Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 09, Issue, 07, pp. 28875-28880, July, 2019

RESEARCH ARTICLE

OPEN ACCESS

EFFECTS OF EXERGAMES ON THE VARIABILITY OF THE HEART RATE OF UNIVERSITY STUDENTS

***[1]Alessandro Reis, [2]Danielle de Freitas Gonçalves, [1]Juliana Ribeiro Gouveia Reis, [3]Caroline da Silva Ribeiro, [2]Lilian Cristina Gomes do Nascimento, [2]Daniel dos Santos, [4]Cassiano Merussi Neiva, [5]Carlos Bandeira de Mello Monteiro, [6]Dalton Muller Pessôa Filho and [2]Maria Georgina Marques Tonello**

[1]Medicine Departament, Centro Universitário de Patos de Minas, Patos de Minas, MG, Brasil
[2]Health Promotion Department, Universidade de Franca, Franca, SP, Brasil
[3]Physiotehreapy Departament, Centro Universitário de Patos de Minas, Patos de Minas, MG, Brasil
[4]Physical Education Departament, Universidade Estadual Paulista, São Paulo, SP, Brasil
[5]Physical Education Departament, Universidade de São Paulo, São Paulo, SP, Brasil
[6]Physical Education Departament, Universidade Estadual Paulista, Baurú, SP, Brasil

ARTICLE INFO

Article History:
Received 29th April, 2019
Received in revised form
27th May, 2019
Accepted 06th June, 2019
Published online 31st July, 2019

Key Words:

Exercise; Students; Heart rate, Virtual reality.

ABSTRACT

The purpose of the present study was to evaluate the effects of an EXG on the variability of the heart rate (HRV) in young people. The participants were divided into two groups: Exergame Group (GE) and Control Group (GC). Initially, anthropometric assessments were performed and to analyze the physical activity's level the International Physical Activity Questionnaire (IPAQ) short version was used. The HRV was recorded through the Polar V800® heart rate monitors in both groups in two moments, before and after 11 weeks and the data was transferred to the Kubios® software for analysis. The EXG training program lasted 11 weeks, with 3 weekly sessions of 30 minutes, using a dance game from Xbox 360 Kinect®. There was astatistically significant ($p < 0.05$) increase in the GE in the following HRV indices between the pre and post measures. Root mean square of successive differences between the normal adjacent RR intervals (rMSSD): 21.77 + 7.6 ms and 27.84 + 4.04 ms; percentage of adjacent intervals with more than 50ms (pNN50%): 3.57 + 3.34 and 7.52 + 3.98, and high frequency band (HF): 185.58 + 72.46 and 322.08 + 13.76ms. There was in CG no statistically significant difference in any of the variables studied. The EXG 11 weeks training was able to determine the improvement in HRV behavior with increased parasympathetic activity.

Citation: Alessandro Reis, Danielle de Freitas Gonçalves *et al.* 2019. "Effects of exergames on the variability of the heart rate of university students", *International Journal of Development Research*, 09, (07), 28875-28880.

INTRODUCTION

In public health it is recorded that cardiovascular diseases are the main causes of death worldwide, especially in large urban centers populations (Simaõ*et al.,* 2013). Among its modifiable risk factors are sedentary lifestyle and obesity (Smeltzer and Bare, 2006). In 1999, the American Heart Association already included sedentarism as one of the major cardiovascular risk factors (Grundy *et al.,* 1999). Although chronic degenerative diseases appear in adult life, the onset of the process occurs in earlier stages of life, such as in childhood, adolescence and youth, precisely when preventive measures should be initiated (Moura *et al.,* 2018). One of the main factors related to the sedentary lifestyle is the increasing involvement of the population with passive leisure activities, such as watching television, using a computer, making use of electronic games, which, in a sense, are associated with inadequate diet and overweight (Eisenmann *et al.,* 2005). Regular physical activity has an inverse relationship to the risk of chronic non-communicable diseases, such as atherosclerotic vascular diseases and has a positive effect on quality of life and other psychological variables (CDC, 1999). In addition, it helps weight control, especially if it is associated with dietary measures, which also contributes to cardiovascular risk

