Effect of a physical training program on healthy physical condition in hypertensive individuals

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Abstract

Objective: To determine the effect of a physical training program on the healthy physical condition of patients with controlled hypertension. *Method:* A clinical trial was conducted of 78 people diagnosed with controlled hypertension. Of those subjects who voluntarily agreed to participate in the study and who met the inclusion criteria a study group of 39 patients with controlled blood pressure was selected, and underwent the physical training program. A control group of 39 patients with controlled blood pressure was also selected and underwent an educational program combined with non-guided exercises which they usually practiced (shuffleboard, "froggy", chess). At the beginning of the study a survey on the sociodemographic characteristics of the participants was conducted, while their clinical characteristics were evaluated at the end of the study. The statistical t test for independent samples was used, along with the paired before or after Student t test, or failing that the nonparametric Mann-Whitney U test. *Results:* 84.6 percent of the sample were women and 64.1 percent had a primary school level education. The mean differences showed statistical significance $p<0.05$ for HDL, LDL, triglycerides, lower limb strength and abdominal strength. *Conclusion:* The results support the conclusion that there were statistically significant differences between the experimental and control groups for the variables HDL, LDL and triglycerides at the two phases of the study, but not between the time periods. The same applied to the strength of the lower limbs and abdominal strength variables, suggesting the implemented program had a positive effect.

Key words: Hypertension. Exercise Physical. Motor Activity. Physical Education and Training .

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INTRODUCTION

Chronic noncommunicable diseases (CNCDs) are a major global health problem. According to WHO estimates, about 60 percent of all deaths and 43 percent of disease-related costs are due to such illnesses, with such figures expected to increase to 73 percent of all deaths and 60 percent of total disease-related costs by 2020.[1,2]

The worldwide prevalence of hypertension is 30% of the total population, rising to 50% among those aged over 50. In Latin America the figure is between 26% and 42%.[3]

In Colombia coronary mortality due to systolic blood pressure adjusted for age is 11.6% where systolic blood pressure is less than 120 mm Hg, increasing to 82.6% when systolic blood pressure is greater than 210 mm Hg.[4] Arterial hypertension (AHT) is characterized by a persistent increase in systolic blood pressure to 140 mmHg or higher and a diastolic blood pressure of 90 mmHg or greater. According to the WHO, one in three adults worldwide have high blood pressure.[5-7]

Arterial hypertension is one of the most common medical disorders and is associated with an increased incidence of death from cardiovascular disease. Antihypertensive drug treatment alone has had little success in reducing cardiovascular complications. Changes in lifestyle should be encouraged as a way of preventing hypertension in patients with risk factors. The results of the present study represent a significant contribution to the area of Geriatrics and Gerontology in terms of providing new evidence for the control of a disease which is one of the most widespread and harmful illnesses of the twenty-first century, due to its potential to lead to CNCDs, one of the leading causes of death worldwide.

According to statistics issued by the District Health Department in December 2010, 66,780 people in the city of Bogota suffered from hypertension, making this disease one of the main chronic diseases to affect the Colombian capital.

Regular physical exercise allows different organ systems to adapt, with such adaptations leading to many benefits, including biological, psychological and social well-being improvements. Hypertensive patients should be instructed and encoraged to perform physical exercise to improve their blood pressure and reduce coronary risk factors.[8]

Physical exercise in these populations has proven to be an effective therapeutic tool. It has been found that physically active hypertensive patients have a lower mortality rate than sedentary individuals.[9] Recent research has shown that aerobic exercise is associated with a reduction in the blood pressure of hypertensive patients of 4.9/3.7 mmHg, a reduction which does not change based on the frequency or intensity of exercise, thus suggesting that all forms of exercise are effective.[8] Another meta-analysis estimated that the decrease in blood pressure of hyper tense people is 6/5 mmHg.[10] The mechanisms by which exercise reduces blood pressure are complex, but include: a reduction in blood pressure after an exercise routine, neurohormonal adaptations in the sympathetic nervous system[11,12] and renin-angiotensin system,[13,14] vascular function responses[15] and structural vascular adaptations[16,17]

