Original Article

Post resistance exercise hypotension on distinct types of somatotype characteristics

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ABSTRACT

The aim of this study was to verify the post-exercise hypotension phenomenon on two distinct somatotype. For this purpose, twenty-four normotensive trained men (23.2 ± 2.91 years; 73.78 ± 4.53 kg; 177.16 ± 5.73 cm; 23.58 ± 2.18 kg/m2) were divided into two groups (mesomorph and ectomorph). All subjects performed two 10-repetition maximum load test sessions (test and retest) for a whole-body workout routine of resistance exercises. After the load tests, subjects performed sessions structured for 3 sets of each exercise with loads of 85% of 10-repetition maximum loads with 2-min of rest between sets of exercises. The two-way ANOVA showed the same reduction pattern (p = 0.001) in post-exercise systolic blood pressure for both groups. Additionally, a prolonged reduction was observed only on the systolic blood pressure of the mesomorph group following the 10-min (Δ = 13.41%; ESs = 2.08) up to 60-min post-exercise (Δ = 5.64%; ESs = 0.89). However, the same kinetics were not observed in the ectomorph group, the reduction was found only at the 10-min post-exercise time point (Δ = 5.55%; ESs = 1.12). On the other hand, no significant differences were found between groups for any diastolic blood pressure post-exercise time points. In conclusion, our data

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suggest that regardless the somatotype (mesomorph or ectomorph) a similar post-exercise hypotension phenomenon for systolic blood pressure was observed. However, it is important to highlight that those individuals classified as mesomorphs remained with a reduced systolic blood pressure about 60 minutes after performing exercise, which did not occurred in the ectomorph group. **Key words:** STRENGTH TRAINING, BLOOD PRESSURE, PHYSICAL FITNESS, BODY TYPES.

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INTRODUCTION

Systemic arterial hypertension is acknowledged as an independent risk factor for stroke, coronary artery disease, and kidney failure (Rosendorff et al., 2007). Physical exercise has been recommended as an effective non-pharmacological strategy for preventing and controlling hypertension (American College of Sports Medicine, 2004; Vasan et al., 2001).

Recently, new epidemiologic data strongly recommends the inclusion of resistance exercise (RE) routines in physical activity regimens for reduced risk of several cardiovascular diseases and type 2 diabetes, independent of aerobic exercise (Shiroma et al., 2017). In Addition, it seems that for an adult diagnosed with hypertension, RE may elicit blood pressure reductions that are comparable or even greater than those reportedly achieved with aerobic training (MacDonald et al., 2016).

There is evidence that the chronic reduction in blood pressure can be associated to the acute decrease after exercise (Kelley and Kelley, 2000). This response to RE sessions induces an acute reduction in blood pressure, which is usually referred to as the post-exercise hypotension (PEH) phenomenon. Accordingly, it has been demonstrated that RE workout sessions can trigger decreases in both systolic (SBP) and diastolic blood pressure (DBP) by 3.0 to 3.5 mmHg approximately 60-minutes post-exercise (Cornelissen and Fagard, 2005; Cornelissen et al., 2011).

The hypotensive response to acute RE seems to be affected by different combinations of training manipulation or even anthropometric characteristics (Cornelissen and Fagard, 2005; Cornelissen et al., 2011; Polito et al., 2003; Senna et al., 2016; de Salles et al., 2010; Simão et al., 2005; Polito and Farinatti, 2009). For instance, it has been shown that exercise intensity influences duration, but not the magnitude of PEH itself (Simão et al., 2005; Polito and Farinatti, 2009). Additionally, some previous research suggests that the amount of exercised muscle mass may also be a determining factor when considering the acute PEH after a RE session.

Somatotype is an indirect measurement intended to estimate body composition. It is based on three components: endomorph (ENDO; adiposity), mesomorph (MESO, development of the musculoskeletal system) and ectomorph (ECTO, body linearity) (Carter and Heath, 1990). The components of the somatotype may be related to anthropometric, biochemical and functional comparisons, or environmental variables such as lifestyle and living conditions (Toselli, Graziani and Gruppioni, 1997). In fact, the somatotype is used as a measurement in multiple applications, as in sports (Gutnik et al., 2015), lifestyle and health measurements (Pereira et al., 2017), and even in exercise physiology (metabolism) (Galić et al., 2018).