****Corresponding author:*** **Alessandro Reis,**
Medicine Departament, Centro Universitário de Patos de Minas, Patos de Minas, MG, Brasil

reduction (Shoji and Forjas, 2000) and improves cardiac autonomic modulation (Nakamura *et al.,* 2013, Sloan *et al.,* 2009). One type of physical activity that has been widely studied in health promotion is interactive video games or exergames (EXG) (Rei, 2017). Conventional physical activities, such as collective sports are more tedious and virtual reality proposes a new interactive and contemporary way of encouraging and facilitating the engagement of children and young people to a healthy modification in their lifestyle (Ilha and Bernardi, 2011). This activity allows a direct connection of the individual with a virtual environment, being the player's body movements captured by the computer and mixing the virtual environment with physical exercise (Belmiro, Preto and Vinicius, 2011). In Xbox360® this interaction takes place by the device Kinect® that captures the free movements of the player which are the input data for the interaction with the electronic game. As previously demonstrated in the literature, EXG is considered a moderate-intensity physical activity (Hiraga, Tonello and Pellegrini, 2017).

Some games involving dance, such as Just Dance® and Dance Central® have also been tested demonstrating moderate-intensity levels of physical activity (Smallwood *et al.,* 2014). One of the indicators of health and physical condition is heart rate variability (HRV) (Buchheit and Gindre, 2006). The HRV describes the oscillations of the intervals between normal consecutive heart beats (RR intervals), which are related to autonomic nervous system influences on the sinus node, being a noninvasive measure that can be used to identify phenomena related to the autonomic nervous system in healthy individuals, athletes and those who have some pathology. Changes in HRV patterns provide a sensitive and anticipated indicator of health impairment (Silva Neto, 2017, Vanderlei *et al.,* 2009). There are some ways to measure HRV, such as the electrocardiogram and heart rate measurements. Polar® presents good accuracy when compared to the ambulatory electrocardiogram, such results were observed in studies comparing the data obtained by the electrocardiogram and Polar S810, in exercise and rest situations 18. The Polar V800® also showed a high correlation of its records with data obtained through electrocardiogram (Giles, Drapper and Neil, 2016).

MATERIALS AND METHODS

This was an interventional, prospective, comparative and quantitative study. The data were collected in the physiotherapy clinic of a University Center in Brazil. The study was approved in the system CONEP / CEP nº 1470601. The study was conducted with a non-probabilistic sampling of convenience and the participants were chosen through invitations in the classroom that explained what the study was about. Twenty individuals, aged 18 to 28 years, enrolled in night courses at the University Center, were divided into two groups, exergames group (EG) and control group (CG), both with 10 participants. The sample split followed the criteria of availability to participate in the training phase and GC maintained their usual activities over the 11-week period. Inclusion criteria: university students of both sexes, age range from 18 to 35 years old, without reporting of preexisting diseases or use of medication routinely and signing of the free and informed consent term. The following exclusion criteria were: do not go in the initial evaluation; report of current treatment for some specific pathology; to miss three consecutive sessions; disease that requires medical leave. All volunteers were informed about the research protocol and after signing the free informed consent they were submitted to the following procedures:

Experimental procedure

- Anamnesis;
- Interview filling the short version of the International Questionnaire of Physical Activity (IPAQ), short version to evaluate the level of physical activity of each participant;
- Participants were assessed between 08:00 and 11:00 am to a room with controlled temperature (23 ° C). After 15 minutes of rest in the supine position, cardiac beats were recorded for 10 min in the supine position using the Polar V800® (Polar Electro Oy Inc., Kempele, Finland) The cardiofrequentiometer was positioned over the precordial region. Anthropometric data were recorded for the calculation of Body Mass Index (BMI);
- Then the CG participants were instructed to maintain their usual activities while GE subjects were submitted for 11 weeks to EXG sessions at the Physiotherapy Clinic, supervised by the researcher. The duration of each session was 30 minutes, 3 times a week. We use the Xbox360® videogame with Kinect® accessory. Just Dance3® was the game used in this protocol. This is a dance video game, where the player imitates the proposed choreography, not obeying a formal pattern of movements and without systematic progression of intensity, and is thus classified as unstructured physical activity (Brito-Gomes *et al.,* 2015). After 11 weeks the participants of both the CG and the participants of the EG were reassessed by collecting the same pre-training measures and then the results were compared.

