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Effect of Isometric Exercise on the Blood Pressure of Hypertensive Older Adults

Efeitos do Exercício Isométrico Sobre a Pressão Arterial de Idosos Hipertensos

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Abstract

Isometric physical exercises, which involve muscle contractions without joint movement, can be beneficial for the elderly by enhancing their ability to generate muscle strength. Additionally, importantly, studies indicate that these exercises can contribute to the reduction of blood pressure. To verify the acute effect of a session of isometric exercises on the blood pressure of the elderly. The study included 13 hypertensive elderly individuals aged between 60 and 79 years (65.5 ± 5.23). An alternating isometric exercise program was prescribed for large muscle groups, which were exercised on the Flat Bench Press, Leg Curl Machine, Seated Row Machine, Leg Extension Machine, Shoulder Press with Dumbbells, and Calf Raise on the Machine. The exercise session had a total duration of 12 minutes of muscle contraction. The behavior of systolic blood pressure (SBP) and diastolic blood pressure (DBP) was analyzed using the auscultatory method pre and post-exercise. Shapiro-Wilk normality tests and Analysis of variance (ANOVA) with Tukey's post-hoc test with a significance level of 5% ($p<0.05$) were performed. A significant reduction in systolic blood pressure values (136.286 ± 20.1167 and 128.857 ± 29.3254) was observed 60 min. after exercise. Although there was an increase in diastolic blood pressure values (72.857 ± 19.7790 and 81.429 ± 12.4697), there was no statistical significance. Finally, isometric exercise for large muscle groups and alternated by segment at low intensity was able to reduce SBP in hypertensive older adults.
Keywords: Exercise. Cardiovascular. Isometric. Elderly. Hemodinamic.

Resumo

Exercícios físicos isométricos, que envolvem contrações musculares sem movimento articular, podem ser benéficos para idosos ao ampliarem a capacidade de gerar força muscular. Além disso, importantemente, estudos indicam que esses exercícios podem contribuir para a redução da pressão arterial. Verificar o efeito agudo de uma sessão de exercícios isométricos na pressão arterial de idosos. Participaram do estudo 13 idosos hipertensos com idade entre 60 e 79 (65,5 ± 5,23) anos. Foi prescrito um programa de exercícios isométrico alternado por seguimento para grandes grupos musculares que foram exercitados no Supino Reto; Mesa flexora; Remada no crossover sentado no banco, Cadeira extensora, Desenvolvimento ombro com halteres e panturrilha em posição vertical na máquina. A sessão de exercícios teve duração total de 12 minutos de contração muscular. Foi analisado pelo método auscultatório pré e pós-exercício o comportamento da pressão arterial sistólica (PAS) e Pressão Arterial Diastólica (PAD). Foram realizados os testes de normalidade de Shapiro-Wilk e Análise de Variâncias - ANOVA com pós-teste de Tukey e significância de 5% (p<0,005). Foi verificada redução significativa nos valores da pressão arterial sistólica 60 min. após o exercício (136, 286 ± 20, 1167 e 128, 857 ± 29, 3254). Embora, houve leve aumento nos valores da pressão arterial diastólica (72,857 ± 19,7790 e 81,429 ± 12,4697), não houve significância estatística. O Exercício Isométrico para os grandes grupos musculares e alternados por segmento em intensidade baixa foi capaz de reduzir os valores da PAS em idosos hipertensos.
Palavras-chave: *Exercício. Cardiovascular. Isometria. Idoso. Hemodinâmica.*

1 Introduction

Aging is a dynamic and progressive process that causes various changes in the body, whether morphological, psychological, functional, or biological, resulting in a decrease in functional capacity and the development of non-communicable chronic diseases[1]. These changes result from the accumulation of damage over a lifetime and are further aggravated when there is an interaction between genetic factors and unhealthy habits such as sedentary lifestyle, unbalanced diet, smoking, and alcohol consumption[2].

Among the risk factors for the development of non-communicable chronic diseases, hypertension (HTN) is the most prevalent, and its risks are associated with age, sex, ethnicity, overweight and obesity, excessive salt and alcohol intake, sedentary lifestyle, socioeconomic factors, and genetics. It constitutes a multifactorial chronic clinical condition characterized by elevated and sustained blood pressure levels[3]. Additionally, it has high prevalence and low control rates. For these reasons, it is one of the most important public health problems, as morbidity, mortality, and treatment costs are high[4].

According to Kramer and collaborators (2015), the rate of hypertension is higher mainly in Western culture. In the USA, more than 52 million adults are hypertensive. In Brazil, HTN affects 32.5% (36 million) of adults, more than 60% of the elderly, contributing to 50% of cardiovascular disease deaths

in Brazil[3].

The treatment of HTN can be carried out through guidance for lifestyle changes and/or using antihypertensive agents. Physical exercise provokes a series of physiological responses resulting from autonomic and hemodynamic adaptations that influence the cardiovascular system[5].

