EFFECTS OF MODERATE-INTENSITY RESISTANCE EXERCISE ON BLOOD PRESSURE IN HYPERTENSIVE INDIVIDUALS

Marya Rahmani Ghobadi,[1, A, B] Rastegar Hoseini,[2, C, E] Zahra Hoseini[3, B, D]

[1] Department of Physical Education and Sport Sciences, Damavand Branch, Islamic Azad University, Tehran, Iran
[2] Department of Sport Science and Physical Education, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran
[3] BSc Student of Physical education & sport sciences Student, Faculty of Physical Education and Sport Sciences, University of Guilan-Rasht, Iran
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation; [E] Funds Collection

Address for correspondence:
Marya Rahmani Ghobadi
Department of Sport Science and Physical Education, Damavand Branch, Islamic Azad University, Tehran, Iran
P.O.Box.1445764436
Email: Rahmani.damavand@gmail.com

Abstract The purpose of this study was to evaluate the effects of moderate-intensity resistance exercise on postexercise hypotension (PEH) in the hypertensive. The study was conducted with eighteen hypertensive elderly individuals (20–30 years). They were subjected to two experimental sessions: control session (SC) and 50% (S50%) of 1RM. For each session, subjects were evaluated pre-and postintervention. In the preintervention, the blood pressure (BP) and FVR were measured after 10 min of rest. Thereafter, they were taken to the gym to perform the exercise sessions or remained at rest in each of the equipment during the same time. In the S50% group was composed of a set of ten repetitions of ten exercises, with an interval of 90 s between exercises. Subsequently, the FVR and BP measurements were again performed at 15, 30, 45, 60 and 75 min of recovery (postintervention). The PEH was greater in S50% compared with SC, with the lower value of BP being found at 75 min of recovery for the two sessions (systolic BP: 125.21 ±0.98mmHg versus 145.45 ±1.72 mmHg; diastolic BP: 83.60 ±1.67 mmHg versus 95.14 ±0.74 mmHg respectively). Moderate-intensity resistance exercise was effective in promoting PEH, this phenomenon being accompanied by a reduction in FVR within the first minute of recovery in the hypertensive young.

Key words blood pressure, exercise, postexercise hypotension

Introduction

Hypertension is associated with increased risk of mortality from all causes and from cardiovascular disease (Godinas et al., 2016). It is related to metabolic, hormonal and trophic phenomena, being classified as a polygenic illness (Chobanian et al., 2003; Pimenta, Oparil, 2012). In Iran, this disease affects about 30–50% of the population, reaching levels higher than 55% in the elderly, one of the most affected groups (Rezazadehkermani, 2008; Farzadfar et al., 2012). Hypertensive individuals have an increased blood flow and vascular conductance at rest, which reduce its vasodilator reserve, with consequent alteration of vasodilator responses (Medeiros et al., 2011). Increased age, associated with genetic and environmental factors, augment the likelihood of changes in vascular adaptive capabilities. Concomitantly, it is already evident in the literature that regular physical activity can prevent these undesired changes (Green et al., 2011). The ability of exercise to reduce blood pressure (BP) is well established. Although most studies show that aerobic exercise promotes greater pressure reductions compared with resistance exercise (RE). One of the possible mechanisms of this reduction would be an improvement in vasodilator function (Fernandes et al., 2011). But, recently, resistance exercise training (RT) has been recommended as part of a well-rounded exercise program by the American Heart Association and the American College of Sports Medicine to maintain or increase skeletal muscle strength and to prevent osteoporosis (Haskell et al., 2007), cardiovascular disease (Williams et al., 2007). Despite the research already carried out so far have investigated the effects of resistance exercise on BP, there are obvious gaps concerning the best prescription of RE, because of the diversity and variations in the protocols of research with respect to intensity, number of sets, interval, method of BP measurement and, principally, concerning to population and what mechanisms are involved in postexercise responses (Papathanasiou et al., 2015; Young et al., 2014). Once the RE is associated with metabolites production, these can promote muscle vasodilatation, reduced peripheral vascular resistance and BP. Thus, it is pertinent and relevant to investigate the hemodynamic effects of a session of moderate-intensity resistance exercise in elderly hypertensive patients. Therefore, the main aim of this study was to evaluate the moderate-intensity RE effects on blood pressure in hypertensive overweight patients.