The VFC data were transferred via the signal interface to a computer via the Polar Flowsync ® program and then the data was exported to Kubios HRV version 3.0 software (The Biomedical Signal and Medical Imaging Analysis Group, Department of Applied Physics, University of Kuopio, Finland) for analysis of HRV data as described in previous studies (Aeschbacher*et al.,* 2016, Anaruma*et al.,* 2016). The results of the HRV data were analyzed using a linear time domain method, thus obtaining the mean RR intervals, standard deviation of all RR intervals (SDNN), square root of the square mean of the differences between the intervals Adjacent normal RRs (rMSSD) and percentage of adjacent intervals greater than 50ms (PNN50) (Anaruma *et al.,* 2016). In order to evaluate HRV in the frequency domain, the parameters were obtained by the HRV spectral analysis technique. Stationary periods of the tachogram, with at least 5 minutes, were decomposed into the low frequency and high frequency bands (AF) by the transformed Fourier method (FT). The frequencies between 0.04 and 0.4Hz were considered as physiologically significant, the low frequency component being represented by oscillations between 0.04 and 0.15Hz and the AF component between 0.15 and 0.4Hz22. The data were analyzed in a comparative way. The Statistical Package for the Social Sciences was used to verify the efficacy of the proposed protocol pre and post-experiment. In the intra-group analysis, in the pre and post-experiment situations, the Wilcoxon test was used accepting the level of significance of 0.05. In order to verify the existence or not of statistically significant differences between the 2 groups, the Mann-Whitney U test was used to obtain the values.

RESULTS

The GE had 10 participants, nine women and one man, of these 50% were active or very active and 50% insufficiently active by the IPAQ. The CG also had 10 individuals, seven women and three men, in relation to the IPAQ, 70% of them were active and 30% were insufficiently active or sedentary, according to Figures 1 and 2 below:

Table 1. Correlation between the HRV values obtained from the participants in the two groups, in the variables analyzed, before the experiment

Analyzed Variables	Group control Averages± Standard deviation	Group exergame Averages ± Standard deviation	P value
Age	21 a 7meses± 3 a 8m	20 a 5 m ± 1 a 2 m	0,3007
IMC	21,02 ± 3,57	26,30 ± 6,34	0,0284*
SDNN (ms)	41,30 ± 11,99	31,10 ± 7,60	0,0494*
rMSSD (ms)	27,52 ± 5,02	21,77 ± 5,09	0,0126*
pNN50 (%)	7,02 ± 3,18	3,57 ± 3,34	0,0191*
LF	298,13 ± 178,77	352,36 ± 308,74	1,0000
HF	279,43 ± 140,54	185,58 ± 72,46	0,0963
LF/HF (ms2)	1,64 ± 2,07	1,71 ± 0,84	0,1306

*p<0,05

Table 2. Comparison of HRV indices of GC at baseline and after 11 weeks

Analyzed Variables	Group	Group	P value
	GC pré	GC pós	
SDNN (ms)	41,30 ± 11,99	40,74 ± 15,48	0,5147
rMSSD (ms)	27,52 ± 5,02	25,98 ± 3,15	0,5147
pNN50 (%)	7,02 ± 3,18	5,27 ± 2,93	0,3139
LF	298,13 ± 178,77	319,39 ± 275,22	0,7989
HF	279,43 ± 140,54	290,07 ± 134,00	0,8785
LF/HF (ms2)	1,64 ± 2,07	3,22 ± 6,97	0,8385

*p<0,05

Table 3. Comparison of the HRV indices of the EG before and after 11 weeks

Analyzed Variables	Group	Group	P value
	GE Pré	GE Pós	
SDNN (ms)	31,10 ± 7,60	40,50 ± 16,22	0,1688
rMSSD (ms)	21,77 ± 5,09	27,84 ± 4,04	0,0051*
pNN50 (%)	3,57 ± 3,34	7,52 ± 3,98	0,0125*
LF	352,36 ± 308,74	362,64 ± 123,24	0,3863
HF	185,58 ± 72,46	322,08 ± 133,76	0,0469*
LF/HF (ms2)	1,71 ± 0,84	1,30 ± 0,73	0,3329

