Decrease in Blood Pressure, Body Mass Index and Glycemia after Aerobic Training in Elderly Women with Type 2 Diabetes

Luciana Zaranza Monteiro, Cássio Ricardo Vaz Fiani, Maria Cristina Foss de Freitas, Maria Lúcia Zanetti, Milton César Foss
Departamento de Clínica Médica - Divisão de Endocrinologia e Metabologia - Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo - USP; Escola de Enfermagem de Ribeirão Preto, Universidade de São Paulo - USP, São Paulo, SP - Brazil

Abstract

Background: The aging process is associated with the development of several diseases, which can be attenuated by the practice of physical activities. Aerobic training is an effective method to maintain and improve cardiovascular function. Additionally, it has a crucial role in the prevention and treatment of several chronic-degenerative diseases, especially diabetes mellitus.

Objective: To verify the effect of a 13-week aerobic training program on blood pressure (BP), body mass index (BMI) and glycemia levels in elderly women with type-2 diabetes mellitus (DM2).

Methods: Eleven sedentary elderly women with DM2, aged 61.0 ± 9.1 years, were submitted a 13-week aerobic training program, constituting group G2. Eleven controlled elderly women (aged 60.2 ± 6.8 years) were not submitted to the aerobic training, constituting the control group (G1). G1 attended educational lectures once a week, whereas G2 walked three times a week.

Results: Both groups presented a significant decrease in glycemia and diastolic blood pressure levels. No significant decreases in BMI were observed after the aerobic training in either group.

Conclusion: The 13-week aerobic training program was enough to promote significant decrease in the diastolic blood pressure and glycemia levels; therefore, this type of exercise training decreases the risk factors for cardiovascular and metabolic diseases. (Arq Bras Cardiol 2010; 95(5): 563-570)

Keywords: Hypertension/prevention and control; exercise; physical exercise; body mass index; aged; diabetes mellitus.

Introduction

Arterial hypertension (AH) and diabetes mellitus (DM) are two important public health problems in Brazil and due to their high prevalence, as well as acute and chronic complications, give origin to risk factors associated with cardiovascular diseases.

The aging process results in a tendency toward the decrease in functional autonomy, due to a reduction in muscle mass and strength, as well as in the cardiorespiratory capacity. The adequate prescription of physical activity seems to be able to ensure the maintenance of these qualities, prolonging functional independence and improving the quality of life of elderly patients. A sedentary lifestyle is more common among elderly individuals than in any other age range, which can contribute to the loss of functional independence at advanced ages.

Although physical exercises (PE) constitute an important factor to decrease the cardiovascular and all-cause morbimortality rates, there seems to be also additional and independent benefits of the regular practice of PE and the improvement in the aerobic condition, which emphasizes the importance of its increasingly more frequent practice.

One of the effects of PE practice is the decrease in the post-training blood pressure (BP) levels in comparison to the pre-training BP levels, with this decrease being more accentuated in hypertensive individuals, when compared to normotensive ones. Although there is abundant evidence demonstrating the beneficial effect of PE on AH, mainly aerobic exercises (AE), both acute and chronic, and, at a lower proportion, of resistance exercises, studies carried out in elderly individuals are relatively scarce.

Aerobic training is considered an effective means to maintain and improve cardiovascular function and, therefore, the physical fitness. Moreover, it has a fundamental role in the prevention and treatment of several chronic-degenerative diseases, especially diabetes mellitus, thus contributing to increase life expectancy and maintain functional independence.
Therefore, it is crucial to carry out studies to analyze the effects of aerobic training on elderly women with DM. Thus, the objective of the present study was to verify the effect of a 13-week aerobic training program on BP, body mass index (BMI) and glycemia levels on elderly women with type 2 DM.

**Methods**

The study was carried out between August and November 2004 and the data were collected on Mondays, Wednesdays and Fridays at the Sports Gymnasium of the Physical Education Sports and Recreation Center - CEFER of Universidade de São Paulo de Ribeirão Preto (USP-RP). Before the training, all the volunteers signed the Free and Informed Consent Form, which contained all the information on the procedures to be developed during the study. The study was approved by the Ethics Committee of the School of Nursing of Ribeirão Preto of Universidade de São Paulo-USP.

The sample was randomly selected and consisted of 22 elderly women followed at the Educational Center for Patients with Type 2 DM (DM2) of Universidade de São Paulo de Ribeirão Preto. Patients were aged > 60 years, had DM2, did not regularly practice physical exercises and presented capillary glycemia < 240 mg/dl, and were divided in two groups:

- **G1 (control group)** - comprised 11 elderly women who attended educational lectures once a week, which lasted two hours per session, totaling 13 weeks; and
- **G2 (aerobic group)** - experimental group comprising 11 elderly women submitted to the aerobic training program, three times a week, for 13 weeks; those with an attendance rate ≥ 5 sessions were selected.

