CARDIOVASCULAR BEHAVIOR AFTER RESISTANCE EXERCISE PERFORMED IN DIFFERENT WORK MODELS AND VOLUME

EXERCISE AND SPORTS SCIENCES

ORIGINAL ARTICLE

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ABSTRACT

Objective: To assess the cardiovascular responses after resistance exercise performed in different work models and volume. Methods: Ten healthy men randomly performed sessions with eight exercises (18 repetitions and 40% of 1RM) and one control session on different days.The exercise sessions were performed with one set in circuit (1CIRC), three sets in circuit (3CIRC), one set of conventional pattern (1CONV) and three sets of conventional pattern (3CONV). Blood pressure (BP) and heart rate variability (HRV) were monitored for a period of one hour after the sessions. Results: Considering the average obtained during the 60-min monitoring period, concerning the systolic BP, only the 3CIRC session (-9.4 ± 3.0 mmHg; P = 0.02) caused reduction in the control session. Regarding diastolic BP, the 1CIRC (-5.7 ± 1.8 mmHg; P = 0.005), 3CIRC (-8.4 ± 1.6 mmHg, P = 0.0002) and 3CONV sessions (-8.6 ± 2.2 mmHg; P = 0.0001) caused reduction concerning the control session. Similarly, mean blood pressure was reduced compared to control after 1CIRC (-5.0 ± 1.8 mmHg, P = 0.02), 3CIRC (-8.7 ± 1.6 mmHg, P = 0.0002) and 3CONV sessions (-7.9 ± 1.9 mmHg, P = 0.0006). Concerning HR, it was also higher in the 1CONV (P = 0.001) and 3CONV sessions (P = 0.04) after the 3CIRC session. The LF/HF component of the HRV was higher in relation to control session after the 3CIRC session. Conclusion: The sessions involving larger volume caused BP reduction in a similar manner. However, the 3CIRC session caused higher post-exercise cardiac effort.

Keywords: resistance exercise, blood pressure, post-exercise hypotension.

INTRODUCTION

Several studies have observed decrease in blood pressure (BP) after a single session of exercise[1-4], a phenomenon which has been called post-exercise hypotension (PEH)[5]. Aerobic exercise seems to be the most efficient in promoting decrease in post-exercise BP[6]. On the other hand, concerning resistance exercise there is lower quantity of information available in the literature[2,7-9]. Although the results obtained in the studies involving resistance exercise suggest that this exercise model is able to promote PEH, sometimes the results of these investigations are contradictory[9-11].

The discrepancy in the results observed may be attributed to the different methodological outlining used, such as different intensities (1RM percentage), performance manner (circuit or conventional) and volume of work performed. Among these variables, the performance manner and the work volume have been issue of some research, which remain observing conflicting results[12,13]. Moreover, studies which compare different performance manners and work volume have not been found. Therefore, it becomes reasonable to investigate which prescription manner promotes higher PEH since it contributes to better understand which prescription model causes higher PEH.

Besides following up the BP, another variable which can be analyzed after exertion is the heart rate variability(HRV), which consists in the intervals between heart beats. The HRV analysis is considered an indicator of cardiac autonomic modulation[14]; however, there is little information on the HRV in the PEH context[1]. Thus, further studies which investigate the exercise effect on these two variables (BP and HRV) are necessary in order to better understand the post-exertion cardiovascular behavior. Therefore, the aim of this study was to verify the BP and HRV responses after resistance exercise performed in different ways and work volume.

METHODS

Subjects

10 normotensive men with minimum experience of six months in resistance exercises training participated in the study. Exclusion criteria were: osteomyoarticular problems, smoking, medication which could interfere in the cardiovascular responses, body mass index above $30kg.m^{-2}$, systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) equal or above 140 and 90mmHg, respectively, and use of anabolic steroids. The sample was told not to ingest caffeinated and/or alcoholic drinks and not to perform vigorous physical activity in the 24 hours prior to the data collection. All individuals signed a Free and Clarified Consent Form and the study was approved by the Ethics and Research of the State University of Londrina (022/2008).

Experimental outlining

Data collection occurred in six visits on distinct days, with minimum interval of 48 hours. The first visit was for maximum load determination (1RM), anthropometric measurements and BP at rest measurement. The other visits occurred for performance of four experimental sessions and one for the control session.