*p<0,05

Regarding age, BMI and heart rate variability indexes, Table 1 shows through means and standard deviation the initial differences between the two groups. In order to verify the existence of statistically significant differences between the groups, the Mann-Whitney U test was applied to the values obtained. Comparing the two groups in the initial phase, the results demonstrated in table 1, showed that there were statistically significant differences of the variables: BMI, SDNN (ms), RMSSD (ms), pNN50 (%), noting that the BMI of GE was higher than the CG. As for the other 3 variables, the results obtained with GC were higher than those obtained with GC. To verify whether or not statistically significant differences between the results obtained by young GC as well as the young of GE in the pre and post-experiment, the Wilcoxon test was applied to the values in the variables analyzed. The level of significance was set at 0.05 in a bilateral test. The results are shown in Table 2 and Table 3, GC and GE, respectively. When we analyzed the GC in the pre and post-experiment situations, we did not notice a statistically significant difference in any of the analyzed variables. When analyzing the GE, we noticed that there was a significant difference in the variables: rMSSD, pNN50% and AF, in relation to the initial measurements. The Mann-Whitney U test was applied to the values obtained in the variables analyzed in order to verify the existence or not of statistically significant differences between the results obtained by the students of the two groups after 11 weeks. The level of significance was set at 0.05 in a bilateral test. After the 11 weeks the statistically significant differences disappeared between the groups, according to Table 4.

This probably occurred due to the improvement of the EG in relation to the initial HRV indexes, as demonstrated previously in Table 3.

DISCUSSION

The present study demonstrated a significant improvement in the HRV patterns before and after a training program (EG). This suggests a significant benefit of EXG as a modality of physical activity after an 11-week training on cardiovascular health. Physical exercise is one of the pillars of a healthy lifestyle and its benefits are widely accepted in public health as a method of health promotion (Simão *et al.,* 2013, Sloan, 2009, CDC 1999). Several societies recommend that individuals perform physical exercises on most days of the week with moderate to vigorous intensity (Goff *et al*., 2014, Simão et al., 2013, Almeida and Araújo, 2003). However, its cardioprotective mechanisms are still unclear, one of the mechanisms proposed for this benefit being the positive effects on autonomic cardiac modulation (Sloan, 2009, Almeida and Araújo, 2003). In this study, the influence of a training using

EXG was evaluated as an alternative practice of physical activity, on the autonomic cardiac modulation measured by heart rate variability. Although studies evaluating exergames as physical exercise (Lin, 2015, Brito-Gomes, 2015, Trout and Zamora, 2008) and others in which HRV was evaluated and its relationship with physical activity or sedentary lifestyle (Aeschbacher *et al*., 2016, Kawaguchi *et al*., 2007), no studies were found in the literature consulted (LILACS, PubMed / Medline, SciELO, EBSCO) who evaluated the effects of a training with EXG on HRV. For the division of the participants in CG and GE, the convenience criteria was used, and the EG was composed of individuals who showed willingness to participate in the sessions on a regular basis (Ochoa, 2015). Due to the fact that age, physical activity level and BMI influenced HRV, the samples were characterized to verify the influence of these data on cardiac autonomic modulation (Aeschbacher *et al*., 2016, Trevizani, Benchimol-Barbosa and Nadal, 2012, Buchheit and Gindre, 2006, Paschoal *et al*., 2006). Short IPAQ was used to evaluate the level of physical activity of the participants, a tool proposed by the WHO since 1998, tested and validated for the Brazilian population (*Matsudo* et al., *2012*)**.** We found 50% of sedentary or insufficiently active individuals in the SG and in the control GC only 30% of the individuals were in this condition of inactivity. Regarding the BMI, the SG values were significantly higher than in the CG.

