Winter 2-15-2015

The Effect of Active Video Games on the Heart Rate of Older Adults

Yeon Bai
Montclair State University, baiy@montclair.edu

Shahla M. Wunderlich
Montclair State University, wunderlichs@montclair.edu

Diane M. Hanel
Montclair State University

OPEN ACCESS Freely available online

HEALTHY AGING RESEARCH

The effect of active video games on the heart rate of older adults

Diane M. Hanel [1], **Yeon Bai** [1], **Shahla M. Wunderlich** [1*]

1 Department of Health and Nutrition Sciences, Montclair State University, Montclair, NJ, USA

Abstract

Background: Heart rate is used as a health biomarker. This aim of this study was to investigate the effects of playing active video games on the heart rate of older adults, in comparison to the heart rate after common table recreational activity.

Methods: An experimental study with 40 participants was conducted: a control group (n=20) participated in common Pokeno® card games; an experimental group (n=20) played *Wii*™ bowling. The participants' pre- and post-activity heart rates were measured, and compared between and within groups using t-tests.

Results: The findings signified an 11.9% increase ($p<0.001$) in the heart rates of those who engaged in active video games, which was 5.7% greater than those taking part in table recreational activity. Additionally, the experimental group's (older adults who played *Wii*™ bowling) mean heart rate of 66.1% was found to be statistically similar to the higher end (i.e. 70%) of the recommended maximum heart rate (50-70%) for moderately intense physical activity.

Conclusions: The inclusion of active video games in older adults' recreational activities can increase their daily activity level to bring long-term health benefits.

Citation: Hanel DM, Bai Y, Wunderlich SM (2015) The effect of active video games on the heart rate of older adults. Healthy Aging Research 4:10. doi:10.12715/har.2015.4.10

Received: December 16, 2014; **Accepted:** January 28, 2015; **Published:** February 15, 2015

Competing interests: The authors have declared that no competing interests exist.

[*] Email: wunderlichs@mail.montclair.edu

Introduction

It is widely known that the American lifestyle is becoming more technology-based, and therefore more sedentary. As a result, many chronic or recurrent diseases are on the rise. The American Heart Association (AHA) has identified physical inactivity as a major risk factor for the development of heart disease and stroke. Inactivity also contributes to obesity, high blood pressure and diabetes [1]. Furthermore, the elderly population in the United States has been dramatically increasing due to the effects of the 'baby boom' that occurred from the late 1940s to the mid 1960s. It is projected that by the year 2030, older adults (of ages 65 and older) will make up about 20% of the US population, totaling approximately 72 million people [2]. The growing percentage of older adults has caused mounting concern for the maintenance of health and well-being in this segment of the population.

Older adults require exercise to remain independent and preserve quality of life. Based on the 2008 Physical Activity Guidelines for Americans, recommended by the US Department of Health and Human Services, people aged 65 or older should have two hours and 30 minutes of moderate intensity, or one hour and 15 minutes of vigorous intensity aerobic exercise per week, when physically possible [3]. This level of activity is needed to maintain or improve balance, therefore reducing the risk of falling. Additionally, exercise has extensive benefits, including reducing the risk of various chronic diseases, controlling weight, strengthening bones and muscles, and improving cognitive function [3].

The intensity of physical activity can be determined by comparing the measured pulse or heart rate in beats per minute (bpm) following physical activity to the target heart rate established by the AHA. The target heart rate of moderate physical activity is defined as staying within 50–70% of maximum heart rate, whereas the target for vigorous intensity physical activity is staying within the 70–85% range [1]. According to the AHA, one's heart rate adapts to the body's changing need for oxygen, which occurs during exercise. To achieve the target heart rate, the AHA recommends monitoring progress during physical activity by measuring one's heart rate periodically, ensuring to stay within 50–85% of the maximum heart rate.

Many health professionals have made efforts to increase exercise and encourage a healthier lifestyle among their older adult patients. In response to these efforts, new technologies have been developed in the form of interactive video games, which may be used as an alternate means of incorporating fitness into the daily routine. Several of these exercise video games, or "exergames" – previously aimed toward adolescents – are now marketed at the older adult population [4]. In 2006, Nintendo® introduced the *Wii*™. This gaming system consists of easy-to-use, wireless, motion-sensitive remote controllers. For this reason, the *Wii*™ continues to gain popularity with older adults in the US, especially in active adult communities where *Wii*™ bowling leagues have been emerging [5].

