

Cardiac Autonomic Modulation after 12 Weeks of Physical Exercise in Elder Women with Overweight and Obesity

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Abstract

Aim: To evaluate cardiac autonomic modulation after 12 weeks of physical exercise in elder women with overweight and obese.

Method: Nine elderly participating of extension project Movimento Ação classified with as overweight and obese. The elder women were submitted to physical evaluation (anamnesis, anthropometry, functional capacity test and heart rate on the electrocardiogram) in moments pre and post-intervention. The physical training program for a period of 12 weeks with a frequency of 3 times per week.

Results: A significant difference was observed in the variables RMSSD, 0V associated with sympathetic modulation, 1V associated with sympathetic and parasympathetic modulation, and 2LV two variations associated with parasympathetic modulation.

Conclusion: The exercise training of moderate to vigorous intensity performed for 12 weeks is capable of to influence positively the cardiac autonomic modulation in elder women with overweight and obese, as well as to reduce percent body fat mass and glycemia, and functional capacity improvements.

Keywords: Cardiac Autonomic Modulation; Elder Woman; Obesity; Physical Training

Introduction

The growth of the elderly population is a phenomenon proven worldwide and has generated the interest of the scientific community [1]. Data from the World Health Organization indicate that the elderly population will reach two billion in the year 2050. Brazil follows

this process very significantly, according to the Brazilian Institute of Geography and Statistics-IBGE, In the year 2030, the country will reach the sixth greater population of elderly people in the world with 40.5 million individuals in this age range, corresponding to 18.7% of the population [2].

This change in the demographic picture is being accompanied by an increasing in the incidence of chronic diseases, which besides affecting the life expectancy of the elderly, also generates conditions of dependence and low self-esteem [3]. The chronic diseases most frequently observed are cardiovascular pathology, cancer, musculoskeletal diseases, type 2 diabetes mellitus and obesity [4], which result in greater demands for public health services.

In parallel, the risk factors related to the elderly individual can be modified by the practice of regular physical exercises, whose benefits are well established in the literature, although there is still an expressive increase of inactive elderly people [5]. Studies indicate that about 60% of Brazilians are inactive, which contributes to the incidence of diseases and the reduction of life quality in the elderly person [3], increasing also the prevalence of obesity, characterized by an accumulation of body fat in the individual [6,7].

Thus, obesity has been classified as a global epidemic that covers all age groups and is responsible by the death of approximately 2.8 million individuals annually. In Brazil, data of 2013 showed that approximately one in four women and one in five men aged 65 to 74 years were obese [8].

Cardiovascular diseases are associated with autonomic alterations that include the reduction of the parasympathetic autonomic nervous system or the increase of the sympathetic autonomic nervous system [9]. It is already possible to detect the cardiac autonomic action by studying the variations of the intervals between R-waves peaks (RR intervals) related to the autonomic nervous system (ANS), thus constituting heart rate variability (HRV) [10]. Changes in heart rate variability are normal phenomena's that indicate the ability of the heart to respond to innumerable physiological as much as environmental stimuli [11].

Thereby, the decrease in HRV is related to a lower cardiovascular prognosis, characterizing inefficiency in the autonomic nervous system. On the other hand, a high HRV index indicates efficient autonomic devices [12]. So, the reduction of autonomic activity in the elderly results in low HRV levels, which consequently becomes a cardiovascular risk factor, especially when it is linked to other pathologies such as hyperglycemia, hypertension, dyslipidemias and obesity [13].

The combat and control of diseases such as obesity can stimulate the population in the search for healthier habits [14], enabling a regular practice of physical exercise that has been proven to be effective for the health-disease relationship [15]. Therefore, this study aims to evaluate cardiac autonomic modulation after 12 weeks of physical exercise in elder women with overweight and obesity.

Methods

Population and sample

The sample was composed for 9 elder women, with aged 60 years or older, participants of the Extension Project "MovimentAção" developed at the Nucleus of Studies and Research in Physical Activity (NEPAF-UFMA). This project aims to encourage the practice of physical exercises for maintenance of an active and healthy lifestyle in the elderly population of the city of Pinheiro-MA.