Studies have identified improvements from the implementation of physical activity programs for older persons, among whom the most prevalent diseases were: hypertension (55.2%), smoking (15.7%) and diabetes (9.7%). It has been concluded that physical activity in older adults provides considerable benefits in physical parameters such as coordination and flexibility. It improves cardiovascular function parameters, systolic blood pressure and pulse stress levels, and symptoms such as nocturia, insomnia and musculoskeletal pain, while also leading to an improvement in weight, BMI and flexibility.[18]

It is also important to note that physical activity and exercise in such patients should be based on an estimate of their capabilities. A conscious and individualized evaluation of each patient should be carried out, in order to achieve the maximum benefits from such physical activity with the least amount of risk. Above all, it should be remembered that the desire to begin a program of physical training in hypertensive patients should originate with the patients themselves, and their desire to improve their quality of life.[19]

There is scientific evidence of the effects of moderate-intensity aerobic exercise on the lipid profile of healthy sedentary subjects,[20-24] showing that a single cycle ergometer exercise session resulted in transient changes in plasma concentrations of lipids and apolipoproteins, regardless of intensity. The changes in the concentrations of total cholesterol, triglycerides, HDL-C, HDL3-C, apo AI and apo B were statistically significant in the samples taken after the completion of the exercise, from immediate post-exertional to 48 hours later, regardless of the intensity of the exercise or the training status of the individual. Exercise practiced at intensities above the anaerobic threshold, namely the metabolic situation in which the participation of the anaerobic lactic metabolism increases, creating a state of imbalance with respect to the body's buffer systems, leads to an increase in blood lactate concentration that facilitates the recombination of acids, decreasing the availability of free fatty acids as an energy substrate.[25] For sufferers of hypertension, performing physical activity is crucial to the control of this condition. It has been shown that regular exercise can decrease systolic blood pressure by between 4 and 10 mmHg and diastolic blood pressure by 8 mmHg.[4] In terms of physical activity, studies in Colombia have identified high frequency as a risk factor, while a study in the Antioquia municipality found a frequency of low physical activity of 48%.[26]

The research question that guided this study was: what is the effect of a physical training program on health-related fitness of subjects with controlled arterial hypertension?

The objective of the study was to determine the effect of a physical training program on health-related fitness in subjects with controlled arterial hypertension aged between 53 and 88 years. The following null hypothesis was raised: after applying a physical training program no significant differences in health-related fitness were found among subjects in the experimental group (intervention) and the control group.

METHOD

Population and sample

A clinical trial was carried out, the population of which consisted of subjects diagnosed with hypertension belonging to Bogota hypertension sufferer groups, aged between 53 and 88 years.[27] Hypertensive patients from care facilities were not included, while a hypertension prevalence rate of 12.78% was used based on the fact that 21,584 people were diagnosed with the condition in 2007.[2]

The experimental population consisted of subjects with hypertension who voluntarily agreed to participate in the study. The study population was those subjects who met the inclusion criteria. The participants were placed in the following groups: *Study group* – subjects with hypertension who participated in a guided educational program aimed at stimulating exercise (fitness program) *Control group* - subjects with hypertension who participated in a non-guided educational program and habitually participated in activities such as shuffleboard, "froggy" and chess.

A sample design for the comparison of means was used to calculate the sample size.[28] This was carried out through a pilot study with 50 subjects, where values were calculated for the variables in the study, based on a level of confidence of 95% and a power of 90 percent, a minimum estimated value of the estimated difference of 13 mm/hg for systolic and diastolic pressure, according to research into the effects of exercise on blood pressure and lipid control through a secondary prevention metacentric study[29,30] and a variance of 17.26 mm/hg for systolic and 10.04 mm/hg for diastolic pressure.

This sample calculation is established on the application of the following formula:

$$n = \frac{2(Z_\alpha + Z_\beta)^2 S^2}{d^2}$$

Where:

Z_α is the value of Z (1.96) corresponding to reliability (95%);

Z_β is the value of Z (1.28) corresponding to power (90%);

S^2 is the variance of systolic blood pressure based on reference studies (297.9 mm/hg^2);

d is the minimum value of the expected difference in diastolic blood pressure that will be detected (according to reference values, 13 mm/hg).