High blood pressure (a risk factor for cardiovascular disease) is directly associated with body mass index, endomorph, and mesomorph state in adults (Gerber and Stern, 1999; Herrera et al., 2004). However, to the authors' knowledge, no study has analyzed the PEH effect in individuals with different somatotype characteristics. Thus, the aim of this study is to verify the PEH effect in individuals with two different somatotype characteristics (mesomorph vs ectomorph). We hypothesize that there will be differences in the PEH effect between individuals with different somatotype classifications.

MATERIAL AND METHODS

Participants

Twenty-four normotensive men (23.2 ± 2.91 years; 73.78 ± 4.53 kg; 177.16 ± 5.73 cm; 23.58 ± 2.18 kg/m2) with a minimum of one year experience in RE were invited to participate in this study (Table 1; anthropometric data for different groups). All subjects volunteered and were divided into two groups: mesomorph (MSG) and ectomorph group (ETG). As for the exclusion criteria, participants could not: a) exhibit musculoskeletal impairments interfering with exercise performance or cardiovascular diseases (hypertension, coronary disease, etc); b) use ergogenic drugs or medication (including caffeine) affecting cardiovascular responses at rest or during exercise. In addition, it was required that all participants responded negative to the PAR-Q (Shephard, 1988). The institutional ethical committee approved (acceptance nº 157.154) the study and a written informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

TABLE 1: Anthropometrics Characteristics for Group

	MSG	ETG
Weigh	78.00 ± 2.85	69.9 ± 2.27
Height	1.74 ± 0.05	1.79 ± 0.06
BMI	24.41 ± 3.31	22.58 ± 2.23
Age	25.71 ± 0.60	22.62 ± 1.06
%Fat	5.76 ± 0.93	5.16 ± 1.20
Mesomorph	5.66 ± 0.53*	1.84 ± 0.22
Ectomorph	2.33 ± 0.22	5.49 ± 0.51*
Endomorph	2.08 ± 0.36	1.90 ± 0.25

*Significant difference between groups (p = 0.05)

Measures

Anthropometrics Evaluations

Initially, clinical examination, anthropometric measures and resting blood pressure assessment were performed. The anthropometric evaluation and preliminary procedures were performed in this order: (a) anamnesis to obtain information on RE experience, eating habits, drugs used and pathological history; (b) assessment of height and body mass to identify BMI; (c) three skinfolds were taken and the Jackson and

Pollock equation (1978) was used to obtain body fat; (d) measurements of the somatotype followed the Heath-Carter formulas (Carter and Heath, 1990).

In addition, a Filizola clinical scale (Brazil), equipped with a stadiometer, scale to 0.1 Kg and weight capacity range between 0 and 150 Kg was used in order to acquire weight and hight. The stadiometer had an accuracy of 0.5 cm and its scale of measurement ranged from 0 to 190 cm. The skinfold fat was measured at the chest, triceps, subscapular, abdomen, supra-iliac, calf, and thigh with a Lange™ skinfold fat caliper, manufactured by Cambridge Scientific Industries (Cambridge, Maryland, USA). The breadth of biepicondylar humerus and femur was evaluated by digital pachymeter MTX™ (Brazil). The arm and calf perimeter were measured by SANNY™ (Brazil) measuring tape. All the anthropometric measures followed the International for Anthropometric Assessment (Marfell-Jones, 2006).

Ten Repetition Maximum Test (10-RM)

After the anthropometric evaluations and preliminary procedures, the volunteers performed a test and retest for 10RM in the following exercises: barbell squat, barbell bench press, lat pull down, seated leg flexion and dumbbell shoulder press. All subjects were instructed to perform repetitions until they reached concentric failure. The 10-RM test has been previously described (Senna et al., 2011).

Briefly, the initial loads for 10-RM testing were estimated from loads used by each subject during the course of their daily RE routines. From this point, the minimal load modification pattern (increase/decrease) followed a 2 kg for barbell and 2.5 kg of total for machine exercises for each attempt. The higher load successfully lifted for each subject was recorded as their 10-RM. Also, the greatest load lifted over both testing sessions (test and retest) was assumed as the 10-RM load. During the 10-RM tests, each subject performed a maximum of three attempts of 10-RM for each exercise with 5-minutes of rest between attempts.

