

Acute intensity and motivation to play: comparison of structured and unstructured active video games - a pilot study

Abstract

Objective: To compare intensity (heart rate, oxygen consumption, and perceived exertion) and motivation to play between AVG types (unstructured, UNS-AVG and structured, S-AVG).

Methods: A Pre-test-Post-test experimental study with randomized counterbalanced groups (UNS- and S-AVG type) was performed at the laboratory. Eight male young adults [Mean (SD), age: 19(1) years, body mass index: 23.1(2.4) kg/m²] volunteered to participate in this study. Participants underwent a diagnostic evaluation for health status, anthropometric, cardiovascular and metabolic measures. After this, they were paired according to oxygen consumption levels and randomly assigned to each group and performed a 30-min AVG session (UNS-AVG: Kinect Sports Boxing game or S-AVG: Nike Kinect Training game). Heart rate (HR) was recorded during all AVG session. At the end of the session, motivation to play and rating of perceived exertion (RPE) were self-reported. Oxygen consumption estimated for the AVG session was obtained by linear regression line from HR reached during the game and maximal HR during the test session. Unpaired t-test was used to compare game type groups ($P < 0.05$). Moreover, effect size (ES) was calculated using Cohen's d statistic.

Results: Average HR ($\% \Delta = 7.1$, $P = 0.025$, $ES = 0.76$) and oxygen consumption estimated ($\% \Delta = 69.5$, $P = 0.002$, $ES = 3.63$) during the sessions were greater for S-AVG compared to UNS-AVG. Motivation to play was similar between groups ($\% \Delta = 18.2$, $P = 0.685$, $ES = 0.72$). RPE was greater for S-AVG compared to UNS-AVG group ($\% \Delta = 20.6$, $P = 0.045$, $ES = 1.85$).

Conclusion: S-AVG type requires more physical exertion than UNS-AVG; however, these AVG types can be used interchangeably if the goal is motivation. Due to the strong correlation between the HR and oxygen consumption for both AVG types, this data suggests that S-AVG may be a better tool to exercise and probably contribute to reducing sedentary lifestyle more than UNS-AVG in young adults.

Keywords: physical exertion, video games, heart rate, motivation, sedentary lifestyle, oxygen consumption, exercise

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Introduction

Sedentary lifestyle is a serious health problem in the world and, in the Brazil, 80% of the population presents this behavior with a lower level of physical activity¹. This behavior is associated with serious health risks and inversely related to physical activity (PA). Low levels of physical activity may develop or aggravate chronic degenerative diseases; however, this PA promotion prevents and treats diseases such as hypertension, obesity, and diabetes. Therefore, PA is important and is conceptualized as any bodily movement with sufficient intensity to elevate the energy expenditure above resting levels.²

Due to the globalization and technological advancement part of the population spent more hours on "screen time" (triad of watching TV, using computer and playing inactive video games).³ In general, video games (traditional ones - with joysticks) have been widely used by children and young adults. However, they provide a low increase in body movement and demand less oxygen consumption compared to stand watching TV, for example.⁴ These may discourage a regular practice of PA and favor the sedentary lifestyle.⁵

According to the official guidelines of exercise and PA, young adults should perform 30 to 60 minutes of moderate intensity (50-69% of maximum heart rate) in at least 5 days a week.⁶ To change habits of "screen time", a new form of video games, named active video games (AVG) has been used to increase levels of daily PA. Previous studies demonstrated that AVG reduce the hypokinesia caused by the sedentary lifestyle and may promote health, raising the heart rate (HR) and energy expenditure in acute analyses⁷⁻¹⁰

Commercially available AVG systems present several kinds of consoles such as Xavix, PlayStation Eye Toy, Nintendo Wii and Xbox 360° with Kinect are found. Nintendo Wii may request the same metabolic equivalent compared to Xavix and other consoles^{7,11} and is used to analyze the body balance.¹² In another hand, AVGs from Xbox360° with Kinect that are used standing with no joystick, it requires greater metabolic equivalent and oxygen consumption compared to Nintendo Wii¹⁰ also greater energy expenditure, oxygen consumption and heart rate.¹³

