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Original Article

Cardiovascular effects of Zumba® performed in a virtual environment using XBOX Kinect

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Abstract [Purpose] This study evaluated the acute cardiovascular responses during a session of Zumba® Fitness in a virtual reality environment. [Subjects] Eighteen healthy volunteers were recruited. [Methods] The following cardiovascular variables: heart rate, systolic blood pressure, diastolic blood pressure, and double product were assessed before and after the practice of virtual Zumba®, which was performed as a continuous sequence of five choreographed movements lasting for 22 min. The game Zumba Fitness Core®, with the Kinect-based virtual reality system for the XBOX 360, was used to create the virtual environment. Comparisons were made among mean delta values (delta=post-Zumba® minus pre-Zumba® values) for systolic and diastolic blood pressure, heart rate, and double product using Student's t-test for paired samples. [Results] After a single session, a significant increase was noted in all the analyzed parameters (Systolic blood pressure=18%; Diastolic blood pressure=13%; Heart rate=67%; and Double product=97%). [Conclusion] The results support the feasibility of the use of Zumba Fitness Core® with the Kinect-based virtual reality system for the XBOX 360 in physical activity programs and further favor its indication for this purpose.

Key words: Exergames, Cardiovascular effects, Fitness

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INTRODUCTION

Recently, a new class of video games, the exergames (EXG), has been employed to provide patients with perceptual and performance emulation and potential for development of sensory and motor abilities[1)]. Several studies have used interactive virtual games by Nintendo Wii, the world's most popular EXG, to assess the implications of this type of intervention in the rehabilitation process and in neuromuscular training[2)] as well as the impact of EXG on physiological parameters, especially those concerning energy expenditure[3, 4)]. However, there is little research exploring the cardiovascular effects of other EXG such as Xbox 360.

Inspired by the popularity of the Zumba® dance program, XBOX 360 released the game Zumba® Fitness Core® to promote similar effects as those of the real environment. In fact, Zumba® is a Latin-inspired dance workout first developed in Columbia in the mid-90s by celebrity fitness trainer Alberto "Beto" Perez. In this program, participants are encouraged to move to the beat of the music, and the choreography is less formal than that of many other group exercise classes. Zumba® is currently performed by over 12 million people, at 110,000 sites, in 125 countries around the world. Recently, Zumba® was ranked ninth in terms of worldwide fitness trends for the year 2012[5)].

Despite the widespread popularity of Zumba®, there is very little research documenting the potential fitness benefits of this dance form. Therefore, this study was designed to determine the cardiovascular effects of the practice of Zumba Fitness Core® using the Kinect-based virtual reality system for the XBOX 360 by assessing the pre- and post-values of systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and double product (DP). This will allow structuring of Zumba® virtual-training sessions based on not only the technical and tactical needs of the practitioners, but also in a manner that enables sufficient cardiovascular conditioning and reduction of cardiovascular risks.

SUBJECTS AND METHODS

The subject population was a convenience sample comprised of nine male and nine female healthy volunteers

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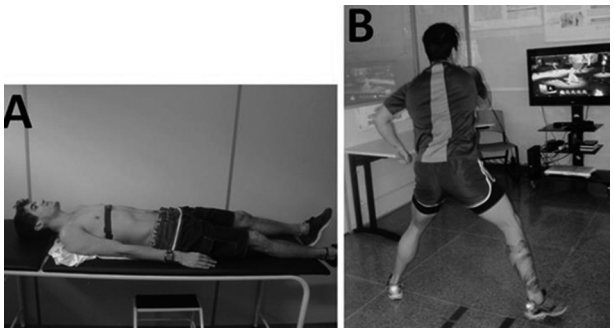

Fig. 1. A: Subjects resting for 10 min in the dorsal decubitus position for assessment of basal cardiovascular parameters; B: Subjects performing the Zumba® Fitness Core® individually

Table 1. Cardiovascular changes between pre- and post-virtual Zumba® practice

Cardiovascular parameters	Initial (SD)	Final (SD)	Δ (%)
Systolic blood pressure	115.37 (13.35)	136.25 (17.94)	0.18*
Diastolic blood pressure	70.50 (7.44)	80.00 (10.94)	0.13*
Heart rate	67.75 (7.32)	112.75 (14.06)	0.67*
Double product	7,865.37 (1,562.65)	15,491.25 (2,890.77)	0.97*

* indicates $p<0.05$ using Student's t-test for paired samples (n=18). SD: Standard deviation.
Delta (Δ) was obtained using the equation Δ=(final–initial)*100/initial

recruited from the physical education faculty. Demographic data for the sample were as follows: (mean±standard deviation [SD]): age, 23±5 years; body mass, 68±8 kg; height, 166±7 cm; fat percentage, 16.6±0.4; and lean mass percentage, 29.0±2.6. None of the volunteers were involved in an intense aerobic training regimen, and none of them had a sedentary lifestyle (exercising at least 30 minutes, three times a week). All subjects were not experienced at participating in Zumba® fitness classes. The following inclusion criteria were used: (a) no history of skeletal muscle injury; and (b) able to perform all the experimental tasks. Prior to participating in this study, the subjects completed the Physical Activity Readiness Questionnaire (PAR-Q) and provided written informed consent, according to the Brazilian Resolution n. 466/2012 of National Health Council (Protocol number° 428.527/20130).

The game Zumba Fitness Core®, with the Kinect-based virtual reality system for Xbox 360 (Microsoft Brazil, Manaus, AM, Brazil) was used in this study. The Kinect sensor is a horizontal bar that is connected to a small base with a motorized pivot and is positioned lengthwise, above or below the video displays designed by Microsoft for Xbox 360. Based around a webcam-style add-on peripheral, it enables users to control and interact with their console/computer, without the need for a game controller, through a natural user interface using gestures and spoken commands; it provides full-body 3D motion capture, facial recognition, and voice recognition capabilities.