Inclusion criteria

Elderly women with age of 60 years or older, classified as overweight or obese, with controlled pathologies (hypertension and diabetes), inscribed in the "MovimentAção" Extension Project in the city of Pinheiro-MA, and which presented a significant capacity to respond to the questionnaires of the study, as well as to perform the tests proposed.

Exclusion criteria

Were exclude of the study the participants who did not present 85% of frequency in the activities, who did not perform in the physical assessment, or that presented some kind of heart failure, peripheral and autonomic neuropathy; physical problems, symptoms and/or

psychological diseases that could to unfeasible the application of questionnaires and/or the performance of the evaluative tests and the intervention activities proposed for this study.

Ethical aspects

The study protocol was submitted and approved by the Research Ethics Committee of the Federal University of Maranhão under the code (61856516.5.0000.5087), respecting all ethical and legal principles. The orientations and accompaniment of the participants in this research were performed for 12 weeks.

Study design

Prior to initiation of the study procedures the participants were verbally informed about all data collection procedures of the study, as well as their objectives. Upon the positive response to participate in the project, they were asked to sign the informed consent form.

Clinical, biochemical and anthropometric evaluations

The anamnesis was performed through of the collection of personal data, medical history, eating habits and the practice of physical exercise by the elderly. Posteriorly was performed analyze of fasting glycemia collected before and after the training program with the assistance of a portable glucose (Accu-Check Active) which followed the parameters recommended by the Brazilian Society of Diabetes- SBD and Brazilian Society of Endocrinology and Metabology-SBEM. Then classified:

- Normal glycemia: Value less or equal to 100 mg/dl;
- Tolerance to glucose decreased: Value superior to 100 mg/dl and less than 126 mg/dl;
- Diabetes Mellitus: Value superior to 126 mg/dl.

In the anthropometric evaluation, the weight was measured (using a digital scale relaxmedic your way-incolor on the kilogram scale), with the participant positioned barefoot in the center of the scale previously zeroed. The clothes used by the women attended the suggested demands of the research team. For the collection of data about height and Waist Circumference (WC) an anthropometric measuring tape (Travan-TR4013 - SANY mark) was used, where the subject was instructed to remain in the orthostatic position with the face turned forward, the upper limbs along of the body and hands in the supine position (facing forward) with the fingers extended pointed downwards. The WC was obtained between the iliac crest and the lateral costal border (midpoint between the hip and the last rib).

To determine the body mass index were used the weight and height variables in the formula: $\text{weight (Kg)}/\text{height (m}^2\text{)}$ [16]. To verify fat percentage, seven cutaneous folds (subscapular, mid-axillary, triceps, thigh, supra-iliac, abdomen and pectoral) were collected with the help of a plicometer (Sanny), following the protocol proposed [17].

Any anthropometric measure used in the assessment of the individuals have as aims to early identify the health risk, and the results composed the battery of evaluations of this study.

Functional capacity assessment

To analyze the functional capacity of the elderly was proposed the 6-minute walking test (6-MWT). This test is used to measure the individual's response to exercise, evaluating the respiratory, metabolic and cardiovascular systems. This test has a low cost, it is wide applicability and can be used in several groups of individuals [18]. Before starting the test, the participant remained in rest for a period of 10 minutes, immediately after the blood pressure was measured by the auscultatory method (hand stethoscope and sphygmomanometer Premium brand), the heart rate by a heart rate meter (Polar H-10), and perception of effort for the Borg scale scores.

The test was performed in the following way: two duly trained evaluators instructed the elderly women to walk the longest possible distance on a flat track, rectangular, and signalized for 6 minutes [19]. In the 6-MWT, the instruction is to walk as fast as possible and the

participant determines the walking speed [20]. The distance traveled for each voluntary was measured with a tape and then was performed another collection of blood pressure, heart rate, and effort perception scale. It is worth pointing out that all the elder women were instructed to discontinue the test if they experienced symptoms such as lower limb pain, tachycardia, or any other symptom of discomfort.