The literature in the area of interactive video games as a form of physical activity has mainly focused on adolescents and children. Previous research on this younger group found that playing active video games uses more energy and physical motion, and increases physiological functions above other sedentary activities [5–8]. Studies using interactive video games targeting the ever-growing senior citizen population are limited. Therefore, there is a need to further explore the potential use of such games as a form of physical activity for older adults. The purpose of this study was to investigate the effect on the health biomarker of heart rate in older adults playing active video games, compared to the heart rate after traditional, indoor recreational activity.

Methods

Using convenience sampling, study participants were recruited from adult community centers in the local area of northern New Jersey. All residents in the centers were invited to participate in the study by advertising through flyers. A total of 40 adults aged 55 and older took part in the study, all of whom had full use of one arm and hand. Written, informed consent was obtained from each volunteer participant. The Institutional Review Board (IRB) of one university in New Jersey approved the study protocol.

Instruments used in the study included a questionnaire to collect demographic information from the participants, the Nintendo® *Wii*™ gaming system, and the Omron Heart Rate Monitor HR-100C, which incorporates a receiver wrist monitor and a transmitter. The Omron HR-100C was reported to have an accuracy rate of ±1 bpm for a heart rate <180 bpm, and ±2 bpm for a heart rate >180 bpm (NB this model is no longer available; the Omron HR-310 is the nearest available alternative). Ultrasound gel was applied to each transmitter before use for better conductivity, and the transmitter was strapped to the participant's chest below the pectoral muscles. Next, the receiver was placed on the participant's wrist, displaying his or her heart rate in bpm.

Participants were self-selected into one of two groups: an experimental group (n=20), and a control group (n=20). The intervention began by taking and recording the participants' heart rates after five minutes of rest. The experimental group received instructions and a demonstration on how to play *Wii*™ bowling. Next, they engaged in 15 minutes of *Wii*™ bowling and their heart rates were taken and recorded again. In the same way, the heart rates of participants in the control group were taken and recorded after five minutes of rest. Then, they engaged in 15 minutes of table recreational activity such as traditional or Pokeno® card games. Finally, their heart rates were taken and recorded a second time.

A descriptive analysis was performed on the demographic data. Chi-square and independent t-tests were carried out to analyze the differences between the two groups. For each group, a comparison of pre- and post-activity heart rates was conducted using a paired-sample t-test. Next, a comparison of mean heart rates in the experimental and control groups was done using an independent-sample t-test. Finally, mean post-activity heart rate was calculated as a percentage of the AHA's maximum average heart rates for both the experimental and control groups, and a one-sample t-test was used to determine the intensity of physical activity. Statistical analyses were completed using SPSS 17.0. The Type I error rate was set at p>0.05.

Results

Demographic characteristics of the participants in each group are shown in Table 1. Each group had similar characteristics. Mean age (in years) of the experimental group was 80.1, and 81.0 in the control group.

Table 1. Mean descriptive characteristics

	Experimental (n=20)	Control (n=20)	*p*
	%	%	
Gender			
Female	65	75	0.490
Male	35	25	
Ethnicity			
White (non-Hispanic)	100	95	0.311
African American	0	5	
Education			0.084
High school graduate	35	65	
Some college	25	30	
College graduate	10	5	
Post-graduate	25	0	
Other	5	0	
Marital status			
Married	25	30	0.496
Single	5	0	
Divorced	0	5	
Widowed	70	60	
Separated	0	5	
	M (SD)	M (SD)	*p*
Age (y)	80.10 (8.04)	81.05 (3.41)	0.631
BMI (kg/m^2)	24.50 (3.65)	26.57 (3.72)	0.088

No significant differences were detected between the two groups in terms of gender (p=0.490), ethnicity (p=0.311), education (p=0.084), marital status (p=0.496), age (p=0.631), or BMI (p=0.088); thereby establishing equivalency between the groups.

Mean heart rates for participants in each group were recorded pre- and post-activity (Table 2). Participants in the control group, who took part in a recreational card game activity, showed no significant difference between their mean pre-activity and post-activity heart rates (86.3±10.76 bpm vs. 87.2±8.90 bpm, p=0.748). Conversely, the experimental group, who played *Wii*™ bowling, showed a significant difference between their mean pre-activity and post-activity heart rates (81.5±10.77 bpm vs. 92.5±9.46 bpm, p<0.001).

