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Acute and Chronic Effects of Exercise in Health

Can exergames be used as an alternative to conventional exercises?

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Abstract - Aim: The present study aimed to analyze if the exergaming exercise produces the same acute effects as conventional training. **Methods:** The Nintendo® Wii was chosen as the stimulus for this study. Participants should conduct a physical training session under Exergames Training (ET) and Conventional Training (CT). Both training conditions use two aerobic exercises and six strength exercises, which were always performed in the same sequence. The study group was composed of 30 young adults (16 men and 14 women, mean age of 23.7 ± 3.7 years). **Results:** Our findings showed significant results between pre and post-tests: the heart rate (HR) and the double product (DP) were higher in the post-exercise period, while the systolic blood pressure (SBP) was lower. Further analysis revealed that ET and CT conditions had no significant differences. ET condition showed to present similar results as CT condition to women (regarding HR, diastolic blood pressure - DBP, and DP), and to men (HR, SBP, and DBP). **Conclusion:** The present research showed that exergaming provides the same acute effects in physiological variables as conventional exercises. Thus, this kind of exercise can be a reliable way to improve the lifestyle of young adults.

Keywords Exergaming, exercise, adults, heart rate, blood pressure.

Introduction

The influence of technology has increased in our society nowadays. Different technologies emerged integrating the physical contexts and persons, providing new opportunities to interact, play, learn, and get knowledge[1]. This influence has been changing the way people interact with each other, how they shop, move, play, and exercise.

The literature shows several understandings about the technology-lifestyle paradigm. On one side, studies argue that mechanical automation, television, computer, and video games are factors that trigger sedentary patterns of lifestyle[2-4]. The time spent in the use of these devices may increase the prevalence of problems related to sedentary behavior, such as increased cardiovascular risks and obesity[2-4]. On the other hand, authors defend that technological advances can modify the relationships that people have with their bodies and with the practice of exercises and physical activities[5-7]. To this last approach the use of digital games, especially Exergames, can enhance the physical fitness of the player. To Jin & Park[8] the Exergames are computer games (or video games) that use motion-sensing technology, in other words, technologies that detect users' body movements, allowing players to interact and control different virtual contexts.

The exergaming can substantially impact the user experience and behavior, as they allow the combination of entertainment and movement[5]. Studies indicate that the use of Exergames has shown a positive effect on physical rehabilitation[9], in humor and engagement[10], increasing adults energy expenditure[11], in the cardiovascular response of people with paraplegia[12], changes in health-related behavior[13], changes in exercise persistence over time[14], the effects of interactivity and controller use on participants' physiological and psychological outcomes[15] and, in physical fitness[5,16]. Research also shows that the use of technological devices can help reduce the number of people who abandon activities and exercise[17,18] and can be used as coping strategies for anxiety disorders pandemic periods[19]. The increase in intrinsic motivation, more significant commitment to activity, fun, pleasure, and feelings of affection allow the engagement with body practice, resulting in repetition of behaviors and maintenance of practice[20-22].

To our knowledge, few studies are found analyzing whether physical training using Exergames is beneficial to the users (or players) and, what the physiological effects they allow in adults[21,23]. The present study aimed to analyze if the practice of exercises with Exergames produces the same acute effects as conventional training sessions. It is expected that training exergaming will produce positive responses in the physiological variables of adults.

Methods

Participants

Fifty-three adults participate in the present research, but only 30 completed all exercises (M = 25.2; SD = 2.4 years). The study group was conveniently composed of young adults (n = 30), 16 men and 14 women, with a mean age of 23.7 ± 3.7 years. The percentage of body fat of men was 16.6 ± 6 and 25.1 ± 7 for women. The selection of participants was voluntary, and the enrollment order was used for the random definition of the type of training (Exergames versus Conventional Training). None of the participants participate in any kind of regular activity program. The recruitment of the participants was carried out through the dissemination of the project on the University's website and social media.

As inclusion criteria, the following aspects were adopted: being in the age group of 18 to 40 years; do not present limiting osteoarticular injuries; ischemic heart disease; symptomatic heart failure; insulin-dependent diabetes mellitus; dyslipidemia and hypertension. People who presented diseases that made it impossible to continue the study; those who did not attend the second training session, 72 hours after the first; those who used controlled psychiatric medication; and those who had a diagnosis of mental illness, were excluded from the study.

The study was submitted and approved by the *Universidade Federal de Santa Maria* Ethics Committee (31095214.0.0000.5346). All the participants were volunteers and signed the Informed Consent Term.

