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INFLUENCE OF LOAD INTENSITY ON POST EXERCISE HYPOTENSION AND HEART RATE VARIABILITY FOLLOWING A STRENGTH TRAINING SESSION

Exercise intensity and cardiovascular response

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ABSTRACT

The purpose of this study was to compare blood pressure and heart rate variability (HRV) responses in trained men following strength training (ST) sessions with loads of 60%, 70%, and 80% of a one-repetition maximum (1RM). Eleven men (age: 26.1 ± 3.6 years; body mass: 74.1 ± 8.1 kg; height: 172.0 ± 4.0 cm; BMI: 25.0 ± 1.96 kg/m^2; %G: 18.3 ± 6.4) with at least six months ST experience participated in this study. Following assessment of 1RM loads for the bench press (BP), lat pull down (LPD), shoulder press (SP), biceps curl (BC), triceps extension (TE), leg press (LP), leg extension (LE) and leg curl (LC); subjects performed three experimental sessions in random order. During each experimental session, subjects performed three sets of eight to10 repetitions at 60%, 70%, or 80% of 1RM loads, with two minute rest intervals between sets and exercises. All experimental sessions were performed in the following exercise order: BP, LPD, SP, BC, TE, LP, LE, and LC. Prior to and for one hour following each experimental session, blood pressure and HRV were tracked. The results demonstrated a greater duration of post-exercise hypotension following the 70% of 1RM session versus the 60% or 80% of 1RM session. These results indicate that the load/volume associated with completion of eight to 10 repetitions at 70% of 1RM load may provide the best stimulus for the post-exercise hypotensive response when compared to training with a 60% or 80% of 1RM loads. In conclusion, strength and conditioning professionals may prescribe exercises with 60%, 70% and 80% of 1RM loads if the intent is to elicit an acute decrease in blood pressure following a ST session; however 70% of 1RM provides a longer post-exercise hypotension.

Keywords: Resistance exercises, training, hypotension, autonomic control.

INTRODUCTION

Strength training (ST) has been recommended as a component of a non-pharmacological intervention to prevent and treat cardiovascular disorders (1,2). Strength training has been shown to promote acute reductions in post-exercise blood pressure; a phenomenon called post-exercise hypotension, which may play a key role in chronic blood pressure and cardiovascular risk reduction (1). A small reduction in blood pressure (i.e., 3 mmHg) has been shown to reduce the probability of having a stroke and coronary arterial disease in normotensive or hypertensive subjects (1,2). In addition, a few numbers of studies have investigated the physiological pathways of blood pressure control derived from a ST session, and the mechanisms were not clear (7,8,13,14), while other studies have focused on the manipulation of methodological variables of ST such as training intensity, training volume or exercise order (7,8,19).

Previous studies have examined post-exercise hypotensive responses following ST sessions performed in different formats such as a circuit approach or a more traditional approach with consecutive sets performed for each exercise (18); different numbers of sets (i.e., one versus two sets) in a circuit format (16), or in a set repetition format (8); different rest intervals between sets and exercises (5); and exercises performed in opposite sequences (7). However, few studies to date have compared the effect of different load intensities (percentage of one repetition maximum) on blood pressure responses and heart rate variability (HRV) following a ST session with strict control of other training variables (i.e., number of sets and exercises, rest interval between sets, exercise order and total volume load); all of which may potentially influence the post-exercise blood pressure response and HRV (3,8,13,16,18,19).

Simão et al., (18) analyzed the effect of two different load intensities (6RM to failure versus 12 repetitions with 50% of a 6RM load) in normotensive trained men, and found no significant differences in the duration of the post-exercise hypotensive response between experimental sessions, independent of the total volume load, suggesting that either low or high intensity loads may induce a post-exercise hypotensive response (16). Conversely, Brown et al., (3) found an increase in systolic blood pressure (SBP) and a reduction on diastolic blood pressure (DBP) following a ST protocol performed at different load intensities (i.e., 40% versus 70% of 1RM loads) and short rest intervals between sets (i.e., 30 seconds). In addition, Niemelä et al., (13) analyzed blood pressure responses following three sets of 12 repetitions at 80% of a 1RM or three sets of 20 repetitions at 30% of a 1RM in trained men. The results did not show significant differences in blood pressure responses between sessions. Presently, there is no consensus in the literature regarding the effects of ST load intensity on post-exercise blood pressure response and HRV. Continued research related to this topic has significant professional value as we attempt to define the most appropriate ST prescription for individuals with, or at risk for, cardiovascular disease.

