Does strength training using the super-set method cause post-exercise hypotension in elderly hypertensive patients?

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ABSTRACT

Traditional strength training can cause post-exercise hypotension in both hypertensive and normotensive elderly individuals; however, few strength training methods have been studied in this population. The aim of this study was to evaluate whether a strength training session using the super-set method in hypertensive elderly individuals causes post-exercise hypotension (PEH). This is a randomized, controlled clinical trial with a cross-over design, with a sample of 30 hypertensive elderly individuals of both genders who performed two protocols: an experimental protocol (EP), which consisted of a strength training session using the super-set method, or a control protocol (CP), which did not involve exercise. The order in which the protocols began was randomized among the participants. Seventy-two hours after completing the initial protocol, the participants performed the remaining cross-protocol. Blood pressure (BP) was measured before (Pre), immediately after (T0), and for 60 minutes, every 15 minutes (T15, T30, T45, T60). As a result, it was observed that SBP of the EP increased in intragroup analysis immediately after, but without significance in the intergroup comparison. Return to baseline at T15, with a reduction in SBP at subsequent times, but with a statistical intergroup difference only at T45 and T60. Regarding DBP, there was no significant difference in the intragroup comparison in any protocol; however, in the intergroup analysis, at T60 (p=0.043), DBP was lower in PE. Thus, we observed that strength training using the superset method, performed by elderly hypertensive individuals, although it tends to increase SBP immediately after exercise, this increase was of small magnitude. There was rapid recovery of SBP at subsequent moments, with a significant reduction in SBP from 30 minutes post-exercise, with post-exercise hypotension then being observed.

Keywords: Super-set strength training; Hypertension; Elderly.

INTRODUCTION

Systemic arterial hypertension (SAH) is considered a chronic systemic disease of concern, associated with major global health problems[1], both in terms of the number of people affected and premature mortality[2]. This disease can be characterized by a sustained increase in blood pressure (BP) above normal levels[3].

Some factors are identified as additional risks for the development of SAH, such as genetics[4] (Singh et al, 2016), gender[5] ethnicity, age, overweight, obesity[6], physical inactivity[7], alcohol, and smoking[8]. The prevalence of SAH in the elderly is higher, since the aging process itself causes vascular and cardiac changes that make individuals more susceptible, making age an immutable risk factor[9] .The aging process can, in isolation, cause various degenerative changes: physical, physiological, and psychological, in a natural and progressive manner as age advances, making humans more prone to developing various diseases, including SAH[10].

Contrary to the above situation, physical exercise can provide both acute and chronic physiological benefits[11], which are important for older adults. Among these, we can highlight improved physical fitness[18;]a reduction in the loss of lean body mass[12 ;]increased strength[13;]improved coordination and balance[14;]increased functional

capacity; and improved well-being and mood[15], in addition to a reduction in post-exercise blood pressure (BP) compared to pre-exercise levels[16], which reinforces the importance of studying different types and methods of training aimed at preventing and/or treating SBP.

In this regard, a previous clinical trial published by our group evaluated the effects of strength training after an acute strength training session. Thirty hypertensive elderly women were enrolled in the study, which used a crossover methodology and two protocols: Experimental (PE) with one strength training session, and control (PC) without exercise. BP was measured before, immediately after, and up to 60 minutes after the session, every 10 minutes. It was observed that SBP and DBP immediately after the session increased significantly, with no changes in BP in the CP. In the moments following the exercise, SBP showed a significant reduction from 10 to 60 minutes. This was observed for DBP; however, in the CP there was also a significant reduction for both SBP and DBP[17.]

There are few studies in the literature on elderly hypertensive individuals undergoing strength training, specifically under some method of strength training. Thus, the objective of this study was to evaluate whether a strength training session using the superset method in elderly hypertensive individuals generates post-exercise hypotension (PEH).

METHODOLOGY

A randomized clinical trial with a cross-over design was conducted at a gym and an exercise physiology laboratory. The research was submitted to and approved by the local research ethics committee, under opinion number 6,276,546. To select volunteers, we initially used a screening of the database of a city program for the elderly, and based on the inclusion-exclusion criteria, they entered the first stage of the analysis. These elderly individuals were then referred to a formal presentation of the research, where those interested in participating in the study signed an informed consent form (TCLE) and, after signing, underwent the planned assessments. Thirty hypertensive elderly individuals of both genders were selected.

The experimental protocol consisted of a strength training session using the superset method, involving six exercises focusing on large muscle groups in the lower and upper limbs, namely closed front pull, incline bench press, seated leg curl, leg extension, barbell curl, and triceps pull, lasting 55 minutes and divided into two periods: Joint warm-up period (~5 minutes), where 15 to 20 repetitions were performed, using 50% of the session load, in 3 exercises: Leg extension, bench press, and high pull with the bar. Main part (~50 minutes), with a strength training session using the superset method, which consisted of 3 sets of 10 repetitions, with a predetermined load of 75% of 1RM, respecting a 1-minute interval between exercises, in a superset methodology that consists of combining two exercises that are normally related to each other, in order to maximize the work of certain muscles. The principle is to move from one exercise to the next without any type of pause or rest[18] (Reis et al, 2014).