Heart rate variability (HRV)

A 12-lead electrocardiogram of the Win Cardio 6.1.1 was used to measure the heart rate variability (HRV). The participants were placed in the supine position for 10 minutes at rest, with spontaneous and normal respiratory rate (between 9 and 22 respiratory cycles per minute). The analysis was made through the following indices:

- **Time domain:** RR (the mean of RR intervals), SDNN (RR interval standard deviation) and RMSSD (square root of the mean to squares of the differences between the adjacent RR intervals) were obtained using the Kubios HRV software, version 2.0 (Kubios, Finland).
- **Frequency domain:** Was performed the Fast Fourier transform (FFT), which measures the low frequency (LF) band, high frequency (HF) band (absolute values of power (ms^2) and standard units (nu)), very low frequency (VLF) representing the sympathetic and vagal modulations, respectively, and also the LF/HF ratio [21].

The analysis of the HRV in the time domain expresses the results in unit time (milliseconds), measuring each normal RR interval (sinus beats) during a certain time interval, and thus based on statistical methods were calculated the translator indices of fluctuations in the duration of cardiac cycles [11].

Protocol of physical exercises

The intervention protocol was initiated aimed to promote health and physical exercise in the elderly. The protocol was organized and guided according to the recommendations of the World Health Organization (WHO, 2010) and the American College Sports Medicine (ACSM, 2009). The WHO warns that should be performed at least 150 minutes of moderate-intensity exercise or 75 minutes of vigorous-intensity per week. The ACSM (2009) and WHO (2010) recommend that the resisted exercises for the elderly population should include large muscle groups, ranging from 8 to 10 exercises. So, the intervention program was contemplated as follows:

- Aerobic and resistance exercises were performed with focus on resistance and muscular strength, flexibility, agility, balance and motor coordination. Low-cost equipment such as disposable plastic bottles filled with water to facilitate load measurement, ropes, cones, broomsticks, rubber bands, rubber balls, bows, and mats were also used.
- The sessions included: a) initial moment: Blood pressure monitoring performed during preheating and dynamics in group (15 minutes); b) moment of conditioning: containing aerobic exercises (dance, guided walking), cognitive exercises (perceptive games) and resistance exercise (resistance and muscular strength, flexibility, agility, balance, coordination and postural reorganization) (40 minutes), c) moment of cooling: with relaxation and stretching exercises (5 minutes).

Evaluations were made at the beginning of physical exercise interventions and after 18 weeks of training. Were performed three weekly sessions with duration of 60 minutes each.

Statistical analysis

BioEstat 5.0 software was used to analyze the data. To compare the initial and final values, normality test of Shapiro-Wilk followed by Student's t-test (paired) was performed, data are presented as mean \pm standard deviation. The value of $p < 0.05$ was considered statistically significant.

Results and Discussion

Table 1 shows the anthropometric, clinical and biochemical characteristics of the nine elder women with mean aged 68.25 ± 6.25 . It was observed 6 participants with hypertension, and 2 with diabetes, however both pathologies controlled by medication. Regarding the

variables: weight, body mass index (BMI), height, Waist circumference (WC), heart rate (HR), double product (DP), systolic blood pressure (SBP) and diastolic blood pressure (DBP) it was not observed significant difference. Nonetheless, a significant difference was observed only in the body fat mass (%fat) and fasting glycemia value.

	Pre - Exercise (n = 09)	Post - Exercise (n = 09)	p
Weight (Kg)	65.72 ± 7.86	64.91 ± 3.54	0.050
BMI (Kg/m ²)	28.78 ± 2.57	29.08 ± 2.33	0.054
Height (m)	1.51 ± 0.05	1.51 ± 0.08	0.230
Body Fat Mass (%)	22.76 ± 5.07	19.26 ± 0.38	0.037
WC (cm)	88.78 ± 6.51	88.56 ± 3.54	0.465
SBP (mm/Hg)	125 ± 11.95	121.25 ± 14.14	0.098
DBP (mm/Hg)	82.50 ± 7.07	80.00 ± 0.20	0.225
HR (bpm)	75.63 ± 11.37	71.89 ± 1.41	0.145
DP (mmHg/bpm)	9.5050 ± 1.8691	9.0116 ± 1.3435	0.084
Fasting glycemia (mg/dl)	102.44 ± 35.21	93.57 ± 36.17	0.007

Table 1: Anthropometrics, clinics and biochemistry variables of elder women with overweight and obesity participants. BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HR: Heart Rate; DP: Double Product; WC: Waist Circumference; (p < 0.05).

