25] Aerobic games appear to produce the greatest energy expenditure, whereas balance games produce the least.[7] Some aerobic games are also fitness games because they focus on simulating exercise (i.e., jogging). Balance games, in contrast, are usually modeled on traditional elements of action games (i.e., maneuvering through environments, collecting objects). Additionally, some aerobic games are more game-like than others. Due to these differences, it is possible that players would find game-like balance games to be more enjoyable than fitness-themed aerobic games.

Young adults are at unique risk for negative health outcomes associated with low levels of physical activity; as youths move from adolescence to adulthood, their physical activity decreases while their sedentary behavior remains relatively stable.[26] In addition, young adults 18–30 years old gain weight at a rate faster than older adults, gaining approximately 1–2 lb per year during young adulthood.[27,28] Adults also make up the majority of video gamers, with an average age of 35.[4] Promotion of active video gaming in young adults has the potential for a large public health impact.

This study investigated differences in energy expenditure with two aerobic and two balance games contained within Wii Fit, and it tested three hypotheses:

Hypothesis 1: Aerobic games will produce greater energy expenditure than balance games.

Hypothesis 2: Balance games will be rated as more enjoyable than aerobic games.

Hypothesis 3: A more game-like aerobic game will be rated as more enjoyable than an exercise-themed game.

Methods

Sample

One hundred 18–35-year-old adults, equal numbers male and female, were recruited using a university online mailing list and television advertisements. To be included, participants were required to weigh <300 lb (a requirement of Wii Fit's balance board controller), have played video games at least three times over the past year, have transportation to the study site, and be willing to be videotaped and fast at least 2.5 h prior to their appointment. Of 757 individuals who requested information and eligibility criteria, 325 completed eligibility information; of those 325, 169 potential participants were scheduled, 20 completed a substudy (not reported here), and 100 completed this protocol. Eligible participants who did not attend their appointments (*N* = 49) were considered dropouts, and 156 eligible participants were waitlisted.

Games

Wii Fit was chosen as a representative fitness game because of its popularity as the highest-selling fitness game at the time of the study (see vgchartz.com for sales data) as well as its inclusion of both exercise-themed and game-themed games. Wii Fit was played on a Nintendo Wii console using Wiimote and balance board controllers. The Wiimote used player arm movement as a game input. Players stood on the balance board, which used shifts in weight distribution as game inputs. Each participant played two of the games included in Wii Fit, one from the aerobic category and one from the balance category. These two games were randomly assigned to be one of two possible games from each category. The aerobic games were hula hoop (10 min version) and jogging (free run). In the hula hoop game, participants stood on the balance board and swung their hips in circles. To increase their score, participants also had to catch new hoops that were thrown to them. In the jogging game, participants held a Wiimote in their dominant hand while jogging through a virtual environment. The balance games were skiing (initial difficulty level) and penguin slide. In the skiing game, participants stood on the balance board and shifted their weight left or right to steer down a slalom ski course. In the penguin slide game, participants shifted their weight left or right on the balance board to tilt an iceberg, which allowed a penguin to slide and catch fish.

Procedure

The study was conducted in a dedicated laboratory in a university-owned office building between April and August of 2009. The room included a 58" high-definition television, a game chair with surround-sound speakers, and measurement equipment. Participants provided written informed consent, and then anthropometric (height, weight) and questionnaire measures were taken. Next, the mask for indirect calorimetry was then fitted, adjusted, and tested as needed prior to a 20 min rest period. Participants sat in a reclined position in a dimly lit room during rest measurement. A series of eight games (three shooter games, two band-simulation games, one dance-simulation game, and two Wii Fit fitness games) were then played in randomized order for 13 min each in a protocol that is described in further detail elsewhere,[25] with the first 3 min considered a training period. Analyses of variance showed that play order did not affect energy expenditure for any game (data not reported). Randomization was performed by assigning individuals separately to game order and game assignment, using random numbers generated by the SAS software system (SAS Inc., Cary, NC). During the training period, the study coordinator provided game instructions as well as a visual aid showing controller functions. Psychological variables were measured by questionnaire at the conclusion of each game. Participants rested 5–10 min between games to allow heart rates to return to within a standard deviation (SD) of baseline levels (approximately 10–15 beats/min). During rest periods, masks were removed and water was provided. The overall protocol for the larger study lasted approximately 4 h per participant and was approved by the University of North Carolina at Chapel Hill Public Health-Nursing Institutional Review Board.