Before data collection, the subjects rested for 10 min in the dorsal decubitus position, and the basal cardiovascular parameters: HR, SBP, DBP, and DP were obtained (Fig. 1A). Following this, each subject individually performed a continuous sequence of five choreographed movements of the Zumba Fitness Core® lasting for 22 min (Fig. 1B). Immediately following this, the same cardiovascular parameters were reassessed.

Blood pressure was measured with auscultation using a mercury column sphygmomanometer (Heidji, São Paulo, Brazil) and a stethoscope (Sprague Rappaport, Omron, USA). For the measurement, the individual placed his/her left arm in a relaxed position on a flat surface at shoulder height. The arm cuff was positioned with its lower edge approximately 2.5 cm above the antecubital fossa. The cuff was inflated, began the emptying process to distinguish the 1st and 5th Korotkoff sounds corresponding to SBP and DBP values, respectively. HR was monitored continuously, and the pre- and post-values were recorded using a frequency meter (Polar RS800CX, Kempele, Finland). Double product was calculated using the formula: DP=SBP × HR.

GraphPad Prism (GraphPad® Software, Inc. La Jolla, CA, USA) was used to perform the statistical analysis, with $\alpha=0.05$ set as the level of statistical significance. Comparisons were made among the mean and SD values for delta (Δ=post-Zumba® minus pre- Zumba® values) for SBP, DBP, HR, and DP, using Student's t-test for paired samples.

RESULTS

Table 1 shows the differences in the pre- and post-virtual Zumba® cardiovascular parameters. The results are presented as raw data (initial and final values) and percentage of increase in Δ variation. All cardiovascular parameters showed a significant increase ($p<0.05$) after the experimental protocol. While SBP and DBP showed an increase of 18% and 13%, respectively, HR and DP showed an increase of 67% and 97%, respectively. In absolute terms, the results were as follows: (i) SBP Δ: +20 mmHg; DBP Δ: +9.5 mmHg; (iii) HR Δ: 45 bpm; (iv) DP Δ: 8933 mmHg.bpm.

DISCUSSION

To date, there is insufficient scientific description of acute cardiovascular responses during physical exertion imposed by EXG. An understanding of cardiovascular responses during physical exertion is critical for developing strategies and obtaining parametric values that allow us to adjust training programs as well as guarantee the safety of practitioners, especially when their clinical condition is associated with high risks. Moreover, EXG are a promoter of physical activity, allowing new possibilities for systematic exercise and rehabilitation.

From a business point of view, Zumba® is an important part of the multi-billion dollar fitness industry and has been rapidly gaining popularity worldwide. Zumba® was

predicted to be one of the top 10 fitness trends in 2012 by the American College of Sports Medicine (ACSM) based on a survey of more than 2,600 fitness professionals[5]. This growing fitness trend of Zumba® therefore requires scientific investigation.

In this study, all cardiovascular parameters were significantly increased after the Zumba® experimental protocol. It is important to note that a greater increase occurred in DP, which is a variable related to the myocardial oxygen demand and cardiac work[6]. Considering that DP depends on HR and SBP and that SBP had a smaller increase (18%) than HR (67%), it is suggested that the experimental protocol imposed stress on the heart with low overload on pressure status. Visual feedback generated by the EXG probably influenced the mechanical efficiency of the movement and favored the lower blood pressure stress.

In this respect, Zumba® in a virtual environment could help participants meet the ACSM recommendation of 150 minutes of moderate cardiovascular exercise per week (30 minutes per day, five days per week)[7]. Other studies have shown that Zumba® intervention improved health and physical fitness, cardiovascular status, body composition, and quality of life in overweight/obese women[8, 9]. Luettgen et al.[10] found that participating in a Zumba® dance class of average length required an average of 9.5 Kcal·min^{-1}, or 369 Kcal. It should be pointed out that the average class length in the current study was approximately 39 minutes. Longer classes would obviously result in greater energy expenditure. Regular participation in Zumba® should positively affect body composition. Therefore, Zumba® may also play a very important role in improving health and reducing obesity-related diseases such as diabetes and hypertension.

In the present study, a comparison with Zumba® classes in a real environment was not performed. Virtual and real situations are probably different. Additionally, despite standardization as a result of licensing and training in Zumba® classes, significant variation among actual Zumba® routines and instructor experience is likely[11]. Delextrat and Neupert[12] compared the metabolic load elicited by Zumba® classes and DVD workouts and linked the physiological responses to participants' psychological characteristics. The results suggested that while both types of workouts are suitable for maintaining fitness status, Zumba® classes allow greater energy expenditure.

However, it is important to consider that virtual activity alone should not replace an oriented rehabilitation program. Lee[13] showed that training using video games played on the Xbox Kinect may be an effective intervention in the rehabilitation of stroke patients. Thus, virtual games should be seen as an auxiliary tool to help reduce the monotony and increase the entertainment value as well as adherence to physical activity under the guidance of a professional[13, 14].

In summary, physical activity in a virtual environment emulated by the XBOX 360 can change acute cardiovascular responses, mainly the DP parameter. The results support the feasibility of the use of the Zumba Fitness Core® using the Kinect-based virtual reality system for the XBOX 360 in physical activity programs and further favor its indication for this purpose. Future research should be focused on using different experimental routines and long-term assessments to better clarify the relationship between Zumba® in a virtual environment and health promotion.

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