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ORIGINAL RESEARCH

Cardiovascular responses induced by acute video game boxing performance in healthy women

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BACKGROUND: Previous studies suggested that some interactive video games induce cardiovascular responses. However, some different styles of video games have not been investigated.

OBJECTIVE: We aimed to evaluate cardiovascular responses induced by video game boxing performance in healthy women.

METHOD: We evaluated ten female sedentary volunteers, aged 20.9 ± 1.4 years, weight 58.7 ± 8.0 kg, height 163.2 ± 5.4 cm. All subjects were weighed and measured. Their heart rate, blood pressure and lactate levels were recorded before and after video game performance. The volunteers played a Sony video game (Nintendo® Wii) by using the boxing method, in which all volunteers played for 10 minutes without interruption. At the end of the game the volunteers were reassessed using the same parameters mentioned above.

RESULTS: At the end of the video game boxing performance we observed highly significant increases of lactate production ($p < 0.0035$) and the double product (heart rate vs. systolic blood pressure) was also higher ($p < 0.0001$). Both parameters indicate that the performance increased demands of the cardiovascular system.

CONCLUSION: We conclude that a ten-minute video game boxing performance induces cardiovascular responses similar to aerobic exercise. This may be a practical form of exercise, but care should be exercised concerning subjects with cardiovascular disorders.

KEYWORDS: Video Games; Lactic Acid; Physiology, Cardiovascular; Oxygen Consumption.

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INTRODUCTION

Physical activity and/or exercise induce health benefits, reducing the chance of morbidity and disability[1–3]. The American College of Sports Medicine recommends aerobic activity (walking, jogging, cycling) for healthy adults[4].

Muscle fatigue is a common phenomenon in endurance sports and may be experienced in usual daily activities. The factors involved in this process include two categories: central (fatigue caused by disorder of neuromuscular transmission in the central nervous system and muscle membrane) and peripheral (changes within the muscular system)[5,6].

Exercise induces a significant increase in plasma lactate concentration, depending on its intensity. The lactate clearance rate has a direct linear relationship with the excess post-exercise oxygen consumption (PEOC), suggesting a contribution to the slow component of PEOC[4]. Previous studies proposed the lactate threshold as an invasive gold standard and widely recommended parameters in the assessment, prescription and monitoring of exercise programs, especially for aerobic exercise[5].

Virtual exercise programs through video game performance have played an important role in achieving the goals of increasing the joy of physical activity performance, starting in childhood, and enabling the concept of health[7].

Many studies have already indicated rehabilitation programs on subjects with cardiovascular diseases based on exercise[8]. Others studies investigated cardiovascular responses to acute therapeutic procedures[9]. Virtual environments are potentially useful in therapy because they may be safer and provide educational benefits compared to dangerous tasks in the real world. They may allow early rehabilitation to follow a simpler course and its feedback may be more consistent Guderian et al[10]. Some studies investigated the effects of video gaming on physiological

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variables[11]. Other studies demonstrated that playing Wii Sports Boxing significantly increases heart rate and oxygen consumption (VO_2)[11,12]. However, it was not clear if the responses were different in women. Therefore, we aimed to evaluate cardiovascular responses induced by video game boxing performance in healthy women.

MATERIALS AND METHODS

Study population

This is a prospective, randomized and quantitative study. We selected 10 healthy female subjects who were students of Physiotherapy, Faculty of Health Sciences (FACIMPA), Pouso Alegre, and aged 18–25. All procedures followed the rules and guidelines of Resolution 196/96 of the National Health Council. The study was approved by the Ethical Committee in Research of our University (Protocol number 003/08). All participants read and signed an informed written consent.

Inclusion criteria

We considered the following exclusion criteria: cardiovascular disorders, diabetes, neurological diseases, congenital or acquired orthopedic alterations and respiratory diseases, according to the evaluation form.

Procedures

Each individual underwent an initial assessment for data collection. Later, the session was held to perform activity through the NINTENDO WII® mode in the "boxing" mode; the session lasted ten uninterrupted minutes. On the day prior to the exercise, each individual ate normally, and after the session, each subject received supplementary food (a banana, a cereal bar and a glass of water). During the session, only water was allowed.

We collected blood samples (a blood drop from the distal region of the index finger, immediately placed on tape collection) for lactate analysis, and we measured heart rate and blood pressure before and immediately after the video game performance. The heart rate and the systolic blood pressure were used to calculate the double product.

Statistical analysis

Distributions were analyzed by the D'Agostino-Pearson normality test. In order to compare the variables between before and after the video game boxing performance, we applied the Student t test, since the distributions were all parametric. Differences were considered significant when the probability of a Type I error was less than 5% ($p < 0.05$). We used the Software Bioestat version 5.0 for Windows.