After the determination of 10-RM load, a 10-minute rest was established before the next 10-RM attempt for the following exercise. For the second day of load testing, all procedures were repeated, however, with an inverted exercise order. Each testing session was separated by 48 hours, wherein participants were restricted from performing any type of additional exercise in between sessions.

In order to minimize eventual data collection errors, the following strategies were adopted: (a) standard instructions concerning the testing procedures were given to the participants before the test; (b) subjects received standardized instructions on exercise technique (Harman et al., 2000); (c) standard verbal encouragement was provided during the testing procedure (McNair et al., 1996); and (d) the mass of all plates and bars were determined by using a precision scale (Senna et al., 2015; Senna et al., 2016). A warm-up before each test was administered which consisted of two sets of 12 repetitions at 40% of 10-RM self-related load of all exercises (Scudese et al., 2015).

Blood Pressure Test

The SBP and DBP were assessed before and after exercises for both groups. Before each training session, all subjects were instructed to remain resting in a seated position for at least 10-minutes in a low light and quiet environment. During the testing procedures, the temperature was held constant at approximately 20ºC. Blood pressure was then assessed using an oscillometric device (Omron MX3 Plus; Omron Healthcare Europe B.V. Hoofddorp, Netherlands) what was previously validated (Coleman et al., 2005). The first SBP and DBP post-exercise values were assessed 10-minutes after the completion of the last routine exercise. Additional post-exercise measures were assessed within a 10-minute gap from each other, totaling six post-exercise verifications until the 60-minute recovery mark was reached. All of those assessments were conducted in similar conditions as previously described for the resting pre-exercise measurement.

Procedures

Forty-eight hours after the loading tests, participants were divided into two distinct groups (MSG and ETG) in order to perform the training sessions. The exercise order was as follows: barbell squat, barbell bench press, lat pull down, seated leg flexion and dumbbell shoulder press. Three sets of each exercise with loads at 85% of 10-RM were followed by a 2-minute rest interval between sets and exercises. As previously described, SBP and DBP were assessed before, 10-minutes after and at each 10-minute interval during the 60-minutes post-exercise recovery for both groups.

Verbal encouragement was also given by an experienced RE professional for all sets and exercises for both groups (McNair et al., 1996). The warm-up before each session consisted of two sets of 12 repetitions with 40% of 10-RM load (Scudese et al., 2015). No attempt was made to control the speed of repetitions, however, subjects were instructed to perform a cadenced and controlled movement (Senna et al., 2009). All sessions were conducted at the same time of day for each subject and the participants were instructed not to perform any type of physical activities and to avoid ingesting beverages containing alcohol or caffeine for at least 48 hours prior to the experimental sessions.

Analysis

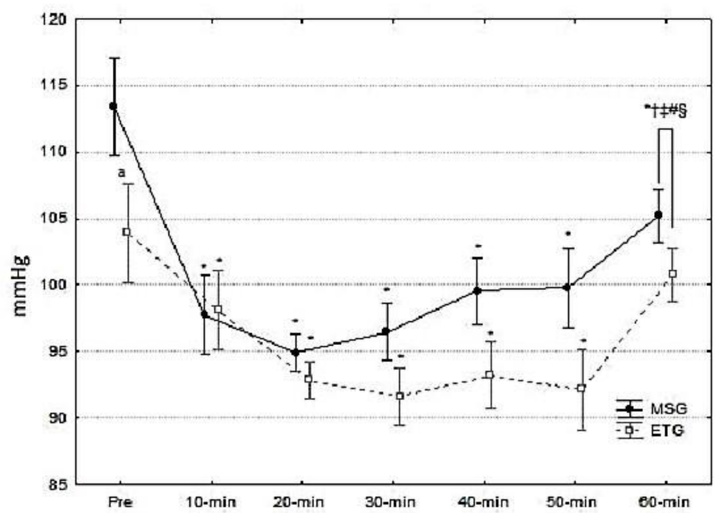
All results are presented as mean ± standard deviation (SD). The intraclass correlation coefficient was calculated to assess the 10-RM load reproducibility. A 2-way ANOVA was applied to test the potential differences of SBP and DBP from the different groups (MSG and ETG) and was followed by a Bonferroni posthoc verification for multiple comparisons. Furthermore, in order to determine the magnitude of the results, the effect size (ESs; the difference between pre blood pressure, i.e. the pre-test and the blood pressure of each verification moments, divided by the standard deviation of the pre-test) was calculated for each set and compared to the initial blood pressure value. The limits proposed by Cohen (1988) were applied to determine the magnitude of the treatment effect. In all cases, the significance level was set at $p \leq 0.05$, and calculations were made using the Statistica 10.0 software (Statsoft TM,Tulsa, OK, USA).

