Research Article

Do different volumes of resistance training cause different acute answers of cardiac autonomic modulation?

Abstract

Introduction: There are cardiac autonomic modulation changes after resistance training. However, influence of training volume on this response is not clear.

Objective: To compare the acute response of autonomic cardiac modulation after two different volumes of advanced resistance training methods.

Methods: Twenty-seven men were divided into two intervention groups, the German Volume Training (GVT) group and Sarcoplasma Stimulating Training (SST). A test of a maximum repetition was used to verify the maximum force and the training volume was calculated by the equation: Total Volume=N. of load (kg) x N. of repetitions. Heart rate variability was measured 10minutes before and 50minutes after exercise.

Results: The groups differed in the exercise volumes (supine GVT: 4465.71±1250.90, supine SST: 2108.15±1092.86, ($p<0.001$), leg 45° GVT: 16717.71±3602, ($P<0.001$)) and total volume (GVT: 21283.43±4421.26; SST: 11592.62±4934.75 ($p<0.001$). There was not statistical difference between the groups before and after resistance training ($p>0.005$).

Conclusion: Both volumes of the advanced training methods similarly altered the acute response of heart rate variability.

Keywords: autonomic nervous system, strength training, heart rate, heart rate variability, resistance training

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Abbreviations: GVT, German volume training; SST, sarcoplasma stimulating training; HRV, heart rate variability; RT, resistance training; BMI, body mass index; RM, repetition maximum; RMSSD, square root mean of squared differences between normal RR intervals; LF, low frequency; HF, high frequency

Introduction

Resistance Training (RT) is highly recommended for the improvement of physical conditioning, and it promotes not only muscular but also cardiovascular ones.[1] Nevertheless, it is needed the control of training dose in order to avoid the process of inadequacy for the body.[2] This way, the use of markers (psychological, physiological and biochemical ones) for determining the effects of training load, has been broadly discussed, and among them cardiac autonomic modulation is shown as a physiological marker of the Autonomic Nervous System (ANS).[3]

The measuring of cardiac autonomic modulation through the heart rate variability (HRV) may indicate a prognostic of the cardiovascular health, and, furthermore, it is used to check if the training may have led to negative reactions. Thus, HRV response to RT depends on the training variables, such as quantity of used load, interval training , number of repetitions, number of sets and exercises, number of exercises per muscular groups exercised and types of exercises (multiarticular or monoarticular); these factors can cause changes in HRV.[4] Some authors found changes in HRV after comparing groups in different intensities of a RT session.[5,6] It was noticed higher sympathetic activation in the post resistance training in groups of higher intensity, and also individuals that had training with higher volumes, showed bigger changes in the autonomic modulation.[7] However, there are few studies that noticed the influence of advanced methods of RT in the acute response of cardiac autonomic modulation.[8]

In this context, the aim of this study was to compare the acute response of cardiac autonomic modulation after different methods of advanced resistance training, testing the hypothesis that the method of higher training volume, German Volume Training (GVT) would cause a bigger change of HRV, than the method of Sarcoplasma Stimulating Training (SST).

Material and methods

Study design and sampling

This is a non-randomized Clinical Study – 27 men, who were apparently healthy- and who were aged between 20 and 40 years old, were part of the sampling. Participants' recruitment was held through invitations in social networks and bodybuilding centers, in the city of Salvador, BA, Brazil. There were included in the study, individuals who had had, at least, a year of resistance training, who were non-smokers and who did not show any kind of metabolic or cardiovascular diseases, joint problems or bone lesions and the absence of any medication that could influence the cardiovascular responses. Volunteers were told about all the procedures they would go through and, those who agreed in participating, signed a term of free and clarified agreement. This study was approved by the Commitee of Ethics in Research at the Bahian School of Medicine and Public Health (CAAE – 57573516.7.0000.5544).

Pre-intervention recommendations

The volunteers were told the following recommendations, 72 hours before the intervention, through e-mails and telephone: 1) Bring appropriate clothes for the practice of exercises; 2) Sleep from 6 to 8 hours the night before; 3) Avoid heavy meals in the two hours before the exams; 4) Avoid alcoholic and energetic drinks on the day before and on the day of the evaluation; 6) Notify about changes in their health picture (illnesses, surgeries, dizziness, fever, headache, chest pain, malaise); 7) Notify about medications and food supplement that are being used.

Anthropometric data

There were evaluated anthropometric data of the volunteers, through variables of weight, height and Body Mass Index (BMI). Weight was measured through Welmy Mechanical Professional Scales (up to 150kg), and Height through the Stadiometer (220cm) that was coupled with the Scales. BMI was calculated with the weight (kg) divided by the square of the height (m).