Table 2 presents the data collected in the functional capacity evaluation measuring the distance covered in the six-minute walk test. The elderly group presented a significant difference comparing the group values in moments pre and post 12 weeks of physical exercise performed three times a week.

	Pre - Exercise (n = 09)	Pre - Exercise (n = 09)	p
Distance (m)	359 ± 42.34	404.848 ± 50.31	0.004

Table 2: Six-Minute Walk Test of elder women with overweight and obesity participants. p < 0.05.

Table 3 presents the measurements of the time domain and symbolic analysis of heart rate variability in obese and overweight elder women. Significant differences were found in the variables RMSSD, 0V, and 2LV associated to the sympathetic and parasympathetic components, respectively.

The objective of this study was to evaluate the cardiac autonomic modulation after three months of physical exercises in elder women with overweight and obese. The main results indicate that the physical training protocol increased the variables in the time domain and symbolic analyzes indexes of the HRV as RMSSD with parasympathetic predominance, 2LV (%) with parasympathetic predominance, and 0V index (%) with representativeness in the sympathetic decrease in elder women with overweight and obesity.

These data confirm the hypothesis that physical exercise improves cardiac autonomic function in elder women with obese and overweight, and suggests a significant advantage in functional capacity, reduction of body fat and glycemic value. The results obtained on HRV corroborates with the study of Albinet., et al [22]. In this study, the author showed that after an aerobic exercises program of 12-week with sedentary elderly, it was an increase in the parameters of HRV, thus reinforcing the role of aerobic exercise as a cardiac protector.

	Pre - Exercise (n = 09)	Post - Exercise (n = 09)	p
Time Domain			
RR (ms)	931.41 ± 125.19	905.06 ± 122.28	0.467
SDNN (ms)	24.54 ± 10.73	38.23 ± 19.49	0.068
RMSSD (ms)	19.87 ± 4.67	26.72 ± 8.80	0.041
Symbolic Analysis			
0V (%)	24.41 ± 4.14	15.24 ± 7.38	0.035
1V (%)	55.39 ± 9.72	49.59 ± 10.85	0.100
2LV (%)	4.26 ± 12.02	11.52 ± 7.50	0.007
2UV (%)	15.83 ± 2.7	19.23 ± 4.06	0.372

Table 3: Heart rate variability (HRV) of elder women with overweight and obesity participants.

RR: Heart Beats Interval; SDNN: Standard Deviation of RR Intervals; RMSSD: Square root of squared mean of the differences between adjacent RR interval; 0V: Three equal symbols, associated with sympathetic modulation; 1V: Two identical and one different symbol associated with sympathetic and parasympathetic modulation; 2LV: Two similar variations associated with parasympathetic modulation; 2UV: Standard with two different variations (associated to vagal modulation); $p < 0.05$.

In this sense, the study of Jurca., *et al.* [23] showed that after eight weeks of moderate-intensity physical training influence on the increase in heart rate variability in sedentary postmenopausal women. Corroborating to this study [24] recruited 52 obese patients after gastric bypass surgery to performed 12 weeks of aerobic exercise. In this study, the authors observed improves in cardiac autonomic modulation and functional capacity [25] studied the effects in twelve weeks of aerobic and resistance exercises in obese elder women from East Asian countries. The results obtained by the authors showed that the elderly improve the indexes of heart rate variability and pulmonary function, as well as reduced the percentage of body fat mass and stress mental.

Nevertheless [26] performed a similar study submitted a group of elder women to a resistance-physical exercises program for a period of three months and frequency of two days per week. The authors concluded that the training had no significant effect on the autonomic parameters. Corroborating with the cited results [27] observed similar results using 16 weeks of a dynamic resistance training program in women with mean age between 65 to 74 years. After the protocol of training the authors did not find changes in relation to cardiac autonomic modulation, evaluated by heart rate variability in time and frequency domains.

