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Effects of Active Video Dancing Game on Heart Rate Responses

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Abstract

Objectives: The purposes of the current study were to determine the heart rate (HR) during the active video game (AVG) dancing, to compare HR of AVG dancing and resting HR, and to investigate HR of AVG dancing in terms of exercise intensity. **Methods:** Twenty-one healthy and physically active females (mean age: 20.76±2.45 years, mean height: 164.38±8.58 cm, mean body mass: 57.45±8.01 kg, mean body mass index (BMI): 21.19±1.83 kg/m^2 and mean body fat percentage (BFP): 22.23±5.87%) volunteered to participate in this study. The participants visited the laboratory 2 times. On the first day, following the anthropometric data collection, the participants rested in the supine position for 15 minutes, and then they were familiarized with the AVG dancing. On the second day, the participants played AVG dancing for 10 minutes. There was a one-week break between the two measurements. **Results:** The HR of AVG dancing was significantly higher than HR resting (162.90±17.27 vs. 76.71±8.29 beats/min) ($p<0.001$). During the 10-minute AVG dancing performance the minimum HR value was recorded as 144.05 (beats/min) and the maximum HR value was recorded as 178.19 (beats/min). The % of HRmax value was determined as 81.75, and the % of HRR value was determined as 70.09. **Conclusion:** The findings of the current study demonstrate that AVG dancing is a vigorous exercise based on the ACSM criteria (ACSM, 2014), and it can be recommended as an alternative exercise model to improve or maintain fitness status and athletic performance.

Keywords: Exer-game, active video game, heart rate, high intensity exercise, athletic conditioning.

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INTRODUCTION

Technological advances have changed people's lifestyles and provided great physical convenience. However, these developments have moved away people from physically active life. As a result, due to an inactive lifestyle of individuals an increase in health problems and decrease in physical fitness occurred. One of the important reasons of not attending sportive activity is people prefer to spend more time at home and during that time entertain themselves with technological tools such as computers, televisions, and video game consoles (Öztora et al., 2006). Therefore, these technological tools take up more and more place in human life, which leads to an inactive life (Lakdawalla & Philipson, 2002). However, besides to these negativities, technological advances can turn this situation into a positive one: individuals can improve their athletic performance with the help of technological devices. At this point, video games are very important.

Video games can be examined in two categories: sedentary (passive) video games and active video games (AVGs). During sedenstary games people sit in front of the screen and have to move only their fingers. On the other hand, AVGs are games played with devices which have motion sensor cameras in their systems, and players have to perform body movements required by the game in front of the screen. There are many consoles in the market for AVGs: Sony Play Station – Move, Nintendo Wii, and Microsoft Xbox Kinect are most preferred and well-known AVGs systems. Among these consoles, the Xbox Kinect is the only one that can be controlled interactively without having to touch any physical object (Kamel Boulos, 2012).

Many studies compared the heart rate (HR) values recorded during games on Play Station - Move, Xbox Kinect and Nintendo Wii game consoles (Marks, Rispen, & Calara, 2015; O'Donovan et al., 2012). The findings of these studies showed that comparing to the other consoles the highest HR values were recorded during games played on Xbox Kinect (Marks, Rispen, & Calara, 2015; O'Donovan et al., 2012). Therefore, the current study was conducted with Xbox Kinect console.

The HR is a valuable tool to guide and plan training program. Since it has been shown that AVGs significantly increase the HR, it seems logical to include AVGs in the program as part of the training. With this viewpoint, AVGs can be an alternative form for exercise done at home. In this way, people can increase their physical activity and thus improve or maintain their athletic performance by doing home-based sport in the long term. Hence, the purposes of the current study were to determine the HR during the AVG dancing, to compare HR of AVG dancing and resting HR, and to investigate HR of AVG dancing in terms of exercise intensity.

METHODS

Participants

Twenty-one healthy and physically active females (mean age: 20.76 ± 2.45 years, mean height: 164.38 ± 8.58 cm, mean body mass (BM): 57.45 ± 8.01 kg, mean body mass index (BMI): 21.19 ± 1.83 kg/m^2, and mean body fat percentage (BFP): 22.23 ± 5.87%) volunteered to participate in this study. The inclusion criteria were participants with no health problems and BMI less than 25 kg/m^2. Participants with a medical, cardiovascular, metabolic and/or respiratory disorder were excluded. Additionally, participants using drugs and/or ergogenic supplements were excluded, too. Health status of the participants was determined by using PAR-Q (Physical Activity Readiness Questionnaire). Participants were asked not to engage in strenuous activity at least 24 hours before experimental test on the measurement days. In addition, they were asked to stop their food intake (eating and drinking activities) at least 2 hours before the tests. Detailed information about the tests to be carried out for each participant included in the study was given, then the purpose, possible benefits, and risks of the study were explained and a signed "Research Volunteer Participation Form" was received from each participant (Kafkas, Eken, Çınarlı, & Kafkas, 2016). The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki and the study was approved by the Anadolu University Institutional Review Board (Protocol number: 29027)

