Journal of Exercise Physiologyonline

February 2019
Volume 22 Number 1

JEPonline

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

Influence of Resistance Training Practice on Autonomic Cardiac Control of Hypertensive Elderly Women

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ABSTRACT

Gambassi Bavaresco B, Schwingel PA, Mesquita F, Carnevali MP, de Oliveira D, Sotão SS, Alves CHL, Almeida FJF. Influence of Resistance Training Practice on Autonomic Cardiac Control of Hypertensive Elderly Women. **JEPonline** 2019;22(1):37-44. The purpose of this study was to investigate the influence of resistance training on autonomic cardiac control of hypertensive elderly women. The study sample consisted of 7 sedentary elderly women with controlled hypertension (age: 65.1 ± 3.5 yrs; systolic blood pressure: 129.1 ± 4.1 mmHg; and diastolic blood pressure: 84.4 ± 4.4 mmHg). Autonomic cardiac control before and after resistance training was evaluated by measuring heart rate variability. Twelve weeks of resistance training (2 wks with 3 sets of 15 reps [low intensity] + 10 wks with 3 sets of 8 reps [moderate intensity]) was performed 2 times·wk^{-1} with a 48-hr rest interval between each session. The results indicate that there were no significant improvements in the indexes rMSSD (P=0.295), NN50 (P=0.424), HF (P=0.733), and LF/HF ratio (P=0.309) in the hypertensive elderly women. The resistance training protocol applied in the present research was not effective in improving the autonomic cardiac control of the study population.

Key Words: Aging, Autonomic Nervous System, Exercise Training, Heart Rate Variability

INTRODUCTION

The aging process is normal and natural. It is related to structural and functional losses and, in particular, a decrease in lean muscle mass followed by a decrease in strength (14). In addition to these changes, there is a negative change in the aging individual's autonomic cardiac control (ACC) that results in an increase in sympathetic response and a decrease in the parasympathetic nervous system activity. These changes result in an increase in the risk of cardiac death.

In fact, according to Paschoal et al. (11), lower vagal modulation was observed in individuals between 51 and 60 yrs of age when compared with younger individuals. These alterations may be associated with lower sensitivity of muscarinic receptors, and/or with dysfunctions in the afferent and efferent neuronal activities of the solitary tract nucleus caused by the aging process.

In this sense, the negative changes of an aging individual's ACC are associated with the malfunctioning of the autonomic nervous system and a decrease in heart rate variability (HRV). This is a problem because the decrease in HRV is associated with an increase in the risk of cardiac death while a high HRV represents good ACC and functioning that is consistent with an individual's good health (12,13).

It has been shown by several studies (2,5,6,15,16) that the practice of aerobic and/or resistance training (RT) improves ACC in elderly adults. However, it appears that RT practice provides important autonomic benefits only in individuals with some disease (1,2,6,15,17). Hence, if that is the case, the purpose of this study was to investigate the influence of RT on ACC of hypertensive elderly women.

METHODS

Subjects

All participants signed an informed consent form after being properly informed about the study proposal, the procedures they would undergo, and their potential risks and benefits. The study was performed according to the Helsinki Declaration of 1975, as revised in 1983. All the procedures were approved by the Research Ethics Committee of the University Ceuma, São Luís, MA, Brazil. The inclusion criteria consisted of the following: (a) not using illicit drugs; (b) not using beta blockers (since this class of medications affects cardiovascular and autonomic response to exercise); (c) controlled hypertension; and (d) do not have any impairment in the skeletal-muscle system.

The sample consisted of 7 sedentary elderly women with controlled hypertension (mean ± SD, age: 65.1 ± 3.5 yrs; body mass index: 26.4 ± 2.4 $kg{\cdot}m^{-2}$; systolic blood pressure: 129.1 ± 4.1 mmHg; and diastolic blood pressure: 84.4 ± 4.4 mmHg).

Procedures

Data collection was performed by physical education undergraduate students from the Ceuma University. They had been previously trained by researchers and professors from the Physical Education Department at Ceuma University, Sao Luis, MA, Brazil.

At the first visit to the laboratory, the subjects were referred to the fitness facilities used in the research to get familiarized with the location of the experiments. From the 2nd to the 17th day, anthropometric measurements, ACC evaluation, and familiarization with the RT protocol were carried out. Since we found it difficult to have the elderly perform the 1 repetition maximum test due to being uncomfortable with it, we applied the protocol with certain repetitions controlling the subjective perception of effort.