Among the various types of exercises, muscle contractions can be classified as dynamic and static. The latter involves a single sustained muscle contraction against an immovable load or resistance with minimal or no change in the length of the involved muscle group. Thus, there is a growing body of evidence supporting the role of this form of training in significantly reducing systolic and diastolic blood pressures in hypertensive or normotensive individuals[6]. However, little is known about the physiological responses in the elderly.

Given the above, it was necessary to evaluate the hypotensive effect of isometric exercise on blood pressure in hypertensive elderly individuals.

2 Material and Methods

2.1 Sample

A randomized clinical trial of an experimental type was conducted to investigate through observation and comparative analysis the acute effect of an isometric exercise session on the resting and post-exercise values of systolic and diastolic blood pressure in hypertensive elderly individuals. The sample consisted of hypertensive elderly individuals who were included in the study for convenience. In this case, elderly participants aged between 60 and 79 years (65.5 ± 5.23) took part in the study. Before participating in the research project, all participants filled out a medical history questionnaire and signed the Informed Consent Form (ICF). All methods and procedures were approved by the Human Research Ethics Committee do Centro Universitário do Maranhão – Uniceuma, approval opinion number – 3.370.500).

2.2 Inclusion and exclusion criteria

Participants of both genders who had not been practicing physical exercise for at least 6 months, thus characterizing them as sedentary, were previously diagnosed with hypertension, and were controlled with antihypertensive medications, were included. Exclusion criteria were normotensive elderly individuals and those with associated pathologies.

2.3 Exercise protocol

An isometric exercise program was developed, consisting of a familiarization session and six exercises for the major muscle groups, both upper and lower body. The exercises included Bench Press, Leg Curl, Low Row in the "Crossover," Leg Extension, Shoulder Press in a vertical position with dumbbells, and Calf Raise in a vertical position on the machine. The training intensity was determined by subjective perception of effort (BORG), estimating 30% of a one-repetition maximum (1RM) voluntary contraction.

2.4 Blood pressure

Blood pressure measurement of the volunteers was performed using the auscultatory method at the following times: before exercise, immediately after exercise, and every 10 minutes for 60 minutes. For obtaining the analyzed variables, an analog blood pressure monitor and stethoscope (Premium) were used.

2.5 Isometric training stages

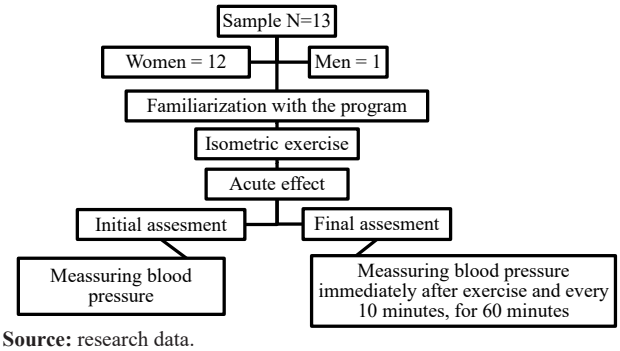
Six exercises were performed, grouped into blocks of two exercises each, one for the upper limbs and the other for the lower limbs. Participants performed 3 sets of each exercise, with a 10-second static contraction, without a rest interval between sets, totaling 60 seconds of work. At the end of each block of exercises, a one-minute rest pause was established.

Four rounds per exercise session (six machines) were performed, with three minutes of work per round, totaling 12 minutes of isometric contraction.

2.6 Experimental design

The study design is detailed in the image below. It shows the initial phase, familiarization with the weight training equipment, and the blood pressure evaluation periods (Figure 1).

Figure 1 - Study intervention protocol with isometric exercises performed in a group of hypertensive elderly individuals controlled with antihypertensive medications.



Source: research data.

2.7 Statistical analysis

After obtaining the data, the Shapiro-Wilk test was conducted to verify normality, followed by analysis of variance (ANOVA) with Tukey's post-hoc test and a significance level of 5% ($p<0.05$).

3 Results and Discussion

After obtaining the results and characterizing the sample, it was found that the participants were overweight and aged over 60 years (Table 1).

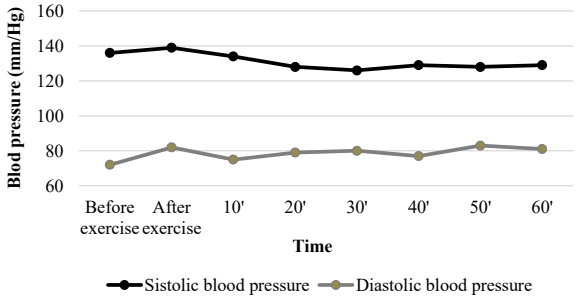
Table 1 - Sample characteristic

	Average	Minimum	Maximum	Satandard deviation
Age	65,92	60,0	79,0	5,23
Weight	63,29	35,00	82,70	13,73
Height	1,51	1,35	1,65	0,09
Body mass index	27,23	19,20	33,24	4,21

Source: research data.