Study design

The participants visited the laboratory 2 times. On the first day of the visit (D1), following the anthropometric data collection, the participants rested in the supine position for 15 minutes, and then they were familiarized with the AVG dancing. Participants were informed about what AVG is and how to play them (familiarization). During the practice session, the AVG dancing was introduced. Afterward, they were allowed to try this game. On the second day of the visit (D2), the participants played AVG dancing for 10 minutes. There was a one-week break between the two measurements. During these two different sessions, the HR values were recorded continuously using a Polar chest band and a Polar brand S810i pulse watch (Polar Electro, Finland) (White et al., 2011).

Anthropometric data collection

First, each participant's height was measured using a stadiometer (±1mm; Holtain, United Kingdom), additionally, the BM and BFP were determined using a bioimpedance analysis system with an accuracy of ± 0.05 kg, and ± 0.1%, respectively (Tanita MC-180-MA, Japan). Body mass index (BMI) was calculated via the "BMI = body mass (kg) / height

(m^2)" formula (Özdemir & Hürmüz, 2015). Measurements were made in the anatomical posture position with the bare foot (with shorts and t-shirt).

Measurement of HR at rest

Second, the participants rested in the supine position for 15 minutes. During the time, they were not allowed to be busy on the phone, or to do anything else. The HR was recorded continuously using the Polar watch S810i and chest band (Polar Electro, Finland) for 15 minutes, but only the last 5 minutes were included in the statistical analysis (White et al., 2011).

Measurement of HR during the AVG dancing

In the current study the AVG dancing was performed using the Xbox game console with the Kinect device. The playing field was determined by the researcher (220 x 160 cm) and the participants were prevented from going out of the area detected by the motion sensor cameras. On the second day of the visit (D2), one week after the familiarization, the participants played the AVG dancing. The participants danced (AVG dancing performance) for 10 minute in the "Fitness Cardio Groove" mode of the "Dance Central 3" (Harmonix, USA) game package. " The HR values were continuously recorded during the 10-minute dancing game performance.

Calculation of percentage increase according to the resting is important to determine exercise intensity and the effectiveness of the application (Isakov, Mizrahi, Graupe, Becker, & Najenson, 1985; White, Schofield, & Kilding, 2011). The percentage exchange ratio based on the resting, percentage of maximum HR (% of HRmax), and percentage of heart rate reserve (% of HRR) values were calculated for AVG dancing using Equations 1, 2, and 3 respectively (Gulati et al., 2010; Kafkas et. al., 2014). The HRmax was defined as 220 minus the participant's age (in years) based on American College of Sport Medicine (ACSM) criteria (ACSM, 2014) (Equations 4). The HRR was calculated using the Equation 5.

((AVGdancing HR-HR rest) / HR rest) * 100 Equation 1

% of HRmax = (AVG dancing HR / HRmax) * 100 Equation 2

% of HRR = (HRmax– HR rest) x target intensity) + HR rest Equation 3

HRmax = 220 – age Equation 4

The HRR = (HRmax – HR rest) Equation 5

Statistical analyses

Descriptive statistics were computed and all values were presented as mean ± standard deviation (SD). The normality of distribution of the data was assessed with Kolmogorov – Smirnov test. Paired sample t-tests were performed to compare HR, and % of HRmax responses recorded during resting and AVG dancing. Additionally, p value <0.05 was accepted as

statistically significant. The statistical analyses were executed using the Statistical Package for the Social Sciences (SPSS) for windows (version 21.0).

RESULTS

The HR values recorded during the rest period and AVG dancing are presented in Table 1. Significant increments were observed for AVG dancing compared with resting condition in terms of HR (beats/min) ($t = 19.859$), and % of HRmax ($t = 19.989$) ($p < 0.001$). During the 10-minute AVG dancing performance the minimum HR value was recorded as 144.05 (beats/min) and the maximum HR value was recorded as 178.19 (beats/min).

Table 1. The HR responses of rest and AVG conditions

Variables	Rest	AVG dancing	t	p value
Heart Rate (beats/min)	76.71 ± 8.29	162.90 ± 17.27	19.859	0.000
% of HRmax	38.50 ± 4.11	81.75 ± 8.47	19.989	0.000

% of HRmax: The percentage of heart rate maximum

The % of HRR of AVG dancing and exchange ratio based on the resting value are presented in Figure 1. When compared with the resting values, the results showed that HR increased two fold (2.1) in the AVG dancing session: the HR value increased from 76 to 162 (beats/min) (115.3%), in addition the % of HRR for AVG dancing was calculated as 70.09 ± 14.58 (beats/min).

