International Journal of
EXERCISE SCIENCE

Original Research

Comparison of Physical Activity during Zumba with a Human or Video Game Instructor

BRIDGETTE SCHNEEKLOTH* and GREGORY A. BROWN‡

Physical Activity & Wellness Laboratory, Department of Kinesiology & Sports Sciences, University of Nebraska - Kearney, Kearney, NE, USA

*Denotes undergraduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 11(4): 1019-1030, 2018. Using a physically active video game presents an opportunity for a person to engage in exercise in the privacy of their own home, yet still receive some feedback on the quality of their exercise performance. The purpose of this project was to compare the physical activity between participating in a Zumba exercise class led by a human and using a Zumba video game. Eight women (33.0 ± 3.0 y, 34.8 ± 8.1 % body fat) who regularly participated in a Zumba exercise class were measured for heart rate, number of steps taken, and minutes of sedentary, light, moderate, and vigorous physical activity while participating in a 60-minute human led Zumba exercise class (HZ) or while playing Zumba on the Xbox Kinect video game system (VZ). There were no differences between HZ or VZ (respectively) in light intensity (11.0 ± 7.3 vs. 11.9 ± 9.6 minutes) or moderate intensity (24.7 ± 7.1 vs. 27.6 ± 8.1 minutes) physical activity, or number of steps taken (5337 ± 899 vs. 5001 ± 1141). HZ resulted in less ($P<0.05$) sedentary time and more ($P<0.05$) vigorous intensity physical activity (22.0 ± 12.0 vs. 14.2 ± 12.8 minutes) and higher ($P<0.05$) average heart rates (149.0 ± 14.8 vs. 125.0 ± 10.9 beats/minute) than did VZ (respectively). The present data indicate that participating in Zumba led by a human or played as a video game can contribute to health promoting moderate intensity physical activity, but human led Zumba produces more vigorous intensity physical activity.

KEY WORDS: Accelerometry, exercise, dance

INTRODUCTION

In 2006, Nintendo introduced a new generation of "physically active" home video game systems with the Nintendo Wii. The Nintendo Wii presented an intriguing opportunity to increase physical activity by converting a primarily sedentary pastime into an active behavior (5, 14, 15, 17). In 2010, Microsoft introduced the Kinect system for the Xbox gaming system. The Kinect system utilizes a motion capture camera system to record a player's body movements and translate those to on screen movements with no handheld controllers required. Playing the Microsoft Kinect increases energy expenditure compared to traditional sedentary video gaming and rest in a manner similar to the Nintendo Wii (20, 23, 25). In addition to baseball, boxing, track & field, and more conventional game scenarios, there are also a number of virtual personal trainer types of games available for the Kinect gaming system that are intended to be used in lieu of a home exercise video.

Home exercise videos, in which an exercise instructor or personal trainer leads the viewer through a series of exercises, have been available to consumers for years as TV programs, on VHS tapes, DVDs, and the internet. Exercise videos allow a person to perform a myriad of styles of exercise in the privacy of their own home (18). However, a disadvantage of the exercise video is that there is no monitoring of the participants' performance of the exercise (24). Delextrat and Neupert (7) observed that while using a Zumba DVD promotes increased energy expenditure, participating in a Zumba class with a human instructor produces a more vigorous exercise experience. The use of a motion capturing camera with the Kinect system allows for the exercise participant to be monitored and receive positive feedback through on screen or audio cues when the movements are performed well (1). This feedback from the Kinect Zumba experience may more effectively emulate participation in a Zumba class than does a video (27).

Zumba is a fitness routine involving music and dance moves from the styles of soca, samba, salsa, merengue, and mambo (27). Frequently, Zumba is provided at a fitness center as a group exercise class led by a human instructor. Yáñez-Sepúlveda (30) observed that 53.8 ± 14.4% of the time in a Zumba class led by a human instructor could be classified as moderate to vigorous physical activity (MVPA). There are also a number of Zumba exercise programs available for the Kinect system (27). When participating in Zumba with the Kinect system, the Zumba dance routine is led by a virtual instructor with the participant trying to move their body in the same manner. The participant receives feedback on how well they perform the desired dance moves in the form of audio cues such as "that's the way to do it!", "looking good", "you got it", and so forth (27). Neves et al. (19) observed that heart rate increased 67% above resting due to participation in 22 minutes of virtual Zumba using the Kinect system. However, a more detailed evaluation of virtual Zumba using the Kinect system is warranted.