Procedures

Participants should conduct a physical training session under two conditions: Exergames Training Session (ET) and Conventional Training Session (CT). Both training conditions use two aerobic exercises and six strength exercises, which were always performed in the same sequence (Aerobic Exercises - Island Cycling and Free Run; Strength Exercises - Rowing Squat, Push up, Lung, Single Leg Extension, Plank, Arm, and Leg Lift). The sequence as mentioned above obeyed the hierarchy of training, proposed by Dantas[24]. The ET condition was performed with the Nintendo® Wii and followed the same guidelines as the CT condition.

To measure the physiological variables (Heart Rate) the Polar Sensor – FT model ® was used. Blood pressure (BP: Systolic Blood Pressure and Diastolic Blood Pressure) was checked using and sphygmomanometer, before the beginning of the training condition and after each exercise/game, and at the end of the session. The double product (DP) was calculated following the formula (HR x SBP = DP (mmHg.bpm/100)].

Exercises

a) Aerobic Exercises

1. Island Cycling: Simulate the pedaling of the bike. The subject stands on the Wii Balance Board of the Nintendo (5.5 cm) holding a joystick with both hands (in 90° flexion of the shoulder joint) and alternately flexes the lower limbs.
2. Free Run: Simulate a stationary run.

b) Strength Exercises

1. Rowing Squat: The subject performs a squat, in which the participant stands up (with the legs at the same width of the shoulders), and a little flexion of the hips and the knees are executed, descending the hip towards the ground.
2. Push up: The subject should position himself in a ventral position, maintaining four supports. The hands should be positioned on the Wii Balance Board.
3. Lung: It is characterized by a deep squat, with the legs arranged in the anteroposterior position and the hands positioned in the neck. The execution occurs in descending towards the ground, maintaining the muscular force in the member that is positioned to the front, one must obey the amplitude of 90º of the joint of the knee.
4. Plank: Consists of keeping the trunk isometrically in the ventral position, with the elbows positioned on top of the Wii Balance Board, and the tip of the feet, based on the ground, the body must be fully aligned and perpendicular to the ground, and should not raise the hip too much or let it falls too much.
5. Single-Leg Extension: Standing with one-legged support on the Wii Balance Board, hip flexion and extension are performed along with flexion and extension of the shoulder joint opposite the one-leg support. The suspended foot does not touch the ground at any point in the exercise, which requires the motor coordination, balance, and muscular endurance of the practitioner.
6. Arm and Leg Lift: In a four-way position, an extension of one of the lower limbs and extension of one of the opposing upper limbs should be done, which should be holding the joystick.

Experimental design

Before the exercises, all participants were instructed to perform the exercises at a comfortable (moderate) intensity and to complete all exercises[25]. Also, participants were asked to perform the movements correctly and safely.

The subjects remained seated for five minutes, without external interference and major movements. In the resting phase and before the start of the activities, the subjects' HR and BP were monitored.

Both conditions began to perform the data collection with the aerobic exercises. At the end of each exercise, HR and BP were monitored. At the end of the last exercise, the subject remained seated for five minutes, following the same orientations of the resting phase. After five minutes, HR and BP were monitored. The exercises, in both groups, were 50 minutes long. No feedback was provided to the participants during the tests.

Data analysis

The Kolmogorov-Smirnov test was used to verify the normality of the data. Descriptive statistics were used with mean and standard deviation for data characterization. Four 2x2 ANOVAs were performed to analyze the effects of exercise conditions during pre and post-tests, and their interaction for each dependent variable (physiological variables). In all analyses, the Alpha level for significance was set at .05. The Software Statistical Package for Social Sciences TM (SPSS 25.0) was used.

Results

The results showed that the anthropometric characteristics of the participants are at healthy levels (Men-BMI = 22.7 ± 2.4; %BF = 25.1 ± 7.0; Women-BMI = 24 ± 2.5; %BF = 16.6 ± 6.0)[26]. Table 1 shows the descriptive values of the two exercise conditions and the pre and post-test. Additionally, the ANOVAs results and main effects were presented in Table 1.

The four overall results of the ANOVAs (see Figure 1) computed with exercise conditions and the physiological variables, do not showed statistical differences. Moreover, the ET and CT conditions present similar results: HR (exercise condition: F(1,116) = 0,509, $p < 0.47$); SBP (exercise condition: F(1,116) = 0,037, $p = 0.84$); DBP (exercise condition: F(1,116) = 0,594, $p = 0.44$); and DP (exercise condition: F(1,116) = 1,446, $p = 0.23$). Results for pre and post-test present significant differences in all physiological variables: HR (pre- and post- test: F(1,116) = 22.245, $p < 0.05$); SBP (pre- and post- test: F(1,116) = 4,462, p = 0.03); DBP (pre- and post- test: F(1,116) = 3,931, $p < 0.05$); and DP (pre- and post- test: F(1,116) = 20,224, $p < 0.05$). Additionally, there was no interaction effect between the exercise conditions and pre and post-tests: HR – F(1,116) = 3,239, $p = 0.07$); SBP – F(1,116) = ,013, $p = 0.90$); DBP – F (1,116) = ,303, $p = 0.58$); and DP – F(1,116) = ,405, $p = 0.52$).