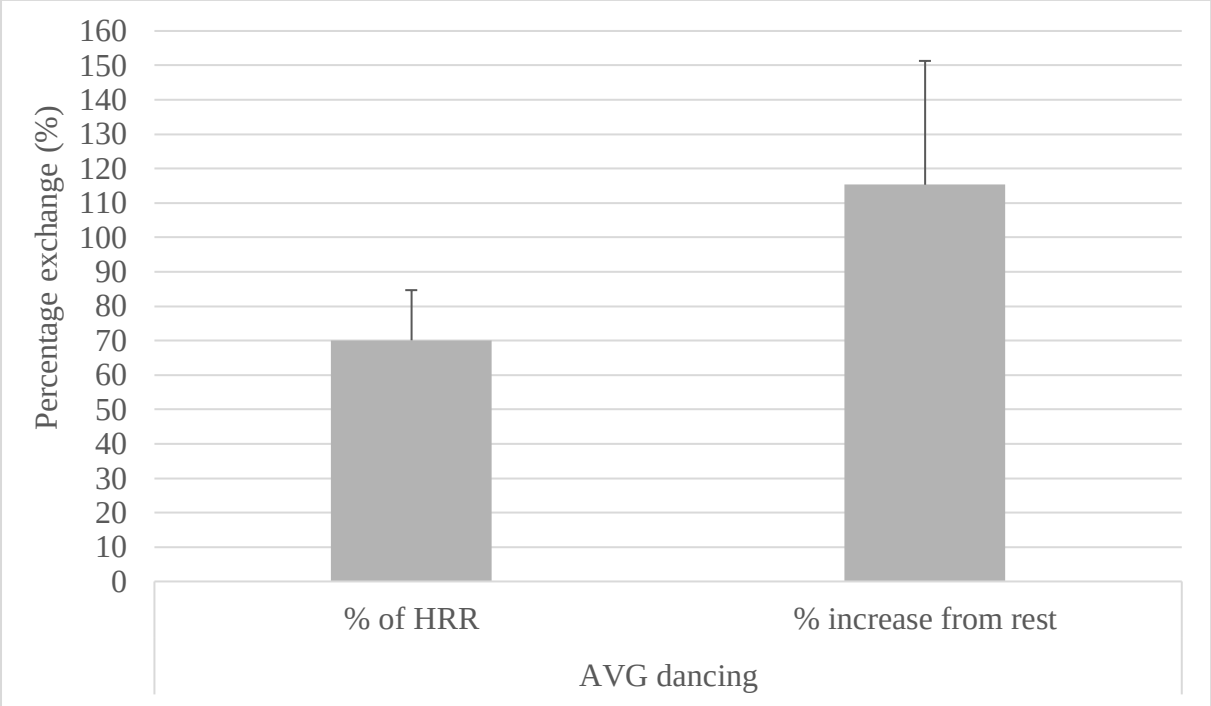

Figure 1. The % of HRR and HR exchange ratio (%) for AVG

DISCUSSION

Studies conducted with AVGs previously have compared the AVGs and passive video games and/or the AVGs and resting and sedentary conditions (e.g. watching television etc.) (Clevenger & Howe, 2015; Graves et al., 2010; O'Donovan et al., 2012; Scheer, Siebrant, Brown, Shaw, & Shaw, 2014; White et al., 2011). The findings demonstrated that AVGs significantly increase the physiological responses compared with passive games or resting conditions (Chaput et al., 2015; Clevenger & Howe, 2015; Graves et al., 2010; Lanningham-Foster et al., 2009; Scheer, Siebrant, Brown, Shaw, & Shaw, 2014; White et al., 2011). Clevenger and Howe (2015) compared the HR values of AVGs and sedentary conditions; consequently, the HR values of AVGs were reported in range of 119 – 146 (beats/min), on the other hand the HR values of sedentary conditions were reported in range of 88 – 96 (beats/min).

The HR values of AVGs were significantly higher than HR values of sedentary conditions (Chaput et al., 2015; Clevenger & Howe, 2015; Graves et al., 2010; Lanningham-Foster et al., 2009; Scheer, Siebrant, Brown, Shaw, & Shaw, 2014; White et al., 2011). The findings of the present study are in agreement with the results of mentioned studies above.