The purpose of this study was to compare the number of minutes and intensity of physical activity during a Zumba exercise class with a human instructor to a Zumba exercise session using the Kinect video game system.

METHODS

Participants

In order to assess the number of minutes and intensity of physical activity during Zumba using the Kinect video game system (VZ) compared to a Zumba exercise session led by a human (HZ), eight healthy adult women who were experienced in Zumba were recruited as study participants. The participants were first assessed for body composition for descriptive purposes. Participants were also measured for peak oxygen consumption (VO_2peak) as a measure of aerobic fitness and to develop a heart rate (HR) / VO_2 regression equation. On two separate days (HZ followed by VZ), the subjects engaged in a session of Zumba while wearing a heart rate monitor, step counter, and accelerometer. The two Zumba sessions were compared for energy expenditure, average HR, maximal HR, VO_2 based on HR, number of steps taken, and minutes of sedentary, light, moderate, and vigorous intensity physical activity.

A flyer indicating that research participants were needed to compare human led Zumba to video game Zumba was posted at a local fitness center that offers Zumba classes. Interested persons were asked to contact the researchers via telephone. Potential participants discussed the goals, purposes, and expectations of the research project with one of the investigators. As an inclusion criterion for this project, potential participants were asked if they had engaged in a Zumba class at least once per week for the previous 3 months but no further measurement of Zumba experience was made. Subjects still willing to participate signed a document of informed consent and completed a written health history to screen for possible contraindications to vigorous exercise (3). Any subjects in whom contraindications were discovered were asked to consult their physician and obtain written permission prior to participating in this project. Subjects then reported to the Physical Activity & Wellness Laboratory on another date for assessment of body composition for descriptive purposes (Table 1) and measurement of maximal oxygen consumption as a measure of cardiorespiratory fitness as well as to develop a HR / VO_2 regression equation. Body composition and aerobic fitness testing were conducted at various times throughout the day that were convenient for the participants. Prior to body composition and exercise testing, participants were instructed to eat no food for three hours and consume no caffeine for six hours prior to the exercise test, come to the test well hydrated and well rested, and prepared to engage in vigorous exercise (3). All procedures in this study were approved by the Institutional Review Board at the University of Nebraska - Kearney.

Table 1. Subject descriptive data for eight women participating in a Zumba session led by a human instructor and a *Kinect* Zumba video game.

Variable	
Age (y)	33.0 ± 3.0
Body Height (cm)	162.4 ± 7.1
Body Mass (kg)	72.0 ± 16.6
Body Mass Index (kg/m^2)	27.1 ± 4.7
Body Fat (%)	35.1 ± 8.6
VO_2peak (ml/kg/min)	31.5 ± 10.2

Data are means ± standard deviation.

Protocol

Body mass was measured and recorded to the nearest 0.1 kilogram using a digital scale (PS 6600ST, Befour Inc, Saukville, WI) and body height was measured to the nearest 0.5 centimeters using a wall mounted stadiometer (Model 707, Seca, Hamburg, Germany). Body composition was then measured using Dual-Energy X-Ray Absorptiometry (DEXA; DPX-IQ, Lunar Corp, Madison, WI). The subjects were asked to wear comfortable clothing with minimal metal snaps, buttons, or zippers and to remove all jewelry in order to enhance the safety and accuracy of the DEXA measurement (21).