As all patients belonged to the Nursing Educational Center for Patients with DM2, they followed the routine established by the Center, i.e., activities for all patients were interrupted during the month of December due to the holiday season. Thus, the study was carried out in 13 weeks, up to November 2004.

**Inclusion criteria**

Elderly female patients with DM2 that agreed to participate in the study and who, after clinical assessment, were considered eligible for the training by the assistant physician were included in the study. The clinical assessment consisted of the evaluation of the cardiovascular, metabolic and osteoarticular status. This evaluation determined whether the participants were eligible for the safe practice of physical activities.

The diagnosis of DM2 was established through clinical-laboratory criteria, according to the ones recommended by the Brazilian Society of Diabetes, which were obtained through the review of the patients’ medical files.

**Exclusion criteria**

The exclusion criteria included the patient’s refusal to participate, those with severe heart diseases, decompensated coronary and heart diseases, limiting peripheral neuropathies, osteoarticular lesions, extremity ulcers, severe dermatological lesions and proliferative retinopathy.

To define these criteria, we used data from the anamnesis, physical examination and complementary routine assessment of the Center.

**Used medications**

Of the 22 elderly women, 12 used anti-hypertensive drugs - 5 mg + diuretics - 1.5 mg (07 from G1 and 05 from G2) and 17 used oral hypoglycemiant drugs - 500 mg (09 from G1 and 08 from G2). The use of medication was not modified during the study period.

**Measurement of blood pressure, BMI and glycemia**

1. **Blood pressure (BP)**

The measurement of BP values was carried out by the indirect method, using cuffs with rubber bulbs, of which width was compatible with the brachial circumference of the participant (8, 12 and 15 cm wide), using a Dixtal 1710 oscillometric equipment, in the automatic operation mode, according to the IV Brazilian Guidelines on Arterial Hypertension.

The examiners placed individuals so that they were in a state of absolute rest for a period of 3 to 5 minutes, sitting on a chair with back support, relaxed legs, parallel feet and relaxed arms. Before measuring the BP, the examiner determined the maximum BP to be attributed to the sphygmomanometer, with the help of the second and third fingers positioned on the radial artery. The examiner then inflated the sphygmomanometer cuff until the pressure at which the individual’s pulse disappeared was identified.

The BP measurement was carried out with the sphygmomanometer placed on the right arm (the measurement was carried out in the left arm in patients submitted to catheterism) and the stethoscope placed on the brachial artery. When the patient presented bulky arm mass, the sphygmomanometer was placed on the forearm and the stethoscope was placed on the radial artery.

2. **BMI**

Weight (kg) was measured once using a portable Filizola digital scale with a maximum capacity of 150 kg and accurate to 0.1 kg. Height (cm) was measured once using an inextensible measuring tape. Body mass index (BMI) was determined as body weight (kg)/height (m)^2_. The BMI is used by the World Health Organization (WHO) to classify the nutritional status of adult and elderly individuals_. The WHO considers as normal a BMI up to 25 kg/m^2_ and overweight a BMI > 25 kg/m^2_.

3. **Capillary glycemia**

Capillary glycemia was assessed using a portable blood glucose meter (One Touch Ultra™, Johnson & Johnson). The participant sat on a chair and the skin of the finger used for the capillary glycemia measurement (lateral portion of the distal phalanx of the middle finger) was swabbed with a cotton swab embedded in alcohol at 70.0%. The examiner used a disposable lancet to puncture the finger and a drop of
blood was placed on the reagent strip inserted in the blood glucose meter.

Although extremely important, the glycated hemoglobin test was not carried out, as some patients were not enrolled at Hospital das Clínicas de RP.

Procedures

The protocol applied to G1 consisted of educational lectures attended once a week, which lasted two hours each, totaling 13 weeks. The lectures included the following subjects: healthy diet, arterial hypertension, chronic complications of diabetes, physical exercises and correct medication use. These educational lectures were given by the multiprofessional team (physical education professional, nurses, nutritionists and psychologists) of the Nursing Educational Center for Patients with DM2.

