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RESEARCH ARTICLE

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MAXIMAL AND SUBMAXIMAL STRENGTH EXERCISEDID NOT ALTER BLOOD PRESSURE IN HEALTHY YOUNG AFTER SESSION

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ABSTRACT

Strength training (ST) is highly recommended for international institutes to promote health improves. Additionally, after ST any studies have evidenced hypotension post-exercise (HPE), however it is not a consensus. The objective of this study was to investigate the subacute blood pressure (BP) impacts after a maximal and submaximal strength exercise session in healthy young. This was an experimental study, in a randomized crossover design carried out on 39 heath untrained young 20.8±2years, 64.0±10.9kg, 170.2±7.09cm e 21.9±2.4 kg/m2. After a maximal and submaximal strength test in 3 exercises: Biceps curl, Bench press, and knee extension, the participants carried out 3 protocols: Maximal Protocol (MaxP), Submaximal Protocol (SubP) and a Control Protocol (CP). In the MaxP, the individuals carried out 3sets of 1 Repetition Maximum (RM); in the SubP carried out 3sets of 10RM; and CP did not exercise. Immediately after each protocol, the BP was measured, and in 10, 20 and 30 minutes after. The systolic BP increased immediately after both exercise sessions, but without significance. In the other moments, the BP did not alter.

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INTRODUCTION

The blood pressure (BP) response to the aerobic exercise is largely related in the literature, but the strength training (ST) need more investigation due to many variables that have be controlled for ST prescription or execution (Garber *et al.,* 2011; Pollock *et al.,* 2000).The guidelines for prevention and management of the hypertension still are very superficial when talking about ST prescription (Barroso *et al.,* 2021; Herdy *et al.,* 2014), and differing information is found regarding the impact of ST in the BP. An increase in BP (O'Connor *et al.,* 1993; McDougal *et al.,* 1985; Mediano *et al.,* 2005), a decrease in BP (Fisher *et al.,* 2001) and no change (Roltsh *et al.,* 2001; Cunha e Jardim, 2012) are all reported. The ST presents many benefits like the increase of the strength (Radaelli *et al.,* 2015), hypertrophy (Radaelli *et al.,* 2015), bone mass (Bolam *et al.,* 2015), help to weight loss(Paoli *et al.,* 2012) that contribute for increase or maintain the people health and quality of life. However, there are many variables for control in an ST prescription, that can influence BP response such as volume (Faraji *et al.,* 2010; Mediano *et al.,* 2005), intensity (Cavalcante *et al.,* 2015; Rezk *et al.,* 2006), muscle size (Mitchell *et al.,* 1980; Battagin *et al.,* 2010), sets (Figueiredo *et al.,* 2015); repetition (Souza *et al.,* 2010; McDougal *et al.,* 1985), recovery (Polito *et al.,* 2004). The ST presents peculiarities in relation to other exercises, because it is characterized not only by the dynamic component of muscle contractions that are similar to the aerobic stimulus, but also by an isometric component that is especially active whenever heavy loads are used. This component can increase the vascular strength, which may exacerbate the increase in BP during exercise (McDougal *et al.,* 1985; Souza *et al.,* 2010). The classic study of McDougal *et al.* (1985) tested bodybuilders that carried out any sets of strength exercises in heavy loads, and the results were incredibly high during execution. The BP mean values were 350x250mmHg, in systolic blood pressure (SBP) versus diastolic blood pressure (DBP), respectively. So, it is important to know the BP effects in the different intensities, objecting to construct major parameters for ST indication or contraindication, mainly for special groups, like hypertensive people. Thus, the objective of the study was toinvestigate the subacute blood pressure (BP) impacts after a maximal and submaximal strength exercise session in healthy young, in an experimental study, randomized crossover design, carried out on 39 healthy untrained young. We hypothesized that the ST will increase the BP in both exercise protocols similarly.