In addition, scientific research with AVG has used, especially, unstructured or structured games. Unstructured AVG has been applied

to recreation, motivation or rehabilitation¹⁴⁻¹⁷ Structured AVG has been used to improve levels of physical fitness in virtual reality because they follow the principles of sports training^{14,18,19} However, few studies have compared these types of AVG, showing long-term effects (pre-post analysis) on aerobic capacity²⁰ physical effort and motivation²¹ after 6-week training. Consequently, a few scientific data about these variables on these types of AVG in a single session.

Due to the widespread use of AVG, health professionals should develop a practical knowledge, especially about their benefits and ways of using in various clinical contexts. Thus, the aim of this study was to compare physical effort (heart rate, oxygen consumption, and perceived exertion) and motivation to play between AVG types (unstructured, UNS-AVG and structured, S-AVG). The hypothesis is the S-AVG elicits greater physical effort and motivation to play than unstructured counterparts.

Methods

Participants and ethical issues

Participants were recruited from the Universidade de Pernambuco (UPE), Recife in the Brazil, via word of mouth advertising and social media websites. Eight male young adults [Mean (SD), age: 19(1) years, body mass index: 23.1(2.4) kg/m²] volunteered to participate in this study. Inclusion criteria were: university students, 19≤aged≤24 years, being apparently healthy (PAR-Q) and physically inactive (three months with no practice of structured physical activities) and no experience with AVG. Participants was excluded for missing the sessions or failing to perform the complete AVG session. Ethical approval for this study was gained from the Research Ethics Committee at the UPE (number: 577.277). Participants were informed about the objective, procedures and potential risks of this study and provided a written informed consent.²²

Study design

A Pre-test-Post-test experimental study with randomized counterbalanced groups (unstructured- and structured-AVG type) was performed at the laboratory with similar conditions among measurements days (temperature: 22-24°C, relative humidity: 40-60%, atmospheric pressure: ≈760 mmHg). Participants completed three visits. At the first, participants underwent a diagnostic evaluation for health status, anthropometric, cardiovascular and metabolic measures. After 48 h, at the second, participants were paired according to oxygen consumption levels and randomly assigned to an unstructured- (UNS-AVG) or structured-AVG (S-AVG) group, and performed an AVG familiarization. After 48 h, at the third visit, each group performed their AVG session.

For all visits, participants were instructed to wear minimal clothing and appropriate footwear for physical exercise, to avoid moderate or vigorous exercise for 24 hours prior to visits, to feed 1-2 hours before the assessment and to refrain from ingesting beverages containing caffeine, others substance stimulants or alcohol during the 24 hours preceding the visits.

Table 1 Differences between unstructured (UNS-AVG) and structured (S-AVG) Brito-Gomes et al.²⁰

UNS-AVG	-Activities that do not mimic formal exercises but rather sporting movements and general body movements. -Players are free to move as they wish during game play and there is no formal progression to higher levels of physical activity difficulty as game play progresses	Boxing, Volleyball, Table tennis, Dance Dance Revolution
S-AVG	-Uses basic exercises such as squats, push-ups, cycling. -Incorporates planned movement patterns. -Movement pattern feedback may or may not be provided based on the operating system -Systematic order of exercise progression and/or intensity (e.g. sets, reps, rate, duration)	Your Shape Fitness Evolved, Game Bike, Nike Kinect Training, UFC Personal Trainer

Procedures

Anthropometry

Body weight (in kilograms) was measured by a mechanical scale (Filizola, Brazil), nearest to 0.1kg. Height (in centimeters) was measured by a wooden stadiometer; nearest to 0.01m. Anthropometric measurements were performed by a single trained professional with standardized international techniques.²³ Height and body mass were used to calculate the body mass index, reported as kilograms per square meter.