Participants put on a HR monitor (E600, Polar Electro, Oy, Finland) and were connected to a metabolic cart (True One 2400, Parvomedics, Sandy, UT) using 2-inch diameter tubing and a facemask (Vmask, Hans Rudolph Inc., Kansas City, MO). Five minutes of seated resting measurements were taken before the start of the aerobic fitness assessment. Participants began the aerobic fitness assessment by walking on a treadmill (425C, Trackmaster Treadmills, Newton, KS) at 1.7 mph with a 10% grade. The treadmill speed and grade gradually increased in small increments every 30 seconds using a Bruce Ramp Protocol (28) so that every three minutes the speed had increased by 0.8 mph and the grade by 2% and the test continued until the participant reached volitional fatigue. Ratings of Perceived Exertion (RPE) were measured every 30 seconds during the aerobic fitness assessment by having the subjects point to an 8.5" X 11" printed table with numerical and descriptive information for the 6-20 RPE scale (4). When the subjects indicated an RPE of 16 they were verbally encouraged to keep going, and were continuously encouraged until they indicated volitional fatigue by stepping off the moving belt. During the aerobic fitness assessment data for VO_2 and heart rate were measured continuously and then averaged over 30 second intervals with the highest 30 second value recorded as VO_2peak. The metabolic cart was calibrated by following the manufacturer's instructions before each aerobic fitness assessment

At least two but not more than 14 days after the fitness assessment (mean = 5.5 ± 2.9 days), the participants gathered at a local fitness center (Just For Ladies Fitness Center, Kearney, NE) for measurement of physical activity during HZ. Testing for HZ was performed on two separate dates to accommodate the schedules of the participants. The measurement of physical activity during HZ occurred prior to VZ. In order to keep the HZ sessions as consistent as possible, they occurred during one of two consecutive regularly scheduled Zumba classes at the fitness center. The HZ session used 15 songs (Table 2) in the order listed and included occasional rest and water breaks, taken as needed. However, time did not stop for these breaks. The songs were chosen and choreographed by the Zumba instructor based upon the list of available songs and corresponding dance moves on the Zumba video game (Zumba Fitness for the XBOX 360 Kinect, Majesco Entertainment Company, Edison, NJ). Environmental conditions in the room where HZ occurred were measured before and after each setting (Fisherbrand Traceable Digital Barometer, Fisher Scientific, Pittsburgh, PA).

Prior to the beginning of HZ, each subject put on a heart rate monitor (E600, Polar Electro, Oy, Finland) that included a chest strap and wristwatch. Each subject also wore an accelerometer (AM7164, Actigraph Inc, Pensacola, FL) on a belt at the level of the superior iliac crest aligned above the right knee. The accelerometers were initialized to begin recording data 1/2 hour before exercise was scheduled to begin, and were set to record 15 second epochs. Each subject also wore a step counter (HJ-113 GO-smart Pocket Pedometer; Omron Healthcare, Inc. Banncockburn, Illinois) on the waistband of their clothing on the left hip. The number of steps on each step counter were recorded right before the beginning of the exercise session, and then the number of steps taken were recorded immediately after the exercise session with the difference being used to determine the number of steps taken during each Zumba session. The time of day each HZ began and ended was recorded. After HZ, using proprietary software for the accelerometers (Actilife v 6.0, Actigraph Inc, Pensacola, FL) and heart rate monitors (E-Series, Polar Electro, Oy, Finland), the data were downloaded to a computer. After the data download the time stamp from the step counters and heart rate monitors were synchronized with the written time records of HZ in order to determine heart rate and accelerometry data during the Zumba session.

Table 2. Song list and duration of each song in Zumba sessions led by a human instructor (HZ) and a *Kinect* Zumba video game (VZ).

	HZ Song Title	Duration (minutes: seconds)	VZ Song Title	Duration (minutes: seconds)
Warm-Up Song	Blurred Lines	4:23	Zocalypso	5:35
	Zumba Mami	3:40	Zumba Mami	3:34
	Pegate Mas	3:19	Con Moviemento	4:53
	Vete (by Los Primeros)	3:28	Bring It On	3:49
	Baila Pa Emociona	4:14	Baila Pa Emociona	4:11
	Crazy Love	3:02	Bla Bla Bla	2:58
	Mawa Sillah	3:59	Mawa Sillah	3:54
	Dance, Dance, Dance	3:45	Vamanos DJ	5:04
	Caipirinha	4:01	Slide	3:12
	El Amor, El Amor	4:24	El Amor, El Amor	4:20
	Mueve La Cadera	5:41	Mueve La Cadera	5:38
	Zommer	3:30	Echa Pa Un Lado	5:02
	Tacata	2:57	Feel Like Dancing	3:52
	Indian Moonshine	4:40		
Cool-Down Song	Beautiful Things	5:10	Zumba Lluvia	4:06
Planned total Zumba time		60:13		60:17
Actual total Zumba time		60:06 ± 0.0		62:0 ± 1:24

The planned Zumba time is based on the length of the songs. The actual Zumba time is given as means ± standard deviation for the time to complete the Zumba session.