RESULTS

Figure 1 displays results related to the lactate before and after video game performance. Lactate increased in all subjects after video game boxing performance and this difference reached statistical significance ($p = 0.0035$) (Figure 1).

The calculated double product of the values before and after the procedures is presented in Figure 2. Double product increased in all volunteers immediately after video game boxing performance ($p = 0.0001$) (Figure 2).

We observe in Figures 3 and 4 the behavior of systolic and diastolic blood pressures, respectively before and after video game boxing performance. Systolic ($p = 0.0025$) and diastolic ($p = 0.0058$) also increased significantly after the procedures.

Figure 5 presents data regarding heart rate before and after a video game boxing exercise.

DISCUSSION

Our study examined the cardiovascular responses to video game boxing performance in ten sedentary and healthy women. Our findings suggest that this activity presented similar effects to aerobic exercise, causing changes in heart rate, systolic and diastolic BP, blood lactate production and double product. The world of video games is continually evolving, and the alternatives are realistic and impressive. Not long ago, the device used for video games was the "joystick", which allowed full control of the game through hand movements only. The Wii (NINTENDO®) consists of a console and a "joystick" called "Wii remote", which captures the body movements that the player makes, functioning as a type of "air mouse"[3].

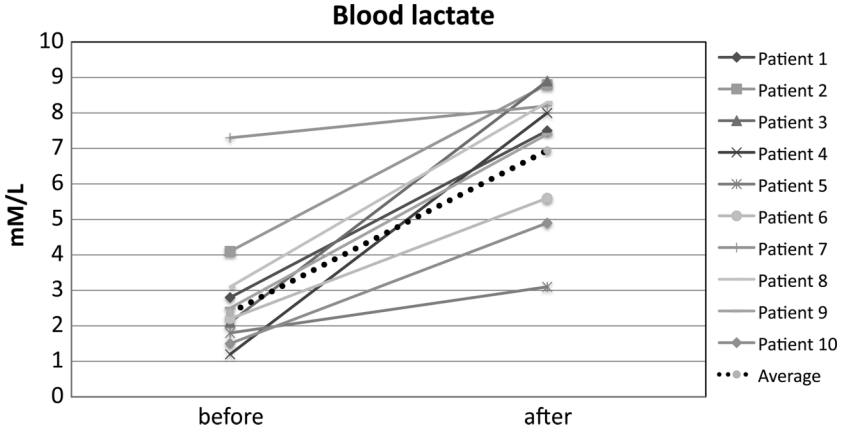

Figure 1 - Lactate production before and after video game boxing performance.

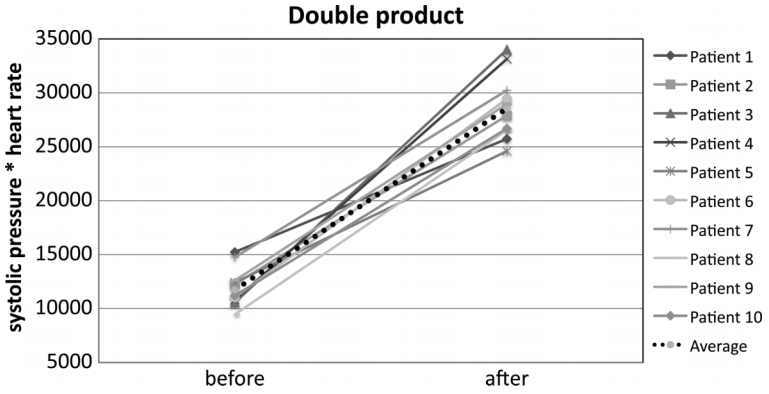

Figure 2 - Double product before and after video game boxing performance.

For the prescription of training intensity, oxygen consumption, rate of perceived exertion (fatigue) and heart rate have been used[1]. Lactate is the final product of glycolysis in hypoxic conditions, the cause of muscle fatigue, and a key factor in tissue injury induced by acidosis. Currently, it is known that lactate plays a key role in metabolism, where the physiological responses to exercise signal, reliably, the predominant feature of metabolism of the energy supply for a given activity[4].

Based on our investigation, we suggest that video game boxing performance induces cardiac demand in healthy women, suggesting high-energy expenditure. Guderian et al[10] investigated total energy expenditure in a Wii Fit video game playing session. They reported that playing Wii Fit video games is a feasible alternative to more traditional aerobic exercise modalities for middle-aged and older adults; it fulfills the American College of Sports Medicine guidelines for improving and maintaining cardiorespiratory fitness. However, they did not study men and women separately.