Aeschbacher *et al*., (2016) studying young adults showed that a healthy lifestyle, such as regular practice of moderate or vigorous physical activity and BMI less than 25, had a positive impact on cardiovascular autonomic function. Sloan et al., (2009) evaluated a group of 149 young / adult individuals (58 males and 91 females), aged between 18 and 45 years, randomly divided into 2 groups according to the planned physical exercise (aerobic training or training of resistance), which were performed for 12 weeks 3 to 4 times a week, and HRV measurements were taken before and after the training program. These authors also concluded in their study that physical conditioning influences HRV and provides cardiovascular health benefit, although this effect was noted only in the male group, however, the women had better HRV pre-study values than the male group, besides a possible female hormonal interference in this result. In the Kawaguchi (2007) study, it was also demonstrated that HRV values were significantly higher in sedentary individuals in their sample of 20 subjects (10 sedentary and 10 athletes). Thus, the significant differences in the HRV indices between the EG and CG in the first measurements are explained by the literature, with better levels in the control group in which 70% of the individuals were active and with a lower BMI. As an exercise protocol, EXG was used and this activity was chosen due to the increasing use of virtual reality and the motivational impact of these games in the practice of physical activity, as demonstrated by Pereira (2016), who evaluated through a qualitative-quantitative research, a group of 18 university students (14 women and 4 men). The IPAQ was applied to characterize the level of physical activity and to evaluate the motivational impact used a specific questionnaire (mood profile), before and after 4 weeks of training with EXG. Regarding the training protocol with EXG, some studies that used Just Dance in their protocol, submitted their volunteers to a training program of 4 to 12 weeks. Staiano et al., (2016) studied 37 girls from 14 to 18 years old with 3 weekly training sessions of 60 minutes; Pereira et al., (2016) evaluated 18 volunteers (14 women and 4 men) training them for 4 weeks with 2 weekly training sessions of 40 minutes, one of which was Just Dance; Trout and Zamora (2008) trained 26 individuals of both sexes for 8 weeks with 3 weekly sessions of 20 minutes. In our study we used 11 weeks with 3 weekly sessions of 30 minutes.

In relation to the physical conditioning potential, Brito-Gomes et al., (2015) carried out a study in which the subjects of the EXG group trained during 6 weeks, 3 weekly sessions of 30 minutes with improvement of the physical capacity in relation to the control. The intensity, based on the American College of Sport Medicine (ACSM), was classified as moderate, that is, reaching 40% to 60% of the RRF or 3 to 6 METs, as demonstrated in the study by Barry et al., (2016) and in a published meta-analysis by Peng, Lin and Crouse (2011). Many works also used, among the EXG, dance games such as Dance Dance Revolution® and Just Dance (Staiano*et al.,* 2016, Lin, 2015, Peng, Lin and Crouse, 2011, Trout and Zamora, 2008). They demonstrated that in these games, participants would reach levels of a physical activity classified as moderate as demonstrated in other modalities of EXG. For the analysis of the impact of these games in the autonomic modulation, HRV indices measured using linear methods were used in both domains, time and frequency (Alves, 2015, Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). After 11 weeks there was no significant difference in the pre and post measures in the CG. In GE, we noticed improvements in the AF, pNN50% and rMSSD variables, reflecting improvement in parasympathetic activation. Since this difference in the HRV of the GE is justified by a probable improvement in the physical conditioning of this group, which at the beginning of the study presented results statistically inferior to the GC. With the improvement in the HRV indexes of the GE, in this second moment of measurements, the differences between the two groups disappeared. Better AF and rMSSD values were seen in several studies comparing sedentary individuals with active (Buchheit and Gindre, 2006, Jurca*et al.,* 2004, Sala *et al.,* 2015) as well as after protocol using physical exercises. Grant *et al.,* (2012), studying youngsters trained for 12 weeks through medium to high intensity physical activity, showed a statistically significant increase in parasympathetic indices, including those used in our study as rMSSD and pNN50 in the domain of the time and AF in the frequency domain. This study had a small group of participants, so there was no separation by sex. The groups were not homogeneous in relation to the level of initial physical activity, which may have limited the analysis of the results. New studies can be proposed by evaluating the difference between sexes and also between groups with the same level of initial physical activity. There is still a need for advances in this field to improve the application of EXG as an alternative practice of physical activity. Considering the encouragement of the National Policy for Health Promotion to corporal practices / physical activity, playful practices, aimed at the whole population and especially for university students, it is believed that the EXGs program can contribute positively to the overall health of this group. The protocol of 11 weeks of training showed positive results with improvement in HRV indices that demonstrate parasympathetic influence, which may reflect benefits to cardiovascular health.

Acknowledgments: This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES).

REFERENCES

Aeschbacher, S., Bossard, M., Ruperti-Repilado, FJ. et al. 2016. Healthy lifestyle and heart rate variability in young adults. *European Journal of Preventive Cardiology*. 23, 1, pp.1037-1044.

Almeida, MB., Araújo, CGS. 2003. Efeitos do treinamento aeróbico sobre a freqüência cardíaca. RevBrasMed Esporte. 9, 2, pp.104-12.

Alves, LAA., Oliveira, JB., Alves, RL. et al. 2015. Comparação da modulação autonômica cardíaca durante esforço de fumantes e não fumantes. RevBrasMed Esporte. 21, 6, pp.462-466.