Measurement

Energy expenditure was measured via indirect calorimetry (Ultima CPX, Medgraphics, St. Paul, MN) using a neoprene mask and open pneumotach. This device has shown small but significant bias similar to other available indirect calorimetry systems,[29] though the less precise model by the same manufacturer has been found to have adequate validity.[30] The calorimeter was calibrated daily using a three-liter syringe as well as prior to each test using certified gases. The umbilical hose connecting participants to the metabolic cart was routed behind each participant's body and was sufficiently long to allow movements required for each game.

The interest/enjoyment subscale of the Intrinsic Motivation Inventory was used to measure enjoyment. This measure has been used in previous virtual reality exercise studies[17] and has shown good reliability and validity.[31] Participants ranked their agreement with each statement on a Likert scale of 1 (not at all true) to 7 (very true). Slight changes to wording were made to specifically reference video game playing. Items included "I thought this game was quite enjoyable" and "This game was fun to play." Responses were averaged (range, 1–7).

Presence was measured using the Slater–Usoh–Steed presence measure.[32] Participants ranked their agreement with each statement on a Likert scale of 1 to 7. Items included "To what extent were there times during the experience when the game environment was the reality for you?" and "When you think back on the experience, do you think of the game environment more as *images that you saw* or more as *somewhere that you visited*?" Typically in virtual reality research, responses of 6 and 7 to each item would be coded as 1 and lower responses as 0. Video games would be expected to produce lower presence scores than more immersive virtual reality headset systems; representing only the highest values could obscure potentially meaningful differences at lower levels of presence. Thus we averaged scores from each of the items to measure presence (range, 1–7) rather than use the sum of very high scores.

Height and weight were measured in light street clothes without shoes, using a wall-mounted stadiometer (Perspective Enterprises Inc., Kalamazoo, MI) and calibrated scale (Tanita, Arlington Heights, IL). Familiarity with the games was measured with two items: "Have you ever played this game before?" (with categorical responses, including "No, I haven't played it at all" and "Yes, I've played it a little bit") and "How often have you played a game similar to this one?" (range, 1–7, from "not very often" to "very often").

Data Analysis

Energy expenditure estimates in kcal/kg^{-1}/h^{-1} were calculated from expired oxygen estimates (ml/kg^{-1}/min^{-1} divided by 3.5) and averaged over the last 10 min of play. Cut points for light-, moderate-, and vigorous-intensity activity were taken from Pate and colleagues.[33] Metabolic equivalent (MET) values were defined as equivalent to kcal/kg^{-1}/h^{-1}.

For the energy expenditure analysis, a mixed model was created that used game type as the repeated variable (as each individual played one aerobic and one balance game) and game as a between-subject variable. Based on hypotheses and findings from previous studies in youth and adults, gender and weight status were included as covariates.[5,25,34] Interaction terms were included to test for moderation effects, based on the hypothesis that gender would affect both energy expenditure and enjoyment and that weight status would affect energy expenditure. Interactions were investigated by testing differences of means using Tukey–Kramer corrections for multiple comparisons. For the enjoyment analysis, nonparametric tests were necessary due to non-normality. Game type was tested using a Wilcoxon matched pair test, and differences between games were tested using Mann–Whitney tests. The procedure for the presence analysis was identical to that used for energy expenditure, with analyses adjusted for gender and weight status. Presence means provided in the text are raw, unadjusted means. Analyses were performed using SAS statistical software (SAS Inc., Cary, NC).

Results

Participant characteristics are displayed in **Table 1**. Significant differences in males and females were found for height and weight but not for body mass index (BMI) or other personal characteristics. The mean age was 23.76 (SD = 3.96) years old. Most (74%) were in their 20s, with 16% aged 18–20 years and 10% aged 30–35 years. Overweight participants were slightly older [mean (M) = 24.87, SD = 4.47] than normal-weight participants (M = 22.40, SD = 2.71; p = .002).