At least two but not more than 14 days after HZ (mean = 4.0 ± 2.2 days), the participants reported individually to the Physical Activity and Wellness Laboratory for VZ. Each participant engaged in the songs in the order listed during VZ (Table 2) and the sessions lasted for approximately 60 minutes in order to closely simulate the Zumba session that was administered by the human Zumba instructor. The song list was compiled by the researchers in cooperation with the Zumba class instructor based upon the song selections and dance moves available in the video game and the songs were performed in the order listed. Rest and water breaks were provided briefly after each song while the next song was selected and the video game system processed the request, unless the participant requested a slightly longer break in which case the game was paused (but time was not). If a participant happened to be in progress of a song at the time they reached 60 minutes of activity, she was allowed to complete that song.

Heart rate, accelerometry, and step counts during VZ were measured using the same techniques as were used during HZ. Environmental conditions of the room where VZ occurred were measured before and after each setting using the same device as was used for HZ.

Statistical Analysis
Heart rate and VO_2 from each 30 second averaging interval from the aerobic fitness assessment were used to develop an individual HR / VO_2 regression equation for each subject (2, 10), and this equation was then used with the average and maximum measured HR during Zumba to determine VO_2 during the Zumba sessions. The cut-points for the categorization of the physical activity by the accelerometers as either sedentary, light, moderate, or vigorous intensity used in this study were based on the guidelines established by Freedson (11), using Actilife software. Comparisons of all data for HZ and VZ were performed using paired t-tests with $P<0.05$ using statistical software (SigmaStat 4.0, Systat Software, San Jose, CA). Throughout this manuscript, data are reported as means ± standard deviation.

RESULTS

None of participants met at least two of the ACSM criteria (3) for attainment of VO_2max (i.e. plateau of VO_2 in spite of increasing exercise intensity, a plateau of HR in spite of increasing exercise intensity, attaining ± 10 beats/min of age predicted maximum HR, Respiratory Exchange Ratio $\geq$ 1.15, due to either attainment of an RPE of 20 (3) or indication of volitional fatigue prior to reaching two criteria. However, all participants attained HR at test termination equal to at least 75% of age predicted maximal HR (3) and the subsequent HR / VO_2 regression equations were able to reflect a large range of intensity with very strong correlation coefficients ($r^2 = 0.94 \pm 0.03$).

Zumba Song List: During HZ the participants completed all 15 songs over (Table 2). During VZ the participants only completed the first 12 of the 14 planned songs. There was no difference ($p=0.086$) for time between HZ and VZ.

Table 3. Heart rates and corresponding estimated VO_2 in eight women while participating in Zumba sessions led by a human instructor and while using a Kinect Zumba video game .

	HZ	VZ	p value
Average HR during exercise (beats/minute)	149.0 ± 14.8	125.0 ± 10.9	0.001
Average estimated VO_2 during exercise (ml/kg/min)	22.7 ± 7.9	14.0 ± 5.6	0.012
% VO_2peak based on average heart rate	71.8 ± 11.8	46.3 ± 14.2	0.001
Maximum HR during exercise (beats/minute)	172.6 ± 13.3	168.5 ± 26.7	0.351
Maximum estimated VO_2 during exercise (ml/kg/min)	30.7 ± 10.0	29.3 ± 14.5	0.415
% VO_2peak based on maximal HR	97.1 ± 9.3	92.1 ± 27.5	0.315

Data are means ± standard deviation. HZ = Zumba sessions led by a human instructor. VZ = using a Zumba video game using Kinect. p value is for HZ vs. VZ.

Heart Rate and Estimated VO_2 during Zumba: There were no differences in the maximal HR during exercise between HZ or VZ (Table 3). Average HR during exercise was higher ($p<0.05$) in HZ than during VZ. Using the HR measured during exercise to estimate the VO_2 based on the individual HR/VO_2 regression equations, there were no differences in maximum estimated

VO_2 between HZ or VZ while the estimated average VO_2 during exercise was higher ($p<0.05$) during HZ than during VZ.