RESULTS

An excellent test/retest correlation was found for the 10-RM loads using the ICC for all exercises (barbell squat, $r = 0.91$; barbell bench press, $r = 0.98$; lat pull down, $r = 0.97$; seated leg flexion, $r = 0.98$; e dumbbell shoulder press, 0.93; $p < 0.0001$) and no differences were found between the test/retest loads via the paired Student t test ($p < 0.05$) for all exercises. The ANOVA two-way analysis demonstrated that the interaction between somatotype x time-point had significant differences in SBP ($p = 0.002$).

Moreover, SBP values for the somatotype main-effect were significantly different ($p = 0.001$) and the main-effect for SBP differences over time showed significant reductions ($p = 0.001$). Specifically, to the somatotype main-effect, the Bonferroni posthoc highlighted differences between MSG and ETG. For distinct time-points, the MSG demonstrated significant reduction to all post verifications compared to the pre-SBP value, that did not occurred for the ETG. The data related to the SBP behavior is presented in Figure 1.

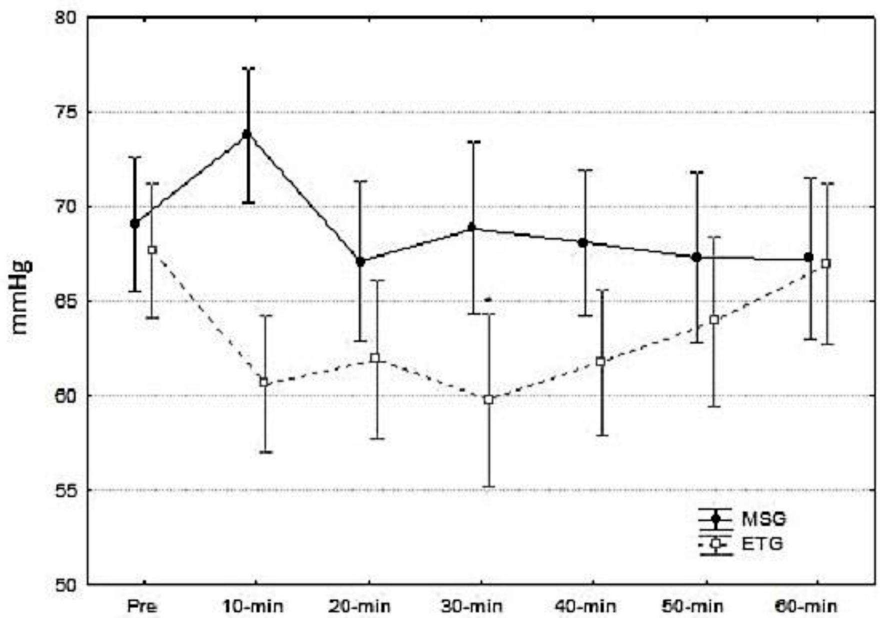
Figure 1: Systolic Blood Pressure.



Legend: * Significant difference compared to pre-exercise; † Significant difference compared to 10-minute post exercise; ‡ Significant difference compared to 20-minute post exercise; # Significant difference compared to 30-minute post exercise; § Significant difference compared to 40-minute post exercise; [a] Significant difference between groups.

However for DBP the ANOVA did not show significant differences on interactions between somatotype x time-point ($p = 0.082$). Beyond that, no significant differences were observed between the main-effect of the different groups ($p = 0.127$). Nevertheless, significant differences were observed in DBP for distinct time-points verifications ($p = 0.01$). Specifically, significant reductions in DBP occurred in ETG at 30-minute post-exercise verification. The data related to the DBP behavior is presented in Figure 2.