Anaruma, CP., Ferreira, M Jr., Sponton, CH. et al. 2016. Heart rate variability and plasma biomarkers in patients with type 1 diabetes mellitus: Effect of a bout of aerobic exercise. *Diabetes Res ClinPract.* 111, pp.19-27.

Barry, G., Tough, D., Sheerin, P.et al. 2016. Assessing the physiological cost of active videogames (Xbox kinect) versus sedentary videogames in young healthy males. Games Health J. 5, 1, pp.68-74.

Belmiro, WO., Preto, W., Vinicius, MA. (2011) A Utilização do Exergame na Área da Saúde. Faculdade de Educação Física de Sorocaba, Sorocaba.

Brito-Gomes, JL., Perrier-Melo, RJ., Wikstrom, EAs. et al. 2015. Improving aerobic capacity through active videogames: A randomized controlled trial. Motriz: *Revista de Educação Física.* 21, 3 , pp.305-311.

Buchheit, M., Gindre, C. 2006. Cardiac parasympathetic regulation: respective associations with cardiorespiratory fitness and training load. *Am J Physiol Heart Circ Physiol.* 291, 1, pp.H451–8.

CDC (National Center for Chronic Disease Prevention and Health Promotion) 1999. Physical Activity and Health: A report of the surgeon general. Disponível online em: http://www.cdc.gov/nccdphp/sgr/chapcon.htm.

Eisenmann, JC., Wickel, EE., Welk, GJ. *et al.* 2005. Relationship between adolescent fitness and fatness and cardiovascular disease risk factors in adulthood: The Aerobics Center Longitudinal Study (ACLS). Am Heart J. 149, 1, pp.46-53.

Farah BQ, Prado WL, Tenório TR, Ritti-Dias RM.Heart rate variability and its relationship with central and general obesity in obese normotensive adolescents. Einstein (Sao Paulo). 2013;11(3):285-290.

Giles, D., Drapper, N., Neil, W. 2016. Validity of the Polar V800 heart rate monitor to measure RR intervals at rest. Eur J Appl Physiol. 116, pp.563–571.

Goff, DC Jr., Lloyd-Jones, DM., Bennett, G. *et al*. 2014. 2013 ACC/AHA guideline on the assessment of cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation. 24,129, 25 Suppl 2, pp.S49-73.

Grant, CC., Viljoen, M., Janse van Rensburg, DC. *et al.* 2012 Heart rate variability assessment of the effect of physical training on autonomic cardiac control. *Ann Noninvasive Electrocardiol.* 17, 3, pp.219-29.

Grundy, SM., Pasternak, R., Greenland, P. et al. 1999. Assessment of cardiovascular risk by use of multiple-risk-factor assessment equations: A statement for healthcare professionals from the American Heart Association and the American College of Cardiology. *Circulation.*100, 13, pp.1481-1492.

Hiraga, CY., Tonello, MGM., Pellegrini, AM. 2017 Contribution of Virtual Reality (Nintendo Wii) for Exercise Training and Rehabilitation. In: Barbieri F, Vitório R. (eds) Locomotion and Posture in Older Adults. Springer, Cham pp.371-384.

Jurca, R., Church, TS., Morss, GM. et al. 2004. Eight weeks of moderate-intensity exercise training increases heart rate variability in sedentary postmenopausal women. *American heart journal*. 147, 5, pp.8-15.

Kawaguchi, LYA., Nascimento, ACP., Lima, MS. et al. 2007. Caracterização da variabilidade da freqüência cardíaca e sensibilidade do barorreflexo em indivíduos sedentários e atletas do sexo masculino. *RevBrasMed Esporte*. 13, 4, pp.231-6.

Lha, PV., Bernardi, G. 2011. O vídeo-game como atividade motivadora na aula de educação física. RevistaBiomotriz. 5, 1, pp.266-279.

Lin, JH. 2015. “Just Dance”: The effects of exergame feedback and controller use on physical activity and psychological outcomes. *Games for health journal.* 4, 3, pp.183-189.

Matsudo, S., Araújo, T., Matsudo, V. *et al.* 2012. Questionário Internacional De Atividade Física (Ipaq): Estudo de Validade e Reprodutibilidade No Brasil.Revista Brasileira de Atividade Física & Saúde. 6, 2, pp.5-18.