Accelerometry and Step Counter Data: Participation in HZ resulted in less ($p<0.05$) sedentary time than participation in VZ (Table 4). There were no differences in the minutes of light or moderate physical activity between HZ or VZ. During HZ, 18.1 ± 12.0% of the time was light intensity physical activity, while during VZ 19.5 ± 15.9% of the time was light intensity physical activity. During HZ, 40.4 ± 11.6% of the time was moderate intensity physical activity, while during VZ 44.9 ± 13.5% of the time was moderate intensity physical activity. Minutes of vigorous physical activity during HZ were higher ($P<0.05$) than during VZ. During HZ, 36.1 ± 19.6% of the time was vigorous intensity physical activity, while during VZ 23.0 ± 20.8% of the time was vigorous intensity physical activity. The estimated energy expenditure based on accelerometry was higher ($p<0.05$) during HZ than during VZ. There were no differences in the number of steps taken between HZ or VZ.

Table 4. Physical activity time based on accelerometry, and the number of steps taken, in eight women participating in Zumba sessions led by a human instructor and also while using a Zumba Kinect video game.

	HZ	VZ	p value
Sedentary time (minutes)	3.3 ± 0.8	7.8 ± 3.2	0.007
Light physical activity during exercise (minutes)	11.0 ± 7.3	11.9 ± 9.6	0.082
Moderate physical activity during exercise (minutes)	24.7 ± 7.1	27.6 ± 8.1	0.402
Vigorous physical activity during exercise (minutes)	22.0 ± 12.0	14.2 ± 12.8	0.038
Energy expenditure (kcal)	410.9 ± 139.4	327.8 ± 153.6	0.029
Step count (steps)	5336.8 ± 898.9	5001.0 ± 1140.8	0.463

Data are means ± standard deviation. HZ = Zumba sessions led by a human instructor. VZ = using a Zumba video game using Kinect. p value is for HZ vs. VZ.

Environmental conditions: Prior to HZ the environmental conditions in the room were 23.0 ± 2.8 Celsius, 48.0% ± 7.1% humidity, and 699.4 ± 2.7 mmHg. Environmental conditions immediately following HZ were 21.5 ± 2.1 Celsius, 42.0% ± 7.1% humidity, and 699.4 ± 2.7 mmHg. Environmental conditions prior to VZ were 21.5 ± 0.3 Celsius, 63.9% ± 4.7% humidity, and 702.4 ± 2.0 mmHg. Environmental conditions immediately following VZ were 21.3 ± 0.3 Celsius, 63.7% ± 4.0% humidity, and 702.1 ± 2.4 mmHg. During HZ there was a significant decrease in temperature ($p = 0.049$) and humidity ($p = 0.038$), but not barometric pressure ($p = 0.85$). During VZ there was no significant change in temperature ($p = 0.490$), humidity ($p = 0.832$) or barometric pressure ($p = 0.85$). The temperature was significantly lower ($p = 0.281$) and the humidity was significantly higher ($p = 0.001$) during VZ than HZ, but there were no differences in barometric pressure ($p = 0.280$).

DISCUSSION

The primary findings of this project were that when adult women who were experienced in Zumba engaged in ~60 minutes of Zumba exercise led by a human instructor or by the Kinect video game system, there were no differences in maximal HR, minutes of light and moderate physical activity, or number of steps taken. However, Zumba exercise led by a human instructor resulted in fewer minutes of sedentary time, more minutes of vigorous physical activity, higher average HR, and greater energy expenditure than participation in Zumba using the Kinect video game system. These data indicate that participation in Zumba exercise led by a human instructor or Kinect video game system may result in health promoting moderate to vigorous intensity physical activity, but Zumba led by a human instructor provides a more vigorous exercise setting.