Heart rate variability is a key cardiovascular variable that has been related to the functionality of the autonomic nervous system and cardiovascular mortality. Decreased HRV following myocardial infarction is a risk factor for mortality (21). Previous studies that analyzed post-exercise hypotension and HRV simultaneously following ST are limited (7,8,14), and the study of this variable can contribute to the physiological interpretation of post-exercise hypotension after a ST protocol (21). In addition, no previous study has analyzed the effect of three different ST load intensities with the same rest interval between sets and exercises on blood pressure responses and HRV, in trained man.

The current literature provides little information concerning the physiological significance of ST and the impact on blood pressure and HRV during the time period post-exercise. Continued research related to ST load intensity has important implications for professionals in the prescription of exercise for individuals with, or at risk for cardiovascular disease. Therefore, the purpose of this study was to compare blood pressure and HRV responses in trained men following ST experimental sessions with loads of 60%, 70%, or 80% of a one-repetition maximum. It was hypothesized that as load intensity increased; a progressively longer hypotensive response would ensue in conjunction with a reduction in HRV.

METHODS

Experimental approach to the problem

The subjects underwent a total of seven laboratory visits; the initial four visits (conducted 72 hours apart) involved assessment of 1RM loads, during which each exercise in the following sequence was tested twice: bench press (BP), lat pull down (LPD), shoulder press (SP), biceps curl (BC), triceps extension (TE), leg press (LP), leg extension (LE) and leg curl (LC). The next three visits (conducted 72 hours apart) involved performance of three sets of eight to 10 repetitions for each exercise in the sequence at 60%, 70% or 80% of a 1RM, and with two minute rest intervals between sets and exercises in a random order. During each experimental session, blood pressure and HRV were assessed following a 10-minute passive rest period upon arrival at the lab, immediately following each experimental session, and then at 10-minute intervals for 60 minutes following each experimental session.

Subjects

Eleven men with at least six months prior ST experience participated in this study (age: 26.1 ± 3.6 years; body mass: 74.1 ± 8.1 kg; height: 172.0 ± 4.0 cm; BMI: 25 ± 1.96 kg/m^2; %G: 18.3 ± 6.4). Subjects were recruited according to the criteria established by the Seventh Joint National Committee (4) and included the following characteristics: (a) nonsmokers; (b) absence of any kind of metabolic disease; (c) no articular or bone injury and; (d) absence of any medication that could influence the cardiovascular response. The subjects were informed about the study procedures, possible risks and benefits and signed an informed consent form. This study was approved by the Ethics Committee of the Rio de Janeiro Federal University. Before the start of each experimental session, subjects were instructed not to consume any caffeinated or alcoholic beverage while maintaining their usual activities and eating habits throughout the study period.

Procedures

One-repetition maximum (1RM) testing

During the first laboratory visit, height and body mass were measured by means of an analogical scale and a stadiometer (Toledo, Brazil) followed by 1RM testing. The 1RM testing began with a warm-up at 50% of an estimated 1RM. The load was then increased to the predicted 1RM for the first attempt. If that attempt was successful, five minutes of rest were given after which another 1RM was attempted; this sequence was repeated until the 1RM attempt was unsuccessful or the subject refused to continue; the highest load successfully lifted was recorded as the 1RM value. Testing was repeated 72 hours later to establish reliability (19). The 1RM assessments were divided over a four day period. On the first and third days BP, LE, BC and LC were tested and retested, on second and fourth days LPD, LP, SP and TE were tested and retested.

To minimize the error during 1RM tests, the following strategies were adopted: a) standardized instructions concerning the testing procedure were given to subjects before the test; b) subjects received standardized instructions on exercise technique; c) verbal encouragement was provided during the testing procedure; d) the mass of all weights and bars used were determined using a precision scale. The 1RM was determined in fewer than three attempts with a rest interval of five minutes between 1RM attempts and 10 minutes before starting the 1RM assessment for the next exercise. The range of motion of exercises used was similar to that by Simão et al., (19).