Cardiovascular measures

All cardiovascular measurements were performed after rest of five minutes in a seated position. Heart rate (HR) was measured by a heart rate monitor (FT1, Polar, Finland) (and was used to calculate the %HR using: %HR= (residual HR x intensity)-rest HR) and systolic (SBP) and diastolic (DBP) blood pressure were measured by an automatic blood pressure monitor (Omron HEM 7113; Omron Healthcare Co. Ltd., Japan).

Test session

Oxygen consumption (mL/kg/min) was analyzed by a submaximal test on a cycle ergometer (EC-1600, Cateye Ergociser, Japan), following the Astrand-Ryhming protocol.²⁴ A metabolic gas analyzer (Metalyzer®, Cortex, Germany) with a face mask with adult head cap (Metalyzer, Germany) was used. HR was continuously registered by an electrocardiograph with three derivations (Micromed, Brazil) using the PC Elite Software 3.0 (Micromed, Brazil).

Familiarization

UNS-AVG group (Kinect Sports Boxing game) performed 20 min of gaming and watched tutorial videos of the game in order to use it in a better form. S-AVG group (Nike Kinect Training game) performed a brief evaluation (20 min), which this AVG provides to prescribe the exercises on the virtual reality. Also, this group watched tutorial videos with the same objective proposed for UNS-AVG group.

AVG session

All AVG sessions were completed with an Xbox 360 Kinect game console (Microsoft, USA). A multimedia projector (Power lite S10+, Epson, Japan) with a sound amplifier (OCM 126 professional, Oneal, Brazil) were used as AVG device. The setup lab measurement was described previously.^{14,20} Each group performed their session (UNS-AVG or S-AVG) for 30 minutes. HR was recorded by a heart monitor (FT1, Polar, Finland) during all AVG session. At the end of the session, motivation to play by Visual Analog Scale (VAS)²⁵ adapted for AVG²⁶ and rating of perceived exertion (RPE) on a scale of 6-20 (Borg Scale)²⁷ were self-reported. Oxygen consumption for the AVG session was obtained by linear regression line from HR reached during the game and maximal HR during the test session. Table 1 illustrates some differences between UNS-AVG and S-AVG.

Statistical analyses

Gauss distribution was confirmed by a Shapiro-Wilk test for all data. Data were reported by mean (SD or 95% interval confidence). Unpaired t-test was used to compare game type groups (UNS-AVG vs. S-AVG). Multiple linear regressions was applied to estimate oxygen consumption of AVG session from HR reached during the game and maximal HR and oxygen consumption during the test session. Effect size (ES) was calculated using Cohen's d statistic by Psychometrica calculator, which a $d=0.01-0.20$ was considered small, $d=0.21-0.50$ moderate, $d=0.51-0.80$ large, and $d \geq 0.80$ very large effect. The level of significance was set at $P < 0.05$ ($\alpha = 0.05$).

Results

Table 2 shows baseline data of participants. The oxygen consumption of participants was classified as regular from the American College of Sports Medicine and the American Heart Association.²⁸

Table 2 Baseline data (mean±SD) of male young adults by AVG type (n=8)

Variable	UNS-AVG(n= 4)	S-AVG(n=4)
Age (years)	19.0±1.0	19.0±1.0
Weight (kg)	72.3±10.2	71.7±13.7
Height (m)	1.70±0.05	1.70±0.06
BMI (kg/m ²)	22.6±2.0	23.6±3.3
Resting systolic blood pressure (mmHg)	131.0±8.8	124.7± 10.8
Resting diastolic blood pressure (mmHg)	69.8±4.5	68.3±10.0
Resting heart rate (bpm)	78.0±17.0	71.0±9.0
Oxygen consumption (mL/kg/min)	37.7±4.5	35.8±6.6

BMI, Body mass index

HR and oxygen consumption during the test session showed a strong correlation for UNS-AVG ($R^2=0.968$, $P=0.008$) and S-AVG ($R^2=0.992$, $P=0.002$) groups. Figure 1 shows HR and oxygen consumption comparisons between UNS- and S-AVG groups. Average HR ($t=-4.15$, $P=0.025$, $\% \Delta=7.1$) and oxygen consumption ($t=-5.12$, $P=0.002$, $\% \Delta=69.5$) were greater for S-AVG compared to UNS-AVG. Very large effects were found for maximal HR and oxygen consumption in relation to the AVG type (Figure 1).

