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EFFECTS OF PHYSICAL EXERCISE ON CARDIOVASCULAR RISK FACTORS IN HYPERTENSIVE OLDER ADULTS

Efeitos de exercícios físicos sobre fatores de risco cardiovascular em idosos hipertensos

Efectos de los ejercicios físicos en los factores de riesgo cardiovascular de mayores hipertensos

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ABSTRACT

Objective: To assess the effects of an exercise program on the reduction of cardiovascular risk factors in sedentary hypertensive older adults. **Methods:** This is a nonrandomized clinical trial carried out in a physical therapy teaching clinic in São Paulo in 2016 with a sample of 34 older adults who performed a ninety-minute exercise program twice a week for three months. The analyzed variables were: blood pressure, body mass index, cholesterol fractions, total cholesterol and triglycerides. Data were compared in two stages, before and after the exercise program, with $p<0.0001$ in all cases using the Wilcoxon test. **Results:** The median age of the participants (interquartile range) was 63 (61-66) years, with 25 (74%) women. After three months, there was a statistically significant reduction in weight, body mass index, systolic (SBP) and diastolic blood pressure (DBP) in the analyzed older adults ($p<0.0001$ in all cases). **Conclusion:** The exercise program was effective in reducing cardiovascular risk factors in the sedentary hypertensive older adults analyzed.

Descriptors: Cardiovascular diseases; Hypertension; Exercise; Aged.

Brazilian Clinical Trials Registry: RBR-4nn8j5

RESUMO

Objetivo: *Avaliar os efeitos de um programa de exercícios na redução dos fatores de risco cardiovascular em idosos sedentários e hipertensos.* ***Métodos:*** *Trata-se de ensaio clínico não randomizado, realizado em uma clínica escola de fisioterapia em São Paulo, em 2016, com amostra de 34 idosos que realizaram um programa de exercícios de noventa minutos, duas vezes por semana, durante o período de três meses. As variáveis avaliadas foram: pressão arterial, índice de massa corporal, frações de colesterol, colesterol total e triglicérides. Houve comparação dos dados em dois momentos, antes do início e ao término do programa de exercícios, considerando-se $p<0,0001$ em todos os casos pelo teste de Wilcoxon.* ***Resultados:*** *Encontrou-se idade mediana dos avaliados (intervalo interquartis) de 63 (61-66) anos, sendo 25 (74%) do sexo feminino. Após três meses, houve redução estatisticamente significativa do peso, índice de massa corpórea, pressão arterial sistólica (PAS) e diastólica (PAD) dos idosos avaliados ($p < 0,0001$ em todos os casos).* ***Conclusão:*** *O efeito do programa de exercícios foi eficaz na redução dos fatores de risco cardiovascular dos idosos sedentários e hipertensos estudados.*

Descritores: *Doenças Cardiovasculares; Hipertensão Arterial; Exercício; Idoso.*

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RESUMEN

Objetivo: *Evaluar los efectos de un programa de ejercicios para la disminución de los factores de riesgo cardiovascular de mayores sedentarios e hipertensos.* ***Métodos:*** *Se trata de un ensayo clínico no randomizado realizado en una clínica escuela de fisioterapia de São Paulo, en 2016, con una muestra de 34 mayores que realizaron un programa de ejercicios de noventa minutos, dos veces a la semana durante el período de tres meses. Las variables evaluadas fueron: la presión arterial, el índice de masa corporal, las fracciones de colesterol, el colesterol total y los triglicéridos. La comparación de los datos se dio en dos momentos: antes del inicio y al final del programa de ejercicios con p<0,0001 para todos los casos a través del test de Wilcoxon.* ***Resultados:*** *La edad mediana de los evaluados (intervalo intercuartil) fue de 63 (61-66) años y 25 (74%) años para el sexo femenino. Tras tres meses hubo reducción estadísticamente significativa del peso, el índice de masa corporal y la presión arterial sistólica (PAS) y diastólica (PAD) de los mayores evaluados (p < 0,0001 para todos los casos).* ***Conclusión:*** *El efecto del programa de ejercicios ha sido eficaz para la reducción de los factores de riesgo cardiovascular de los mayores sedentarios e hipertensos estudiados.*

