Manual Therapy, Posturology & Rehabilitation Journal
Formely REVISTA TERAPIA MANUAL

RESEARCH ARTICLE

https://doi.org/10.17784/mtprehabjournal.2021.19.745

HIIT and RT or vice versa: The order of stimulations alters acute hemodynamic response?

Samuel Gomes da Silva[1], Fábio Santana[1,2], Iransé Oliveira-Silva[1,2]

[1]Centro Universitário de Anápolis– UniEVANGELICA, Anápolis, Goiás, Brazil; [2]Universidade Estadual de Goiás, Goiânia, Brazil.

ABSTRACT
Background: The High Intensity Interval Training (HIIT) has had space in social networks that disseminate its practice and also among practitioners of physical exercises in a global way. **Objective:** To verify if the stimuli order (HIIT-RT or RT-HIIT) changes the acute hemodynamic response. **Methods:** 10 young adult male participants aged between 18 and 30 years (24.7 ± 2.2). For the test protocols the High intensity interval training (HIIT) and the conventional resistance training (RT) were performed in Cross-over using a Spinning Exercise Bike in addition to the apparatus: Bench press; Leg Press; Pull down; Leg curl; Low Rower. The hemodynamic variables were collected at rest, post-training, and 10', 20' and 30 'minutes of recovery. **Results**: A significant difference was found in HR and SBP at the end of the training in the SBP and DBP variables there were significant differences in the 20' and 30' minutes and in the MAP there was a significant difference in all recovery times with RT and HIIT higher post-workout and recovery values. **Conclusion:** The stimuli order changes the acute hemodynamic response. When the orders were analyzed (HIIT-RT; RT-HIIT), the order that presented the best results was HIIT-RT. It presented changes during exercise as they presented better post-training responses.
Keywords: High intensity training; Exercises Order; Hemodynamic Responses.

BACKGROUND

The High Intensity Interval Training (HIIT) has had space in social networks that disseminate its practice and also among practitioners of physical exercises in a global way[(1)]. HIIT is a training method composed of brief periods of intense activity and followed by passive rest intervals or less vigorous activities of short duration and they are thus seen as an effective alternative when compared to other types of training due to the smaller volume, saving time and bringing equal or better results, mainly in the case of hemodynamic adaptations[(2)]. Curiel-Regueros, Fernández-Lucas and Clemente-Suárez[(3)] found in soldiers the increase in hearth rate (HR) and lactate, the decrease of oxygen saturation in the operational HIIT, using the low volume protocol showed to be an efficient protocol. The HIIT appears to be quite efficient also in relation to the VO_{2max}. According to Naves et. al.[(4)], active youths underwent HIIT training at the end of 8 weeks were found positive results in relation to VO_{2max}, revealing that HIIT brings benefits in cardiorespiratory adaptations.

In the special groups a study using the low-volume HIIT protocol in adults with type 1 diabetes found elevation in heart rate, as well as in plasma glucose levels in GH, lactate and catecholamines where it was shown to be an effective exercise in individuals belonging to this particular group especially when done in a fast [(5)]. HIIT has also been applied in cardiac rehabilitation and other coronary diseases showing benefits to the cardiovascular system influencing the improvement of variables such as HR, Mean Blood Pressure, LDL, HDL, VLDL, Glycemia and Improved Body Composition[(6,7)]. On the other hand RT brings with it results and changes in most of the hemodynamic and physiological responses if carefully and carefully prescribed[(8)]. Some of these changes are hypertrophy and increase of muscle strength, alteration in body composition, hormone release and neuromuscular alteration[(9)], cardiac response and blood flow[(10)]. Additionally to all changes resistance training may still be used as an effective method to minimize the injury risk[(11)]. When comparing RT with HIIT was found a greater change in HR lactate during training and also increase in cortisol during exercise and after a rest period showing to be efficient in the issue of cellular wear and alteration of homeostasis even if there was the same time under tension in both[(8-10)].

Resistance training with load does not bring many physiological changes but being done with greater volume and lower overload brings about greater physiological changes[(9)] and also alters plasma lipids reducing the incidence of cardiovascular diseases[(11)]. Other studies show that resistance training may be effective in treating systemic arterial pressure since it has an acute response reducing post-exercise levels. Thus the present study aims to verify if the stimuli order (HIIT and RT or RT and HIIT) changes the acute hemodynamic response.