Table 2. Heart rates pre- and post-activity among groups

	Experimental M (SD*)	Control M (SD)	*p***
Pre-activity (bpm)	81.5 (10.77)	86.3 (10.76)	0.167
Post-activity (bpm)	92.5 (9.46)	87.2 (8.90)	0.076
P***	p<0.001	p=0.748	

bpm = beats per minute
* SD = standard deviation
** Between-group comparisons, experimental vs. control
*** Within-group comparisons, pre- vs. post-activity

The mean heart rates of both groups were compared after five minutes of rest before activity. No significant differences were evident between the two groups while at rest (p=0.167). Then, the mean heart rates of the control and experimental groups were compared with each other after 15 minutes of activity. The mean post-activity heart rate of the experimental group was higher than that of the control group: 92.5±9.46 bpm vs. 87.2±8.90 bpm, though not significantly statistically different. Finally, mean post-activity heart rate was calculated as a percentage of maximum heart rate (Table 3).

Table 3. Post-activity heart rate vs. maximum target heart rate*

	Experimental M (SD**)	Control M (SD)
Mean heart rate (MTHR)	66.1%	62.7%
Post-activity (bpm)	92.5 (9.46)	87.2 (8.90)
MTHR*** (bpm)	140.00	139.00

* Based on the American Heart Association's maximum target heart rate (MTHR)
** SD = standard deviation
*** MTHR = 220-mean age

These results showed that the mean heart rate of the participants who played card game activities (62.7%) was significantly lower than the recommended target level (69%) for moderate intensity physical activity ($p<0.001$). In comparison, the mean heart rate of the participants who played the *Wii*™ bowling (66.1%) showed no significant difference compared to the target heart rate of 69% for moderate intensity physical activity ($p=0.199$).

Discussion

The purpose of this study was to investigate the effect of playing active video games on the heart rate of older adults, compared to heart rate after traditional, indoor recreational activity. Based on previous research, it is known that playing active video games uses more energy and greater physical motion, and increases physiological functions above other sedentary activities [5–8]. Similarly, when children aged 8–12 years played activity-promoting video games, they expended more than twice the energy compared to playing non-active games [6, 7]. In a study comparing young boys as they played either action-promoting video games or engaged in passive video watching, several metabolic and physiological variables, including heart rate and blood pressure, were increased [8]. The question arose as to whether playing active video games would increase the heart rate of older adults as it did in the younger population when compared with other indoor activities. The results of this study indeed confirm that playing active video games increases the heart rate of older adults when compared with playing card game activities. In addition, when compared to resting, *Wii*™ bowling raised the participants' heart rates significantly more than playing card games. An increase in heart rate in older adults while playing active video games, as compared to that of resting, was consistent with the previous findings that showed increased physiological functions during interactive video game play [5, 6].

Furthermore, the heart rate of older adults who played *Wii*™ bowling reached a level of 69% of maximum heart rate, meeting the AHA's recommended target heart rate zone of 50–85%. This means those playing *Wii*™ bowling were engaged in moderate intensity physical activity [5]. In a similar study conducted by Graves and others [4], in which the heart rates of younger adults (mean age 57.6±6.7) were taken, heart rates of 86.8±10.2 bpm were recorded after *Wii*™ muscle conditioning, and 94.7±11.2 bpm after brisk treadmill walking. Researchers [4] have also determined that use of *Wii Fit*™ by older adults is within the daily health-benefiting level of physical activity. Thus, the outcome of this study suggests that playing active video games on a regular basis may have a positive effect on increasing the heart rate of older adults through moderate exercise, thereby improving health.

As a result of the demographic similarities between the experimental and control groups, this study demonstrated a strong internal validity. The groups contained participants with similar mean ages, ethnicities, educational levels, marital statuses, BMI and an even ratio of males to females. It was conducted in a natural setting using an equal number of participants in each group. The instrument used to monitor the heart rates had high reliability and validity.

On the other hand, external validity may have been compromised through the use of convenience sampling and voluntary subject participation. Although a small sample size was used, this is analogous with other research studies of this type [4–8]. The study design used less rigorous games than some of other *Wii*™ games such as *Wii*™ Boxing or *Wii*™ Tennis. The *Wii*™ bowling game was chosen to reduce the risk of injuries to participants, and because it is already established as an activity currently used in senior facilities.