The groups were balanced by gender, and, as this was a quasi-experimental study, the criteria used to assign subjects to each group was defined by researchers who tried to ensure a greater control of the resulting variables and homogenize the groups. The following inclusion and exclusion criteria were used: *Inclusion* - People with high blood pressure controlled by either drugs or diet: systole values of under 130 and diastole values of under 100; people with hypertension aged between 53 and 88 years; people with hypertension from both genders, as the behavior of hypertension is the differential for this condition; people who had a lipid profile assessment in the month before the start of the study and who guaranteed they could perform a lipid profile assessment at the end of the intervention, and people from elderly groups organized by the Bogota Ministry of Social Integration. *Exclusion* - people with arterial hypertension, with an associated decompensated pathology and/or damage to the target organ.

The initial control variables were age, gender and medications consumed. These variables were controlled as they could alter the dependent variable; the variable of eating habits was not controlled in the course of the study.

Procedure

The population was selected from elderly persons from groups organized by the Bogota Ministry of Social Integration in the region of Engativá (Consolación, Aguas Claras and Ferias) who were medically diagnosed with hypertension and met the inclusion criteria for the study.

In collaboration with professors and students of Physiotherapy at the Universidad Manuela Beltrán (Manuela Beltran University) previously calibrated by the research group, the exercise and education program was applied to the population during the months of July and November 2011.

Prior medical diagnosis of arterial hypertension (AH) was performed and once both the control and experimental groups were formed, pre-test valuations were conducted regarding sociodemographic and study variables such as health-related fitness (cardiorespiratory fitness and lipid profile), anthropometric variables and physical capacity.

Next a physical exercise program was implemented in the community of elderly persons who met the inclusion criteria and who lived in nursing homes and participated in groups for the elderly promoted by the Ministry of Social Integration of Bogota in the Engativá region (Consolación, Aguas Claras and Ferias). This program was applied for 15 weeks, with three weekly sessions lasting 60 minutes, featuring aerobic type exercises and weight work based on aerobic effort. The vital signs (heart rate, respiratory rate, oxygen saturation and blood pressure) were measured at the beginning and end of the session. The initial or warm-up phase had a duration of 10 minutes, the central phase lasted 40 minutes and the final or recovery phase was 10 minutes.

The physical and educational exercise program was carried out with the people in the experimental group, while for the same period of time the control group participated in an educational program and performed traditional unguided exercise (shuffleboard, "froggy" and chess). The educational program was carried out in classroom sessions and featured activities aimed at enhancing knowledge and practices. Each session was 30 minutes long and included, in addition to the thematic content, practical joint workshops. Some of the topics discussed were: arterial hypertension, nutrition and AH, medication and AH, among others. Adherence was good in both the experimental group and the control group, with all the participants taking part in the intervention from the beginning to the end.

Permanent control of each of the study variables was then carried out and post-test assessment was performed once the program was finished. From this the effect of the program could be analyzed.

The following assessments were carried out for both the experimental group and the control group: *in physical ability* - tests to evaluate resistance and muscle strength in the abdomen, upper limbs and lower limbs, anthropometric assessment, and an evaluation of cardiovascular risk through waist and hip circumference and body mass index, fat composition and the vital signs of a healthy physical condition (blood pressure, oxygen saturation and heart rate). Upper and lower limb strength (sit-up), abdominal, flexibility (Wells test) and cardiorespiratory endurance (six-minute walk) tests were used. The lipid profile was established through laboratory testing of the EPS of each individual before and after the physical training program.

Data analysis

Data processing was performed using the SPSS version 19 program licensed from the Universidad Autonoma de Manizales. Descriptive analysis of the sociodemographic variables was performed. Quantitative variables were subjected to statistical testing in order to test the normality, linearity and homoscedasticity of the variables for the different comparison groups (Kolmogorov-Smirnov and Levene). The statistical t-test for independent samples was used, as well as the paired before and after Student's t-test, or in the event of this failing, the nonparametric Mann-Whitney U test. Relative Risk calculation was performed as a Measure of the Strength of Association. A confidence interval of 95% was used.