Exercise Sessions

Seventy-two hours following the last 1RM testing session, subjects performed the first of three experimental sessions in a random order. The three experimental protocols involved the same sequence of exercises (BP, LPD, SP, BC, TE, LP, LE and LC) performed at 60%, 70%, and 80% of 1RM loads. The BP, SP and BC were performed using free weights and the LPD, TE, LP, LE and LC were performed using resistance machines (Life Fitness, USA).

The warm-up procedure for each experimental session consisted of one set of 10 repetitions of the BP and LP at 40% of a 1RM. A two minutes rest interval followed the warm-up prior to the assigned experimental session. All experimental sessions involved performance of three sets for each exercise in the sequence with two minute rest intervals between sets and exercises. During all exercise sessions, irrespective of the load intensity, subjects perform eight to 10 repetitions per set through a complete range of motion. The loads were held constant for all exercise sets during each experimental session. No pause was permitted between the eccentric and concentric phases of each repetition and repetition velocity was volitionally controlled. The total number of repetitions for each set of each exercise was recorded to calculate the total volume load performed (load x total number of repetitions performed).

Measures of heart rate and heart rate variability

A heart rate monitor (Polar RS800cx, Finland) was used for 10 minutes before and for 60 minutes following each experimental session. Heart rate (HR) and HRV data were collected with subjects in a seated position with palms facing up in a quiet room with temperature maintained between 20° and 22°C. Data were recorded and subsequently downloaded to a computer for analysis. The data were digitized in *Matlab* (*Matlab version 6.0 Mathworks* - Massachusetts - USA) and analyzed for time domain and frequency. The spectral analysis in the frequency domain was performed by the Fourier transform algorithm. The HRV parameters were analyzed according to the components of low frequency in normalized units (LF-nu), which provides information about the activity of the sympathetic nervous system; high frequency in normalized units (HF-nu), which provides information about the activity of the parasympathetic nervous system; and the standard deviation of differences between adjacent normal R-R intervals (RMSSD), which provides information about the predominance of sympathetic or parasympathetic nervous system, following Fourier transformation and noise filtering (21).

Arterial blood pressure assessment

Systolic blood pressure, diastolic blood pressure, and mean arterial pressure (MAP) were measured using an automatic oscillometric device (*PM50 NIBP/Spo2, CONTEC* - USA). The equipment was auto-calibrated before each use. During each experimental session, blood pressure was assessed following a 10-minute passive rest period upon arrival at the lab. The resting blood pressure values were averaged over two consecutive measurements with five minutes between measurements. Blood pressure was then assessed immediately following each experimental session, and then at 10-minute intervals for 60 minutes following each experimental session, resulting in a total of six measurements following each experimental session. Measurements were performed from the left arm, consistent with the recommendations of the American Heart Association (2).

Statistical analysis

Data for all variables were analyzed using the Shapiro-Wilk normality test and homocedasticity (Bartlett criterion). A one-way ANOVA was used to compare the following parameters: 1RM test and retest; the total repetitions performed in the three experimental sessions; and the resting values of SBP, DBP, MAP, HR, RMSSD, LF-nu and HF-nu. Subsequently, the resting values and post-exercise values were compared within and between sessions using a MANOVA with repeated measures. In all cases, Tukey post-hoc comparisons were used to identify statistically significant differences. Additionally, to determine the magnitude of differences, effect size statistics (ES; the difference between pre-test and post-test scores divided by the pre-test standard deviation) were calculated for the SBP, DBP, MAP and RMSSD for all exercise sequences. The scale proposed by Rhea (15) was used to determine the magnitude of the ES. The alpha was set at $p < 0.05$ and all tests were performed using SPSS software (v. 19.0, Graphpad).

RESULTS

All tested variables followed a normal distribution. The data for the 1RM test and re-test were analyzed using intra-class correlation coefficients (BP r=0.99, LPD r=0.96, SP r=0.98, BC r=0.94, TE r=0.97, LP r=0.97, LE r=0.90 and LC r=0.97) and showed high reliability. The total volume load for the 60% of 1RM experimental session was 12,711.22 ± 974.88 kg; for the 70% of 1RM experimental session, 14,822.34 ± 1168.65 kg; and the 80% of 1RM experimental session was 15,594.02 ± 1647.92kg. Significant differences were found between the 60% of 1RM experimental session and the 70% and 80% experimental sessions, respectively ($p<0.05$). The total volume load and the total number of repetitions performed for each set or each exercise did not significantly differ between 70% of 1RM and 80% of 1RM experimental session;

therefore, the work performed during the 70% of 1RM and 80% of 1RM experimental sessions was similar (p=0.354).