Descriptores: *Enfermedades Cardiovasculares; Hipertensión; Ejercicio; Anciano.*

INTRODUCTION

Cardiovascular diseases (CVDs) are part of a group called noncommunicable diseases (NCDs), the most common being cardiac ischemia, stroke and peripheral artery disease (PAD)[1-3]. Today, they represent a threat to health and are a constant target of public health policies worldwide due to the associated morbidities. They cause a significant reduction in productivity, disability, adverse effects on quality of life, direct material costs to patients and their families, and a significant financial impact on the health system[1,3].

Physical exercise programs are an important strategy for the prevention and treatment of CVDs[2,4]. They are non-drug therapies that directly act on the associated risk factors, such as systemic arterial hypertension (SAH), obesity, dyslipidemia and diabetes mellitus (DM)[4]. Regular physical activity can significantly reduce the risk of cardiovascular mortality by up to 60%. However, the prescription should take into account the assessment of the overall cardiovascular risk, social conditions and interests of the patient in order to promote good adherence to changes in lifestyle[5].

SAH is an important risk factor for the occurrence of cardiac events. It is a multifactorial clinical condition characterized by elevated and sustained levels of blood pressure (BP), which can cause damage to vital organs such as the brain, heart and kidneys, and high prevalence rates in both developed and developing[2,5,6]. It is estimated that there are one billion hypertensive people in the world: 24-29% of economically active adults in the US and 22-44% in Brazil. SAH has been one of the major public health problems nowadays because it is directly related to CVDs and their sequelae[1,5].

The important protective effect of aerobic exercises against cardiovascular events should be highlighted[7]. A reduction of only 3 mmHg in systolic blood pressure (SBP) may represent a decrease of 5-9% and 8-14% in the risk of cardiovascular diseases and acute myocardial infarction (AMI), respectively. This effect can be observed after aerobic exercises of low, moderate and high intensity, but it is significant only if it remains during the subsequent 24 hours. A single session of aerobic exercise produces post-exercise hypotension associated with sustained vasodilation[8]. Thus, physical exercise is even more relevant to prehypertensive individuals.

According to the I Cardiovascular Prevention Guide[7], at least 30 minutes per day of moderate-intensity exercise five times a week is recommended for individuals with or without SAH. For many inactive older adults, it can be difficult to become active and meet the current recommendation, with lack of motivation being the main issue involved.

The aging process has received great attention worldwide and many actions have been targeted at older adults to encourage engagement in regular physical activity to reduce the effects of chronic and degenerative diseases and improve quality of life[9,10]. Social programs that are intended for this population mainly offer aerobic exercises, such as walking or water aerobics, and are often recommended as an important way to ameliorate dysfunctions such as SAH[10]. Aerobic exercises, circuits, water exercises, flexibility training and relaxation techniques are non-drug methods used to control cardiovascular risk factors[11,12] in older adults with or without excess weight[13]. In hypertensive older patients, adequate exercise prescription (in relation to type, intensity, duration and recovery intervals) may contribute to encourage, motivate and promote patient adherence[9,11].

SAH is associated with increased abdominal adiposity, accounting for 65% to 75% of cases of primary hypertension[12]. Chronically, these conditions lead to more severe conditions such as the development of difficult-to-treat SAH, insulin resistance, DM, target organ damage, such as kidney failure (KF), PAD, and increased chances of stroke and AMI[3-5]. Such conditions lead to health systems to spend more[12,13] and often require the use of multiple drugs and the treatment of other risk factors, including dyslipidemia[12].

Thus, programs to encourage regular physical activity are important resources in the fight against overweight and abdominal adiposity, promoting an increase in energy expenditure, both acutely during its performance and chronically due to changes in the resting metabolic rate (RMR) deriving from changes in body composition[14].