The control protocol consisted of a session of the same duration as the PE, lasting approximately 55 minutes, but without performing any exercise, also carried out at the same gym and under similar environmental conditions to the PE. During the CP session, participants could sit or stand as they wished, and were allowed to read, talk, and drink water, but were prohibited from exercising or eating.

The Statistical Package for the Social Sciences-SPSS 22 was used for analysis. The Shapiro Wilk test was used to assess the distribution of numerical data. The Student's t-test for paired samples (normally distributed data) and the Wilcoxon test (non-normally distributed data) were used to compare intragroup BP before the protocols (Pre) with the various points after the protocols: T0, T15, T30, T45, and T60. The same tests were used to compare intergroup crossings (PE vs. CP). The results were presented as mean and standard deviation, and $p<0.05$ was considered statistically significant.

RESULTS

The characteristics of the sample are summarized in Table 1 below. This is an elderly group diagnosed as overweight (BMI: 28.3 ± 3.81 kg-m2) with controlled BP. The low variance in the pre-study characteristics suggests sample homogeneity. Regarding medication, 50% (15) use beta-blockers, 46.6% (14) use angiotensin-converting enzyme (ACE) inhibitors, and 3.33% (1) use diuretics.

Table I - Sample characteristics.

Table 1 - Sample characteristics (n = 30)	
	Mean ± SD
Age (years)	72.10 ± 14.15
Body mass (kg)	73.07 ± 0.09
Height (m)	1.60 ± 3.81
Body Mass Index (kg/m^2)	28.3 ± 3.81
Systolic blood pressure	127.4± 24.48
Diastolic blood pressure	78± 11.55
Medications used	
Beta blockers	15
ACE inhibitors	14
Diuretics	0

Mean ± SD; BMI: body mass index.

Pre-study SBP showed a difference between protocols (p=0.002), although the mean was very close, with high standard deviation, but at controlled levels. Immediately after the protocols were performed, a significant intragroup increase in SBP was observed in the PE of 10.3%, but without significance in the intergroup evaluation. At minute 15, SBP returned to baseline, and in the subsequent minutes, post-exercise hypotension (PEH) was observed at all times. At minute 30, there was a significant reduction of 2.8%, mirroring this difference in the intergroup analysis (p=0.011), at minute 45 (5%), PEvs.PC, p=0.004, and at minute 60 (4.9%), PEvs.PC, p=0.001, as can be seen in Table 2 below.

Table II. Systolic blood pressure (SBP) before the sessions, immediately after, and every 15 minutes up to 60 minutes after the sessions.

	SBP		
Point	EP	CP	p (Between groups)

Pre	124.7±20.8	131.9±18.6	0
Min	137.5±18.7	132.7	0.053
Min	121.1	137.8±58.9	0.206
Min	120.2±16.7	126.6±19.0*	0.011
Min	118.4±15.7	129.6±21.4	0.004
Min	118.6±16.1*	129.8±16.9	0

*Variation in SBP relative to pre-point, intragroup (P<0.05)
Variation in SBP between groups (P<0.05)
Values expressed as means and standard deviations.
EP: experimental protocol; CP: control protocol

The pre-study PAD showed a difference between the protocols (P=0.014), with a small mean difference and high standard deviation, but also within controlled blood pressure levels. At all subsequent time points, in both protocols, there were no significant intragroup changes (p>0.05), but there was a tendency toward a 1.5% reduction in PE at minute 60. In relation to intergroup values, significant differences were identified at minute 45 (PEvs.PC, p=0.024) and at minute 60 (PEvs.PC, p=0.006), as can be seen in Table 3 below.

Table III. Diastolic blood pressure (DBP) before the sessions, immediately after, and every 15 minutes up to 60 minutes after the sessions.

	DBP		
Point	EP	CP	p (Between Groups)
Pre	77.1±11.0	79.9±9.0	0.014
Min	79.3±12.3	80.1±9.2	0.694
Min	77.8	78.7±9.1	0.635
Min 30	77.1	79.9±9.7	0.128
Min 45	74.8	79.9±9.5	0.024
Min	75.9	81.1±8.5	0

*Variation in PAD in relation to pre-point, intragroup (P<0.05)
Variation in PAD between groups (P<0.05)
Values expressed as means and standard deviations.
EP: experimental protocol; CP: control protocol

CONCLUSION

Thus, as a conclusion of this clinical trial, it was observed that although the study sample had control of BP prior to the study, they did not exercise and were diagnosed as overweight, which are also risk factors for other metabolic diseases. In the present study, there was a significant intragroup increase in SBP immediately after exercise, but this was not significant in the intergroup analysis. DBP did not change. This indicates, to a certain extent, that it is safe from a blood pressure standpoint for elderly hypertensive patients treated with medication to practice this method of strength training.Blood pressure reduced significantly ( ) 30 to 60 minutes after PE, with intergroup significance only at 45 and 60 minutes, evidencing PEH at these two time points. DBP showed only intergroup statistical differences, and only at 60 minutes after PE.