For SBP, there was a significant difference between the 60% of 1RM and 70% of 1RM experimental session at the 20 minute time point post-exercise ($p<0.05$). Additionally, for the 70% of 1RM experimental session, significant reductions in post-exercise SBP were found from 30 minutes through 60 minutes post-exercise (see Figure 1 and Table 1).

For DBP, there was a significant difference between the 60% of 1RM and 70% of 1RM experimental session at the 50 minute time point post-exercise ($p<0.05$). Additionally, for the 70% and 80% of 1RM experimental session, significant reductions in post-exercise DBP were found across all time points post-exercise (see Figure 2). The ES data showed a large reduction in DBP for the 70% and 80% of 1RM experimental sessions from 10 minutes through 30 minutes post-exercise; and for the 70% of 1RM experimental session from 40 minutes through 60 minutes post-exercise (see Figure 2 and Table 1).

For MAP, a significant difference was noted between the 60% of 1RM and 80% of 1RM experimental sessions at the 30 minute time point post-exercise ($p<0.05$). Additionally, for the 70% of 1RM experimental session, significant reductions in post-exercise MAP were noted across all time points post-exercise (see Figure 3). The ES data showed moderate and large reductions in MAP for the 70% of 1RM and 80% of 1RM sessions across all time points post-exercise (see Table 1).

No significant post-exercise differences (versus baseline values) were found in LF-nu or HF-nu across all time points post-exercise. The post-exercise RMSSD value was reduced throughout the 60 minute post-exercise monitoring period following the 70% and 80% of 1RM experimental sessions, with a significant difference (versus immediately post-exercise) at the 60 minute time point ($p<0.05$) (see Figure 4). The ES data showed a large reduction in RMSSD at the 10 minute time point post-exercise in all sessions, especially for the 70% of 1RM experimental session (See Table 1).

INSERT FIGURE 1

INSERT FIGURE 2

INSERT FIGURE 3

INSERT FIGURE 4

INSERT TABLE 1

DISCUSSION

The purpose of this study was to compare blood pressure and heart rate variability responses in trained men following ST experimental sessions with loads of 60%, 70%, or 80% of a 1RM. The key findings of this study were that ST reduced SBP, DBP, and MAP following exercise independently of the exercise intensity, and the duration of the post-exercise hypotensive response was significantly related to the load intensity utilized. All ST protocols showed a post-exercise hypotensive response; however, the 70% of 1RM condition elicited a longer response versus the 60% and 80% of 1RM conditions, respectively. Only following the 70% of 1RM experimental session did blood pressure values remain significantly below baseline for the entire 60 minutes post-exercise. Therefore, our hypothesis was partially confirmed in that the 70% of 1RM condition elicited a longer post-exercise hypotensive response, but there were no significant differences in HRV between conditions.

In the present study, subjects performed three different ST experimental sessions consisting of the same exercises; number of sets and repetitions per set; and rest interval between sets and exercises; but differed only in the load intensity utilized during each experimental session. A possible mechanism that may account for the longer post-exercise hypotensive response following the 70% of 1RM condition might be that repetition failure did not occur as frequently (compared with the 80% of 1RM condition), given that eight to 10 repetitions were performed for all sets. With fewer sets performed to repetition failure, there might have been less predominance of the sympathetic nervous system during and following the 70% of 1RM condition (see Figure4 and Table 1, index RMSSD). The ES data showed large and a moderate reduction of sympathetic nervous system predominance following 70% of 1RM condition, and it's not occurs in 80% of 1RM condition (Table1). Conversely, the 60% of 1RM condition might not have involved a sufficient volume load to stimulate a long duration post-exercise hypotensive response. Thus, it appears from the current study that the 70% of 1RM condition involved the right trade-off between less sympathetic nervous system activation (via fewer sets to failure versus the 80% of 1RM condition) and a greater load volume completed (versus the 60% of 1RM condition) to stimulate the longest duration reduction in post-exercise blood pressure in trained men.