In this sense, another factor that may influence the reduction of sympathovagal activity in women is menopause, due to the increase in body fat mass, blood pressure and lipid profile that are characteristics of this period. Thus, a study performed for [28] evaluating post-menopausal women, noticed a lower heart rate variability in the group with higher body mass index, body fat mass, systolic and diastolic blood pressure, as well an increase on the total cholesterol and triglycerides, and a decrease in the low-density lipoprotein. So, the physical training can be applied as a method of non-medicated treatment, because the modify of these variables may mediate the balance of cardiac autonomic modulation, and consequently to increase the heart rate variability [29].

Possibly these negative findings on HRV occurred due to low stimulation of physical training, so hindering modifications in the heart autonomic control. Saboul., *et al.* [30] confirm that HRV changes during exercise and recovery post-exercise occur according to the intensity and physiological impact of the exercise.

Our study observed a reduction in body fat mass percentage in elder women with overweight and obesity. Corroborating with our findings, study anterior performed with individuals’ practitioners of the modalities of swimming, water gymnastics, gymnastics or body-

building also observed reduction in percent body fat. In this study was performed the analysis of the predictive indices of body fat of the participants after 8 weeks of training, observing reduction in waist-hip ratio, confirming the role of the regular practice of physical exercises in the maintenance of health standards [31].

In this same perspective, the results of this study contribute to the of Brum., *et al.* [32] whose results suggest that the reduction of percent body fat associated to weight reduction results in a decrease in the leptin plasma levels, followed by a lower resistance to insulin, accompanied by a decrease in sympathetic nerve activity and blood pressure.

Ciolac and Guimarães [33] still studying the energy expenditure and reduction of the percent of body fat promoted by the physical exercise, found similar results to our study. In this sense, the authors showed the efficiency of an aerobic exercise program associated with resistance exercises in reduce of the percent of body fat and overweight. Thus, the physical exercise has proven to be an effective tool in reduction of percent body fat mass, where active individuals can achieve better results than those who do not perform any activity [34,35].

In the present study, we observed that there was a reduction in the glycemic values of the elderly in relation to the pre- and post-exercise program. Thus, during the muscular effort the consumption of glucose increases considerably. The hormones insulin and glucagon interfere in the supply of energy to the activated muscles, allowing that the insulin accelerate the entrance of glucose inside the cells, thus reducing the rate of blood glucose in the blood [36].

During the practice of physical exercise occurs the decrease of insulin and increase of production of glucose and oxygen to the skeletal muscle, so it is observed that the demand for glucose is proportional to intensity of effort, thus reducing the glycemic values after the exercise through insulin and GLUT4 receptors [37]. This effect can be observed in only a single exercise section [38].

Regarding the significant improvement in functional capacity observed in this study influenced by physical exercise practice [39] affirm that individuals who maintain an active rhythm of life, with practices of regular physical exercises will presents positive effects on functional capacity, due to the reduction of percent body fat, blood pressure, blood glucose, increased energy expenditure, muscle strength and cardiorespiratory capacity. Corroborating with this study [40] recruited a group of sedentary elder women with over the age of 60 years, who realized a physical exercise program for 16 weeks, in this study the authors observed that the time proposed of training was enough to promotes significant changes in physical aptitude of the elderly.

The control of the physiological variables during the exercise is realized by the cardiac autonomic nervous system, through the sympathetic and parasympathetic pathways. Thus, any cardiac autonomic dysfunction is associated with the heart rate variability, which exerts an important health indicator [41]. This leads us to believe that the physical exercise is an effective method in controlling of blood glucose.

Therefore, the information described in the literature, along with the results obtained in this study, corroborates to the finding that an 18-week physical exercise program in elder women with overweight and obesity promotes significant health effects. It is important highlight that in this study the regular practice of physical exercises promoted improvements in functional capacity and metabolism, as well as greater variability of heart rate independent of the physiological process of aging, characterized by the presence of chronic diseases and obesity.

Conclusion

The exercise training of moderate to vigorous intensity performed for 12 weeks is capable of to influence positively the cardiac autonomic modulation in elder women with overweight and obese, as well as to reduce percent body fat mass and glycemia, and functional capacity improvements.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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