Test of 1 repetition maximum (1RM)

In this study the strength of 1 RM from participants, was obtained during the first set of tests. Individuals held a rehearsal to establish the maximum number of repetitions that can be concluded by a determined percentage of 1 RM.

Firstly, participants got to know the exercises, followed by standardized warming up of 3-5minutes of light activities, which involved the muscular grouping to be tested. After 1 minute of interval, there was the warming up of 3-5 repetitions, moderate weight (60% to 80% of estimative of 1 RM). After an interval of 2minutes, 1 RM with load close to the maximum estimated was requested, through the participant's perception. If the participant was able to perform 2 to 3 additional repetitions for tests of upper limbs, it would be added 5 to 10% of the estimated load, and for tests with lower limbs it would increase from 10% to 20%. Based on these adjustments, the test is once again repeated after a 3-5minute interval. The aim was just to do 1 RM. It was only considered a valid try, the one with the technique that followed the correct standard.[9]

Experimental protocol

Volunteers needed to make an appointment for the resistance training, and each one lasted two hours. In the first 10 minutes before the 1 RM test, the Heart Rate Variability was measured, where the individual was laid down, without excessive exposure to light, in an air-conditioned room and with no noises. After the anthropometric evaluations and determining of the load of 1RM, the 27 volunteers were randomly divided into two intervention groups (German Volume Training (GVT) who showed n=14 and Sarcoplasma Stimulating Training (SST)) with n=13 – these are advanced methods of resistance training.

GVT group did ten repetitions in ten sets, with intervals of 30seconds. Intensity was 50% of 1RM. It is required that the volunteer reaches ten repetitions; if he gets to training to failure, the auxiliary evaluator will help in the phase of training to failure of the movement, until the volunteer finishes the ten repetitions.

The protocol for the SST group consisted in three blocks- on the first block the intensity was of 85% of 1RM so that the participant can do the initial eight repetitions, and after 10 seconds of interval the load remains the same for free repetitions with 10 second intervals between the sets. This block was interrupted when the volunteer got to the training to failure in one repetition. In the 10 seconds of interval, the participant went to Block 2, where 20% of intensity was subtracted, and the same procedure above was repeated. When arriving to the training to failure in a repetition with the current intensity, once again 20% of intensity was subtracted, getting to Block 3 and repeating the same protocol until the training to failure. After the intervention procedures, individuals remained at rest, for the measuring of HRV, for 50minutes.

Analysis of heart rate variability

For the record of heartbeats, it was used the frequency meter V800 by Polar®. These data were transferred to the software polar precision performance, with the objective of analyzing HRV, and they were imported to the software Kubios HRV 2.0 (Biosignal Analysis and Medical Imaging Group, Kuopio, Finland) in order to calculate the linear methods for the domains of time and frequency. Measurement of HRV in the domain of frequency, was held through Fast Fourier Transform (FFT) in sets of 5 minutes with interpolation of 4Hz, 50% of overlapping. The selected variables were: low frequency (LF) (0:04 to 0:15Hz and this component mainly refers to the sympathetic modulation, high frequency (HF) (0,15 to 0,4Hz, refers to parasympathetic modulation), the ratio between LF/HF (it refers to sympathovagal balance) and RMSSD (it refers to parasympathetic activity). The sympathovagal index (LF/HF) was calculated based on standardized LF and HF.[3]

Statistical analysis

The descriptive statistical analysis was held by using the software Statistical Package for Social Sciences (SPSS), version 14.0 for Windows. The continuous variables are shown as mean and standard deviation. After the verification of the normality of the data, with the use of Shapiro-Wilk test, the independent t student test was used to compare the variables in the groups. The comparisons between the averages of the different conditions, were done through the analysis of one-way repeated measures (ANOVA) with post hoc Sidak test. All the measurements were two-sided and the significance level was 5%.

Results

Out of 27 participants, 14 completed the protocol GVT and 13 completed the protocol SST. The values of the tests of 1 RM and the Total Volume of the sets of strength exercise are found on Table 1. It was found normal distribution and homogeneity among the groups, and similarity was seen between the variables age, BMI, 1 RM supine and Leg 45º; however, it was found difference among the groups when comparing the total volume of training and volume of the exercises.

The data of the heart rate variability before and after the two test sessions (GVT and SST) are shown on Table 2. The values of the indexes of HRV pre-training were similar among the sessions ($p>0,05$). As a comparison of the averages of the responses of the indexes of HRV between the interventions, it was not found any statistical difference either (Table 2).