Ethical considerations

The investigation falls under the guidelines of Resolution 008430 (Chapter 1 Article 11 of 1993 of the Ministry of Health of Colombia), classified as greater than minimum risk due to the intervention process performed on the subjects. It was approved by the Ethics Committee of the Universidad Autonoma de Manizales, in accordance with Act No. 010 dated October 7, 2010. A free and informed consent form was completed by the participants in the study.

RESULTS

In terms of sociodemographic variables, both the experimental and control groups were composed of 32 women and six men. With regard to social security, 89.7 percent of participants in the experimental group and 84.6 percent of the control group were members of the contributory scheme; the rest of the people in both groups were members of the subsidized scheme. A total of 52.6 percent of participants were married.

It can be seen in Table 1 that statistically significant differences were found between pre-test and the post-test evaluations for HDL (p=0.031), LDL (p =0.046) and triglycerides (p=0.039). Statistically significant differences were also found for lower limb (p=0.030) and abdominal strength (p=0.002) (Table 2).

Table 1. Comparison of lipid profile at the beginning and end of the intervention. Bogota, Colombia, 2011.

Lipid profile (pre-test/post-test)	Group	Mean	Standard deviation	Difference in means	Bilateral significance
Total cholesterol (pre-test) mg/dl	Experimental	167.636	51.3788	16.6154	0.212
	Control	151.021	64.4916	16.6154	0.212
Total cholesterol (post-test) mg/dl	Experimental	140.426	45.0488	-3.3154	0.774
	Control	143.741	55.7840	-3.3154	0.774
HDL (pre-test) mg/dl	Experimental	77.182	29.4649	6.2103	0.375
	Control	70.972	31.8888	6.2103	0.375
HDL (post-test) mg/dl	Experimental	83.328	25.6273	11.7615	0.031*
	Control	71.567	21.4329	11.7615	0.031
LDL (pre-test) mg/dl	Experimental	90.438	31.6647	13.1846	0.071
	Control	77.254	25.4519	13.1846	0.072
LDL (post-test) mg/dl	Experimental	90.687	31.8345	12.0282	0.046*
	Control	78.659	25.9629	12.0282	0.046
Triglycerides (pre-test) mg/dl	Experimental	146.985	59.9169	23.2974	0.264
	Control	123.687	34.9107	23.2974	0.264
Triglycerides (post-test) mg/dl	Experimental	137.23	17.712	-4.487	0.039*
	Control	141.72	17.481	-4.487	0.040

HDL= high density lipoprotein analysis; LDL= high density lipoprotein analysis; *p<0,05 (statistically significant).

Table 2. Comparison of physical capacity at beginning and end of intervention. Bogota, Colombia, 2011.

Physical capacity (pre-test/post-test)	Group	Mean	Standard deviation	Difference in means	*p*-value
Upper limb strength (pre-test) Kg	Experimental	11.03	6.297	-2.897	0.057
	Control	13.92	6.918		
Upper limb strength (post-test) Kg	Experimental	16.23	5.631	1.154	0.361
	Control	15.08	5.445		
Lower limb strength (pre-test) Kg	Experimental	12.49	6.160	-0.821	0.569
	Control	13.31	6.494		
Lower limb strength (post-test) Kg	Experimental	18.90	6.328	3.051	0.030*
	Control	15.85	5.869		
Abdominal strength (pre-test) Repetitions	Experimental	1.82	5.808	0.615	0.549
	Control	1.21	2.648		
Abdominal strength (post-test) Repetitions	Experimental	5.31	3.847	2.718	0.002*
	Control	2.59	3.761		
Flexibility test (pre-test) cm	Experimental	-15.18	14.121	4.091	0.164
	Control	-19.27	10.964	4.091	
Flexibility test (post-test) cm	Experimental	-14.154	13.872	5.5256	0.072
	Control	-19.679	12.877	5.5256	

*p<0,05 (statistically significant).

In establishing the measure of the strength of association through Relative Risk (RR), it was found that the calculated value for LDL was less than 1.0, suggesting that the program is a protective factor. However, it should be noted that the upper limit of the confidence interval exceeded 1.0. (Table 3).