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BIBLIOGRAPHICAL REFERENCES

1. Anderson, Elizabeth, and J. Larry Durstine. "Physical activity, exercise, and chronic diseases: A brief review." Sports Medicine and Health Science 1.1 (2019): 3-10.
2. Aronow, W. S., Fleg, J. L., Pepine, C. J., Artinian, N. T., Bakris, G., Brown, A. S., … Wesley, D. J. (2011). ACCF/AHA 2011 Expert Consensus Document on Hypertension in the Elderly. Journal of the American Society of Hypertension, 5(4), 259–352. doi: 10.1016/j.jash.2011.06.001
3. Barroso, W. K. S., Rodrigues, C. I. S., Bortolotto, L. A., Mota-Gomes, M. A., Brandão, A. A., Feitosa, A. D. D. M., ... & Nadruz, W. (2021). Brazilian Guidelines for Hypertension– 2020. Brazilian Archives of Cardiology, 116, 516-658.
4. M. Singh, A.K. Singh, P. Pandey, S. Chandra, K.A. Singh & I.S. Gambhir (2016) Molecular genetics of essential hypertension, Clinical and Experimental Hypertension, 38:3, 268- 277, DOI: 10.3109/10641963.2015.1116543
5. Henry, S. L., Barzel, B., Wood-Bradley, R. J., Burke, S. L., Head, G. A., & Armitage, J. A. (2012). Developmental origins of obesity-related hypertension. Clinical and experimental pharmacology and physiology, 39(9), 799-806.
6. Concha, Alejandro Tavera, and Franklin Alejandro Rico Mendoza. "Sedentarism, a modifiable risk factor for developing chronic kidney disease in healthy people." *Korean Journal of Family Medicine* 43.1 (2022): 27.
7. Venkataraman, R., Satish Kumar, B. P., Kumaraswamy, M., Singh, R., Pandey, M., Tripathi, P., ... & Dahal, P. (2013). Smoking, alcohol and hypertension. *International Journal of Pharmacy and pharmaceutical sciences*, *5*(4), 28-32.
8. Jan;29(1):43-47. PMID: 31915334.
9. Oliveira, A. S. Demographic transition, epidemiological transition, and population aging in Brazil. Hygeia - Brazilian Journal of Medical and Health Geography, Uberlândia, v. 15, n. 32, p. 69–79, 2019. DOI: 10.14393/Hygeia153248614.
10. WHYTE, J. J.; HAROLD LAUGHLIN, M. The effects of acute and chronic exercise on the vasculature. **Acta physiologica**, v. 199, n. 4, p. 441-450, 2010.
11. Caspersen, Carl J., Kenneth E. Powell, and Gregory M. Christenson. "Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research." Public health reports 100.2 (1985): 126.
12. Aguirre, Lina E., and Dennis T. Villareal. "Physical exercise as therapy for frailty." Frailty: Pathophysiology, phenotype and patient care 83 (2015): 83-92.
13. Ralston, Grant W., et al. "Weekly training frequency effects on strength gain: a meta-analysis." Sports medicine-open 4 (2018): 1-24.
14. Wooton, Angela Conrad. "An integrative review of Tai Chi research: an alternative form of physical activity to improve balance and prevent falls in older adults." Orthopaedic Nursing 29.2 (2010): 108-116.
15. Sarasso, Elisabetta, et al. "Virtual reality balance training to improve balance and mobility in Parkinson's disease: a systematic review and meta-analysis." Journal of neurology (2021): 1-16.
16. Fountoulakis KN, O' Hara R, Iacovides A, Camilleri CP, Kaprinis S, Kaprinis G. Unipolar lateonset depression: a comprehensive review. Ann. Gen. Hosp. Psychiatry., 2003;2: 1-14.
17. Pescatelo LS, Franklin BA, Fagard R, Farquhar WB, Kelly GA, Ray CA. American College of Sports Medicine Position Stand. Exercise and hypertension. Med. Sci. Sports Exerc. 2004;36(3): 533-53.

18. Reis, J. P. C. D., Almeida, K. D. S., Souza, R. A. D. S., & Sousa, M. S. S. R. D. (2015). Effect of resistance training at different intensities on blood pressure in hypertensive individuals. *Int. j. cardiovasc. sci.(Impr.),* 25-34.