In relation to SBP, DBP and MAP, this study demonstrated that the load intensity influenced both the magnitude and duration of the response during the 60 minutes post-exercise. The effect size data demonstrated a longer duration of SBP, DBP and MAP decrease following the 70% of 1RM session versus the 60% and 80% of 1RM sessions, respectively (see Table 1). Previous studies demonstrated a hypotensive response following single bouts of ST in normotensive and hypertensive subjects (8, 11, 14, 18). In the current study, a possible explanation for the longer PEH response for the 70% 1RM session might be the load being at the optimal level to promote moderate, but not excessive muscular fatigue with eight to 10 repetitions per set. Thus, a dose-response appears to be evident when other prescriptive factors are controlled (8,14).

The blood pressure results of this study are partially in agreement with previous studies (18, 20). These studies showed greater and longer post-exercise hypotensive responses with higher load intensities (i.e., 6RM vs. 12 repetitions with 50% of 6RM and 30 repetitions with 23% of 1RM vs. 16 repetitions with 43% of 1RM); although the latter is not common in ST prescription.

One study to date analyzed the influence of load intensity on blood pressure and HRV (14). Resk et al., (14) investigated the effect of two different load intensities (20 repetitions with 40% of 1RM vs. 10 repetitions with 80% of 1RM) on post-exercise hypotension and HRV in young normotensive untrained men and women. Different from the present study, Resk et al., (14) showed a longer duration post-exercise hypotensive response for the 40% of 1RM session. These divergent results might be attributed to different rest intervals between sets and exercises (45 seconds for 40% of 1RM and 90 seconds for 80% of 1RM) and the training status of the sample (i.e., untrained men and women). A recent study found that different rest intervals between sets can influence the post-exercise hypotensive response due to variation in training intensity and the longer time of the ST stimulus (5).

In the current study, no significant differences were found in HRV between sessions, with an increase in sympathetic modulation and a decrease in parasympathetic modulation following all sessions, irrespective of the load intensity. This absence of significant differences can be attributed to the large variability in responses amongst subjects (21). In addition, the results for HRV showed that all experimental sessions elicited significant cardiac stress (see Figure 4 and Table 1). Lima et al. (12) demonstrated that cardiac sympathetic activation remains higher than resting values following upper body ST protocol. Their results partially corroborate the results of the current study. For example, following all sessions there was an increase in sympathetic activation, and a reduction of parasympathetic activation observed by the RMSSD index. This finding may have an important clinical implication; an increase in sympathetic activation combined with a reduction of parasympathetic activation may increase the risk of cardiovascular events in patients with cardiovascular disease (21).

Conversely, the ES data showed a large increase in sympathetic tonus and a large decrease in parasympathetic tonus as indicated by RMSSD results (see Table 1), following the 80% of 1RM session when compared to the 60% and 70% of 1RM sessions, respectively. Sets for the 80% of 1RM session would have been closer to a repetition maximum given that the repetitions per set were controlled at eight to 10 for each load intensity session. Thus, the 80% of 1RM session may have activated a greater number of motor units with greater activation of the sympathetic nervous system to maintain consistent repetitions on each set (see Figure 4 and Table 1) (17). The higher occurrence of repetition failure during the 80% of 1RM session, may have prompted a greater reduction in plasma volume, and consequently, a greater reduction in cardiac output and end-systolic volume, which may have led to a greater imbalance in cardiovascular neural control following the session (9,14). Furthermore, the 80% of 1RM condition may have involved greater activation of metaboreceptors, mechanoreceptors, and the arterial baroreflex due to a reduction in blood flow (due to a reduction in plasma volume) to the active muscles. Finally, an increase in peripheral vascular resistance induced by the mechanical occlusion of blood flow promoted by muscular contraction may have resulted in less blood pressure reduction (14).