Method

The study was conducted with eighteen young patients with mild hypertension, according to the classification proposed by the ACSM (Pescatello et al., 2004). All were physically active and participated regularly for at least 3 months of the program of resistance exercise in the gym at the Damavand Islamic Azad University of Iran. To participate in the study, they should have had a minimum age of 20 and maximum of 30 years, assiduously practicing physical exercise three or more times per week, presenting only hypertension as cardio metabolic disease and use only the drug class of angiotensin-converting enzyme inhibitors and diuretics. The subjects' characteristics are shown in Table 1. All participants were informed about the procedures that would be made in data collection and, prior to their participation, signed consent pursuant to resolution 162/11 of National Health of Iran for human experiments. All of them agreed to participate in the methodological procedures proposed in the research, approved by the ethics committee of the Center for Health Sciences UFPI, under protocol number 112/15. Considering that classically resistance training protocols to promote postexercise hypotension (PEH) in hypertensive individuals were performed with mild to moderate intensity, The subjects were randomly divided into two groups (experimental and control) (www.randomizer.org).The sessions consisted of ten exercises, in which it was performed with one set ten reps, in loads of 50% of 1 RM and with an interval of 90 s between exercises (Pescatello et al., 2004). BP, heart rate (HR), forearm vascular resistance (FVR) and FBF were evaluated before and after each experimental session. Before the experimental sessions, the young underwent a familiarization session (a series of ten repetitions of each exercise with the minimum weight allowed by the machines). Three days later, they underwent a 1 RM test to leg extension, front pulley, leg 45, fly, knee flexion, low row, adductor, triceps, plantar flexion in the leg 45 and biceps following the protocol (Kraemer et al., 1995). Seven days later, we performed a retest to legitimize the validity of previous results. The maximum weight was considered to be the major load in either of 2 days. Hypertensive patients underwent two experimental sessions: control session (CS) and exercises with three sets at 50% 1 RM

(S50%), always performed between seven and nine o'clock in the morning and at an interval of at least 7 days. The order was determined individually and randomly using the website Research Randomizer (www.randomizer.org), so that each subject had their own order to carry out the three study sessions. Before the study, all were instructed to not perform physical activities 48 h before the experimental sessions. For each session, subjects were evaluated pre-and postintervention. In the preintervention, at rest in the supine position was recorded the BP. They were later taken to the gym, where they remained for about 20 min to perform the exercise sessions (S50%) or CS, which remained at rest in each of the equipment during the same time of the sessions exercise. The S50% group followed the protocol of Pescatello et al. (2004) for variables such as intensity, number of repetitions, time interval and number of exercises, differing only in exercise workload. Thus, the elderly performed one set of ten repetitions of ten exercises mentioned above, with a 90 s interval between exercises for loads of 50% of 1 RM. During the execution of the sessions, the Valsalva manoeuvre was constantly discouraged, without any stimulus to motivate the subjects. In sequence, they returned to the laboratory for the postintervention period where, positioned in the supine position, measurements for FBF and BP were performed at five times over 90 min of recovery. After a 5-min rest in the seated position, BP was measured three times during two different visits to the laboratory. On the occasion of each visit, BP was measured by the same experienced observer using a standard mercury sphygmomanometer (ALPK2, Japan), taking the first and the fifth phases of Korotkoff sounds as SBP and DBP values, respectively. Participants were excluded if the average of the last two values obtained during each visit for SBP and DBP was greater than 139 and 89 mmHg, respectively. To determine heart rate, an electrocardiogram (ECG) was used. Three electrodes were placed in the patient's chest, in D2 position. The acquisition and visualization of the ECG signal was obtained through WINDAQ Acquisition software (WinDaq DI-720; Dataq Instruments Inc). The final data analysis was carried out using SPSS-19 (version 19; SPSS Inc., Chicago Illinois, USA).After confirming of normal distribution of the variables using by the Kolmogorov-Smirnov (K-S) test. Data were statistically analyzed by dependent t-test, independent t-test and two-way ANOVA for repeated measures. Data are presented as mean ± SE. Significance for all analyses were set at $P < 0.05$.