Some of the risk factors for the onset of CVDs are dyslipidemias, which are disorders of lipid metabolism with repercussions on the levels of lipoproteins in the blood. High levels of triglycerides (TG) and low-density lipoprotein (LDL-cholesterol), associated with low levels of high-density lipoprotein (HDL-cholesterol) in the blood, are often related to abdominal obesity[15].

Cardiovascular diseases and associated risk factors are public health problems that require the implementation of health promotion actions[1,3]. It is a way of empowering the community and improving its participation in the process of improving quality of life, which is described by the World Health Organization (WHO) as a state of complete physical, mental and social well-being, with emphasis on personal aspects and physical abilities, and not merely on the absence of disease[16,17].

Given that, the present study aimed to assess the effects of an exercise program on the reduction of cardiovascular risk factors in sedentary hypertensive older adults.

METHODS

This is a clinical trial with a sample of 34 older patients who were previously sedentary for at least one year, hypertensive on antihypertensive drugs, and authorized by a physician to engage in mild- to moderate-intensity physical exercise.

The concept of older adult was defined according to the chronological age of the individual, i.e., an older adult is anyone who is 60 years old or older in developing countries[18,19]. It should be noted that there was no control group or randomization in this study and all the patients attending the Physical Therapy Clinic of the Santo Amaro University (*Universidade Santo Amaro – UNISA*) and who agreed to participate in the study were included.

The patients were selected in March 2016 from a list of electronic database of the Physical Therapy Clinic of the Santo Amaro University Campus I located in the city of São Paulo, São Paulo, Brazil. The initial diagnosis of systemic arterial hypertension was determined by checking the patients' medical charts. Older adults who were interested in participating and who met the inclusion criteria in this study attended the Campus I of UNISA to sign the Free Informed Consent Form. Patients underwent a consultation with a collaborating physician and those who were authorized were checked by the physical therapist responsible for the study for the collecti1on of anthropometric data and resting blood pressure measurement.

Initially, 54 patients were selected. All of them were informed that their attendance would be monitored through roll calls and that those who exceeded the number of absences would be automatically excluded from the program. The total number of absences allowed was 25%, with a maximum of two absences in a single month. Of the 54 patients selected at the beginning of this protocol, 20 did not complete the program because of personal problems or because they exceeded the limit of absences; thus, 34 older adults participated in the study.

Blood pressure was measured using a digital sphygmomanometer approved by INMETRO with the patient in the sitting position and at rest for a minimum of five minutes and arm on a table. Reference values for the classification of systemic arterial hypertension were those recommended by the VII Brazilian Guidelines on Hypertension[20].

For the calculation of the body mass index (BMI), weight and height were measured using a calibrated mechanical anthropometric scale (Welmy®). The BMI reference values for older adults were in accordance with the 2016 Brazilian Guidelines on Obesity[21], which are accepted by the Ministry of Health.

Waist circumference (WC) was measured with the abdomen relaxed and the measuring tape positioned at the midpoint between the lowest rib and the iliac crest according to recommendations of the Brazilian Guidelines on the Diagnosis and Treatment of Metabolic Syndrome[22]. The AC cut-off values considered as increased cardiovascular risk were in accordance with the I Cardiovascular Prevention Guide[7], the Brazilian Guidelines on Dyslipidemias and Prevention of Atherosclerosis[23] and the 2016 Brazilian Guidelines on Obesity[21].

The older adults were sent for lipid profile tests and received information about the procedures necessary for the tests with a 12-hour fasting, as recommended by the Outpatient Clinic of the University. The parameters adopted by the V Brazilian Guidelines on Dyslipidemias and Prevention of Atherosclerosis were used for the biochemical classification of fasting glucose and lipid profile tests[23]. Other questionnaires were used in interviews to assess smoking, occurrence of previous cardiovascular event and use of medications.

After three months of physical exercise, all the older adults repeated laboratory tests of fasting blood glucose and lipid profile and were again submitted to resting blood pressure and anthropometric measurements, which were performed by the same examiner at both moments. Table I exhibits the reference standards used for anthropometric data.

Table I - Reference standards used for anthropometric data. São Paulo, Brazil, 2017.