Figure 2: Diastolic Blood Pressure.



Legend: * Significant difference compared to pre-exercise

In addition, the ESs demonstrated a large magnitude in SBP reductions for the MSG for all time-point verifications. In contrast, the ESs of the ETG presented only a moderate magnitude on the last time-point. It also shown that the ESs demonstrated small and moderate magnitude reductions in both groups following time-point verifications. All the ESs data are shown in table 2.

Table 2: Effect Size Values of SBP and DBP on Both Groups (MSG and ETG).

	MSG	ETG
Systolic Blood Pressure		
10 min	2.08 (large)	1.12 (large)
20 min	2.45 (large)	1.97 (large)
30 min	2.25 (large)	2.05 (large)
40 min	1.90 (large)	1.77 (large)
50 min	1.81 (large)	1.69 (large)
60 min	0.89 (large)	0.61 (moderate)
Diastolic Blood Pressure		
10 min	0.25 (small)	0.41 (moderate)
20 min	0.66 (moderate)	0.79 (moderate)
30 min	0.31 (moderate)	0.79 (moderate)
40 min	0.41(moderate)	0.77 (moderate)
50 min	0.63 (moderate)	0.48 (moderate)
60 min	0.53 (moderate)	0.01 (small)

DISCUSSION

This experiment aimed to investigate the PEH phenomenon in individuals with distinct somatotypes characteristic (mesomorph vs ectomorph). The key findings of this study suggest that regardless of the group tested (MSG or ETG), a similar PEH phenomenon ocurred. Although, in SBP the subjects predominantly classified as mesomorph remained with this decreased response during all experimental procedure (until 60-minutes after exercise intervention) which did not occur in the ETG group.

These data suggest that although both somatotypes presented a similar PEH pattern, the mesomorph subjects seem to benefit more by RE as they experienced a prolonged decrease in SBP compared to ETG.

This data seems to be relevant since the duration and magnitude (verified by the ESs) of the PEH was important considering blood pressure reduction after the exercise intervention was significantly longer lasting in MSG than ETG. The DBP data suggests that the distinct somatotypes analyzed did not respond differently to the acute responses.

Recently, RE has been recommended as an effective non-pharmacological strategy for preventing hypertension in normotensive subjects and even for those hypertensive intending to control the desease (American College of Sports Medicine, 2004; Vasan et al., 2001). The latest American College of Sports Medicine position regarding exercise and hypertension recommends that RE is also an important component of a well-rounded exercise program and RE prescription should serve as an adjuvant to an aerobic-based exercise program (American College of Sports Medicine, 2004).

Also, there is some new evidence that contributes to the growing body of knowledge on RE research that recommending its inclusion in physical activity regimens intended to prevent cardiovascular disease, independent of the aerobic exercise practice (Shiroma et al., 2017). Furthermore, it seems that RE may also promote blood pressure reductions that are comparable or even greater than those achieved with aerobic training in adults with hypertension (MacDonald et al., 2016).

It is important to note, that the scientific literature is still controversial regarding the exact benefits of RE on blood pressure. In contrast, several studies were not able to demonstrate the PEH beneficial phenomenon promoted by a RE session, regardless of subject fitness status or gender. For instance, O'Connor et al. (1993), have observed SBP increases within 15-minutes after exercise intervention performed by females at 80% of 1-RM (repetition maximum) load.

Moreover, Hill et al. (1989) noted an important blood pressure reduction in trained males immediately after performing RE, but in a few minutes period, the blood pressure levels reached pre-exercise levels, which were maintained over the following 60-minutes of monitoring. Roltsch et al (2001) did not identify significant blood pressure level changes after RE performed by normotensive males and females, both sedentary and physical exercise trained practitioners. However, the present study demonstrates that this beneficial PEH phenomenon can be achieved and will affect all subjects regardless of somatotype.

Specifically, for those who were classified as and mesomorph (MSG), in which the PHE was even greater in duration. As this might be one of the key points of interest around RE research regarding cardiovascular health benefits, several other studies have analyzed the PHE effect induced by RE. According to de Salles et al. (2010) compared the post-exercise hypotension response with different rest intervals between sets (1- and 2-minute) in 17 normotensive elderly trained subjects. As the authors, significant differences in post-exercise were evident between the rest intervals in SBP and DBP on all verification moments.