Results

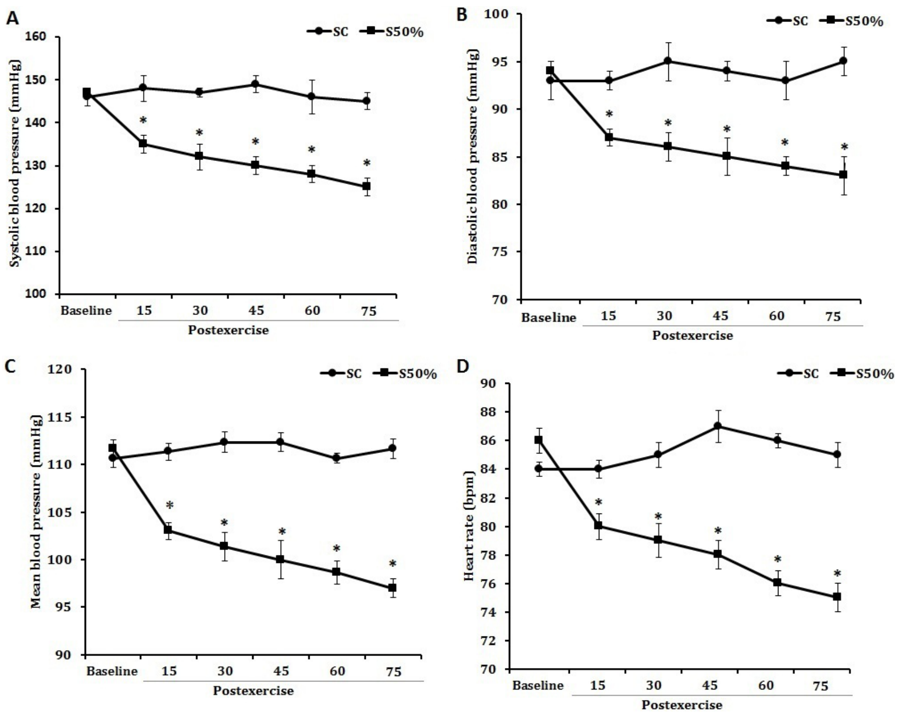
During the days of experimental procedures, subjects presented similar baseline values for BP and HR, being not identified any statistical difference between the sessions. Data summarized in Table 1.

Table 1. Hemodynamic characteristics of subjects

Variables	Groups		PV[a]
N	CS	S50%	
1	2	3	4
SBP(mmHg)			
Before	146.31 ±2.96	147.72 ±3.97	0.068
After	145.45 ±1.72	125.21 ±0.98	0.001†
PV[b]	0.201	0.002*	
DBP(mmHg)			
Before	93.45 ±0.86	94.69 ±0.96	0.065
After	95.14 ±0.74	83.60 ±1.67	0.001†
PV[b]	0.323	0.001*	
MBP(mmHg)			

1	2	3	4
Before	110.33 ±0.96	111.30 ±0.056	0.481
After	111.33 ±0.026	97.35 ±0.022	0.046†
PV[b]	0.749	0.154*	
HR (bpm)			
Before	84.03 ±0.91	85.12 ±1.033	0.928
After	85.04 ±1.021	75.11 ±0.88	0.002†
PV[b]	0.501	0.001*	

CS – control session; **S50%** – resistance exercise session with 50% RM; **SBP** – systolic blood pressure; **DBP** – diastolic blood pressure; **mmHg** – millimetres of mercury; **HR** – heart rate; **bpm** – beats per minute; **MBP** – mean blood pressure. Data are presented as mean ± standard deviation. ***** – significantly different in comparison pre and post-test within the groups; **†** – significantly different in comparison with pre and post-test between groups; **P** – statistical value; **a** – the values are calculated using independent t-test and **b** – the values are calculated using paired t-test.



CS – control session; **S50% –** resistance exercise session with 50% RM; *** –** significantly different in comparison with pre and post-test between groups. The values are calculated using two-way ANOVA for repeated measures test.

Figure 1 (A, B, C and D). Comparison of mean ± SD of variables between the groups

The systolic blood pressure, diastolic blood pressure, mean blood pressure and heart rate have been shown in the Figures 1 (A, B, C and D). Two-way ANOVA for repeated measures test showed a significant difference in systolic blood pressure, diastolic blood pressure, mean blood pressure and heart rate between CS and S50% groups. The resistance exercise session with 50% RM compared with control session significantly caused reduction in systolic blood pressure (125.21 ±0.98 mmHg versus 145.45 ±1.72 mmHg; Figure 1, A), diastolic blood pressure (83.60 ±1.67 mmHg versus 95.14 ±0.74 mmHg; Figure 1, B), mean blood pressure (97.35 ±0.022 mmHg versus

111.33 ±0.026 mmHg; Figure 1, c), and heart rate (75.11 ±0.88 mmHg versus 85.04 ±1.021 mmHg; Figure 1, D). However, the exercise protocols with intensities of 50% of 1RM were able to promote hypotension in the moment of postexercise recovery.