The heart rate, which is one of the most important criteria for determining the exercise intensity has been examined in many studies (Clevenger & Howe, 2015; Graves et al., 2010;

Marks et al., 2015; O'Donovan et al., 2012; Scheer et al., 2014; White et al., 2011). In a study conducted with six different AVGs, it has been shown that the lowest HR values were recorded for Disney Rush AVG (119 beats/min), and the highest HR values were recorded for Reflex Ridge AVG (146 beats/min) (Clevenger and Howe (2015). In another study conducted with four different games - Wii yoga, Wii muscle, Wii balance, Wii aerobics – the HR values were determined as 77.6 (beats/min), 82.4 (beats/min), 76.7 (beats/min), and 94.5 (beats/min), respectively (Graves et al., 2010). O'Donovan et al. (2012) compared single player mode and multi-player mode of Wii Sports Boxing AVG and concluded that multi-player mode of AVG significantly increased the HR responses (119 beats/min) compared with single player mode (107 beats/min).

Marks et al. (2015) compared Xbox Kinect and Nintendo Wii game consoles and showed that the HR responses of playing Xbox Kinect Boxing (124.9 beats/min) for 10 minutes were significantly higher than HR responses of playing Wii Boxing (115.4 beats/min). The findings of the current study show that the HR responses for AVG dancing played with Xbox Kinect were recorded as 162.9 (beats/min) and found to be higher than HR responses reported in previous studies. The results of the studies show that the selection of the brand of the game console, the characteristic structure of selected AVGs for playing and its mode (single player or multi-player) can affect the HR responses.

It is important to know the % of HRmax value of exercise, especially for individuals who is not engaged in regular training. The % of HRmax value is commonly used, but it can lead to suggestions of higher or lower intensity exercise in determining individual exercise intensity (ACSM, 2014). There are studies investigated the % of HRmax during AVGs. Donovan and Hussey (2012) investigated four different AVGs - Wii boxing, Wii tennis, Wii baseball and Wii jogging – and reported the % of HRmax as 58%, 42%, 42%, 71%, respectively. Furthermore, the % of HRmax were determines as 52%, 53%, 72%, 62%, and 58% for Wii tennis, Wii bowling, Wii boxing, Wii step, and Wii ski, respectively (White et al., 2011). Monedero et al. (2014) showed that the % of HRmax of Wii sports was 45% and modified Wii sports was 62.2%. In addition, Monedero et. al. (2017) indicated that the % of HRmax of Xbox entertainment-themed AVG and Xbox fitness-themed AVG were 60.9% and 77.4%, respectively. In the current study, the % of HRmax values reported (81.75%) were higher than those in mentioned studies. The nearest finding to our study is the one conducted by Monedero et al. (2017) which reported the % of HRmax as 77.4 for the fitness-themed AVG. According to the findings, these two games (the fitness-themed AVG and dancing AVG) fall into the

vigorous intensity exercise classification (77% - < 94% of HRmax) set by ACSM (ACSM, 2014).

Another important criteria used in determining the intensity of exercise is % of HRR. The HRR method may be preferable for exercise prescription because the exercise intensity can be underestimated or overestimated when the HRmax is used. However, the advantage of the HRR method can not be suitable in every case, for everyone. It can be used for individuals who are trained or physically active and it can be recommended to use for special groups such as overweight and obesity, hypertension, individuals with human immunodeficiency virus, arthritis, fibromyalgia, intellectual disability, parkinson, multiple sclerosis, osteoporosis (ACSM, 2014). There are only two studies examined the % of HRR values of AVGs (Monedero et al., 2014; Monedero et al., 2017). In one of them, the % of HRR were reported as 22.4 for Wii sports, and 46.6 for modified Wii sports (Monedero et al., 2014). In the other one, the % of HRR were determined as 46.5 for Xbox entertainment-themed AVG, and 67.1 for Xbox fitness-themed AVG (Monedero et al., 2017). In the current study, the % of HRR value is determined as 70.09. Similar to the results of the % of HRmax, when take account of the % of HRR values, the fitness-themed AVG and AVG dancing fall into the vigorous intensity exercise classification (60 % - < 85 % HRR) set by (ACSM) (ACSM, 2014).

CONCLUSION

In the present study the HR of AVG dancing was determined as 162.90 ± 17.27 (beat/min) which shows that AVG dancing significantly increase the HR according to the rest. Considering the % of HRmax value (81.75) and the % of HRR value (70.09), the findings of the current study demonstrate that AVG dancing is a vigorous exercise based on the ACSM criteria (ACSM, 2014). Furthermore, instead of moderate intensity programs, there is evidence that physically active people can more improve their fitness status with higher intensity programs (65% - 75% of HRR) (ACSM, 2014). For all these reasons, the AVG used in this study may be recommended as an alternative exercise model to maintain or improve fitness status and athletic performance.

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