Anthropometric Measurements
The subjects' total body mass in kilograms (kg) and height in centimeters (cm) were measured using an anthropometric scale (PL-200, Filizola S.A. Pesagem e Automação São Paulo, SP, Brazil), with an accuracy of 50 g and 0.1 cm following calibration (NBR ISO/IEC 17025:2005). Body mass index was determined by body mass (kg) divided by the square of subjects' height (m^2).

Autonomic Cardiac Control (ACC) Evaluation (Heart Rate Variability)
To obtain the subjects' beat-to-beat intervals (R-R interval), a electrocardiographic signal (protocol with three derivations) was used at a 600-Hz sample rate for a 20-min period in the supine position with a 30-degree head elevation. At the end of the examination, the series of R-R intervals was extracted in text format through a Kubios HRV Standard software for Windows (Kubios Oy, Kuopio, Finland, Release 3.1.0) to analyze time- and frequency-domain parameters of HRV.

The following variables were selected for time domain analyses: (a) RMSSD (square root of the mean squared differences between adjacent normal R-R intervals, expressed in ms); and (b) NN50 (number of pairs of adjacent R-R intervals differing by more than 50 ms, expressed in count units). Frequency domain analyses of HRV were performed using Fast Fourier Transform (FFT) in portions of 5 min with an interpolation of 4-Hz and 50% overlap. The following variables were selected: (a) high frequency (HF: 0.15 to 0.4 Hz – refers to parasympathetic modulation); and (b) high-frequency/low-frequency ratio (LF/HF is the ratio between low frequency/high frequency components). The LF/HF ratio was calculated based on normalized LF (LF nu) and HF (HF nu).

Resistance Training (RT) Program
The RT protocol proposed was previously described and explained in a detailed lecture for the subjects. The program of RT was performed 2 times·wk^{-1} with a 48-hr rest interval between each session for 12 wks. The first 2 wks consisted of 3 sets of 15 reps (low intensity). During the last 10 wks of RT, the subjects performed 3 sets of 8 reps (moderate intensity).

The RT protocol consisted of a 45-degree leg press (machine), seated row (machine), leg curl (machine), bench press (free weights), abduction (machine), push down (machine), adduction (machine), and biceps curl (free weights), alternated by segment, performed with a rest interval between sets and exercises of 2 min. All exercises were performed with full amplitude. The exercises were performed by isotonic contraction lasting 3 sec for the concentric phase and 3 sec for the eccentric phase (6 sec per repetition). Subjective perception of effort was used to control the training intensity before and after each set for all exercises. When necessary, the load adjustment was performed so that the subject performed the series with moderate effort according to subjective perception.

Statistical Analyses

The data were processed and analyzed using PRISM software (GraphPad Software Inc., San Diego, CA, USA, release 7.01, 2016). Initially, descriptive statistics were applied to the Shapiro-Wilk test. Continuous variables were expressed as mean and standard deviation (±SD) and paired-sample *t*-test compared baseline (pre-) with final (post) measurements. All statistical methods are two-tailed, P values were calculated, and statistical significance was set at $P \le 0.05$. The magnitude of the differences in variables was calculated from the effect size (3).

RESULTS

After 12 wks of the RT program, no significant positive differences were found for the HRV indexes rMSSD, NN50, HF, and LF/HF ratio (Table 1). In addition, small positive effect sizes were observed for NN50 (n) (d = 0.4), HF (nu) (d = 0.2), and LF/HF (d = 0.4). A medium effect size was identified for rMSSD (d = 0.6) (Table 2).

Table 1. Changes in Heart Rate Variability (HRV) in Baseline and After 12 wks of Resistance Training in Sedentary Elderly Women with Controlled Hypertension.

INDEXES	**BEFORE** (n = 7) Mean ± SD	**AFTER** (n = 7) Mean ± SD	**P-VALUE**
rMSSD (ms)	17.9 ± 9.8	24.2 ± 12.5	0.295
NN50 (n)	8.1 ± 17.4	14.6 ± 14.8	0.424
HF (nu)	124.7 ± 152.7	149.6 ± 116.1	0.733
LF/HF	1.1 ± 1.0	0.8 ± 0.4	0.309

SD = Standard Deviation of the Mean; **Rmssd** = Square Root of the Mean Squared Differences between Consecutive R-R Intervals; **NN50** = Number of Pairs of Adjacent RR Intervals Differing by More than 50 ms; **HF** = High Frequency; **LF/HF** = Ratio between Low and High Frequency Components.
*Significant difference between pre- and post-test results

Table 2. Comparison and Effect Size (ES) for Heart Rate Variability (HRV) Indexes Before and After 12 wks of Resistance Training in Sedentary Elderly Women with Controlled Hypertension.