Factors such as overall physical health of the subjects, and any medications taken, may have had a direct effect on heart rates. Likewise, the level of game-playing experience, level of coordination, interest/competitiveness, and the time of day may have indirectly affected heart rates. However, since the main objective of this study was to examine subjects' change in heart rate pre- and post-activity, rather than the differences in heart rates between subjects, these factors would have had a minimal effect on the findings. For future studies, it may be beneficial to increase the sample size and expand the sampling area to provide stronger external validity and allow for generalization to a larger demographic population.

Fifteen minutes of indoor interactive video game-playing increased participants' heart rates significantly, to the level of moderate intensity physical activity as indicated by the target heart rate zone recommended by AHA. This suggests there would be a potential benefit for older adults' health if more active gaming systems were integrated into the older adult community. Doing this may enable older adults, who might otherwise find it difficult to participate in physical sports, to benefit from the indoor active video versions. A recent study conducted in Dublin, Ireland, and Belfast, UK, also reported that elderly adults who played active video games showed significantly greater improvements in balance control compared to those who did not [9]. However, one study [10] raised a potential concern, in that older people prefer traditional exercise to electronic games like *Wii*™. This requires further investigation.

The findings of this research may be useful in future studies to determine whether gaming systems could benefit people with physically impairments or disabilities. Because they are easy to use, interactive video games may be used as a form of physical rehabilitation. Preliminary research has already begun to establish the potential for such applications [11]. Thus, there is a need for future research to determine the potential health benefits of active video game playing on older adults.

References

1. Heart.org [Internet]. Dallas: American Heart Association; c2014. Target heart rates; 2009 Nov 20 [cited 2014 Dec 12]. Available from: http://www.heart.org/HEARTORG/GettingHealthy/PhysicalActivity/FitnessBasics/Target-Heart-Rates_UCM_434341_Article.jsp.
2. Census.gov [Internet]. District of Columbia: US Department of Commerce, US Census Bureau. Projections of the population by selected age groups and sex for the United States: 2015 to 2060; 2012 Jul 6 [cited 2014 Dec 12]. Available from: http://www.census.gov/population/projections/data/national/2012/summarytables.html.
3. Health.gov [Internet]. Bethesda (MD): Office of Disease Prevention and Health Promotion, US Department of Health and Human Services. Physical activity guidelines for Americans; 2008 Oct [cited 2014 Dec 12]. Available from: http://www.health.gov/paguidelines/guidelines/default.aspx.
4. Graves L, Ridgers N, Williams K, Stratton G, Atkinson G, Cable N. The physiological cost and enjoyment of Wii Fit in adolescents, young adults, and older adults. J Phys Act Health. 2010;7(3):393–401.
5. Graves L, Stratton G, Ridgers, ND, Cable NT. Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: cross-sectional study. BMJ. 2007;335(7633):1282–4.
6. Lanningham-Foster L, Jensen TB, Foster RC, Redmond AB, Walker BA, Heinz D, et al. Energy expenditure of sedentary screen time compared with active screen time for children. Pediatrics. 2006;118(6):E1831–5.
7. Lanningham-Foster L, Foster RC, McCrady SK, Jensen TB, Mitre N, Levine JA. Activity promoting games and increased energy expenditure. J Pediatr. 2009;154(6):819–23.
8. Wang X, Perry AC. Metabolic and physiologic responses to video game play in 7 to 10-year old boys. Arch Pediatr Adolesc Med. 2006;160(4):411–5.
9. Cardi.ie [Internet]. Dublin, Ireland: Center for Ageing Research and Development In Ireland. CARDI launch: A Wii bit of fun can help prevent falls in older people; 2012 Sept 20 [cited 2014 Dec 12]. Available from: http://www.cardi.ie/news/cardilaunchawiibitoffuncanhelppreventfallsinolderpeople.
10. Laver K, Ratcliffe J, George S, Burgess L, Crotty M. Is the Nintendo Wii Fit really acceptable to older people? A discrete choice experiment. BMC Geriatr. 2011;11(Suppl 1):64.
11. Rand D, Kizony R, Weiss PL. The Sony PlayStation II EyeToy: low-cost virtual reality for use in rehabilitation. J Neurol Phys Ther. 2008;32(4):155–63.