Maximal load test (1RM)

In order to avoid errors during the test performance, the correct performance of each exercise was demonstrated previously to the performance of the 1RM test. The individuals performed specific warm-up (subjectively light load) for the first exercise of the upper limbs (bench press) and lower limbs (*leg-press*). The 1RM was determined with the individuals trying from three to five times, with intervals range of 3-5 min. In case the evaluee performed two repetitions with the estimated load, the weight was increased for the following trial, and in case he could not perform a complete repetition, the load was reduced. All tests were followed by the same technician.

The exercises order was bench press, *leg-press*, low row, knee extension, military press, laid knee flexion, biceps curl and triceps curl. Except for the bench press and biceps curl exercises (performed with free weight),the other exercises were performed in machines (Physicus, São Paulo, Brazil).

Experimental sessions

Once the 1RM was determined, the participants returned to the laboratory in five different occasions for performance of the experimental sessions, which were randomly performed. Therefore, on the days of the exercise sessions the participants should perform the exercises in one of the following models: one set in circuit (1CIRC), three sets in circuit (3CIRC), one set conventionally performed (1CONV) or three sets conventionally performed (3CONV). The number of repetitions was set in 18, at intensity of 40% of 1RM. The adopted intervals were of 1-2 min when the participants performed the exercise in a conventional model andof 3-5 min at the end of each passage by the exercises in circuit. The exercises order was the same applied to the 1RM test. In the control session, the participants remained seated for 30 min. The subjects were told to have a light meal two hours before the beginning of the sessions.

Blood pressure and heart rate variability measurement

BP was measured with an automatic instrument (OMRON HEM-742, Bannockburn, USA), according to the recommendations by the *American Heart Association*[15]. BP at rest was measured (first visit), with individuals seated for 10 min and three measurements were performed with interval of five minutes on the left arm. The BP at rest was determined by the mean of the three measures. The pre--exercise BP was measured with participants remaining seated for 10 min and a single measurement was performed at the end of this period. After each session (exercise and control), the individuals went to the laboratory, where they remained seated at rest in a calm environment for one hour. A single measurement was performed at the 10th, 20th, 30th, 40th, 50^{th} and 60^{th}min. Mean BP (MBP) was calculated by the equation: MBP = DBP + [(SBP – DBP)÷ 3]. Water consumption was allowed during the monitoring period.

HRV ws monitored by a HR monitor (Polar S810i, Kempele, Finland). At the pre and post-exertion moments, the subjects remained seated without respiratory frequency control. The data were analyzed by the *Polar Precision Performance software (release* 3.00, Kempele, Finland). The HRV parameters in the frequency domain were analyzed by the ratio between the low frequency components (LF) and high frequency components (HF) (LF/HF), after the Fourier transformation and noise filtering by the HRV *Analysis Software* 1.1 program (Kuopio, Finland), with intervals of 5 min. Furthermore, the HRV was analyzed in the time domain according to the root mean square of the differences between adjacent normal RR intervals (RMSSD). The record of the considered HRV values was obtained before the BP measurements.

STATISTICAL ANALYSIS

Once data normality was confirmed, two-way ANOVA compared the SBP, DBP, MBP, HR, LF/HF and RMSSD variation between rest and recovery period and between the experimental sessions. LSD-Fisher post-hoc test was applied whenever necessary.Statistical significance level adopted was $P < 0.05$. The statistical package used was the Statistica 7.0 (Statsoft, Tulsa, OK, USA).

RESULTS

Data were expressed in mean and standard error. Table 1 presents the characteristics of the participants in the study and the 1RM values of the exercises.

Table 2 presents the rest values and the recovery period values for the assessed variables after the experimental sessions. When the moments were analyzed in isolation, significant differences were not identified between the experimental sessions. None alteration was identified after the control session. There was decrease of SBP from 30th to40th min after 1CIRC, at 40th min after 1CONV, in all moments and in the mean of the follow-up period after 3CIRC and at 20th, 40th, 50th, 60th min and in the mean of the recovery period after 3CONV. Concerning the DBP, there was reduction from 10th to30th min after 1CIRC, from10thto 20th min after the 1CONV session, in all moments and in the mean of the recovery period after 3CONV and at 10th, 20th, 40th, 50th min and in the mean of the follow-up period after the 3CIRC. Concerning the MBP, there was reduction from 10thto 40th min after the 1CONV session, from 20th to 40th min after the 1CIRC session and in all moments and in the mean of the recovery period for 3CIRC and 3CONV.