The protocol applied to G2 consisted firstly in measuring the maximum oxygen consumption (VO$_{2\text{max}}$), determined in an ergometric treadmill model ATL 10200 (Inbramed) and walking three times a week at an intensity determined as 60, 70 and 80.0% of the maximum heart rate (HR$_{\text{max}}$). The patients walked for 50 minutes at the CEFER and the heart rate was verified every two minutes. Initial and final BP and capillary glycemia were measured at each session. The VO$_{2\text{max}}$ test was carried out on the first and the last day of the training program. VO$_{2\text{max}}$ was measured using a Vista CPX system, Vacumed, 1996. This system allowed the measurement of O$_2$ and CO$_2$ of the expired air at every 30 seconds, using a mixing and analysis chamber, Oxygen Analyzer OM-11 and Carbon Dioxide analyzer LB-2 respectively and determining the expired-air volume using a fluxometer, Flow Transducer K-520.

G2 did not participate in the educational activities, although it was important for the elderly women. The fact that lived far from the Center and needed public transportation to get there was taken into account when deciding that this group would not be submitted to both procedures (aerobic training + educational lectures).

Statistical analysis

The statistical analysis was carried out using the Student’s t test and ANOVA. Analysis of variance (ANOVA) for repeated measures and post-hoc Tukey’s test were used to verify the difference between the groups. Values are expressed as means ± standard deviations. SAS software release 9.0 was used for all statistical analyses and the level of significance was set at p < 0.05.

Results

Tables 1 and 2 show the characteristics of G1 and G2. The sample consisted of 11 sedentary elderly women with DM2, whose mean age was 61.0 ± 9.1 years, weight was 73.1 ± 10.6 kg and height was 1.7 ± 0.1 m, who comprised the aerobic group (G2); and 11 elderly women, whose mean age was 60.2 ± 6.8 years, weight was 74.9 ± 18.3 kg and height was 1.6 ± 0.1 m, who comprised the control group (G1).

Regarding the VO$_{2\text{max}}$ of the elderly women in G2, we observed a significant difference (p<0.01) between the first (34.9 ± 8.9 ml.kg.min.$^{-1}$) and the last day of aerobic training (35.9 ± 9.2 ml.kg.min.$^{-1}$).

Chart 1 shows that there was no statistical difference between the basal and final BMI in G1 (p = 0.68) and G2 (p = 0.65). Chart 2 shows that there was a significant difference in G1 (p < 0.01) and G2 (p < 0.01) regarding the glycemia levels after the 13-week aerobic training program and educational lectures. These differences were significant between the basal and final glycemia levels in G1 and G2. Although G1 was not submitted to the aerobic training, we believe that the educational interventions were of utmost importance for the participants to improve glycemic control.

Table 1 - Characteristics of the Control Group (G1)

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DBP - diastolic blood pressure; SBP - systolic blood pressure.
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BMI - body mass index; DBP - diastolic blood pressure; SBP - systolic blood pressure.

Charts 3 and 4 depict the effects of the 13-week intervention period on BP, showing that both G1 and G2 attained decreases in SBP and DBP. Although these decreases were verified, we did not observe a significant difference in BP between the aerobic group and the control group (F = 1.74 and Sig = 0.174). As for the DBP, we observed a significant difference in G2, which presented a significant decrease in basal and final DBP (p < 0.01). G2 presented a 27.0% decrease in the final DBP.

We observed that educational interventions are also extremely important to obtain the improvement of BP control in diabetic patients.

Discussion

The study results demonstrated that a 13-week aerobic training program is capable of promoting significant reductions in glycemia and BP levels in elderly diabetic women.

Some limitations to the present study must be considered. The small sample size somewhat impaired the analysis of the data, but only these met the inclusion criteria. This number is explained by the fact that the participants lived far from research site and needed public transportation to get there.

In our study, we observed that the elderly women presented an increase in VO\text{2max} after the 13-week aerobic training program.

With the objective of evaluating the effectiveness of a physical exercise program (PEP) in sedentary individuals, a study observed a significant increase in VO\text{2max} in a group of 22 individuals that trained three times a week, with sessions lasting 50 minutes at intensity of 60.0%-75.0% of VO\text{2max}.

Arq Bras Cardiol 2010; 95(5): 563-570
Such data corroborate the findings of other authors\textsuperscript{18-20} and, according to Monteiro\textsuperscript{18}, the mechanisms related to the decrease in BP are associated with hemodynamic, humoral and neural factors.

Stathokostas et al\textsuperscript{21} verified that the VO\textsubscript{2max} decreases with age, although women present a lower decline rate. Tjonna et al\textsuperscript{22} studied 32 individuals with metabolic syndrome and observed that, after a 16-week aerobic training program at moderate intensity, three times a week, these individuals presented a significant decrease in VO\textsubscript{2max}.

We know that moderate-intensity aerobic activity (such as walking), for at least 30 minutes 3-5 times a week results in benefits to cardiovascular health.