Heart rate is frequently used to monitor the intensity of physical activity due to the strong positive relationship between increased workload and increased HR, as well as the strong positive HR/VO_2 relationship (2, 3, 22). In the present study, HZ resulted in HR that were ~79.7% of age predicted maximal HR while VZ resulted in HR that were ~66.8% of age predicted maximal HR, which corresponded to ~71.8% and 46.3% VO_2peak for HZ and VZ (respectively). Delextrat and Neupert (7) observed that participation in a 60-minute Zumba class led by a human instructor resulted in average HR that were 78.3 ± 5.4% of peak HR. Delextrat and Neupert (7) further observed that participation in 60-minutes of Zumba while using a DVD led session resulted in average HR that were 73.8 ± 6.7% of peak HR (which were significantly lower than those from the human led class). Neves et al. (19) observed that HR increased to ~67% of age predicted maximal HR due to 22 minutes of Zumba using a Kinect Zumba video game, which were lower than the HR in the present data and those of Delextrat and Neupert (7). The higher average HR during human led Zumba in the present and previous research (7), suggest that the average exercise stimulus for a Zumba class led by a human is greater than in an individual session led by a virtual Zumba instructor, whether that instructor is on a DVD (7) or a video game (19). Interestingly, in the present data there were no differences in maximal HR attained during HZ or VZ session suggesting that the peak intensity of exercise did not differ between a Zumba class led by a human or virtual Zumba instructor. Taken together, the HR data indicate that a human Zumba instructor provides a more strenuous exercise session than does a virtual Zumba instructor. The more strenuous exercise session in HZ may be due to the group instructor's verbal encouragement and example increasing a participant's desire to try harder (16).

Engaging in sufficient amounts of MVPA is necessary to promote health and prevent many diseases associated with a sedentary lifestyle (3). The data from accelerometry in the present investigation indicate no difference in minutes of light or moderate intensity physical activity between Zumba with a human instructor compared to a virtual Zumba instructor. However, a Zumba class with a human instructor resulted in less sedentary time and more minutes of vigorous intensity physical activity than did the virtual Zumba instructor. The greater sedentary time during VZ compared to HZ is likely due to the pause between songs while the video game system loaded the next song, which also gave the participants more time for self-selected rest and water breaks. However, during HZ there was peer pressure and leadership to minimize the amount of time spent in rest and water breaks. In the present study, ~77% of the time during HZ was MVPA while during VZ ~68% of the time was MVPA. Yáñez-Sepúlveda et al. (30) observed that in a one-hour Zumba session with a human instructor ~54% of the time was MVPA. The differences in the amount of MVPA between Yáñez-Sepúlveda et al. (30) and the present data may be due to differences in the tempo of the songs and dance moves used in these studies. The accelerometer data in the present study supports that Zumba led by a human instructor, as compared to a DVD or video game, may result in more vigorous intensity exercise (7, 16). However, engaging in a one-hour session of either HZ or VZ seem to result in a sufficient amount of MVPA to promote improved health if done on a regular basis. The notion that regular participation in a human led Zumba class can promote health is supported by several studies (6, 8, 9). The present data extend these findings to suggest that regular use of a Zumba video game using the *Kinect* system may also be part of a physically active lifestyle.

Yáñez-Sepúlveda et al. (30) observed that a one-hour session of Zumba led by a human instructor resulted in ~4533 steps. The present data indicate ~5169 steps were taken during a one-hour Zumba session. Yáñez-Sepúlveda et al. (30) also observed that overweight and obese individuals took fewer steps during Zumba than did normal weight individuals. The number of steps taken by normal weight individuals (30) were similar (~5184) to the number of steps taken by Zumba participants in the present study, even though the mean BMI of the subjects in the present study (27.1 kg/m^2) is within the classification of overweight. The difference in number of steps taken between the previous (30) and present data may be due to the tempo of songs and dance moves used. In the present data it is somewhat perplexing that the number of steps taken were not different between HZ or VZ given the greater average heart and minutes of vigorous physical activity combined with less sedentary time during HZ. These discrepancies may highlight the inconsistencies in step counter accuracy (13), but step counter inaccuracy should have been minimized by having participants use the same step counter during both HZ and HZ. No difference in the number of steps taken between HZ and VZ in comparison to more time in vigorous physical activity and less sedentary time in HZ may be due to differences in how the devices measure physical activity, as step counters simply measure the number of steps taken, while accelerometers measure the forcefulness of the body movement (11, 12).