Discussion

The main findings of this study are (i) moderate-intensity RE are able to promote PEH with significant magnitude in hypertensive young patients, (ii) this magnitude was significantly higher when compared to RE performed with SC. In spite of RE increasingly gaining notoriety for its ability to promote reduction of BP after exercise, making assertions about the best prescription for this type of exercise in promoting PEH is still something rash. This stems from the wide variety of experimental designs reported in the literature on differences in training models (conventional or circuit), time interval (30–120 s), intensity (medium to high), number of repetitions (8–20), number of exercises, analytical methods for measuring BP (clinic, ambulatory) and sample (young, middle-aged adults, elderly, healthy and/or hypertensive) (Anunciação, Polito, 2011; Cardoso Jr et al., 2010; Bruneau et al., 2015). Thus, generalizations are inappropriate. Although the existence of other studies using the young as the sample population, most of them were conducted with healthy subjects and in isometric or isokinetic resistance training (Maior et al., 2015; de Freitas Brito et al., 2014). Studies using resistance training in the young are scarce. In this way, our findings represent an important contribution to explain how RE may benefit the hypertensive young.

To date, studies investigating moderate-intensity exercises and its hemodynamic effects have only been performed in normotensive elderly individuals. Rezk et al. (2006) and Brown et al. (1994) observed similar PEH between moderate intensity exercises (Rezk et al., 2006; Brown et al., 1994). In contrast, O'Connor et al. (1993) and Focht, Koltyn (1999) did not observe this phenomenon (O'Connor et al., 1993; Focht, Koltyn 1999), while Simão et al. (2005) found differences in the hypotensive responses (Simão et al., 2005). To DBP observed in the present study, a significant reduction in all moments of post-exercise recovery, this behavior being not observed by other authors (Mediano et al., 2005; Rezk et al., 2006; Moraes et al., 2007). Only the study by Melo et al. (2006) observed similar behaviour as found in this study(Melo et al., 2006). As stated by Fisher (2001), these contrasting results can be attributed to different baseline BP in studies (Fisher, 2001), as different population groups (normotensive and hypertensive varying degrees) respond differently to exercise (Halliwill, 2001). Additionally, the intensity of exercise used varied from one study to other. Another interesting argument to elucidate this question is provided by Gotshall et al. (1994), affirming that the subject's position during the recovery period influences the pressure responses (Gotshall et al., 1994). The orthostatic stress imposed in the seated position, position used in various trials, could reduce venous return and cardiopulmonary reflex, resulting in increased peripheral vascular resistance and consequently the DBP. In subjects, hypertension is usually associated with reduced cardiac output (or even normal), and a combination of peripheral vascular resistance and decreased vascular compliance (Grobbee, Hofman, 1986). To our knowledge, this is the first study that aimed to investigate the mechanisms involved in post resistance exercise hypotension in the hypertensive young. The suggesting that the reduction in BP, but possibly by decreasing venous return; basically, two factors may explain these different results. First, the fact that the population of our study consisted of hypertensive young patients, which could allow a better response to exercise than normotensive subjects. Second, we use only one set of ten repetitions with moderate – intensity. Thus, we conjecture that, for moderate intensity, a resistance exercise session that takes a smaller number of sets may be more effective in promoting a minor component of sympathetic activity after exercise in hypertensive elderly patients. Thus, although the cardiovascular repercussions prove beneficial, it is necessary to investigate whether hypertensives can keep a training protocol with moderate loads for several sessions without symptoms of chronic fatigue. These issues constitute a line of future research to provide effective and safe methodologies on the prescription of resistance training for the young. The present study has some limitations. First, only the clinical behaviour of BP was measured. Although BP measured in clinical laboratory is the classical form of diagnosis and assessment of BP, ambulatory BP (characterized by measurements throughout the day) has been shown to be a better predictor of target organ damage (Perloff et al., 1983). Second, subjects performed repetition maximum tests (RM) for homogenization of training intensity in the different exercises. The RM test for hypertensive patients should be discouraged due to the risk of stroke, a result of the sudden increase in BP during activity. Thus, the results obtained in this study cannot be played with different loads or repetitions. In this context, we can infer that a single session of moderate-intensity RE is able to promote PEH in hypertensive young patients, being this phenomenon accompanied by a reduction in forearm vascular resistance.

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