Discussion

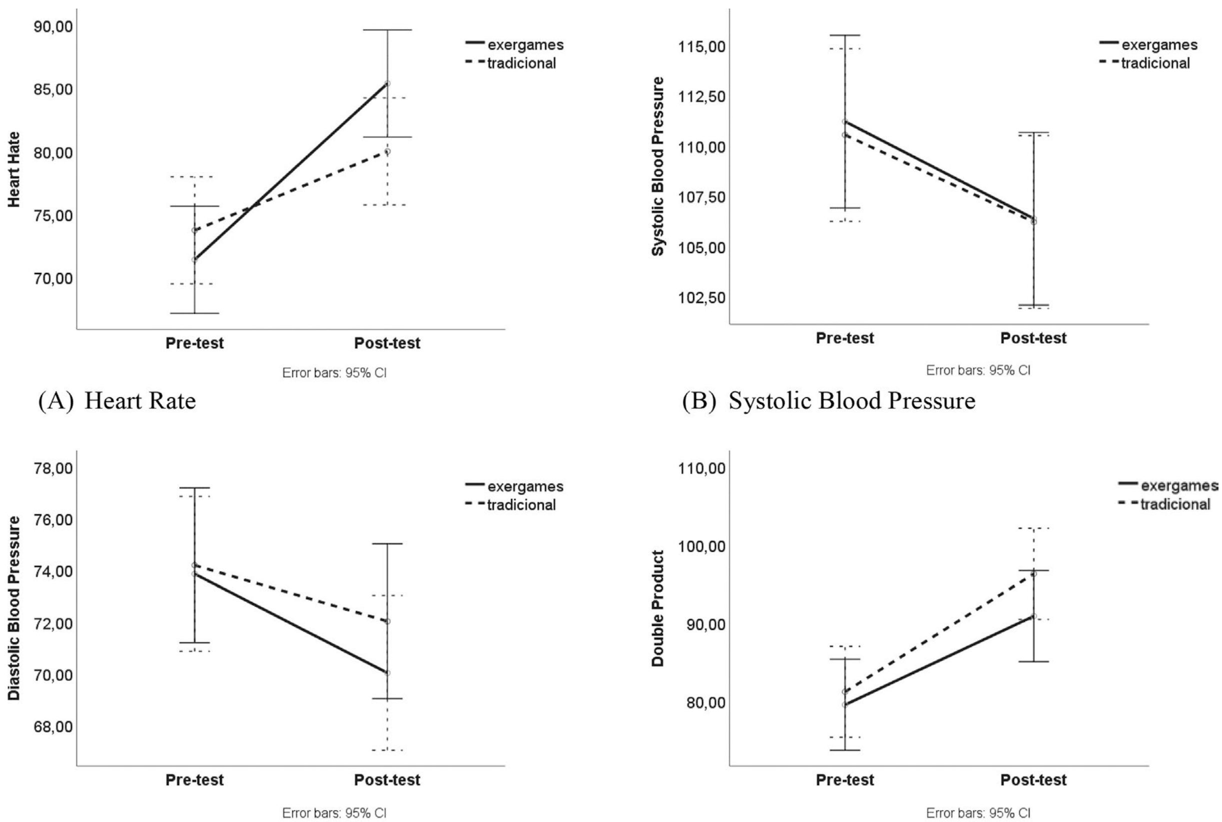
The present study aimed to compare the acute effects caused by exercises in exergames training and conventional training session on healthy adults. The primary hypothesis of the study was confirmed. The ET condition produced positive responses in physiological variables in adults comparing pre and post-tests. Also, the acute results showed that the ET condition could be so effective as the CT condition.

Comparing the two conditions of training, our results indicate that both conditions had an acute effect on the analyzed variables. Table 1 shows the means and standard deviation for all physiological variables. The literature shows that HR and DP variables are increased when the subject is performing a physical exercise[27,28]. In the same way, SBP and DBP presented a decrease in their values[27,28]. Thus, as expected, similar results in both conditions were found in the present research.

Table 1 - Group characterization with mean, standard deviation, and test values.