MATERIAL AND METHODS

This was an experimental study, in a randomized design, developed in Multi-sport Center, and in an Exercise Physiology Laboratory. The study conforms to the provisions of the Declaration of Helsinki and was approved by the Research Ethics Committee (0013.0.177.000-10). All subjects read and signed the informed consent before participation in the study. The sample consisted of 39 healthy untrained young, after general invitation for academics, by institutional folders and verbal invitation in a public university of the city. Inclusion criteria consisted of age between 18 and 25 years, non-participation in structured exercise programs for at least 3 months, blood pressure within normal range (SBP < 140mmHg and DBP < 90 mmHg). Subjects which presented body mass index ≥ 30Kg/m^2, physical or mental conditions limiting physical exercise, diabetes mellitus, cardiovascular, renal or hepatic diseases, or any other were excluded. The study protocol included one visit to our laboratory before to start protocols, at least 48-hours apart. The study procedures were explained to potential participants. On the visit, the participants' medical history was taken and a physical assessment was carried out (height [m], body mass [kg], body mass index [kg/m^2]). After, the repetition maximum tests were performed, 48h-apart between 1RM and 10RM test session. To begin the study, all participants underwent a 10RM test and a 1RM test, forty-eight hours-apart, in a randomized way, where the sequence was decided by a lot. The tests defined the load to be used in the experimental protocols. This was done in the strength training room of the institutional multisport center for the following exercises: knee extension machine, biceps curls and bench press machine. The 1RM testing protocol was described by Kraemer and Fry (1995), and the 1RM testing protocol was described by Fleck and Kraemer (2007). To minimize the error during the RM tests, the following any strategies were adopted (Simão *et al.,* 2007): standardized instructions concerning the testing procedures were given to participants before the test; standard verbal encouragement was provided during the testing procedure. Forty-eight hours apart the finishes of the RM tests, the participants were randomized, by a lot, for begin one protocol: 1) Maximal Protocol (MaxP), 2), Submaximal Protocol (SubP), and Control Protocol (CP). In all research moments the participants were encouraged to avoid smoking, alcohol and caffeine consumption, as well as unusual physical activity before each trial. The protocol sequence was randomized, by a lot, with 48-hours-apart. The research procedures occurred in the same time of the day (9:00am).

Control protocol (CP) – This protocol consisted of a session identical to the experimental protocols but without exercises. The participants (n=39) did not exercise, but had BP measurements carried out in estimated similar times of the exercise protocols. The participants were allowed to sit or stand, drink water, go to the bathroom or talk, but were not allowed to ingest any food or caffeine. Maximal Protocol (MaxP) – This protocol was carried out in the strength training room of the Multi-sport Center. It consisted of a strength exercise session with 3 sets of 1 repetition with a 1 RM load and two-minute intervals between the sets. Machine knee extension, biceps curl and machine bench press exercises were performed. All participants were discouraged from performing the Valsalva maneuver. Submaximal Protocol (SubP) – This protocol was carried out in the strength training room of the Multi-sport Center. It consisted of a strength exercise session with 3sets of 10 repetitions with a 10 RM load and two-minute intervals between the sets. Machine knee extension, biceps curl and machine bench press exercises were performed. All participants were discouraged from performing the Valsalva maneuver. The BP was measured with the individual seated using the Omron 705-CP semiautomatic apparatus, scientifically validated (Gomes, 2003), and following techniques adopted by The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (Chobanian *et al.,* 2003). The BP was measured before the session (Pre); immediately after (minute 0); 10 minutes (Minute 10); 20 minutes (Minute 20); and 30 minutes (30 Minutes) after session. The measurements were repeated at 2-minute intervals and the mean was calculated. For statistical analysis was used SPSS (v.22.0). Descriptive data (mean ± SD, standard deviation) was used to characterize the study sample. To analyze the distribution and assess the normality of numerical data, the Shapiro-Wilk test. BP were analyzed between the groups at the pre-exercise time and with the control session by one-way ANOVA, considering a $p<0.05$ for significant differences.

RESULTS

The population under study (n=39, 20 males) presented 20.8±2years, 64.0±10.9kg, 170.2±7.09cm, 21.9±2.4 kg/m^2, SBP: 112.2±11.1mmHg, DBP: 66.7±8.2mmHg, values that did not differ between genders (data not presented). The 1RM loads was 41%, 35% and 48% higher than 10rm loads, for biceps curl, bench press and knee extension, respectively. The absolute loads tested in the 10RM test and 1RM test can be observed in the Table 1.

Table 1. Loads for 1 repetition maximum and 10 repetitions maximum

	1 RM	10 RM
Biceps Curl	24.8±5.5	17.5±4.2
Bench Press	44.6±6.1	32.9±9.9
Knee Extension	44.8±9.6	30.1±8.6

Load in kg

The table 2 show that BP increased after 2 exercise protocols in minute 0, but without significance. After, the BP mean was similar to baseline values in both protocols. The intergroup analyzes did not show significance for all moments. The CP did not change.