Table 1.
Participant Characteristics by Gender and Weight Status[a]

Characteristic	Male			Female			Total
	Overweight (N = 30)	Normal weight (N = 20)	All male (N = 50)	Overweight (N = 25)	Normal weight (N = 25)	All female (N = 50)	
Age (years)	25.00 (4.90)	22.75 (2.69)	23.96 (4.25)	25.00 (3.99)	22.12 (2.74)	23.56 (3.69)	23.76 (3.96)[b]
Weight (kg)	96.57 (16.11)	73.66 (8.77)	87.40 (17.66)	87.46 (21.43)	59.35 (6.42)	73.40 (21.13)	80.40 (20.62)[b,c]
Height (cm)	179.47 (7.38)	179.52 (6.74)	179.49 (7.06)	165.67 (7.32)	164.88 (5.37)	165.27 (6.37)	172.03 (10.26)[c]
BMI (kg/m^2)	30.55 (5.60)	22.81 (1.87)	27.45 (5.88)	31.76 (7.05)	21.80 (1.73)	26.78 (7.15)	27.12 (6.52)[b]
Resting metabolic rate (kcal/kg^{-1}/h^{-1})	0.72 (0.17)	0.89 (0.15)	0.79 (0.18)	0.66 (0.13)	0.83 (0.16)	0.74 (0.17)	0.77 (0.18)

[a] Mean (SD).
[b] Significant difference by weight status, $p < .001$.
[c] Significant difference by gender, $p < .001$.

Seventy-three percent of participants were white, 15% black, 8% Asian, and 4% other, with 6% reporting Hispanic ethnicity (data not shown). Approximately half of the participants (55%) were overweight (BMI ≥ 25 kg/m^2).

The majority of participants (71% for aerobic and 73% for balance games) had not played the games before, though nearly half (47% and 44%) reported having played similar games in the past, so they were familiar with exergames (data not shown). Familiarity with exergames did not affect energy expenditure or enjoyment ($p > .10$). Lower age predicted greater energy expenditure in aerobic games (B = -0.128, p = .001) but not in balance games (B = -0.012, p = .322). Higher age predicted greater enjoyment of balance games (B = 0.085, p = .026) but not aerobic games (B = 0.024, p = .600).

Energy Expenditure

In support of hypothesis 1, a main effect of game type was found such that aerobic games produced greater energy expenditure than balance games ($p < .001$). An effect of individual game was also found ($p < .001$). Unadjusted means and SDs are displayed in **Table 2**. All differences in the following text are between means adjusted for gender and weight status and thus may differ slightly from the unadjusted means shown.

Table 2.
Energy Expenditure (kcal/kg^{-1}/h^{-1}/METs) across Four Wii Fit Games[a]

	Aerobic			Balance		
	Hula hoop	Jogging	Overall aerobic	Skiing	Penguin	Overall balance
Normal weight						
Female	4.10 (0.92)	5.76 (1.16)	4.83 (1.31)	1.66 (0.44)	1.80 (0.39)	1.72 (0.42)
Male	3.66 (1.24)	6.81 (1.71)	4.76 (2.06)	1.92 (0.51)	2.00 (0.39)	1.95 (0.47)
All normal weight	3.89 (1.09)	6.17 (1.45)[b]	4.80 (1.67)	1.78 (0.49)	1.88 (0.39)	1.82 (0.45)
Overweight						
Female	3.97 (0.97)	4.16 (1.12)	4.07 (1.04)	1.69 (0.55)	1.46 (0.31)	1.56 (0.44)
Male	3.43 (1.37)	4.76 (1.81)	4.23 (1.75)	1.76 (0.48)	1.80 (0.44)	1.79 (0.45)
All overweight	3.69 (1.20)	4.50 (1.55)	4.16 (1.46)	1.72 (0.51)	1.65 (0.42)	1.68 (0.46)
Total						
Female	4.04 (0.92)	4.86 (1.38)	4.45 (1.23)	1.67 (0.48)	1.61 (0.38)	1.64 (0.43)[c]
Male	3.55 (1.28)[d]	5.33 (1.98)	4.44 (1.88)	1.84 (0.50)	1.86 (0.43)	1.85 (0.46)
All	3.80 (1.13)	5.10 (1.70)	4.45 (1.58)	1.76 (0.49)	1.73 (0.42)	1.75 (0.46)

[a] Mean (SD).
[b] Significantly higher than normal-weight hula hoop, overweight jogging, and overweight hula hoop, $p < .001$.
[c] Significantly lower than males, $p = .019$.
[d] Significantly lower than jogging in males, $p < .001$.