Conversely, the HR increased concerning the rest values from 10th to 40th min and in the mean of the recovery period after 1CIRC and 3CONV. Moreover, the HR remained high in all moments (except for the 50th min) after 3CIRC, and from 10^{th} to 30^{th} min and in the mean of the recovery period after 1CONV.

Figure 1 presents the variations (Δ = delta) of the variables analyzed between rest and the mean of the follow-up period. Concerning the SBP. Only 3CIRC (–9.4 ± 3.0mmHg; $P = 0.02$) promoted reduction compared to the control session (–1.7 ± 1.4mmHg). Con-

Table 1. Characteristics of the participants in the study.

SBP (mmHg) *	126.5 ± 4.4
DBP (mmHg) *	69 ± 6.1
MBP (mmHg) *	87.31 ± 4.6
HR (bpm) *	72 ± 11.2
Weight (kg)	77.3 ± 7.3
Height (cm)	177.1 ± 6.9
Age (years)	22.6 ± 1.6
1RM-Bnch press (kg)	66 ± 19.1
1RM-Leg Press (kg)	260 ± 38.3
1RM-Pulley row(kg)	85 ± 11.9
1RM-knee extension (kg)	55 ± 7.2
1RM-Military press (kg)	58 ± 10.7
1RM-Knee flexion (kg)	50 ± 9.6
1RM-Biceps curl (kg)	40 ± 7.9
1RM-Triceps curl (kg)	70 ± 12.1

* Values obtained at rest; SBP = systolic blood press; DBP = diastolic blood press ;MBP = mean blood press; HR = heart rate at rest; 1RM = one repetition maximum.

Table 2. Variation of the systolic blood press (SBP), diastolic blood press (DBP), mean blood press (MBP) and heart rate (HR) measured at rest (RE), at isolated moments and in the mean of the recovery period after the control session, one set in circuit (1CIRC), three sets in circuit(3CIRC), one set in conventional model (1CONV) and three sets in conventional model (3CONV).