We were able to demonstrate a significant increase of systolic and diastolic blood pressure in healthy women while they played a 10 minute video game boxing session. We investigated only one single session of ten uninterrupted minutes. Previous studies have predominantly provided shorter testing periods lasting around five minutes or less. We could argue that previous findings were potentially due to the initial excitement and that children, during the playing time, could physiologically adapt to multiple stimuli. Only in one analyzed study did subjects play four different games of 15 min each in a randomly determined order, dividing the 15-min game periods into five 3-min trials[13]. Their baseline values of heart rate, systolic and diastolic blood pressure during each period did not differ, but the changes during the diverse game periods were significantly different. For example, heart rate response during Period 1 was significantly greater than responses to Periods 2, 3, and 4. The authors concluded that these findings indicate habituation in response to video game playing. However, in their study, subjects had to exceed certain scores in order to avoid electric shocks, which might have acted as a confounder.

In our study, we investigated boxing video game style. Most studies evaluated interactive video game cycling[14,15]. The varying results of previous studies might be due to different age groups and diverse types and duration of video games tested. Regarding increases in systolic and, to a lesser extent, in diastolic blood pressure. The most distinct findings in our study compared to most other studies could be due to the more sophisticated and realistic game scenes employed in our study. This may be supported by similar elevations

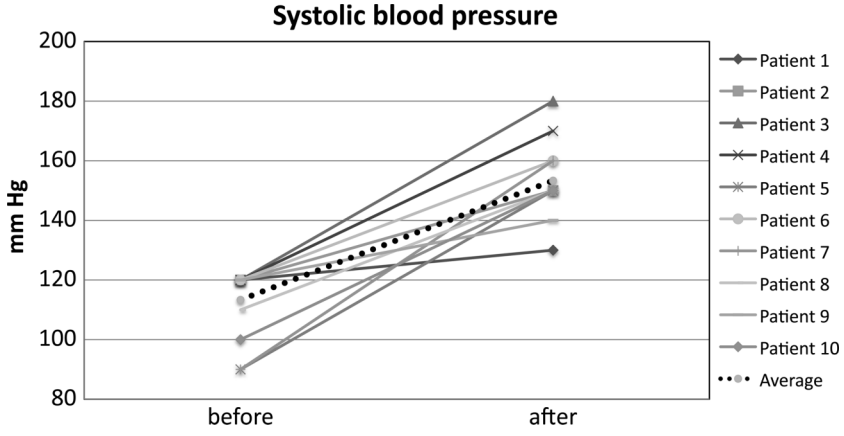

Figure 3 - Systolic blood pressure before and after video game boxing performance.

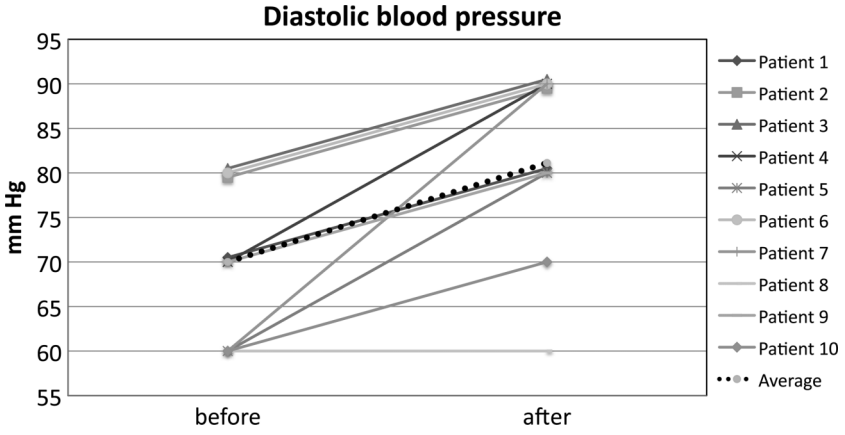

Figure 4 - Diastolic blood pressure before and after video game boxing performance.

noted in a previous published study[14]. It is also important to mention that the additional stressor represented by boxing should be recognized that might potentially provoke the elevation of those cardiovascular parameters.

Considering that cardiovascular responses, such as heart rate, systolic and diastolic blood pressure, were intense in a single 10-minute video game boxing performance, caution should be exercised with subjects suffering from cardiovascular disorders. A previous study by Miller and Ditto[16] analyzed heart rate, systolic and diastolic blood pressure, oxygen consumption, and carbon dioxide production in 17 male adolescents during a racing simulation video game and compared their resting state and exercise testing measurements. They reported a significant increase in heart rate, systolic and diastolic blood pressure in male adolescents. Those effects persisted during two consecutive game phases of a video racing game lasting 12 minutes each, with a return to baseline values after the game phases. The authors suggested that playing video games may cause disproportionate elevations in blood pressure with respect to energy consumption. Taken together, our study and Miller and Ditto's findings might constitute a possible risk for unfavorable effects on the cardiovascular system.