Because three-way interactions were found in this initial analysis, the aerobic and balance games were tested separately to investigate effects of game, weight status, and gender.

In the aerobic games, two interactions were found, between game and gender (p = .021) and between game and weight status (p = .004). Male participants expended 2.18 kcal/kg^{-1}/h^{-1} more while jogging than while hula hooping [95% confidence interval (CI) 1.18–3.18; p < .001]. In female participants, the difference between jogging and hula hooping was not significant, though a trend toward higher energy expenditure in jogging was found (0.94 kcal/kg^{-1}/h^{-1}; 95% CI -0.04–1.91; p = .077). No significant differences across genders were found in the jogging (p = .189) or hula hoop (p = .563) games. Normal-weight participants who jogged expended 2.37 kcal/kg^{-1}/h^{-1} (95% CI 1.32–3.42) more energy than normal-weight participants who hula hooped. Normal-weight joggers also expended 1.81 kcal/kg^{-1}/h^{-1} (95% CI 0.77–2.83) more energy than overweight participants who jogged and 2.55 kcal/kg^{-1}/h^{-1} (95% CI 1.46–3.64) more energy than overweight participants who hula hooped (all p < .001). Other comparisons were not significant (p > .17).

In the balance games, a difference was found by gender (p = .019), such that males expended 0.22 kcal/kg^{-1}/h^{-1} (95% CI 0.035–0.40) greater energy than females. A trend toward significance was found for weight status (p = .069). Game was not significant (p > .90). No significant interactions were found (p > .20).

Energy expenditure estimates for the four games by gender and weight status are shown in **Figure 1**.

Enjoyment

In support of hypothesis 2, a Wilcoxon test found that balance games were rated as more enjoyable than aerobic games (z = -4.356, p < .001). In support of hypothesis 3, subsequent Mann–Whitney tests within game category found that the game-like hula hoop aerobic game was reported to be more enjoyable than the fitness-themed jogging aerobic game (z = -2.663, p = .008), whereas no difference existed between the penguin and skiing balance games (z = -1.01, p = .312). Tests in each game by gender and weight status found no differences (all p > .15). Medians and interquartile ranges for the four games are displayed in **Table 3** and **Figure 2**.

Controlling for game, gender, and weight status, the effect of enjoyment (square root transformed for normality) on energy expenditure was investigated in each game type. In the aerobic games, enjoyment (B = 0.767, t = 2.635, p = .010, R^2 = 0.302) significantly predicted energy expenditure, but in the balance games, it did not (p = .903).

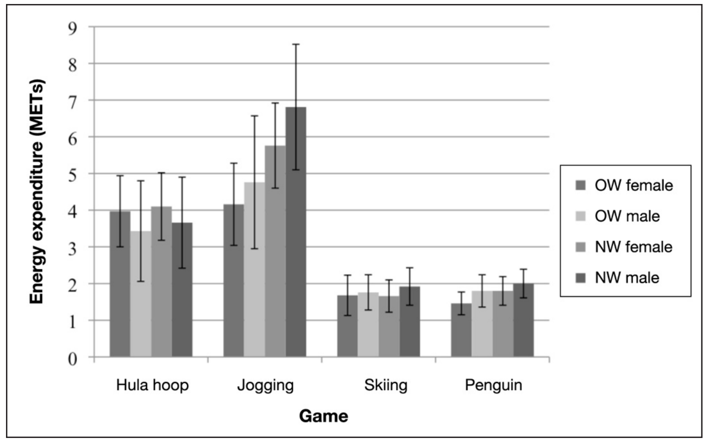

Figure 1. Energy expenditure in four Wii Fit games by gender and weight status. In the jogging group, a significant difference (p < .001) was found between normal-weight and overweight participants. No other differences were significant. Error bars are SDs. OW, overweight; NW, normal weight.