A study by Conte et al\textsuperscript{23} verified that elderly women presented a decreased or average VO\textsubscript{2max} and that these women have a 9.84-fold higher risk of presenting obesity than women with elevated VO\textsubscript{2max}.

Overweight individuals have 180.0\% higher chance of developing arterial hypertension and 1,000\% higher chance of developing insulin resistance than individuals with...
normal weight, which shows a direct association between BMI and BP

The BMI of the study group was improved, which was assessed by the decrease in the post-training values. Pratley et al. demonstrated that the aerobic training decreases the amount of body fat in elderly individuals, which can mediate some metabolic effects of the aerobic physical exercise, mainly due to the fact that excess of abdominal fat is associated with insulin resistance and hyperinsulinemia.

Our data are in agreement with those of other studies, which also observed a decrease in BMI after a physical training program.

In another study, we verified that the authors did not find significant differences in BMI values of diabetic individuals submitted to a physical exercise training program. Tjonna et al. studied 32 individuals with metabolic syndrome and observed that such individuals, after a 16-week aerobic training program at moderate intensity, presented a decrease in BMI, although it was not significant.

Other studies have demonstrated that the aerobic training decreases body mass in diabetic individuals. Most of these studies, in addition to the intervention through physical activity, associated a controlled diet for the patients.

We must consider that the physical exercise, even without a significant loss in body weight, improves the metabolic profile and has an anti-inflammatory effect on patients with DM2.

In our study, we observed that the elderly women presented significant decreases in glycemia, with the control group being 22% higher than the aerobic group at basal glycemia and presenting a 27% decrease in the final glycemia. Duarte and Martins reported that significant decreases in fasting glycemia were demonstrated in the first three months of training; after this period, the decreases in this variable did not present a significant difference until the end of the training program, which lasted 9 months.

The decrease in capillary glycemia, immediately after the physical exercise session, indicated the acute effect of the exercise. A lower capillary glycemia variation could be detected after the physical exercise in diabetic patients; however, this variation was not statistically significant.

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The association between fasting glycemia levels and the physical exercise programs is controversial.

A recent study showed that the fasting glycemia increased within 24-72 hours after a physical exercise session (60.0% of VO2 max, with a one-hour duration, three times a week). In this program, the patients were being treated with diet and oral medications. The decrease in BP levels after an aerobic exercise session confirms the results obtained by other authors that also demonstrated post-exercise hypotension.

The systolic and diastolic blood pressures did not show any statistically significant differences in the group submitted to the aerobic exercise training three times a week. In the group submitted to an exercise program 5 times a week, there was tendency toward a decrease in the SBP and DBP. AH is one of the main risk factors for the establishment and progression of chronic complications of DM2. One of the mainstays of the hypertension treatment in diabetic patients is physical exercise, which has a positive influence on BP decrease in patients with DM2.

The effect of physical exercise on resting BP levels of mild to moderate degree is especially important, as the hypertensive patient can decrease the anti-hypertensive medication dose or even have the AH controlled without...
the necessity of pharmacological therapy\(^{18}\). The tendency to use pharmacological agents at an early stage has been substituted by non-pharmacological approaches, and among them, aerobic physical exercises have been recommended for the treatment of mild systemic arterial hypertension\(^{18}\).

More recently, Takata et al\(^{19}\) submitted 207 individuals with essential hypertension grade 1 and 2 to an 8-week physical exercise program. The patients were divided in 5 groups, based on the duration and frequency per week of exercise training (control group - sedentary, 30 to 60 minutes/week, 61 to 90, 91 to 120 and > 120 minutes/week). They verified that the resting DBP did not change in the control group. However, there was a significant decrease in the resting systolic and diastolic BP in the 4 groups submitted to the exercise program. The magnitude of the decrease in the systolic BP was higher in the group that exercised 60 to 90 minutes/week, when compared with the group that exercised 30 to 60 minutes/week. A higher decrease was not associated with the increase in exercise volume. The magnitude of the decrease in the diastolic BP was not significantly different in the four groups.

### References


25. Pratley RE, Hagberg JM, Dengel DR, Rogus EM, Muller DC, Goldberg AP. Aerobic exercise training induced reductions in abdominal fat and glucose

### Conclusion

The results of the present study add knowledge to the scientific literature, by demonstrating that diabetic individuals can improve their metabolic control, blood pressure and anthropometric parameters through the practice of aerobic exercises performed just three times a week. Other benefits for elderly diabetic women that practice physical activities have been demonstrated in the literature, supporting the idea that the physical activity must be encouraged since childhood.

### Potential Conflict of Interest

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

### Sources of Funding

There were no external funding sources for this study.

### Study Association

This study is not associated with any post-graduation program.