Further the ESs of the SBP and DBP demonstrate increased magnitude at all post-exercise moments for the 2-minute rest protocol. Another experiment conducted by Senna et al. (2016) verified the PEH response of fifteen trained normotensive women to a RE session performed on both stable and unstable surfaces. The authors also have found a similar pattern of magnitude reduction in SBP after both distinct surfaces tested; however, a prolonged reduction of SBP was evident from the traditional stable method.

Besides that Arazi, Ghiasi and Afkhami (2013) compared SBP and DBP responses after two circuit-training sessions with rest intervals of 30- and 40-second between exercises and an additional control session. The results showed a reduction of SBP values in both protocols on post-exercise moments while no differences occurred for DBP. In the present study, similar responses to SBP and DBP were verified in mesomorph and ectomorph subjects. However, the PEH duration was higher in MSG for SBP. The greater PEH length was observed for the high intensity regardless of volume (Simão et al., 2005; Polito and Farinatti, 2009).

For instance, Simão et al. (2005) investigated two different RE intensities, volume, and method on the PEH. Briefly, the authors investigated the differences in SBP and DBP at post-exercise on 5 and 6 exercise (volume) loads of six 6-RM and 12 repetitions with 50% of 6-RM (intensity) on block repeated and paired sets (training method). The results of the study indicate that the RE intensity influenced the duration, but not the magnitude of the post-exercise hypotension response.

Additionally, Polito and Farinatti (2009) compared the effects of two RE sequences, with different intensities with the same training volume, on post-exercise blood pressure responses. The authors concluded that RE had hypotensive effects on blood pressure, mainly in SBP. This absolute decline (SBP) seemed to not be influenced by different interactions between workload and number of repetitions, although, higher absolute workloads seems to extend the total time of SBP post-exercise reduction. Also, the number of repetitions seems to have more influence on DBP than SBP, but for an acute period.

In a study perfomed by Polito et al. (2003) they observed that the muscle mass activated during resistance exercise has a direct influence on PEH, especially in high-volume multiple-set RE training sessions. Nevertheless, there is a connection between the cause and effect of post-exercise hypotensive response, this phenomenon is yet to be fully comprehended. The physiological mechanisms that could explain the influence of mesomorph characteristics on blood pressure after RE is the reduction in vascular resistance, caused by the liberation of dilating endothelial substances (e.g., nitric oxide and prostaglandins) (Osada et al., 2003; MacDonald, 2002).

In addition, the baroreflex compensation mechanism that redefines the lower values obtained during the post-exercise situation may also play an important role in blood pressure after RE, thus resulting in a decreased cardiac output and sympathetic activation (Senitko, Charkoudian and Halliwill, 2002). The stimulus for the specific responses seems to be caused by an increase in blood flow (Halliwill, 2001) triggered by the exercise.

Therefore, it is proposed that an absolute load during the activity or even the specific physiologic characteristics in MSG (i.e. greater in muscle mass) would raise the need for blood in the active region, and thus increasing the PEH on those subjects. These results are applicable and limited to the specific characteristics of the subjects analyzed, type of exercise, routine design and blood pressure assessment. When different goals are desired in the RE, program variations may be necessary and might also modify the PEH. These changes within the population investigated present a gap in scientific knowledge.

CONCLUSION

The present study seems to be in accordance with the current state of the RE and PEH phenomenon because regardless of somatotype, significant blood pressure reductions were observed. Additionally, this data suggests that subjects predominantly classified as mesomorph may sustain a prolonged hypotensive response (in comparison to ETG), although not presenting differences on the magnitude of such effect. Therefore, it can be proposed that distinct somatotypes would not change the magnitude of acute responses to DBP.

This data might contribute to future recommendations focused on PEH response and a prevention of arterial hypertension disease specifically on subjects predominantly classified as mesomorph through the inclusion of a regular RE routine intervention. However, we strongly recommend the expansion and execution of other clinical trials in order to confirm these results and expand them to another spectrum of the distinct somatotype characters, including the control of potentially intervening variables, such as absolute load and the association to an aerobic training.

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