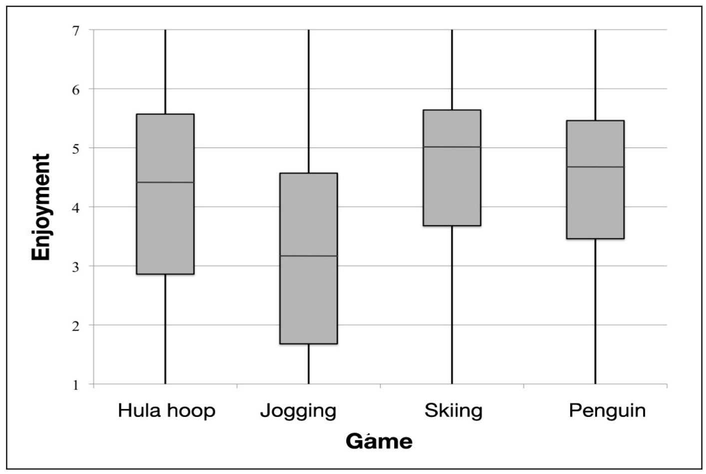

Figure 2. Median and interquartile range for enjoyment in four Wii Fit games. Balance games (skiing and penguin) produced significantly higher scores than aerobic games (hula hoop and jogging; p < .001), and hula hoop produced a significantly higher score than jogging (p= .008).

Presence

A mixed model that included gender and weight status found that presence levels in aerobic games (M = 3.22, SD = 1.79) and balance games (M = 3.05, SD = 1.47) did not differ significantly (p = .467; raw means provided in text and data not shown in tables). In the aerobic games, presence levels were similar in the jogging (M = 3.16, SD = 1.79) and hula hoop games (M = 3.31, SD = 1.79; p = .958). In the balance games, lower presence was felt while playing the penguin game (M = 2.62, SD = 1.30) than while skiing (M = 3.50, SD = 1.49; p = .001).

Table 3.
Enjoyment across Four Wii Fit games[a]

	Aerobic			Balance		
	Hula hoop	Jogging	Overall aerobic	Skiing	Penguin	Overall balance
Normal weight						
Female	4.79 (3.04)	2.86 (2.43)	3.86 (3.14)	4.64 (2.14)	4.86 (1.43)	4.71 (1.43)
Male	3.41 (3.71)	2.86 (1.71)	3.00 (3.14)	5.14 (2.21)	4.00 (4.29)	4.57 (2.39)
All normal weight	3.57 (3.71)	2.86 (2.07)	3.14 (3.14)	4.71 (2.14)	4.50 (1.54)	4.71 (1.79)
Overweight						
Female	4.14 (2.43)	2.14 (3.43)	3.71 (3.57)	5.14 (1.29)	5.07 (3.86)	5.14 (2.93)
Male	4.71 (1.93)	3.64 (2.21)	4.43 (2.21)	5.07 (2.18)	4.43 (1.68)	4.57 (1.96)
All overweight	4.57 (1.57)	3.21 (3.07)	4.00 (2.71)	5.14 (2.14)	4.71 (2.54)	4.71 (2.43)
Total						
Female	4.71 (2.93)	2.43 (3.29)	3.79 (3.18)	4.86 (1.64)	4.86 (2.29)	4.86 (1.75)
Male	4.14 (2.93)	3.14 (2.21)	3.43 (2.75)	5.14 (2.14)	4.43 (2.07)	4.57 (2.00)
All	4.36 (2.71)[b]	3.14 (2.89)	3.57 (2.82)[c]	5.00 (1.96)	4.64 (2.00)	4.71 (1.96)

[a] Median (interquartile range).
[b] Significantly higher than jogging, $p < .008$.
[c] Significantly lower than overall balance, $p < .001$.