Beyond the findings presented here, it is important to consider some limitations of this study. Blood pressure can be affected during a supine position following a ST session, because of the enhanced venous return, which stimulates baroreceptors, increases cardiac filling and stroke volume, and reduces heart rate for the same cardiac output (6). Conversely, the HRV can be affected during a prolonged seated position due to a reduction in venous return and increased baroreflex activity (10). Due to a lack of studies reporting the influence of load intensity on HRV following a ST session, and how to perform the two measurements together, a seated position was adopted. We could not analyze variables closely related to post-exercise hypotension, such as cardiac output and blood flow. Additionally, because this study tested systolic isolate pre hypertensive young subjects, the results presented here may not be applicable to other populations, such as hypertensive individuals that use medication. Further research is needed to examine the post-exercise hypotensive response with the manipulation of other ST methodological variables like rest interval between sets, training method and exercise order.

PRATICAL APPLICATIONS

The findings of this study demonstrated the longest duration of post-exercise hypotensive response in normotensive trained men at a load intensity of 70% of 1RM when compared to 60% or 80% of 1RM loads intensities. Therefore, it is possible to assume that ST composed of upper and lower body exercises performed at a 70% of 1RM load intensity for a fixed number of repetitions per set (i.e., eight to 10) and for multiple sets per exercise, may elicit a longer duration of post-exercise hypotension versus routines utilizing lower or higher intensity and total volume load. In conclusion, strength and conditioning professionals can prescribe exercises at moderate to high intensity (from 60% to 80% of 1RM) if the goal is to acutely reduce blood pressure following training. Consistent post-exercise hypotension may have positive impacts on early phases of high blood pressure development. However, the results of this study are likely applicable only to systolic isolated pre-hypertensive, trained, male adults and further research testing other populations is warranted.

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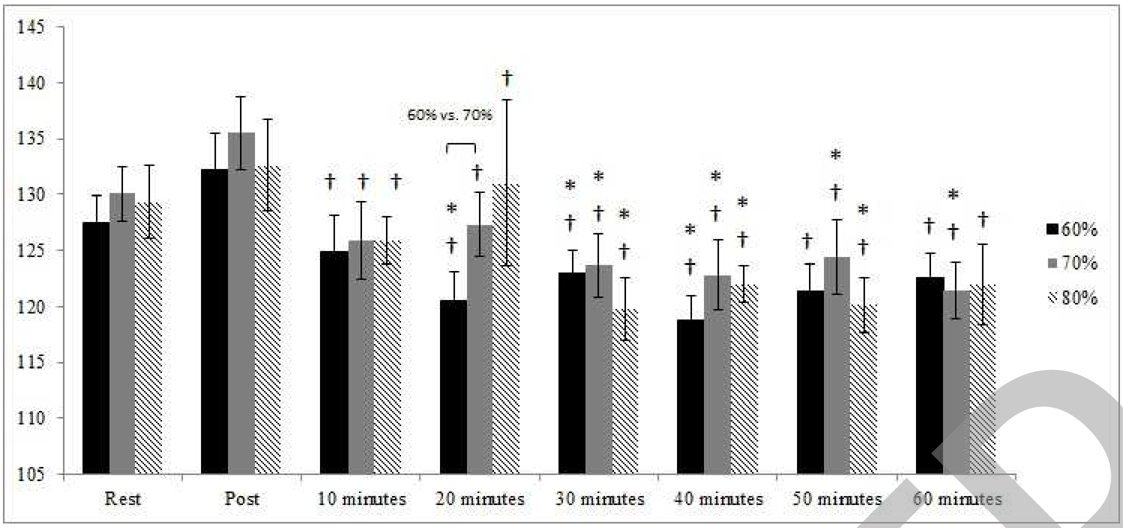

Figure 1 – Systolic Blood Pressure response to three strength exercise sessions (Mean ± SD).
* Significant difference from Rest.
† Significant difference from Post
] Significant difference between group.