Video games may also be considered as a tool for physical activity or rehabilitation programs. On the other hand, Warburton et al[14] evaluated the effectiveness of interactive video games (combined with stationary cycling) on health-related physical fitness and exercise adherence in comparison with traditional aerobic training (stationary cycling alone). They indicated that a training program that links interactive video games to cycle exercise results in greater improvements in health-related physical fitness than that seen after traditional cycle exercise training. Our study aimed to investigate the acute effects of video game performance on cardiovascular responses.

In our protocol, subjects performed only a boxing video game, using upper limbs with more intensity than lower limbs. There are some accessories that may be coupled to the "Wii" to work different muscle groups. For the lower limbs the accessory used is a "Balance Board" (a different control that measures the force applied to it and recognizes balance changes through pressure sensors) and the game "Wii Fit" (a pack of games that seeks to make the player's life healthier, offering games that stimulate aerobic exercise, muscle conditioning, balance and strength). As for the arms, it uses the "Wii mote" with the game "Wii Sports" which consists of a sports package that offers the player five different

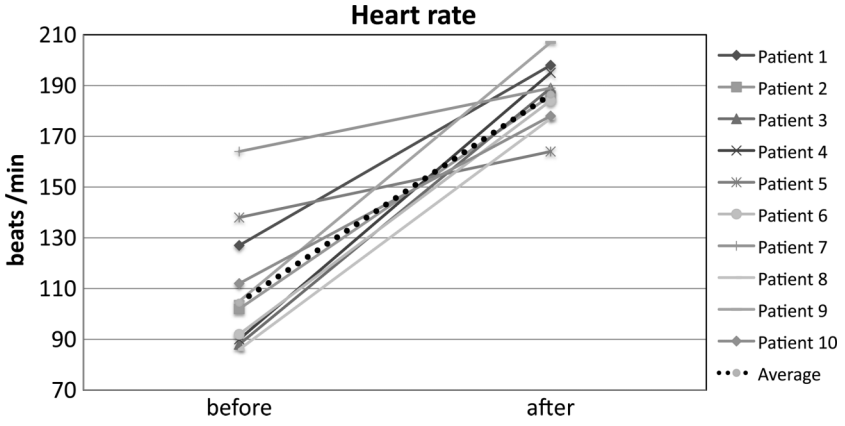

Figure 5 - Heart rate before and after video game boxing performance.

sport activities, such as tennis, baseball, golf, bowling and boxing[3].

Our study presents some important points. We utilized a small sample of healthy women. Thus, it is uncertain whether our findings may be generalized to overweight and obese adolescents. On the other hand, the statistical analysis indicated a high level of significance. Because, in general, males spend more time video gaming than females, we studied only women in order to verify the cardiovascular responses induced by video game boxing performance in this specific population.

CONCLUSION

Playing Wii Sports Boxing significantly increases heart rate, systolic blood pressure, diastolic blood pressure, lactate production and double product in healthy women. This indicates an overall increase in metabolic activity not dissimilar to aerobic exercise.

RESUMO

BACKGROUND: Estudos anteriores sugerem que certos jogos de vídeo interativos induzem respostas cardiovasculares. No entanto, alguns estilos diferentes de jogos de vídeo não foram investigados.

OBJETIVO: Nosso objetivo foi avaliar as respostas cardiovasculares induzidas pelo video game desempenho boxe em mulheres saudáveis.

MÉTODO: Foram avaliadas dez voluntárias sedentárias do sexo feminino, com idades de 20,9 ± 1,4 anos, peso 58,7 ± 8,0 kg, estatura 163,2 ± 5,4 cm. Todas foram pesadas e medidas. Suas frequências cardíacas, pressões arteriais e níveis de lactato foram registrados antes e depois de um jogo em vídeo game. As voluntárias jogaram um jogo de vídeo Sony (Nintendo ® Wii) usando a modalidade boxe, na qual todas jogaram por 10 minutos ininterruptos. No final do jogo, as voluntárias foram reavaliadas utilizando os mesmos parâmetros mencionados acima.

RESULTADOS: Ao final da performance de vídeo game boxe observamos aumentos altamente significativos de produção de lactato ($p < 0.0035$) e do duplo produto (frequência cardíaca versus pressão arterial sistólica) também foi maior ($p < 0.0001$). Ambos os parâmetros indicam que o desempenho aumentou a demanda de trabalho do sistema cardiovascular.

CONCLUSÃO: Concluímos que uma performance de jogo de vídeo de boxe de dez minutos induz respostas cardiovasculares similares aos exercícios aeróbicos. Esta pode ser uma forma prática de exercício, mas cuidado deve ser exercido em relação a indivíduos com doenças cardiovasculares.

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