Discussion

Large differences in energy expenditure exist across games contained within Wii Fit, and normal-weight and overweight individuals differ in their expenditure during some games. Only normal-weight male participants playing the jogging game engaged in vigorous-intensity physical activity (≥6 METs; equivalent to $kcal/kg^{-1}/h^{-1}$) in this study. Overweight males, normal-weight females, and overweight females who jogged engaged in moderate-intensity activity (3–6 METs), as did participants of all groups while hula hooping. Balance games produced light-intensity activity (1.5–3 METs) regardless of gender or weight status. No games were sedentary. In males and normal-weight participants, jogging produced greater energy expenditure than hula hooping, whereas in female and overweight participants, these aerobic games did not differ.

The energy expenditure values reported here are similar to those found in previous work. Other explorations of Wii Fit play in adults have reported MET values of 1.9 and 2.0 METs for balance games and 3.6 and 3.0 METs for aerobic games,[7,24] as compared with 1.75 METs in balance and 4.45 METs in aerobic games in this sample. Weight and gender differences are, to our knowledge, yet to be explored in adults, but findings in youth have been equivocal. In some investigations, males have shown greater energy expenditure than females,[5,35] but in others, no difference has been found.[36,37] For weight status, energy expenditure differences found in previous studies have disappeared when corrected for body mass.[34,36] In the current study, weight and gender interacted with game type. Weight and gender differences were found in one game (jogging) but not in the other three less-active games. More research is needed into the moderating effects of demographic characteristics on responses to active video games, as they may influence physical activity. These results suggest that future studies should include demographic characteristics as moderators due to effects on acute energy expenditure and potential effects on energy expenditure over time.

As hypothesized, the two balance games studied here were rated as more enjoyable than the two aerobic games, and the game-like aerobic game (hula hoop) was rated more enjoyable than the exercise-themed aerobic game (jogging). Differences by gender and weight status were not found for enjoyment. Greater enjoyment predicted greater energy expenditure, but only in the aerobic games played.

These results suggest that, not only do fitness games differ from one another (even those housed within the same overall game disc, such as Wii Fit) in terms of energy expenditure, but they also differ in terms of enjoyment.

A previous study in 15 normal-weight young adults (8 female) with no previous experience playing Wii Fit found no difference in enjoyment between aerobic and balance games.[24] The games used in that study differed from those used in this study. For aerobic games, step aerobics (an exercise-themed game) was included as well as hula hooping and jogging. Thus, although an additional exercise-themed game was added, these games were not found to be less enjoyable than balance games. The difference in findings may be due to measurement. The instrument used in the previous study (an adapted version of the physical activity enjoyment scale) included questions regarding how good the participant felt physically while playing. The questions also asked about physical activity being performed rather than a video game being played. The findings from the study may reflect how those participants felt about Wii Fit games as a type of physical activity (as compared with other physical activities) rather than as video games (as compared with other video games), which was how they were measured here.

The higher enjoyment ratings found for a game-like game (hula hoop) as compared with an exercise-themed game (jogging) support the hypothesis that, all else being equal, video games that call attention away from bodily sensations produce greater positive affective reactions during exercise activities. However, two distinct games were contrasted, so some of these effects could be due to the quality and entertainment value of the games themselves, regardless of their level of game-like qualities or exercise-themed qualities. Future research should contrast two games that are completely identical to each other except that they vary only in the level of exercise orientation of the game challenge.

Feelings of presence were similar in jogging and hula hooping. In other words, both games successfully simulated a virtual activity that captured players' attention and immersed them in a virtual environment. However, the exercise-themed jogging game was found to be far less enjoyable than the more game-like hula hoop game. This difference is concerning, as behavioral choice theory states that an alternative behavior must be as reinforcing as or more reinforcing than the less healthy behavior to be chosen in its stead.[8] Games that simulate "working out" for the purpose of fitness/health/appearance may be less likely to produce intrinsic motivation for play than games that use motion as a novel form of game input intended to increase enjoyment of play. Thus exercise-themed active games may be less attractive alternatives to sedentary games than game-themed active games. Behavioral choice, longitudinal studies, and more tightly controlled studies of contrasting game designs are necessary to further investigate how game characteristics affect play and exertion over time and thereby affect health. Theoretical investigations of the relationship between game content and predictors of intrinsic motivation would also provide valuable insight.