*Corresponding author: Iransé Oliveira-Silva; E-mail: iranse.silva@unievangelica.edu.br

Submission date 16 April 2020; Acceptance date 10 January 2021; Publication date 16 March 2021

METHODS

Procedures

This article focuses on a quantitative crossover descriptive study. The sample was selected for convenience and comprised 10 young adult male participants aged 18 to 30 years (24.7 ± 2.2). The study followed the recommendations of resolution 466/2012 dealing with ethical principles, and data preserved. As inclusion criteria they could not present any musculoskeletal problems that could interfere in the application of the protocols and did not make use of ergogenic resources that could interfere in the hemodynamic variables. As exclusion criterion were those individuals that after the application of the Anamnesis and Questionnaires were detected some problem that could interfere in the collection of data, besides being excluded from the sample, individuals, for some reason, did not perform any of the research steps.

It was first adopted the contact with the teacher in charge of the academy when the research proposal was presented for the respective authorization. Subsequently the Coparticipant Term was sent to the responsible person in order to formalize the execution of the research. After these initial procedures a contact was made with the students of the academy at random and for convenience in the search of volunteers to compose the respective sample.

Instruments

For the test protocols was used a Spinning Ergometer Bike (LF-480, Lion®, Brazil). In relation to the apparatus for Resistance Training we used: Bench press; Leg Press; Pull down; Leg Curl; Rowing Low, all Lion Fitness® equipment. The following parameters were used for hemodynamic: BP measurement (BP A100, Microlife®, Brazil) for heart rate (HR) a frequency (ES055, Atrio®, Brazil) and for the oxygen saturation (SaO_2) an Oximeter (SB100, Mark Rossmax®, Brazil).

Training protocol

The training was divided into two types of stimuli: HIIT followed by TR and TR followed by HIIT. The following procedures were adopted for the development: a pilot test with two men who fit the same age group and who were not part of the sample. With the purpose of evaluating hemodynamic responses at rest the participant was instructed to arrive at the place 10 minutes before starting the data collection so that there was adequate rest time and should remain seated in a chair until the time of the beginning of the evaluation.

Hemodynamic responses

In order to measure the heart rate (HR) systolic blood pressure (SBP) and diastolic blood pressure (DBP) the patients were seated in a chair with their right arm on the table and the answers were measured in the same arm in all subjects every moment. With these values the mean arterial pressure - MAP was calculated according to the following formula: MBP = DBP + [(SBP - DBP) / 3]. HR and SaO_2 were measured before blood pressure measurement. All hemodynamic variables were collected at five different moments: rest, post-training and at 10', 20' and 30 'minutes post-exercise.

HIIT

For the determination of HIIT, the Maximum Heart Rate – HR Max of the individual was first calculated through the Ball State University formula: Max HR = 209 - (0.7 x Age), in the sequence the formula was used for Target Training Zone, HR Training =% x (Reserve HR) + HR Rest, where Reserve HR is the product of (Max HR - HR Rest). The variable used to standardize the HIIT intensity was the Training Target Zone, and the percentages of training used were 80% to 90%. HIIT was applied according to Tabata's protocol, which consisted of 8 Sprints of 20 seconds for 10 seconds of passive rest.

Resistence training (RT)

For the determination of conventional RT, the estimated load was within the hypertrophy zone where subjects were asked to do between 8 and 12 maximal repetitions and three sets of each exercise with a two-second cadence in the eccentric phase for one second in the concentric phase and interval of one minute between sets. The exercises of the Conventional Resistance Training were alternated by follow-up, being they; Bench press; Leg Press; Pull down; Leg curl; Low Rower.

Data analysis

It was used SPSS software version 21.0, and repeated measures ANOVA and a Student's t-test were used to compare HIIT-TR and TR-HIIT. The data was presented on mean and standar error. It was adopted the value of ($p \leq 0.05$) for significance level.

RESULTS

Figure 1 shows the values of hemodynamic responses such as HR, SBP, DBP and MBP, in order to identify the acute changes resulting from Cross-over between HIIT-RT and RT-HIIT stimuli.

Analyzing figure 1, the significant difference in HR ($p = 0.006$) at the post-training moment was identified in the post-training period ($p = 0.012$), 20' ($p = 0.004$) and 30' ($p = 0.052$) respectively. When analyzing the DBP, it was found a significant difference in the rest period ($p = 0.038$), and also in the recovery periods of 20 '($p = 0.002$) and 30' minutes ($p = 0.000$). MBP, as well as in DBP, showed a significant difference during rest ($p = 0.027$) and also in the respective periods during recovery of 10 '($p = 0.007$), 20' ($p = 0.001$) and 30 'minutes ($p = 0.000$) respectively.