From the mean of the percentage of HR reserve, the UNS-AVG session was considered as a physical activity of moderate intensity while the S-AVG session as vigorous intensity, according to American College of Sports Medicine.²⁸

The RPE and motivation to play for UNS-AVG and S-AVG groups are presented in Figure 2. Motivation to play was similar between groups ($t=-2.48$, $P=0.685$, $\% \Delta=-16.4$, $ES=0.72$). A large effect was found for RPE, which S-AVG was greater than UNS-AVG group ($t=0.71$, $P=0.045$, $\% \Delta=22.4$, $ES=1.85$). According to American College of Sports Medicine, UNS-AVG was deemed as moderate (RPE: 12 to 13 points) and S-AVG as vigorous intensity (RPE: 14 to 17 points).²⁸

Discussion

In the present Pre-test-Post-test experimental study, we compared physical exertion (HR, oxygen consumption, and perceived exertion) and motivation to play between the UNS-AVG and S-AVG type. Our data confirmed the hypothesis that S-AVG elicits greater physical exertion compared to the UNS-AVG. However, the motivation to play was similar between the AVG types. Therefore, S-AVG type requires more physical exertion than UNS-AVG; however, they can be used interchangeably if the goal is motivation.

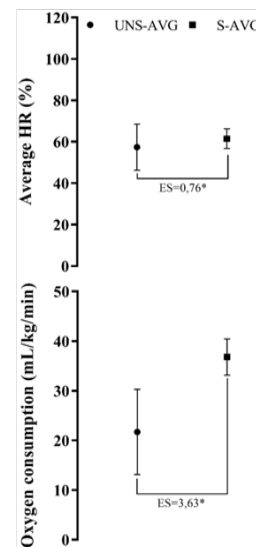


Figure 1 Average and maximal heart rate (HR) and oxygen consumption of male young adults between unstructured (UNS-AVG) and structured (S-AVG) active video games. Data reported as mean and 95% interval confidence. ES, Effect size (Cohen's d). *Significant difference ($P < 0.05$).

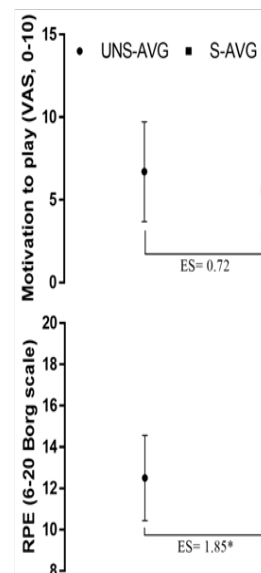


Figure 2 Motivation to play (Visual Analog Scale, VAS: 0= low, 10=high) and rating of perceived exertion (RPE, Borg scale: 6=no exertion at all, 20=maximal exertion) of male young adults between unstructured (UNS-AVG) and structured (S-AVG) active video games. Data reported as mean and 95% interval confidence. ES, Effect size (Cohen's d). *Significant difference ($P < 0.05$).

According to American College of Sports Medicine²⁸ both AVG type met the recommendations for physical activity as moderate-to-vigorous intensity exercise. However, S-AVG elicited an effect almost 70% greater than the UNS-AVG for oxygen consumption and almost 36% greater for maximal HR. In addition, UNS-AVG was considered moderate (RPE: 12 to 13 points) and S-AVG as vigorous intensity (RPE: 14 to 17 points). Then, health professionals should understand the best way to use the AVG types, according to the need of the individual person. Moreover, AVG (as aerobic exercise) combined with resistance training may confer additional health benefits.²⁸

For UNS-AVG, similar results have been presented for HR.^{29,30,31} Young adults have shown an average of 58% reserve HR during a 15-min Wii Sports Boxing trial³⁰ an average of 50 to 69% of maximal HR during a 10-min Kinect Sports Boxing trial²⁹ and Kinect Sports Boxing >160bpm (moderate intensity). Even with differences between console types and duration of activity, there seems to be clear scientific information about the moderate intensity of boxing in a virtual environment.