The present study has several limitations. One limitation is that there was no randomization of the order in which the HZ and VZ occurred. As the HZ sessions occurred during one of two consecutive regularly scheduled Zumba classes in order to keep the HZ sessions as consistent as possible, randomization of the order of HZ and VZ was not possible. The small sample size (N=8) used in the present project is also a limitation. However, using the mean minutes of moderate intensity physical activity for HZ and VZ and a statistical power of 0.80, 105 subjects would be required for the difference to be significant. Furthermore, in spite of the small sample size, a significant difference in minutes of vigorous physical activity between HZ and VZ was detected (albeit with a power of only 0.23). The difference in environmental conditions between

HZ and VZ could also contribute to some of the measured differences in HR. However, while the environmental conditions were statistically different between HZ and VZ, all trials occurred in what is considered normal comfortable room environmental conditions (3). Lastly, although the use of accelerometry and HR to measure physical activity is frequently used in free living conditions, there are other techniques that may be more accurate yet are prohibitively more expensive (3, 22).

As a lack of physical activity leads to an increasing burden of untoward health throughout society, increasing voluntary physical activity through any means possible is desirable (26). Playing an exercise video game may be an attractive fitness activity for those who do not feel comfortable exercising in a public or group settings (8, 19, 24) and warrant more research on its efficacy. The video game market is continually changing and advancing as improvements in technology occur. Unfortunately, it seems that consumer interest in physically active home video games has waned. However, games based on mobile technology apps, such as Pokemon Go can also be used to increase physical activity (29) and present intriguing research opportunities regarding physically active gaming. Physically active gaming is also receiving increasing interest in rehabilitation settings (18, 26), which also warrants more research. Ultimately, it seems that physically active video gaming is one more possible mode of exercise for health and fitness professionals to consider when helping individuals to adopt a more physical active lifestyle.

In conclusion, previous evaluations of physically active video games have compared the intensity of physical activity while playing sedentary video games to game systems that require body movement for game play (5, 14, 15, 17, 20, 23, 25). There is a shortage of data comparing playing a "live" game to a "virtual" game. The present and previous data suggest that engaging in a Zumba video game can increase physical activity and may lead to physical activity associated health improvements. However, the exercise stimulus from a Zumba class based in a setting with a human exercise instructor provides a more vigorous exercise stimulus than does a Zumba video game.

ACKNOWLEDGEMENTS

This project was supported by the Summer Student Research Program and Undergraduate Research Fellowship at the University of Nebraska – Kearney.

REFERENCES

1. "Accessories: Kinect." Microsoft Support. Microsoft, 2018. Web. 1 April 2018.

2. Achten J, Jeukendrup AE. Heart rate monitoring: applications and limitations. Sports Med 33(7): 517-538, 2003.

3. ACSM's Guidelines for exercise testing and prescription. 9th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins, 2014.

4. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc 14(5): 377-381, 1982.

5. Bosch PR, Poloni J, Lynskey JV. The Heart Rate Response to Nintendo Wii Boxing in Young Adults. Cardiopulm Phys Ther J 23(2): 13-29, 2012.

6. Delextrat AA, Warner S, Graham S, Neupert E. An 8-Week Exercise Intervention Based on Zumba Improves Aerobic Fitness and Psychological Well-Being in Healthy Women. J Phys Act Health 13(2): 131-139, 2016.

7. Delextrat A, Neupert E. Physiological load associated with a Zumba® fitness workout: a comparison pilot study between classes and a DVD. J Sports Sci 34(1): 47-55, 2016.

8. Domene PA, Moir HJ, Pummell E, Knox A, Easton C. The health-enhancing efficacy of Zumba® fitness: An 8-week randomised controlled study. J Sports Sci 34(15): 1396-1404, 2016.

9. Donath L, Roth R, Hohn Y, Zahner L, Faude O. The effects of Zumba training on cardiovascular and neuromuscular function in female college students. Eur J Sport 14(6): 569-77, 2014.

10. Edwards RH, Ekelund LG, Harris RC, Hesser CM, Hultman E, Melcher A, Wigertz O. Cardiorespiratory and metabolic costs of continuous and intermittent exercise in man. J Physiol 234(2): 481-497, 1973.

11. Freedson PS, Melanson E, Sirard J. Calibration of the computer science and applications, inc. accelerometer. Med Sci Sports Exerc 30(5): 777-781, 1998.