The hypotensive effect induced by isometric exercise on systolic blood pressure was also observed after 60 min. of exercise (Figure 2). Although it did not show a statistically significant difference, a long time there was an average reduction of 3.5 mmHg. However, a slight increase in diastolic blood pressure values (6.0 mmHg) was also observed during the 60 minutes following the isometric exercise.

Figure 2 - Responses of systolic blood pressure (SBP) and diastolic blood pressure (DBP) to the supervised isometric training protocol. * = p<0,05 vs. before exercise. Source: own elaboration. Analysis of variance (ANOVA) and Tukey's post-hoc test with a significance level of 5% (p<0.05)



Source: research data.

This study analyzed the influence of isometric exercise on large muscle groups, alternated by segment, on systolic and diastolic blood pressure. It was found that blood pressure values revealed a drop in systolic blood pressure (SBP) and an increase in diastolic blood pressure (DBP) (~7 mm/Hg) between rest and one hour after physical exercise. It is worth noting that no statistically significant differences were found for these variables (p>0.05).

The American College of Sports Medicine (Pescatello et al., 2004)[7] recommends in its guidelines that physical exercise should not cause an increase in SBP and DBP above 220 and 110 mm/Hg respectively, for hypertensive individuals. The values obtained in the study, after an isometric exercise session, were well below what the ACSM considers unsafe blood pressure levels. In this case, the protocol used in this study does not appear to present significant risks to hypertensive elderly individuals.

Regarding the Pre-Test, Post-Test, and one hour after the isometric exercise protocol, a slight initial increase was observed, followed by a reduction in SBP. This initial increase is due to the physiological response derived from increased cardiac output and stroke volume.

This response is a way for the body to meet the metabolic demand of exercise during the transition from a resting state to an active state, which occurs during exercise. However, these changes did not represent acute cardiovascular risks to hypertensive elderly individuals[8]. Thus, we can assume that the increase in SBP is necessary as it helps deliver nutrients through the cardiovascular system. This is justified by the increase in chemoreceptors and mechanoreceptors responsible for cardiovascular control during exercise[9,10].

Therefore, even though isometric exercise is still not widely recommended for hypertensive elderly individuals, some studies have reported it as a non-pharmacological treatment strategy due to its benefits. Inder et al.[11] demonstrated in their study a reduction of 10 mmHg and 5 mmHg in SBP and DBP, respectively. These findings contribute to a 40% lower risk of stroke and a 30% lower risk of cardiovascular disease mortality. As for DBP values, the changes in pre-training, post-training, and one hour after training were small. This can be explained by the regulation of the autonomic system during exercise, even with increased tension, due to the type of contraction used in the intervention (isometry).

It is expected that DBP does not change significantly during and after exercise, as it reflects the pressure in the arteries when the heart is in diastole[12]. These findings confirm the observations in DBP after a session of isometric exercise with large muscle groups, and over one hour, the values remained similar to baseline levels.

According to Richter et al.[13], aerobic exercise program in individuals with hyperreactive blood pressure induces a significant decrease in initial SBP (-5%), initial DBP (-4.6%), peak SBP (-12.4%), Peak DBP (-14.7%), final SBP (-4.6%) in the group. While the control group continued with its hyper-reactive behavior, which evolved to more exaggerated levels when comparing the results before and after the study

In Accordance to Souza et al.[14], the decrease in blood pressure after aerobic exercise has important clinical relevance and can last up to 24 to 48 hours after exercise, being related to the duration of aerobic physical exercise rather than its intensity. For a long time, it was believed that the increase in BP was directly related to the isometric component. However, studies with isometric exercise sessions have shown a reduction in BP. A meta-analysis indicated an average BP reduction of 12 mmHg SBP, thus surpassing the antihypertensive effects of aerobic exercise[12]. The study's hypothesis is that isometric exercise involves a large muscle mass and, when performed at low intensity in a combined form, represents an important volume of work, optimizing the post-exercise hypotensive effect.

Therefore, the present study contributes to the literature by investigating the effects of isometric exercise on BP in hypertensive elderly individuals. However, some limitations such as lack of a control group and sample size need to be considered, such as possible drug interactions since the study volunteers used various medications with different actions

in blood pressure control and the BP measurement period, which in the present study was 60 minutes. Future studies investigating different isometric exercise protocols, as well as longer periods regarding BP evaluation, may contribute to the results presented so far.

4 Conclusion

It can be concluded that the low-intensity isometric exercise protocol, alternated by segments, was able to reduce SBP. However, further randomized controlled trials are necessary to confirm and extend these findings. Thus, strength and conditioning professionals may have plus this non-pharmacological option to help control hypertension in older adults.

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