Moura, LR., Torres, LM., Cadete, MMM. et al. 2018. Fatores associados aos comportamentos de risco à saúde entre adolescentes brasileiros: uma revisão integrativa. Rev. esc. enferm. USP. 52, pp.e03304.

Nakamura, M., Hayashi, K., Aizawa, K. et al. 2013. Effects of regular aerobic exercise on post-exercise vagal reactivation in young female. *Eur J Sport Sci.* 13, 6, pp.674-80.

Ochoa, C. 2015. Amostragem não probabilística: Amostra por conveniência. Disponívelonline em: https://www.netquest.com/blog/br/blog/br/amostra-conveniencia.

Paschoal, MA.,Volanti, VM., Pires, CS. et al. 2006. Variabilidade de frequência cardíaca em diferentes faixas etárias. *Rev Bras Fisioter.* 10, 4, pp.413-419.

Peng, W., Lin, JH., Crouse, J. 2011. Is playing exergames really exercising? A meta-analysis of energy expenditure in active video games. Cyberpsychology, Behavior, and Social Networking. 14, 11, pp.681-688.

Pereira, FC. 2016. Exergames: Fator motivacional para a prática de atividades físicas. Rio Claro (SP). Mestrado em Desenvolvimento Humano e Tecnologias. Universidade Estadual Paulista, São Paulo (SP) Brasil.

Reis, JRG., Neiva, CM., Filho, DMP. et al. 2017. Virtual Reality Therapy: motor coordination and balance analysis in children and teenagers with Down syndrome. European Journal of Human Movement.38, pp.53-67.

Sala, R., Malacarne, M., Pagani, M. et al. 2015. Evidence of increased cardiac parasympathetic drive in subjects meeting current physical activity recommendations. *Clinical Autonomic Research.* 25, 5, pp.285-291.

Shoji, VM., Forjas CLM. 2000. Treinamento Físico na Hipertensão Arterial. *Rev. Soc. Cardiol. Estado de São Paulo.* 10, 6, pp.7-14.

Silva Neto, VM. 2017. Influência do nível (estado ou prática regular) de atividade física sobre a recuperação autonômica cardíaca após sessão aguda de exercício físico em diabéticos tipo 2. Mestrado em Educação Física. Universidade Federal do Triângulo Mineiro, Uberaba (MG) Brasil.

Simão, AF., Precoma, DB., Andrade, JP. *et al.* 2013. I Diretriz Brasileira de Prevenção Cardiovascular. Arq. Bras. Cardiol. 101, 6 supl 2, pp.1-63.

Sloan, RP., Shapiro, PA., DeMeersman, RE. *et al*. 2009. The effect of aerobic training and cardiac autonomic regulation in young adults. Am J Public Health.99, 5, pp.921–928.

Smallwood, SR., Morris, MM., Fallows, SJ. *et al.* 2012. Physiologic responses and energy expenditure of Kinect active video game play in schoolchildren. *Arch Pediatr Adolesc Med.* 166, 11, pp.1005–9.

Smeltzer, SC., Bare BG. 2006. Brunner & Suddarth: Tratado de Enfermagem Médico-Cirúrgica, 10nd ed, Rio de Janeiro, Guanabara Koogan.

Staiano, AE., Beyl, RA., Hsia, DS. et al. 2016. Twelve weeks of dance exergaming in overweight and obese adolescent girls: Transfer effects on physical activity, screen time, and self-efficacy. *Journal of Sport and Health Science.* 6, 1, pp.04-10.

Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. 1996. Heart rate variability. Standards of measurement physiologic interpretation and clinical use. *Eurheart J.* 17, 3, pp.354-381.

Trevizani, GA., Benchimol-Barbosa, PB., Nadal, J. 2012. Efeitos da idade e da aptidão aeróbica na recuperação da frequência cardíaca em homens adultos. Arq Bras Cardiol.99, 3, pp.802-810.

Trout, J., Zamora, K. 2008. Dance Dance Revolution: A physiological look at an interactive arcade game. ICHPERD Jour Research.3, pp.67-72.

Vanderlei, LMP.,Pastre, CM., Hoshi, RA. *et al*. 2009. Noções básicas de variabilidade da frequência cardíaca e sua aplicabilidade clínica. *Rev Bras Cir Cardiovasc.* 24, 2, pp.205-217.

****