To our knowledge, to this present data, there are no acute investigations analyzing the Nike Kinect Training game. Nevertheless, other studies were performed with different S-AVG, such as the Your Shape Fitness Evolved game (Xbox 360 Kinect) and Wii Fitness game (Nintendo Wii). Falcade et al.³² investigated young adults in a 3-minute Your Shape Fitness Evolved session and they verified a significant increase of the HR near to 181 bpm, considered a vigorous intensity according to American College of Sports Medicine.²⁸ In another study, adults performed a Wii Fitness session and the HR has increased to about 180 bpm³³ even though being a console that presents AVG with lower physiological costs in comparison to Xbox 360 Kinect.

Oxygen consumption in our UNS-AVG session was similar to study by Perusek et al.³⁴ with direct metabolic analysis in 30 young adults in a virtual boxing session (19.6 mL/kg/min). Thus, knowing that a direct analyze is the gold standard but expensive, this present analysis shows similar values that may be trustful to estimate the oxygen consumption during the AVG. The present work provides the first reference for oxygen consumption in response a 30-min Nike Kinect Training session. A study with similar S-AVG (Your Shape Fitness Evolved game) showed an oxygen consumption near to 38.2 mL/kg/min, presenting a significant difference from the rest.³²

In addition, analyzing the metabolic elicited and turned on the intensity of physical activities, by the literature is possible to divide the oxygen consumption by 3.5 and estimate the metabolic equivalents (METs).³⁵ Thus, 6.2 METs and 10.5 METs were verified for UNS-AVG and S-AVG in our study, respectively, confirming the moderate (3-6 METs) and vigorous intensity (>7 METs) discussed above.²⁸ Different results were showed by Taylor et al.³⁶ with lower MET values (2.97±1.16; light-moderate activity) for UNS-AVG. For S-AVG, young adults performed a 3-min Your Shape Fitness Evolved trial at 7.3 METs.²⁸ Therefore, this virtual type of structured physical activity may be most efficient than UNS-AVG as a form to reduce the sedentary style because of the greater elicitation of intensity.

In general, UNS-AVG is used as a form to motivate people to move their body and is considered more motivating than structured physical education activities.^{26,37} However, in this study, AVG type presented the same motivation to play levels. Although the S-AVG showed the highest metabolic elicitation, it should be possible the fact of the participants can do the activities correctly motivating themselves to continue with a good enjoyment as have been seen in

others UNS-AVG, which were made to keep a high enjoyment during the session.²¹ Also, the novelty of using new forms of virtual reality to exercise may motivate them to play, even though a structured form of exercising that sometimes may be no motivating.^{13,38} In this case, the S-AVG can be a good tool too to initiate physical activities, because, the participants may be as motivated as gaming a UNS-AVG.

A limitation of this study was to examine only young men. Since men and women have unique characteristics, motivation to play promote exercise economy and over this point, may change the HR, oxygen consumption and perceived exertion in dependency to different AVG used to each population³⁹ Others sex and special population (as hypertensive, obese and diabetics) must be tested to analyze the cardiovascular changes (blood pressure, double product, and HR variability) related to oxygen consumption and motivation to play these two types of AVG, especially the structured ones. In practical terms, this study advances the knowledge of the “screen time” using in an active form. It must be possible to reduce the negative effects of sedentary lifestyle found in the population, promoting physical fitness with motivation to play in a virtual reality.

Conclusion

S-AVG can be a vigorous exercise according to the international guidelines, showing greater values of average and maximal HR and oxygen consumption compared to UNS-AVG for young adults. Moreover, both AVG types can be used to motivate to exercise. Due to the strong correlation between the HR and oxygen consumption for both AVG types, this data suggests that S-AVG may be a better tool to exercise and probably contribute to reducing sedentary lifestyle more than UNS-AVG in young adults.

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None

Conflict of interest

The author declares no conflict of interest.

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