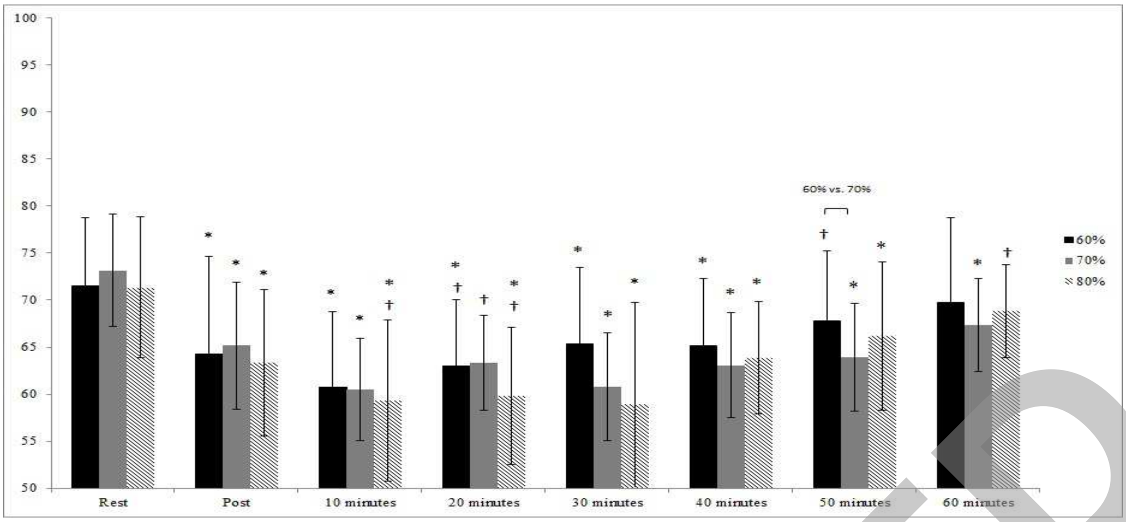

Figure 2 – Diastolic Blood Pressure response to three strength exercise sessions (Mean + SD).
* Significant difference from Rest.
† Significant difference from Post
] Significant difference between group.

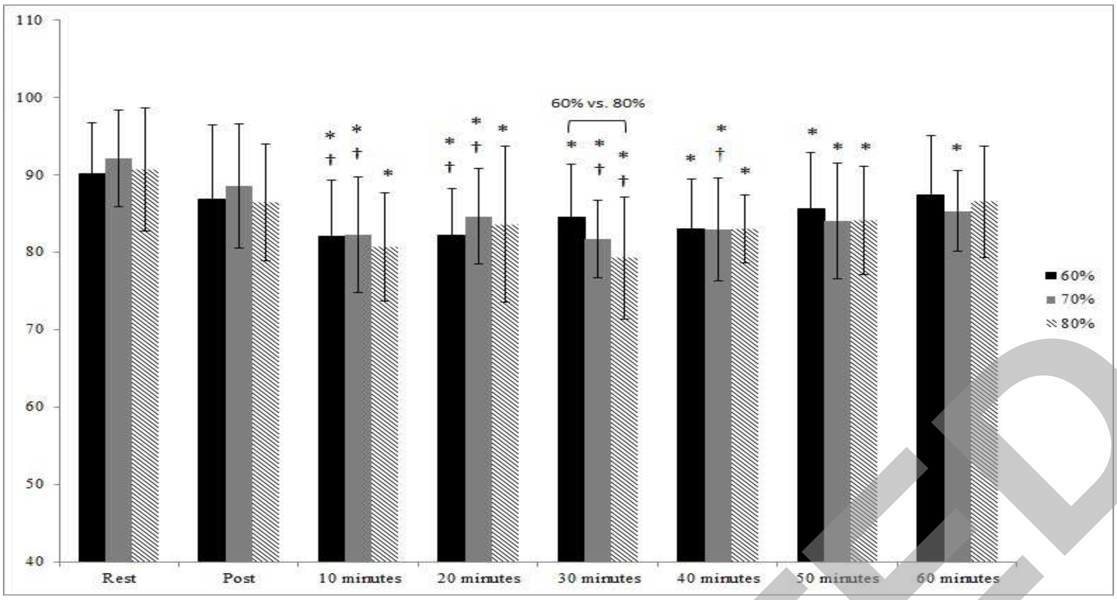

Figure 3 – Mean Arterial Pressure response to three strength exercise sessions (Mean ± SD).
* Significant difference from Rest.
† Significant difference from Post
] Significant difference between group.