Table 1 Anthropometric characteristic of men who underwent training in Salvador, Bahia, Brazil, 2018

Variables	GVT (N=14)	SST (N=13)	p
Age	28,29±6,21	27,23±4,69	0,625
BMI	25,88±2,36	25,89±2,74	0,990
1 RM supine	90,37±19,43	86,61±20,03	0,625
1 RM Leg. 45°	315,55±64,39	319,93±106,44	0,897
Volume supine	4465,71±1250,90	2108,15±1092,86	0,001
Volume Leg. 45°	16717,71±3602,42	9484,46±4157,50	0,001
Total volume	21283,43±4421,26	11592,62±4934,75	0,001

BMI, body mass index; 1 RM, one repetition maximum; GVT, German volume training; SST, sarcoplasma stimulating training; N, number of sampling

Table 2 Comparison between the advanced training methods on the acute response of heart rate variability during and after 50 minutes of training. Salvador, Bahia, Brazil, 2019

Variables	GVT				SST			
	RMSSD	LF	HF	Ratio LF/HF	RMSSD	LF	HF	Ratio LF/HF
Pre- intervention	54,17±37,58	55,47±17,46	44,39±17,46	1,66±1,23	42,97±23,16	62,92±11,64	37,06±11,64	1,98±1,07
0-10 minutes	32,63±53,22	68,64±24,37	31,30±24,38	4,49±4,42	16,13±21,48	82,16±15,69	17,59±15,11	8,47±6,36
10-20 minutes	22,82±26,19	74,25±23,35	25,74±23,36	5,57±3,99	25,43±30,59	81,25±15,9	18,71±15,92	7,74±5,75
20-30 minutes	17,49±17,89	79,65±13,17	20,35±13,17	7,97±8,66	16,72±10,81	81,45±15,84	18,53±15,83	7,3±4,19
30-40 minutes	23,85±15,41	69,2±19,1	30,75±19,13	10±21,13	22,36±12,23	76,26±21,23	17,74±12,76	6,45±4,28
40-50 minutes	28,10±18,32	64,63±17,54	35,35±17,53	5,09±3,34	48,43±67,13	77,46±14,68	22,53±14,68	5,09±3,34

GVT, German volume training; SST, sarcoplasma stimulating training; RMSSD, square root mean of squared differences between normal RR intervals; LF, low frequency; HF, high frequency

Discussion

Our data do not confirm the hypothesis that a higher volume of resistance training (GVT) would cause higher acute changes in the cardiac autonomic modulation. It is suggested that it may happen because of the high intensity of the group (SST), or because this method shows different characteristics, as the interval between the series is smaller than the ones from the traditional resistance training.[1]

In this context, some aspects must be observed, as for example: the recruitment of motor units requires a progressive activation of the sympathetic system to keep the volume of training, and this way it looks as if in the GVT group, as well as in the SST group there was higher activation of metaboreceptors, mechanoreceptor and mechanisms of arterial baroreflex, which seems to explain the non-difference between the methods.[4] Additionally, the lack of a control group with traditional training volume could better explain the influence of volume in HRV.

Our findings differ from the study of Figueiredo et al.[7] which analyzed three different numbers of sets for each exercise (1 set, 3 sets and 5 sets) and it was observed that the higher volume of training caused more changes in HRV. However, the training sessions were done by the same individuals, which can decrease the power of comparison among groups. Despite previous studies not having checked the specific effect of training volume, they suggest that the higher the number of sets, repetitions and intensity, higher changes in the sympathetic and parasympathetic activities.[5,6,10–14]

It is observed a similarity with our data and literature findings,[5,6,10–14] in where the higher number of used sets, repetitions and intensity, cause alterations in HRV through the increase of cardiac sympathetic modulation and reduction of vagal modulation. In another situation,[13] it was analyzed the influence of the intensity in the acute response of HRV (keeping the same volume for the groups); it was also verified that when increasing the intensity, the higher the change after the exercise, which corroborates with previous findings.[5] However, it was highlighted[6] that two protocols of different intensities of resistance training caused similar changes in the cardiac autonomic modulation. Nevertheless, the protocols differed in the volume (10 repetitions in 80% of 1RM , and 40% in 1RM), and it was not possible to clearly state the impact of the intensity alone , which suggested that the volume shows great influence in the cardiac autonomic modulation-post training- independently of the intensity, which corroborates with our findings.

In previous studies,[11–14] despite investigating the influence of variables of RT , which are different from the ones in this study, it can be seen the great influence of the aspects of intensity and volume. For example, Figueiredo et al.[10] investigated if the time of rest between the sets and exercises have an influence on the acute response of VFC. Both groups did three sets of 70% 1 RM for 8 to 10 repetitions, however a group with time of rest of 2 minutes, and another one of 1 minute, then, observed that independently of the time of rest, the two groups increased the cardiac sympathetic modulation, and decreased the cardiac parasympathetic modulation after 40 minutes. It seems that there is more influence of volume and intensity than of the time of rest. Then, we can observe that resistance training can change the Heart Rate Variability, increasing the sympathetic activity and reducing the parasympathetic one.