Table 2. Blood pressure before, and after protocols 0, 10, 20 and 30 minutes

Moments	BP	maxP	subP	CP	p
		x(*s*)	x(*s*)	x(*s*)	
Baseline	SBP	111.4	109.7	113.9	ns
	(mmHg)	(15.5)	(23.7)	(16.4)	
	DBP	65.8	66.3	66.9	ns
	(mmHg)	(7.2)	(7.4)	(9.0)	
Min. 0	SBP	118.1	121.8	113.6	ns
	(mmHg)	(17.5)	(17.5)	(15.5)	
	DBP	65.5	63.1	67.7	ns
	(mmHg)	(8.5)	(7.6)	(9.4)	
Min. 10	SBP	111.7	114.17	111	ns
	(mmHg)	(13.6)	(16.9)	(17.1)	
	DBP	66.5	63.2	66.8	ns
	(mmHg)	(9.5)	(8.5)	(9.2)	
Min. 20	SBP	110.9	110.3	109.8	ns
	(mmHg)	(14.7)	(16.4)	(15.9)	
	DBP	66.1	63.8	66.4	ns
	(mmHg)	(7.5)	(9)	(8.7)	
Min. 30	SBP	110.5	110.1	112.6	ns
	(mmHg)	(16.8)	(15.4)	(14.5)	
	DBP	67.8	65.1	68.4	ns
	(mmHg)	(8.3)	(8.3)	(9.4)	

Intragroup comparisons presented $p>0.05$; ns: No significance intergroup ($p>0.05$)

DISCUSSION

This was an experimental study, in a crossover randomized design that assessed the response of the BP immediately after different loads in the strength exercise sessions in healthy young. The main finding of this study was that the different intensities, in maximal and submaximal strength exercises sessions increased SBP immediately after session in both exercise protocols, but without significance. The other moments the BP are similar to baseline. A total of fourth-five participants started the study, but six were excluded because they did not complete the protocols, resting a total of 39 participants (20 men; 19 women). Similar to our results, Rodriguez et al. (2008) carried out a study with trained men with 30±0.7 years, where they performed intense strength exercise sessions, with different methods of training, with 3 groups: multiple set group; Tri-set group; and control group. The experimental groups performed 3 sets of 10 repetitions for the same exercises (bench press, cross-over, peck-deck and lat pull-down, seated cable row and barbell row), with 1 minute rest interval, with its respective method of training. After sessions, there were no significant alterations for Systolic and Diastolic BP. Different from ours, Roltsch et al. (2001) evaluated the ambulatory BP for acute strength exercises in 36 healthy young, male and female, sedentary, trained in strength exercises or endurance exercises. They carried out a session of strength exercise with 2 sets of 8-10 repetitions, 10RM, in 12 exercises, and observed that the BP were identical between sedentary, strength-trained and endurance-trained participants. In the first hour the BP did not alter comparing exercise day and control day.

Cunha e Jardim(2012) examined the effects of 3 sets of 10RM in 6 exercises, with 1 minute rest, in strength exercises in elderly hypertensive untrained participants, and observed the same result from ours, the systolic BP increased immediately after in the minute 0, without significance, and the other moments were similar to baseline. There were no significance between experimental and control group. Interestingly, McDougallet al. (1985) investigated the effects of different intensities in only one set in healthy young bodybuilders. The BPwas directly recorded by means of a capacitance transducer connected to a catheter in the brachial artery, in exercise for arms and legs. The BP increased in all situations during execution of strength exercises, but immediately after the end, the BP decreased from similar baseline values. This information can help to explain, at least in part, the no alteration of the BP found in our study, evidencing a fast adaptation of BP adaptation after the stimulus in this young healthy public. Other important fact about McDougall et al study, and our study, was the limited strength sets and exercises, that probable limited the cardiovascular stress, and BP increases (in the first minutes) and decreases (HPE in the other moments). The different acute BP effects to strength exercises found in various studies (Cunha e Jardim, 2012; Rolstch et al., 2001.; Rodriguez et al., 2008) may be associated to innumerable researchrelated variables (way of measuring blood pressure; age; use or non-use of drugs; follow-up period after exercise; type of exercise prescription and state of training). It is thus a difficult task to compare these studies since their methodological characteristics are so varied.

The present study presents some limitations suchthe indirect BP measurement method, which has a tendency to underestimate the BP values when measured by the auscultatory method or by direct method (arterial catheter), both during and after exercise.The environment where the protocols were carried out did not present possibilities of a major control. However, it is important to point out that the study was conducted under a typical scenario of the population's training reality, using validated devices, however, feasible to exercise professionals in their daily lives.

CONCLUSIONS

In conclusion, the strength exercise carried out in different intensities, in maximal e and submaximal protocols, for healthy untrained young increased the SBP without significance, and the BP in other moments did not alter, presenting similar responses after sessions comparing to CP. The state of training, age, type of strength training prescribed are directly linked to our results, and more studies are necessary, manipulating these variables, aiming to better understand the effects during and after maximal and submaximal strength exercises sessions.

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