INDEXES	BEFORE (n = 7) Mean ± SD	AFTER (n = 7) Δ
rMSSD (ms)	17.9 ± 9.8	6.3
ES		Medium
NN50 (n)	8.1 ± 17.4	6.5
ES		Small
HF (nu)	124.7 ± 152.7	24.9
ES		Small
LF/HF (nu/nu)	1.1 ± 1.0	-0.3
ES		Small

SD = Standard Deviation of the Mean; **Rmssd** = Square Root of the Mean Squared Differences between Consecutive R-R Intervals; **NN50** = Number of Pairs of Adjacent RR Intervals Differing by More than 50 ms; **HF** = High Frequency; **LF/HF** = Ratio between Low and High Frequency Components.

DISCUSSION

The main finding of this study was that there were no significant positive changes in ACC of the hypertensive elderly women after 12 wks of RT. Also, when comparing the pre- and post-training moments, there were no large effect sizes in any HRV index. Thus, we can affirm that the practice of the RT protocol used in the present study did not provide benefits for the variables investigated.

In agreement with our findings, Wanderley et al. (19) did not observe positive alterations of the RT practice on autonomic function of older adults with the following controlled conditions: (a) hypertension; and/or (b) diabetes. Additionally, Collier et al. (4) did not show improvement in ACC of 29 mild hypertensives after performing RT.

Furthermore, according to Kanegusuku et al. (10), the practice of progressive RT lasting 16 wks did not improve cardiovascular function or autonomic neural regulation of apparently healthy older adults. Similarly, Gerage et al. (9) did not find positive effects of RT (12 wks) on non-hypertensive elderly women HRV. Takahashil and colleagues (17) also did not observe improvement of the ACC of healthy older men after the accomplishment of 12 wks of RT.

In opposition to our findings, Caruso et al. (2) and Selig et al. (15) found benefits of RT on ACC in individuals with chronic heart failure and coronary artery disease patients, respectively. Additionally, Gambassi et al. (7) demonstrated that elderly women who engaged in RT had better autonomic control when compared to sedentary women. However, this is a cross-sectional study with small sample size. Additionally, in another study conducted by Gambassi et al. (8), they found benefits of the practice of RT on ACC, body composition, and muscle strength in healthy elderly women. Yet, interestingly, according to the authors, the reduction of body fat observed in the elderly may be responsible for the positive findings in the ACC.

In the same sense, in an elegant systematic review study with metanalysis, Bhati et al. (1), affirmed that probably the practice of RT has minimal effects on ACC of healthy individuals, and it results in positive cardiovascular adaptations in the autonomic control of diseased individuals. However, these authors recommend more high-quality randomized controlled trials with individuals who present autonomic dysfunction, in addition to performing animal studies with the purpose of investigating the mechanisms involved in the adaptations of RT practice on ACC.

Our hypothesis was that the effects of RT on HRV depend on how much ACC is committed (i.e., level of the impairment on autonomic parameters caused by chronic degenerative diseases) and how training variables will be manipulated. It may be that the application of an RT protocol without absolute rest intervals with the execution of alternating exercises by segment will cause positive adaptations about HRV. In this way the cardiovascular system will be stimulated frequently, and this may increase the sensitivity of the muscarinic receptors that improves the ACC. Without question, it is important that well controlled studies should be performed to confirm this explanation.

Limitations in this Study

Among the limitations of the present study are the absence of a control group, the lack of randomization, and the small sample size.

CONCLUSIONS

We conclude that the proposal of RT applied in the present research study was not effective in improving the ACC of hypertensive elderly women. It is necessary to carry out high quality randomized controlled trials with the purpose of investigating the effects of different protocols of dynamic RT on the autonomic parameters of healthy individuals and/or with different chronic degenerative diseases (e.g., diabetes and different classifications of hypertension).

ACKNOWLEDGMENTS

The authors are grateful to the volunteers who participated in this study.

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