		RE	10 min	20 min	30 min	40 min	50 min	60 min	Mean of the 60 minutes
Control	SBP (mmHg)	125.8 ± 4.4	124.2 ± 7.5	125.4 ± 6.4	125.5 ± 5.1	121.8 ± 7.9	123.0 ± 7.6	124.4 ± 6.6	124.1 ± 5.1
	DBP (mmHg)	69.2 ± 6.1	70.8 ± 7.1	69.2 ± 6.5	69.4 ± 6.1	68.6 ± 6.8	70.1 ± 7.9	74.0 ± 6.7	70.3 ± 5.7
	MBP (mmHg)	88.0 ± 4.6	88.5 ± 6.5	87.9 ± 5.5	88.1 ± 4.5	86.3 ± 6.3	87.7 ± 6.6	90.7 ± 6.2	88.2 ± 4.9
	HR (bpm)	73.3 ± 11.2	79.5 ± 13.6	68.9 ± 8.4	69.6 ± 10.3	69.3 ± 13.2	67.9 ± 9.1	70.5 ± 9.7	70.9 ± 7.7
1CIRC	SBP (mmHg)	125.0 ± 10.7	126.2 ± 9.3	124.1 ± 9.2	119.0 ± 11.5*	118.7 ± 5.1*	120.0 ± 5.8	120.0 ± 8.3	121.3 ± 6.9
	DBP (mmHg)	68.8 ± 8.5	60.7 ± 6.7*	57.1 ± 11.3*	62.3 ± 11.2*	63.8 ± 9.7	67.6 ± 7.7	67.1 ± 9.1	63.1 ± 7.9
	MBP (mmHg)	87.5 ± 8.5	82.5 ± 5.9	79.4 ± 9.8*	81.1 ± 10.9*	82.1 ± 7.6*	85.0 ± 6.4	84.7 ± 8.4	82.4 ± 7.4
	HR (bpm)	73.4 ± 9.0	92.5 ± 10.3*	88.2 ± 12.1*	85.5 ± 8.6*	82.2 ± 8.2*	78.4 ± 8.2	78.5 ± 9.8	84.2 ± 8.7*
3CIRC	SBP (mmHg)	128.5 ± 6.5	114.1 ± 15.3*	116.4 ± 14.1*	121.9 ± 12.4*	121.6 ± 9.6*	117.8 ± 11.1*	122.6 ± 7.5*	119.1 ± 7.9*
	DBP (mmHg)	70.0 ± 6.7	57.2 ± 9.1*	56.0 ± 6.8*	65.7 ± 18.1	63.1 ± 11.3*	61.9 ± 4.7*	65.6 ± 14.1	61.5 ± 5.1*
	MBP (mmHg)	89.4 ± 5.9	76.1 ± 9.7*	76.1 ± 7.6*	84.4 ± 14.8*	82.5 ± 8.8*	80.5 ± 5.6*	84.5 ± 9.3*	80.7 ± 4.1*
	HR (bpm)	77.8 ± 12.3	108.4 ± 4.8*	100.7 ± 13.4*	94.0 ± 15.0*	88.2 ± 12.6*	84.6 ± 11.1*	82.7 ± 10.5	93.1 ± 12.3*
1CONV	SBP (mmHg)	126.1 ± 7.1	127.3 ± 9.9	127.6 ± 4.9	121.0 ± 8.2	117.4 ± 13.5*	123.8 ± 7.8	122.7 ± 8.4	123.3 ± 5.1
	DBP (mmHg)	68.0 ± 4.6	60.0 ± 5.4*	62.0 ± 5.1*	65.6 ± 8.2	66.4 ± 5.2	68.3 ± 6.8	72.7 ± 4.6	65.7 ± 4.1
	MBP (mmHg)	88.1 ± 5.1	83.6 ± 6.8*	84.3 ± 4.3*	84.1 ± 7.8*	83.9 ± 5.4*	87.5 ± 6.6	89.8 ± 4.8	85.5 ± 4.6
	HR (bpm)	75.1 ± 10.8	88.2 ± 8.3*	85.5 ± 10.6*	82.0 ± 8.1*	77.8 ± 7.6	76.8 ± 6.9	76.0 ± 9.2	81.1 ± 7.4*
3CONV	SBP (mmHg)	128.3 ± 6.1	125.2 ± 8.4	119.4 ± 8.0*	124.0 ± 8.0	119.1 ± 7.7*	120.5 ± 8.2*	122.5 ± 5.4*	121.7 ± 5.9*
	DBP (mmHg)	69.9 ± 8.1	55.8 ± 7.2*	61.7 ± 11.4*	60.5 ± 10.4*	60.0 ± 9.8*	64.7 ± 12.0*	64.6 ± 8.6*	61.2 ± 8.7*
	MBP (mmHg)	89.3 ± 7.0	78.9 ± 6.6*	80.9 ± 8.5*	81.6 ± 8.5*	79.6 ± 8.1*	83.2 ± 10.1*	83.8 ± 6.8*	81.3 ± 7.4*
	HR (bpm)	74.7 ± 10.1	95.7 ± 9.5*	86.8 ± 9.6*	84.6 ± 8.6*	82.5 ± 9.8*	78.8 ± 8.3	77.8 ± 9.6	84.3 ± 8.2*

* significant difference related to rest.