Table 3. Relative risk summary. Bogota, Colombia, 2011.

AHT mm/hg	Estimate		1.976
	Asymptotic confidence interval of 95%	Lower limit	0.528
		Upper limit	7.397
LDL mg/dl	Estimate		0.149
	Asymptotic confidence interval of 95%	Lower limit	0.017
		Upper limit	1.300
HDL mg/dl	Estimate		1.862
	Asymptotic confidence interval of 95%	Lower limit	0.634
		Upper limit	5.469

AHT= arterial hypertension; LDL= low density lipoprotein; HDL= high density lipoprotein.

The training program did not result in significant changes in anthropometric measures such as weight, BMI, and waist and hip circumference, but did show improved results in fat percentage by combining aerobic and strength work, obtaining improvements in fat reduction and muscle mass gain, allowing the reduction of blood pressure in the study group. In contrast, body composition increased in the control group.

DISCUSSION

Functional capacity and properly performed physical exercise, carried out at the recommended intensity, are inversely associated with the development of cardiovascular risk factors and also with long-term mortality from cardiovascular and neoplastic diseases.[31]

Exercise promotes lipoprotein lipase activity, which increases chylomicron catabolism and VLDL, while reducing LDL. These effects result in a decrease in circulating levels of triglycerides, LDL and cholesterol, and an increase in HDL, improving the lipid profile of patients who take part in physical exercise. In the present study it was found that LDL and triglyceride levels improved through the guided exercise program.[20,32]

Statistically significant differences ($p<0.05$) were found for the physical capacity, such as lower limb and abdominal strength, of hypertensive individuals. This data contrasted with that obtained in another study, where cardiovascular parameters were measured at rest and every ten minutes during exercise. This study did not find significant changes in vital signs and heart rate after ten and 30 minutes of exercise, while blood pressure increased after ten minutes. However, the same indicator gradually decreased from tento 30 minutes of exercise, while blood lactate concentration gradually increased.[33]

Lifestyle interventions can be sufficiently effective among patients with slightly elevated blood pressure (BP), and should always be recommended for patients undergoing antihypertensive treatment, as they can reduce the dosage of antihypertensive drugs needed to control blood pressure, as was observed in this study. The control group, which practiced unguided game-based recreational type exercise (shuffleboard, "froggy" and chess) and underwent an educational program for the control of cardiovascular risk factors only, also resulted in changes in the same vital sign variables at rest, although these were less significant than in the study group.[28]

Lower body strength is a reliable marker of the health and welfare of an individual. The isokinetic strength of the extensor muscles (quadriceps) and especially knee flexors (hamstrings), is strongly associated with mortality, even surpassing the predictive value of the other variables studied, such as cardiorespiratory endurance (six-minute walk test).[34] Such a condition is accompanied by a loss of functional capacity and an increase in muscle fat, resulting in a substantial negative impact on the quality of life of older people, causing weakness, dependence and increased morbidity and mortality. As described above, strength training is not recommended as the sole type of training for hypertensive individuals[36], but as a supplement to aerobic training.[36]

The main limitations of this study lie in the low number of participants and the fact that it features an uncontrolled variable which has a direct influence on the event studied, namely eating habits.

CONCLUSION

The high density cholesterol (HDL), low density cholesterol (LDL) and triglyceride variables measured differed in a statistically significant manner between the experimental and control groups in the two time periods of the study of the study, although there was no difference between the time periods.

LDL, HDL and triglyceride levels improved in hypertensive patients, with better results achieved by the experimental group through the practice of guided exercise within thresholds, with a frequency of not less than 45 minutes three times a week.

In terms of physical capacity, there were statistically significant differences in the experimental group following the implementation of a guided exercise program aimed at the variables of lower limb strength and abdominal strength.

The importance of defining protocols for reproducible physical activity with the aim of permanently reducing blood pressure is extremely important in the area of Geriatrics and Gerontology. It is also important to evaluate the long-term effects of such interventions, and their possible effects on mortality and reducing cardiovascular events.

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