Variables	Reference Standard		
	Normal / Ideal (%)	Borderline (%)	Altered (%)
BMI[*] (Kg/m²)	> 22 e < 27		≥ 27
Waist circumference (cm)	< 90 M < 80 W		≥ 90 M ≥ 80 W
Total cholesterol (mg/mL)	< 200	200 - 239	≥ 240
LDL-C[**] (mg/dL)	< 130	130 -159	≥ 160
HDL-C[***] (mg/dL)	> 60		< 40
Triglycerides (mg/dL)	< 150	150 - 199	≥ 200
Fasting glucose (mg/dL)	≤ 99	100 - 125	≥ 126
Systolic blood pressure (mmHg)	≤ 120	121 - 139	≥ 140
Diastolic blood pressure (mmHg)	≤ 80	81- 89	≥ 90

M: Man; W: Woman; [*] Body Mass Index; [**] Low-density lipoprotein; [***] High-density lipoprotein

The exercise protocol was applied between April and June 2016. The older adults were divided into two groups for a better organization of the exercises, which took place twice a week in the afternoon in the Santo Amaro University Campus 1 and lasted approximately ninety minutes per day in each group. The program consisted of thirty minutes of initial walking, thirty minutes of a circuit workout with free active exercises for upper limbs and trunk, and thirty minutes of final walking. The circuit consisted of five movements performed for one minute each, repeating six sets: trunk flexion, shoulder flexion, shoulder extension, shoulder horizontal abduction, and spinal lateral flexion. The selection of this protocol was based on data from the literature on the benefits of aerobic exercise, such as walking, to reduce hypertension[2-4] and to control other cardiovascular risk factors, such as obesity, hyperlipidemia and hyperglycemia[14,15]. The circuit included free exercises for the upper limbs and trunk as they do not increase heart rate that much; instead, they promote high stimulation of peripheral blood circulation in the muscles involved[9,11,24-27]. Intercalating the movements through short sets of exercises was a strategy to motivate and encourage the older adults[18]. The absence of equipment to improve the exercise program was a limitation in this study.

Data were analyzed using the SPSS software, version 20.0. The Kolmogorov-Smirnov test found that the variables analyzed (weight, lipid profile, blood glucose and blood pressure) were not normal; therefore, the Wilcoxon test was used to compare the values obtained at baseline and final visit. Significance level was set at $p<0.05$.

The study was approved by the Research Ethics Committee of the Santo Amaro University, Opinion No. 1436639, and is in accordance with the Declaration of Helsinki and Resolution No. 466/12 of the National Health Council. The following Brazilian Clinical Trials Registry number was also obtained: RBR-4nn8j5.

RESULTS

Of the 34 older adults who participated in the study, 25 were women (74%) and 47% were ex-smokers (n=16). In addition, the median age (interquartile range) of the participants was 63 (61-66) years. Smokers corresponded to 6% (n=2) of the individuals and 53% (n=18) were diabetic. Regarding the medications used, 88% (n=30) of the participants used antihyperglycemic drugs and 32% (n=10) used statins. In all, 15% (n=5) had had at least one outcome (acute myocardial infarction) in the last seven years.

Table II exhibits the data obtained before and after the exercise protocol regarding the variables weight, BMI, waist circumference, total cholesterol, LDL-C, HDL-C, triglycerides and fasting glycemia. There was a significant reduction in weight, BMI, and systolic and diastolic blood pressure ($p<0.0001$ in all cases, Wilcoxon test).

DISCUSSION

The increase in life expectancy worldwide, often accompanied by the onset of NCDs[1], has led to the development of actions aimed at promoting healthier aging through exercise programs targeted at the older population[9,13,25-27]. These programs are strategies for tackling SAH and may also minimize sequelae associated with the disease[9,11,14,28].

The sample was predominantly composed of women (74%), which is justified by a greater number of women who accepted to participate in the present study, a fact that can be justified by the hypothesis that men are more reluctant to take care of their own health while women are concerned with appearance, weight and with healthy aging. Research has shown that most men consider themselves immune to diseases, thus prioritizing the pleasures of life over health[29].