12. Fudge BW, Wilson J, Easton C, Irwin L, Clark J, Haddow O, Kayser B, Pitsiladis YP. Estimation of oxygen uptake during fast running using accelerometry and heart rate. Med Sci Sports Exerc 39(1): 192-198, 2007.

13. Giannakidou DM, Kambas A, Ageloussis N, Fatouros I, Christoforidis C, Venetsanou F, Douroudos I, Taxildaris K. The validity of two Omron pedometers during treadmill walking is speed dependent. Eur J Appl Physiol 112(1): 49-57, 2012.

14. Graf DL, Pratt LV, Hester CN, Short KR. Playing active video games increases energy expenditure in children. Pediatrics 124(2): 534-540, 2009.

15. Graves L, Stratton G, Ridgers ND, Cable NT. Energy expenditure in adolescents playing new generation computer games. Br J Sports Med 42(7): 592-594, 2008.

16. Laukkanen RM, Kalaja MK, Kalaja SP, Holmala EB, Paavolainen LM, Tummavuori M, Virtanen P, Rusko HK. Heart rate during aerobics classes in women with different previous experience of aerobics. Eur J Appl Physiol 84(1-2): 64-68. 2001.

17. McWha JA, Horst S, Brown GA, Shaw I and Shaw BS. Metabolic changes associated with playing an active video game against a human and computer opponent. Afr J Phys Health Educ Recreat Dance 9 (supplement 1): 219-227, 2009.

18. Moore J, Fiddler H, Seymour J, Grant A, Jolley C, Johnson L, Moxham J. Effect of a home exercise video programme in patients with chronic obstructive pulmonary disease. J Rehabil Med 41(3): 195-200, 2009.

19. Neves LE, Cerávolo MP, Silva E, De Freitas WZ, Da Silva FF, Higino WP, Carvalho WR, De Souza RA. Cardiovascular effects of Zumba® performed in a virtual environment using XBOX Kinect. J Phys Ther Sci 27(9): 2863-2865, 2015.

20. O'Donovan C, Hirsch E, Holohan E, McBride I, McManus R and Hussey J. Energy expended playing Xbox Kinect and Wii games: a preliminary study comparing single and multiplayer modes. Physiother 98(3): 224-229, 2012.

21. Pietrobelli A, Wang Z, Heymsfield SB. Techniques used in measuring human body composition. Curr Opin Clin Nutr Metab Care 1(5): 439-448, 1998.

22. Powers SK, Howley ET. Exercise physiology: Theory and application to fitness and performance. 8th ed. New York: McGraw-Hill, 2012.

23. Scheer KS, Siebrant SM, Brown GA, Shaw BS, Shaw I. Wii, Kinect, and Move. Heart Rate, oxygen consumption, energy expenditure, and ventilation due to different physically active video game systems in college students. Int J Exerc Sci 7(1): 22-32, 2014.

24. Schoo A, Morris ME. The effects of mode of exercise instruction on correctness of home exercise performance and adherence. Physiother Singapore 6(2): 36-43, 2003.

25. Smallwood SR, Morris MM, Fallows SJ, Buckley JP. Physiologic responses and energy expenditure of Kinect active video game play in schoolchildren. Arch Pediatr Adolesc Med 166(11): 1005-1009, 2012.

26. Smith ST, Bird ML. Interactive games for home delivery of exercise and rehabilitation interventions for older adults: An Australian perspective. Stud Health Technol Inform 231: 110-118, 2016.

27. "Who are we? We are …" Zumba.com, Zumba Fitness LLC, 2017. Web. 20 December 2017.

28. Will PM, Walter JD. Exercise testing: improving performance with a ramped Bruce protocol. Am Heart J 138(6 pt 1): 1033-1037, 1999.

29. Wong MC, Turner P, MacIntyre K, Yee KC. Pokémon-go: Why augmented reality games offer insights for enhancing public health interventions on obesity-related diseases. Stud Health Technol Inform 241: 128-133, 2017.

30. Yáñez-Sepúlveda R, Barraza-Gómez F, Báez-San Martin E, Araneda OF, Zavala JP, Hecht GK, Tuesta M. Differences in energy expenditure, amount of physical activity and physical exertion level during a Zumba fitness class among adult women who are normal weight, overweight and obese. J Sports Med Phys Fitness 58(1-2): 113-119, 2018.