The findings in this present study show that different volumes caused stress that is similar in the cardiac autonomic control. Despite the sample is made by trained individuals, our data show great increase in the sympathetic activity and reduction in the parasympathetic activity, which lasted for 50 minutes, which highlights that these training methods are advanced. In this context, it can be contraindicated in individuals with high cardiovascular risk; However, it is noticed that individuals who are considered to have low risk and who are highly conditioned, may be part of daily training strategy, once high intensity and volume exercises are not contraindicated in this population.[1]

Then, it is deemed necessary periodic clinical and physical evaluations, as well as the monitoring of training sets for a better prescription of resistance training methods; so, the measuring of HRV , may it be pre or post the exercise, may demonstrate how much stressing the exercise was for the cardiac autonomic control, or if it was a stimulus of appropriate/ optimal load for the body. Nevertheless, additional studies need to confirm the effect of training volume in the response of HRV, once there were limitations in our study that may have undermined a detailed analysis on the variables, as for example, the short period of intervention and the size of the sampling. On the other hand, the results of our study may encourage other researchers to investigate different methods and their effects on HRV, testing other populations, including individuals with dysautonomia.

Conclusion

The acute response of heart rate variability was the same for both methods of resistance training, in men who were apparently healthy and experienced in RT. A This way, professionals of physical conditioning can make use of trainings, may they be of high volume or high intensities, with the purpose of prescribing stimulus that promote positive answers aiming the adaptation and improvement of physical performance. For so, it is necessary the monitoring of HRV post session of resistance training, once the unbalance of sympathovagal balance can lead to consequences in cardiovascular health.

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Conflicts of interest

The authors declare that there is no conflict of interest that could influence the study and publication.

References

1. Franklin BA, Garber CE, Gaesser GA, et al. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sport Exerc*. 1998;30(6):975–991.
2. Freitas DS, Miranda R, Filho MB. Psychological, physiological and biochemical markers of the training load and the overtraining effects. *Rev Bras Cineantropometria Desempenho Hum*. 2009;11:04.
3. Marek Malik. The Task Force was established by the Board of the European Society of Cardiology and co-sponsored by the North American Society of Pacing and Electrophysiology. Guidelines Heart rate variability. *Eur Heart J*. 1996;17:354–381.
4. Aubert AE, Seps B, Beckers F. Heart rate variability in athletes. *Sport Med*. 2003;33(12):889–919.
5. Lima AHR de A, Forjaz CL de M, Silva GQ de M, et al. Acute effect of resistance exercise intensity in cardiac autonomic modulation after exercise. *Arq Bras Cardiol*. 2011;96(6):498–503.
6. Rezk CC, Marrache RCB, Tinucci T, et al. Post-resistance exercise hypotension, hemodynamics, and heart rate variability: Influence of exercise intensity. *Eur J Appl Physiol*. 2006;98(1):105–112.
7. Figueiredo T, Rhea MR, Peterson M, et al. Influence of number of sets on blood pressure and heart rate variability after a strength training session. *J Strength Cond Res*. 2015;29(6):1556–1563.
8. Gambassi BB, Queiroz C, Muniz D, et al. Acute effect of German volume training method on autonomic cardiac control of apparently healthy young. *Journal of Exercise Physiology*. 2019;22(2):49–57.
9. Rodrigues Pereira MI, Chagas Gomes PS. Muscle strength and endurance tests: reliability and prediction of maximum repetition - Review and new evidence. *Rev Bras Med do Esporte*. 2003;9(5):325–346.
10. Figueiredo T, Willardson JM, Miranda H, et al. Influence of rest interval length between sets on blood pressure and heart rate variability after a strength training session performed by prehypertensive men. *J Strength Cond Res*. 2016;30(7):1813–1824.
11. Michael S, Jay O, Graham KS, et al. Influence of exercise modality on cardiac parasympathetic and sympathetic indices during post-exercise recovery. *J Sci Med Sport*. 2018;21(10):1079–1084.
12. Isidoro NJ, Santana MDR, Valenti VE, et al. Cardiac autonomic recovery after strength exercise in lower and upper limbs. *Acta Cardiol*. 2017;72(4):467–473.
13. Figueiredo T, Willardson JM, Miranda H, et al. Influence of load intensity on postexercise hypotension and heart rate variability after a strength training session. *J Strength Cond Res*. 2015;29(10):2941–2948.
14. Mayo X, Iglesias-Soler E, Fariñas-Rodríguez J, et al. Exercise type affects cardiac vagal autonomic recovery after a resistance training session. *J Strength Cond Res*. 2016;30(9):2565–2573.