It is believed that the high number of ex-smokers (47%) found in the present research is due to current campaigns against tobacco use, such as the Anti-Smoking Law, the increase in the price of cigarettes, prohibition of advertisement on tobacco and tobacco products and banning of smoking rooms in the city of São Paulo. Research by the Ministry of Health shows a 30.7% decrease in the number of smokers in Brazil in the last nine years. Nicotine triggers several diseases, especially cardiovascular diseases. Smoking is not a direct cause of hypertension, but hypertensive patients who smoke are at increased risk of death due

Table II - Results of the variables analyzed at initial and final visits, n = 34. São Paulo, Brazil, 2017.

Variables	Initial Visit	Final Visit	p	Reference standards					
				Normal / Ideal (%)		Borderline (%)		Altered (%)	
				Baseline	Final	Baseline	Final	Baseline	Final
Weight (Kg)	81 (2)	79 (2)	< 0.0001	-	-	-	-	-	-
BMI* (Kg/m²)	32.1 (0.8)	31.5 (0.8)	< 0.0001	12	12	-	-	88	88
Waist circumference (cm)	105.0 cm (1.6)	104.6 (1.6)	0.22	3 M, 0 W	3 M, 0 W	-	-	97 M, 100 W	97 M ,100 W
Total cholesterol (mg/dL)	230 (9)	224 (9)	0.47	29	33	65	27	6	40
LDL-C ** **(mg/dL)**	149 (8)	143 (7)	0.66	35	33	21	40	44	27
HDL-C *** **(mg/dL)**	52 (2)	53 (2)	0.38	29	20	62	74	9	6
Triglycerides (mg/dL)	170 (13)	156 (13)	0.20	20	7	15	34	65	59
Fasting glucose (mg/dL)	114 (8)	112 (6)	0.64	47	60	30	13	23	27
Systolic blood pressure (mmHg)	139 (3)	120 (3)	< 0.0001	9	44	35	44	56	12
Diastolic blood pressure (mmHg)	86 (2)	72 (1)	< 0.0001	24	88	38	12	38	0

Values are described as means and standard errors of the means. Wilcoxon test. M: Man; W: Woman; * Body Mass Index; ** Low-density lipoprotein; *** High-density lipoprotein

to malignant hypertension and AMI[26]. In the current research sample, 15% of the patients reported having suffered an AMI in the last seven years, which is why 31% of the ex-smokers quit smoking; none of the patients reported previous stroke.

More than half (53%, n=18) of the participants in the present study had type 2 diabetes, which corroborates data from other studies[1,2], which show that diabetes constitutes one of the main risk factors for cardiovascular diseases and for health problems treated in the primary health care network.

Regarding the waist circumference measures found in this study, the mean values were above the acceptable values to prevent the risk of cardiovascular diseases[21]. The cut-off value for increased cardiovascular risk is defined according to ethnicity and sex: equal to or greater than 90 cm for men and 80 cm for women in South American countries[7,22,23]. The short period of time (three months) in which the exercise protocol of the present study was carried out may have been a factor that determined the absence of a statistically significant reduction in WC, represented by the excessive deposition of visceral abdominal adipose tissue. Variables that could not be controlled should also be considered, such as the use of other medications in addition to antihypertensives, other diseases, diet and socioeconomic conditions.

Data on body weight and BMI suggest that regular physical exercise of mild to moderate intensity may have been a factor that encouraged healthy lifestyles in the previously inactive older adults in this study, thus contributing to a statistically significant reduction in body weight and, consequently, BMI. The process of active aging and participation in a physical exercise program sharply increase energy expenditure and seem to contribute to the fight against obesity[14]. It is known that small changes in daily habits represent essential requirements for the treatment of SAH[2,3].