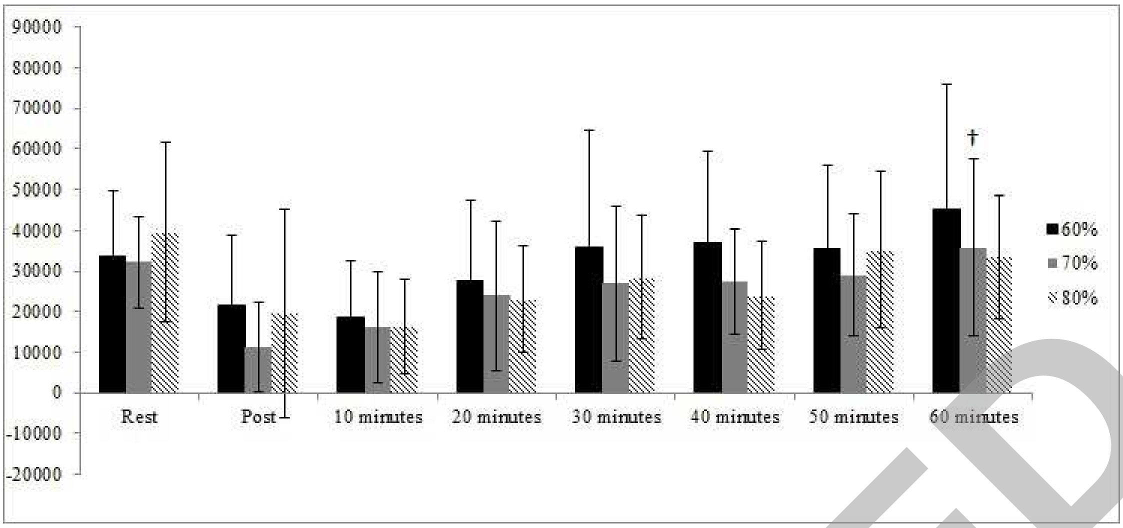

Figure 4 – Index RMSSD results.

No difference between each timeline and between intensities

† Significant difference from Post

Table 1. *Effect Size*: SBP, DBP, MAP, and RMSSD after three sequences of strength training.

			10min	20min	30min	40min	50min	60min
SBP	**60%1RM**	Magnitude	-1.01	-2.70	-1.73	-3.36	-2.38	-1.89
		Classification	Mod	Large	Large	Large	Large	Large
	70%1RM	Magnitude	-1.68	-1.11	-2.58	-2.92	-2.28	-3.50
		Classification	Large	Mod	Large	Large	Large	Large
	80%1RM	Magnitude	-1.07	0.5	-2.93	-2.27	-2.83	-2.27
		Classification	Mod.	Sm	Large	Large	Large	Large
DBP	**60%1RM**	Magnitude	-1.49	-1.18	-0.85	-0.88	-0.52	-0.24
		Classification	Large	Mod	Mod	Mod	Sm	Trivial
	70%1RM	Magnitude	-2.12	-1.65	-2.08	-1.69	-1.55	-0.98
		Classification	Large	Large	Large	Large	Large	Mod.
	80%1RM	Magnitude	-1.60	-1.53	-1.64	-1.0	-0.69	-0.33
		Classification	Large	Large	Large	Mod	Sm	Trivial
MAP	**60%1RM**	Magnitude	1.55	1.55	1.44	1.14	0.65	0.81
		Classification	Large	Large	Mod.	Mod.	Small.	Mod.
	70%1RM	Magnitude	1.51	1.09	1.57	1.37	1.33	1.07
		Classification	Large	Mod.	Large	Mod.	Mod.	Mod.
	80%1RM	Magnitude	1.05	1.49	1.62	1.12	1.39	0.9
		Classification	Mod.	Mod.	Large	Mod.	Mod.	Mod.
RMSSD	**60%1RM**	Magnitude	-1.22	-1.21	-0.85	-1.07	-0.69	-0.42
		Classification	Mod	Mod	Mod	Mod	Sm.	Sm.
	70%1RM	Magnitude	-1.57	-1.19	-1.66	-1.46	-1.29	-1.08
		Classification	Large	Mod	Large	Large	Mod	Mod
	80%1RM	Magnitude	-1.26	-0.89	-1.44	-0.96	-0.82	-0.52
		Classification	Mod	Mod	Large	Mod	Mod	Sm

Legend: SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; RMSSD = standard deviation of differences between adjacent normal; Sm – Small; Mod – Moderate.