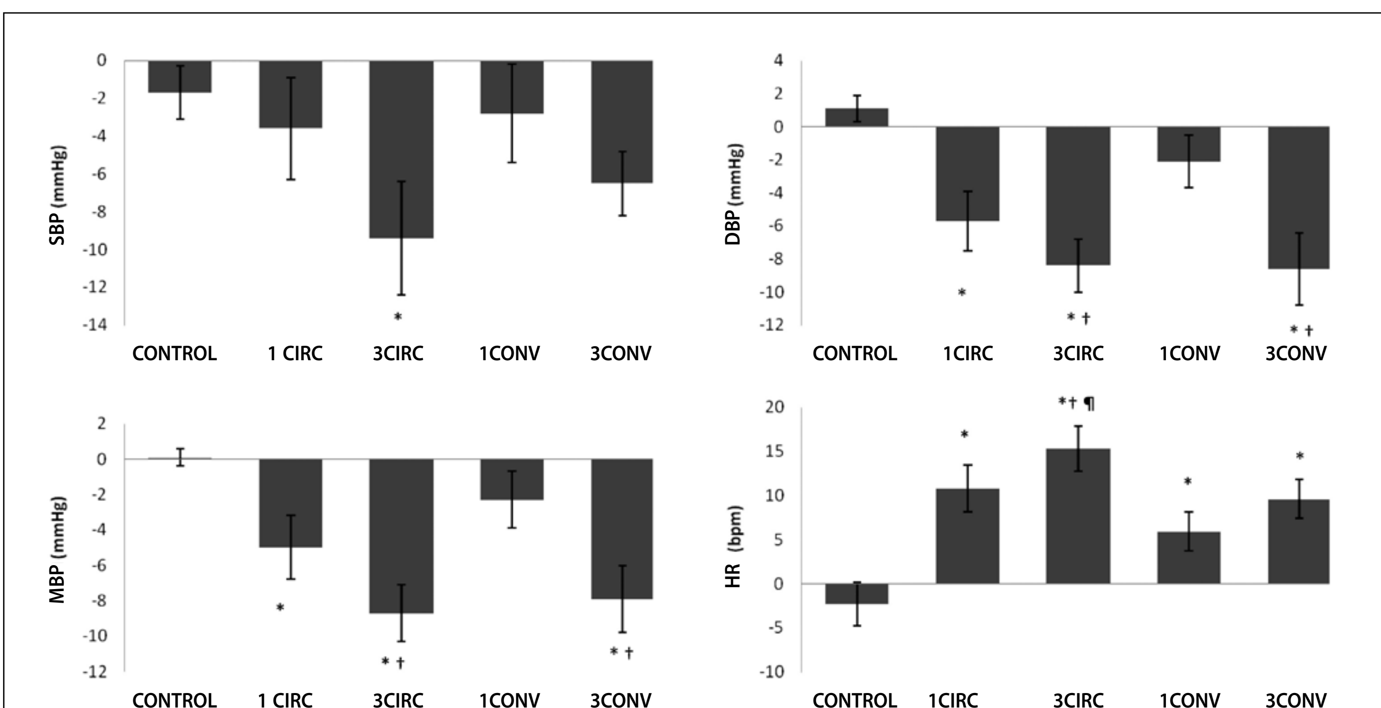

Figure 1. Variation between rest and the mean of the recovery period for the systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP) and heart rate (HR) after the different conditions (control and exercise).
* Difference vs. control session; † Difference vs. 1CONV session; ¶ Difference vs. 3CONV session. Adopted significance P ≤ 0.05

cerning the DBP, the 1CIRC (–5.7 ± 1.8mmHg; $P = 0.005$), 3CIRC (–8.4 ± 1.6mmHg; $P = 0.0002$) and 3CONV (–8.6 ± 2.2mmHg; $P = 0.0001$) sessions caused reduction compared with the control session (+1. 5 ± 0.8mmHg). Moreover, after 3CIRC ($P = 0.01$) and 3CONV ($P = 0.007$), the DBP values were lower than the 1CONV session values. Identically, the MBP was reduced compared to the control (–0.1 ± 0.5mmHg) after 1CIRC (–5.0 ± 1.8mmHg; $P = 0.02$), 3CIRC (–8.7 ± 1.6mmHg; $P = 0.0002$) and 3CONV (–7.9 ± 1.9mmHg; $P = 0.0006$). After 3CIRC ($P = 0.006$) and 3CONV ($P = 0.01$), the MBP was reduced compared to the1CONV (–2.3 ± 1.6mmHg). On the other hand, the HR remained higher than the rest values after all the sessions involving exercise. However, after 3CIRC, the HR was higher also than 1CONV ($P = 0.001$) and 3CONV ($P = 0.04$).

Table 3 presents the HRV values (LF/HF and RMSSD) at rest and in the mean of the recovery period after sessions. Concerning the RMSSD component, all sessions involving exercise caused reduction in the rest and there was not difference between sessions. Conversely, 3CIRC and 3CONV caused increase in the LF/HF component compared to the rest. More over, 3CIRC caused increase in the mean values of the follow-up period of the control session.