Dyslipidemia represents an important risk factor for atherosclerosis and CVDs, as fat accumulated in the walls of the arteries can lead to partial or total obstruction of blood flow to the heart and brain[30]. The lipid profile of the sample analyzed in this study exhibited borderline levels for all variables[23]. However, it is important to consider other associated factors, such as aging, obesity, diabetes, previous AMI and smoking[30,31]. Dyslipidemia usually shows no signs or symptoms, but studies show that this disorder has a strong association with abdominal obesity and an inadequate diet rich in fatty foods, which increase the risk of cardiovascular diseases[30,31].

According to an interview carried out at the beginning of the present study, 32% of the sample used statins. This suggests that at least one third of the patients are hyperlipidemic. Thus, it is believed that physical exercise, together with drug therapy, has contributed to maintaining the mean of these values at borderline levels[23]. There was also a reduction in mean levels of total cholesterol (TC), LDL-C and TG, a small reduction in fasting glucose, and an increase in HDL-C, but these differences were not statistically significant in the present study. Possibly, the short duration of the protocol and variables that could not be controlled, such as diet, drugs used to treat hyperlipidemia, other therapies and life habits, were limiting factors and should also be considered.

In a trial carried out in 2008, 30 individuals divided into two groups were observed for six months. There was a significant reduction in TC and an increase in HDL-C in the exercise and diet group. The group that received only the exercise program presented a significant decrease in TC and LDL-C[32]. These results do not corroborate those of the present study. Despite the similar duration of the protocol and number of patients, no nutritional monitoring was offered in the present study over the three-month period, which is a limitation of the research. Regarding glycemia, the benefits of physical activity are described in the literature. Regular physical activity is currently recommended for overweight and obesity individuals with diabetes and should be part of the treatment[33].

The chronic effects of physical activity on the BP of hypertensive individuals has been assessed by several studies. There is a consensus in the literature that physical training promotes a decrease in BP at rest[7,20]. However, specific characteristics of the prescription, such as protocol duration, intensity and type of exercise, seem to influence the results of the research. Blood pressure reductions have been observed over the years in studies with protocol duration ranging from four weeks to six months[9,10,15,32,34].

In 2004, regular physical activity of moderate intensity three days a week for 10 weeks was able to reduce BP in individuals with moderate hypertension[35]. However, in 2006, other authors found that the decrease in BP after six months of physical training was significantly higher than that observed after three months[36]. Another study, involving 207 individuals submitted hypertensive people to a physical exercise program for eight weeks. Patients were randomized into five groups: a control group with sedentary individuals and four groups that differed in volume of weekly exercises. The authors found that there was a statistically significant reduction in SBP and DBP at rest in the four groups submitted to training, and that there was no greater reduction with the increase in exercise volume. The magnitude of DBP reduction was not significantly different in the four groups, thus demonstrating that the increase in volume, i.e., the total weekly minutes, was not a primary factor for the hypotensive effect of the exercises[37]. Thus, the studies suggest that regular physical activity throughout life may have more significant effects on BP reduction than the total weekly minutes, improving older adults' health.

In the present study, moderate-intensity physical exercise totaling 180 minutes per week for a period of three months was able to chronically and statistically significantly reduce both mean SBP and mean DBP in older patients with moderate hypertension when comparing the initial values, when the participants were sedentary, with the final values, after three months of physical activity.

The search for an explanation for the chronic effects of physical training on hypertensive patients has been motivated by other studies[8,38]. The mechanisms involved and the decrease in blood pressure seem to be related to both hemodynamic and humoral factors[39]. It is believed that one of the chronic effects of low-intensity physical activity is the reduction in cardiac output due to a reduction in the resting heart rate[20] caused by a decreased sympathetic stimulation and an increase in the number of impulses transmitted by the vagus nerve, thus generating parasympathetic myocardial stimulation[39].

Regardless of the mechanisms underlying the occurrence of post-exercise hypotension (PEH), physical exercise – which can be of mild intensity but regular – is a clinically important non-drug strategy to chronically reduce SBP and DBP levels in the older population. However, further research to analyze the factors that influence this reduction and other studies involving exercise and older adults are needed.

CONCLUSION

The mild to moderate exercise program performed for three months twice a week was effective in reducing the cardiovascular risk factors of the sedentary and hypertensive older adults analyzed.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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