The lower presence ratings reported for the penguin game are likely due to its lack of realism in comparison with more typical games or behaviors. Despite differences in presence, the two balance games were similarly enjoyable. It appears that the relationship between presence and enjoyment is complex and can differ across game types. Other features, in addition to the type of simulated activity, are likely to influence enjoyment and presence. These features may include an involved narrative, realistic graphics, and identification with the player character.

Previous studies have found that video-game-enhanced stationary cycling produces greater physical activity over time than nonenhanced stationary cycling[15] and that this difference is mediated by positive affect, which includes enjoyment.[18] Game-enhanced cycling was also found to produce greater energy expenditure in a discrete period of time.[16] In this study, enjoyment of an active game predicted energy expended per game-play session only in the aerobic games. It is likely that this effect was not replicated in the balance games due to the nature of the movement necessary. The balance games required greater precision of movement in order to excel, not larger or faster movements. Future studies of balance games should explore relationships between player enjoyment and precision of movement to discover whether enjoyment motivates the types of effort that are required to win the game. In the aerobic games, faster movements positively affected performance (i.e., more spins of the hula hoop or faster jogging speed), whereas faster movement was not a strategy for winning a balance game. This finding underscores the importance of enjoyment for active game design and for tailoring of game-based interventions. Improving enjoyment of active games may produce greater health effects due to more vigorous activity intensity during play. Due to the popularity of motion-controlled active video games, integration of more game-like, enjoyable components into these games could produce a positive public health impact on a large scale.

The results of this study should be viewed in the context of several limitations. This study was a cross-sectional laboratory study, and thus its conclusions may not be applicable to behavior in natural settings over time. The use of self-report for psychological measures may have introduced bias due to social desirability.

The device used to measure energy expenditure has shown similar results to other available metabolic cart devices.[29] Resting and exercise energy expenditure reported here is similar to that reported in previous video game studies of adults[7,38] as well as larger investigations of resting energy expenditure.[39] Additionally, estimates reported here were highly correlated with energy expenditure estimated by accelerometers worn by participants (data not presented).

Comparisons to other active gaming studies should be made with caution, as some studies calculate METs by dividing game energy expenditure by resting energy expenditure,[7,24] while others calculate METs using the standard constant value for rest.[40] Though division by measured resting rates is recommended for children,[41] we used the conventional definition for adults of 1 MET = 1 $kcal/kg^{-1}/h^{-1}$ (or 3.5 $ml/kg^{-1}/min^{-1}$) in order to facilitate comparisons to standard cut points.[33] However, this measure may be conservative because resting rates are often lower than 1 (including in this study).

Additionally, there may have been specific aspects of each game other than their category (aerobic or balance, exercise-themed or game-themed) that affected enjoyment and/or energy expenditure. It is possible that, for example, differences in difficulty level, game challenge, entertainment quality, aspects of the virtual environment, or type of input (motion-sensing controller, camera-based controller) may have dramatic effects. Future research that compares games that are identical to each other—except that they differ from each other in one characteristic that is being tested and compared—is needed to investigate the generalizability of these results to other, similar games.

Despite these limitations, the study also had a number of strengths. This study sampled a larger and more diverse population than most studies of energy expenditure during gaming and is the first, to our knowledge, to directly investigate effects of thematic development choices (i.e., use of a gaming context or workout context) on physiological and psychological outcomes. Few active gaming studies have analyzed enjoyment and related outcomes, and to our knowledge, none have analyzed presence or related variables. Inclusion of adult women in the sample increased the generalizability of these findings, as games such as Wii Fit are often targeted toward this demographic. Furthermore, the purposeful sampling of equal numbers of males and females allowed for hypothesis testing regarding moderating effects of gender.

Conclusions

The results of this study show that, even within a single suite of games such as Wii Fit, it is likely that game choice will impact overall energy expenditure. The more enjoyable games appear to be those that best mask exercise activities in a game scenario, and enjoyment was associated with greater energy expenditure in the aerobic games. Future fitness games may benefit from integration of game-like elements rather than simulations of exercise activities to increase player enjoyment. Longitudinal investigations are needed to investigate effects of game elements and psychological reactions to games on physical activity intensity and frequency over time.

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