Table 3. Measures of rest and mean of the recovery period for the components of the HRV (LF/HF and RMSSD) after the control session, one set in circuit (1CIRC), three sets in circuit (3CIRC), one set in conventional model (1CONV) and three sets in conventional model (3CONV).

	LF/HF (%)		RMSSD (ms)	
	Rest	Mean of 60 min	Rest	Mean of 60 min
CONTROL	3.5 ± 0.9	2.8 ± 0.5	54.4 ± 12.7	64.2 ± 12.8
1CIRC	3.4 ± 0.7	4.8 ± 0.5	46.1 ± 7.4	27.2 ± 3.5 *
1CONV	3.6 ± 0.9	5.1 ± 0.8	59.8 ± 15.8	38.8 ± 7.3 *
3CIRC	2.8 ± 0.8	6.1 ± 1.3 * †	58.1 ± 12.1	24.9 ± 6.7 *
3CONV	2.9 ± 0.7	4.8 ± 0.7 *	55.1 ± 12.9	33.8 ± 8.9 *

* $P \leq 0.05$ vs. rest; † $P \leq 0.05$ vs. Mean of the 60 min of the control session.

DISCUSSION

The main results of the present study were: 1) the sessions with greater volume, regardless of the performance model, were more efficient in causing decrease, especially of DBP and MBP; 2) when the sessions of lowest volume were compared, the 1CIRC session was more efficient in causing decrease of DBP and MBP compared to the control session, when analyzed by the variation delta; 3) the 3CIRC session caused higher HR increase compared to the sessions performed in a conventional model when analyzed by the variation delta; 4) only the sessions of higher volume led to increase of the LF/HF component of the HRV compared to the rest values.

Some studies proposed to compare the effect of different work volume both of aerobic exercise[16] and resistance exercise[12,13] over the PEH, which, in most of the cases, observed that post-exertion pressure decrease is related to higher work volume. In that context, the results of the present study somehow agree with these findings, since the sessions which involve higher work volume were those which caused higher PEH.

Concerning resistance exercise, only two studies[12,13]which compared the effect of different work volume on the PEH were found.However, there is great methodological difference between these investigations. Mediano *et al.*[12], when using as sample hypertensive individuals, observed that the session with higher volume (three sets) provided more consistent pressure decrease when compared with the session involving lower volume (one set). Nevertheless, differently from our studies, the variable which suffered the highest alterations in this study was especially the SBP. Moreover, Polito and Farinatti[13] also observed that the resistance exercise performed in higher volume is more efficient in promoting PEH. Similarly to the results by Mediano *et al.*[12], Polito and Farinatti[13] only observed decrease in SBP. Nevertheless, the results of such studies should be carefully analyzed, since the authors only observed the BP behavior, neglecting the cardiac stress after exercise (mediated in our study by the HRV).

Regarding the exercise performance model (circuit or conventional) and the PEH occurrence, as in the present study, Simão *et al.*[17]did not observe significant differences in PEH after resistance exercises performed in different models with the same work volume. Furthermore, in this study[17] the SBP was the variable which suffered greater variations.Thus, the data of the present study and the findings by Simão *et al.*[17] do not let us state which performance model is more efficient to reduce the post-exertion BP. The 3CIRC session was the only which promoted reduction in SBP compared to the control day. On the other hand, when the HR and HRV behavior was analyzed (LF/HF) it was observed that this session caused higher cardiac stress after exercise when compared with the control session (LF/HF), as well as when compared with the sessions conventionally performed (HR delta).

The HRV analysis is considered as an indication of autonomic modulation in the heart [14]. However, there is little information about this variable in the PEH context[1]. In the present study, all sessions involving exercise caused reduction in the RMSSD component, and, on the other hand, only the sessions with higher volume promoted increase in the LF/HF component. Such behavior is indication of higher sympathetic activity post-exertion, a fact which justifies the HR increase after exercise and which was also observed by Rezk *et al.*[1]. The HR increase may be explained by increase in the baroreflex control activity, which, in a trial to keep the BP in the levels considered "normal", promotes HR increase.