	Exergames condition		Conventional condition		Repeated ANOVA	η^2	Observed power
	Pre	Post	Pre	Post			
HR	71.33 ± 10.24	85.33 ± 11.41	73.67 ± 11.00	79.93 ± 14.07	Fcondition (1,116) = 0,509; p = 0.477	.004	.109
					Fpre-post (1,116) = 22,245; p = 0.000	.161	.997
					Fcondition*pre-post (1,116) = 3,239; p = 0.075	.075	.431
SBP	111.17 ± 12.15	106.33 ± 10.98	110.50 ± 11.01	106.17 ± 13.24	Fcondition (1,116) = 0,037; p = 0.848	.000	.054
					Fpre-post (1,116) = 4,462; p = 0.037	.037	.554
					Fcondition*pre-post (1,116) = 0,013; p = 0.908	.908	.051
DBP	73.83 ± 7.62	70.00 ± 8.30	74.17 ± 8.31	72.00 ± 8.87	Fcondition (1,116) = 0,594; p = 0.442	.005	.119
					Fpre-post (1,116) = 3,931; p = 0.050	.033	.503
					Fcondition*pre-post (1,116) = 0,303; p = 0.583	.583	.085
DP	79.50 ± 15.75	90.84 ± 15.77	81.16 ± 13.32	96.25 ± 19.04	Fcondition (1,116) = 1,446; p = 0.232	.012	.222
					Fpre-post (1,116) = 20,224; p = 0.000	.148	.994
					Fcondition*pre-post (1,116) = 0,405; p = 0.526	.526	.097

Legend: HR: Heart Rate; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; DP: Double Product.



(A) Heart Rate

(B) Systolic Blood Pressure

(C) Diastolic Blood Pressure

(D) Double Product

Figure 1 - Mean for dependent variables by exercise condition in the pre and post-test.

Our findings showed that ET condition and CT condition might have similar results on physiological variables in healthy adults. In an extensive literature review, Mohd Jai and colleagues[29] suggest that exergames can produce intensity-adequate physical activity among younger adults. Besides, the exergames are beneficial for cardiometabolic improvements and may be employed as an effective exercise tool to increase energy expenditure and physical activity level in young adults. Wiederhold et al.[30] also showed that exergames using augmented reality effectively contribute to exercise programs.

Using the Nintendo Wii Fit ® to analyze HR with moderate intensity, Douris, McDonald, Vespi, Kelley, & Herman[31] found similar results compared to the present research. The authors compare physiologic responses of college students using exergames and an equal duration of moderate-intensity brisk walking. Participants' rating of perceived exertion when playing Wii Fit was significantly greater when compared with brisk walking on the treadmill. Also, the results showed that college students achieve higher intensities during exercises with the Wii Fit when compared to the conventional training session. Besides, the manuscript conclusion was that exercises using the Wii Fit may act as an alternative exercise to the traditional aerobic exercise. These findings provide evidence that exergames can help to maintain a healthier and active lifestyle. Additionally, research has shown[32] that exergames can be used as coping situations during pandemic situations, and appears to be an enjoyable easy-to-use tool for reducing social isolation, as well as an interesting mode of home-based exercise for tackling anxiety disorders and sedentary behavior.

All the data provided, as well as the results, showed that exergaming exercises can be used as an important tool in maintaining the health of young adults. The present study shows that young people with greater technology contact can present greater ease in the use of active video games. To summarize, our main findings showed that (1) ET condition produced positive responses in physiological variables, like the CT; and (2) no differences were found between the ET and CT conditions, showing that ET could be used as an important instrument to promote a healthy lifestyle. Thus, our results corroborate the literature, showing the importance of exergaming training, which is an important new way to engage people in training.

Despite the interesting findings, our research presents some limitations. First, we believe that a bigger sample would strengthen our findings. As a second limitation, we do not know the relationship between acute and long-term effects, so further research should try to understand this important issue. Also, sex differences have not been assessed. Finally, since the primary aim of the present research was to analyze the acute effects in two different conditions during exercise, doubt remains, could more practice sections result in different behavior?

Conclusions

Nowadays young adults move less than recommended. The use of new ways of moving around, using video games or active technological devices, seems to be a way to be more explored and studied. Thus, the present research showed that exergaming provides similar benefits in physiological variables than conventional training sessions. Improve the practice of alternative ways of movement, using exergames, is a reliable way to improve the lifestyle of young adults. It is important to note that despite the positive acute effects of the practice with exergames, this can be an ineffective strategy when there is no guidance from physical education professionals because the practice with exergames without guidance can generate a long-term injury and will not present any kind of physiological benefit. Finally, Physical Education professionals and/or Personal Trainers should pay close attention to the new forms of exercise, which can increase physical activity in this population.

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