Thus, although the 3CIRC session has caused decrease in SBP, DBP and MBP, there was great increase of post-exertion HR. It is worth mentioning that there were not differences in the post-exertion BP decrease compared with the session involving higher exercise volume; however, HR was higher after the 3CIRC session when compared with the session involving exercise conventionally performed. Thus, the use of multiple sets (three sets) may be a better strategy for prescription aimed at prevention and/or high BP treatment, when conventionally performed as the 3CONV session, since it promotes decrease similar to the 3CIRC session, but with lower post-exertion cardiac stress.

Despite the results found, some limitations of the present study deserve some comments, for example: lack of homogenization on the training status of the participants in the study, short follow-up period of the analyzed variables and reduced number of the sample. Additionally, the experimental sessions were not performed at the same time of the days, a fact which may have influenced on the post-exercise cardiovascular responses.

All authors have declared there is not any potential conflict of interests concerning this article..

REFERENCES

1. Rezk CC, Marrache RC, Tinucci, T, Mion D Jr, Forjaz CL. Post-resistance exercise hypotension, hemodynamics, and heart rate variability: influence of exercise intensity. Eur J Appl Physiol 2006;98:105-12.
2. Melo CM, Alencar Filho AC, Tinucci T, Mion D Jr, Forjaz CL. Postexercise hypotension induced by low-intensity resistance exercise in hypertensive women receiving captopril. Blood Press Monit 2006;11:183-9.
3. Syme AN, Blanchard BE, Guidry MA, Taylor AW, Vanheest JL, Hasson S, et al. Peak systolic blood pressure on a graded maximal exercise test and the blood pressure response to an acute bout of submaximal exercise. Am J Cardiol 2006;98:938-43.
4. Blanchard BE, Tsongalis GJ, Guidry MA, Labelle LA, Poulin M, taylor AL, et al. RAAS polymorphisms alter the acute blood pressure response to aerobic exercise among men with hypertension. Eur J Appl Physiol 2006;97:26-33.
5. Kenney MJ and Seals DR. Postexercise hypotension. Key features, mechanisms, and clinical significance. Hypertension 1993;22:653-64.
6. Anunciação PG, Polito MD. Hipotensão pós-exercício em indivíduos hipertensos: uma revisão. Arq Bras Cardiol 2011;96(5):425-6.
7. Fisher MM. The effect of resistance exercise on recovery blood pressure in normotensive and borderline hypertensive women. J Strength Cond Res 2001;15:210-6.
8. Hardy DO and Tucker LA. The effects of a single bout of strength training on ambulatory blood pressure levels in 24 mildly hypertensive men. Am J Health Promot 1998;13:69-72.
9. Mota MR, Pardono E, Lima LC, Arsa G, Bottaro M, Campbell CS et al. Effects of treadmill running and resistance exercises on lowering blood pressure during the daily work of hypertensive subjects. J Strength Cond Res 2009;23:2331-8.
10. Brown SP, Clemons JM, He Q, Liu S. Effects of resistance exercise and cycling on recovery blood pressure. J Sports Sci 1994;12:463-8.
11. O'connor PJ, Bryant CX, Veltri JP, Gebhardt SM. State anxiety and ambulatory blood pressure following resistance exercise in females. Med Sci Sports Exerc 1993;25:516-21.
12. Mediano MFF, Paravidino V, Simao R, Pontes FL, Polito MD. Subacute behavior of the blood pressure after power training in controlled hypertensive individuals. Rev Bras Med Esporte 2005;11:337-40.
13. Polito MD, Farinatti PT. The effects of muscle mass and number of sets during resistance exercise on postexercise hypotension. J Strength Cond Res 2009;23:2351-7.
14. Vanderlei LC, Pastre CM, Hoshi RA, Carvalho TD, Godoy MF. Basic notions of heart rate variability and its clinical applicability. Rev Bras Cir Cardiovasc 2009;24:205-17.
15. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN et al. Recommendations for blood pressure measurement in humans and experimental animals: Part 1: blood pressure measurement in humans: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Hypertension 2005;45:142-61.
16. Forjaz CL, Santaella, DF, Rezende LO, Barretto AC, Negrao CE. Effect of exercise duration on the magnitude and duration of post-exercise hypotension. Arq Bras Cardiol 1998;70:99-104.
17. Simao R, Fleck SJ, Polito MD, Monteiro W, Farinatti PTV. Effects of resistance training intensity, volume, and session format on the postexercise hypotensive response. J Strength Cond Res 2005;19:853-8.