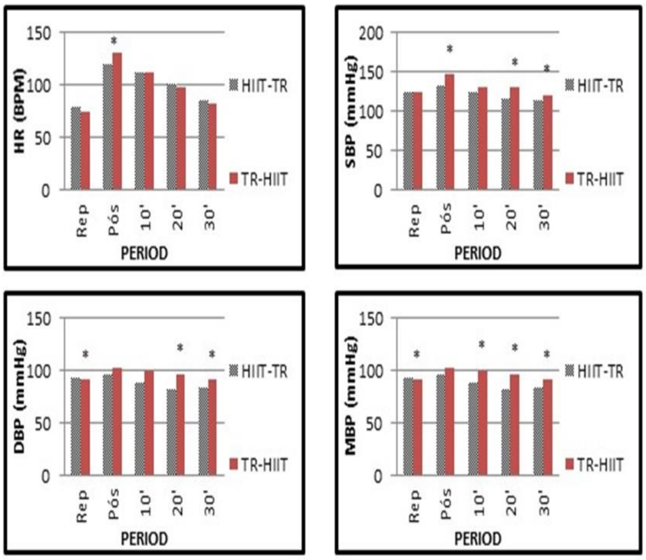

Figure 1. Stratification of hemodynamic response data in HIIT-RT and RT-HIIT.

***Note:** Heart rate (HR); systolic blood pressure (SBP); diastolic blood pressure (DBP); mean blood pressure (MBP); High intensity interval training (HIIT); Resistance training (RT). indicates the differential ($P < 0.05$).

In Figure 2 shows the difference between the values of post-training and resting hemodynamic responses, in order to identify those in which periods obtained higher elevation and acute reduction resulting from Cross-over between HIIT-RT and RT-HIIT stimuli. Analyzing Figure 2 the HR is higher during all periods of the RT-HIIT stimulus this factor may be occurring because HIIT is a low-volume, intense cyclic exercise method, requiring greater blood flow through the body thus raising HR and because data were collected shortly after HIIT, may have directly influenced this change. When analyzing SBP it is observed that there is not much alteration compared to rest in the HIIT-RT stimulus however it is noteworthy that there was a hypotensive effect in the 10 ', 20' and 30 'minutes respectively, RT-HIIT stimulus the hypotensive effect is only identified in the 30 'minute period.

Analyzing the DBP, it is possible to highlight the hypotensive effect during recovery, starting at 10 'minutes and extending between the 20' and 30 'minutes respectively in the HIIT-RT stimulus, in the RT-HIIT stimulus the hypotensive effect is reached only at 30 'minutes post-training.

In the analysis of MBP, the hypotensive effect in relation to the two stimuli is highlighted according to the figure the HIIT-RT stimulus presented the hypotensive effect during the recovery already in the 10 'minutes reaching 30 minutes respectively in the RT-HIIT stimulus, presents the hypotensive effect only at 30 minutes.

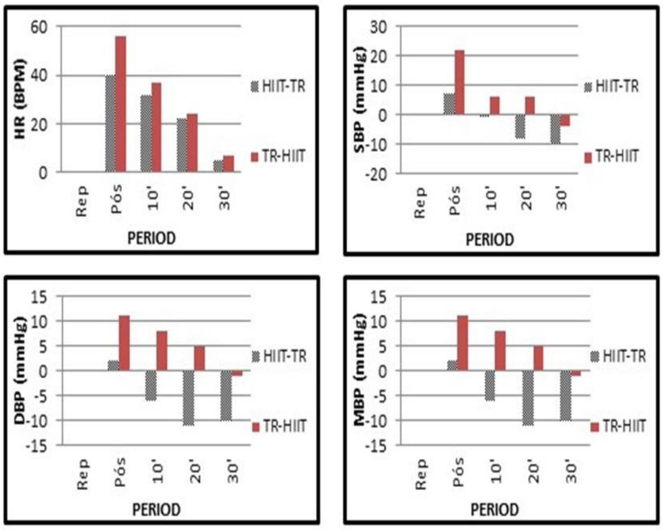

Figure 2. Difference between the values of post-training and rest hemodynamic responses.

***Note:** Heart rate (HR); systolic blood pressure (SBP); diastolic blood pressure (DBP); mean blood pressure (MBP); High intensity interval training (HIIT); Resistance training (RT).

Figure 3 shows the acute adaptations of the oxygen saturation (SaO_2), when analyzing the figure it is observed the SaO_2 in the RT-HIIT stimulus begins reducing the values in the post-workout and continues reducing until the 10 'minutes and it goes up again only after 30' of recovery and still do not reach rest levels in the HIIT-RT analysis, SaO_2 reduces post-training, maintains in the 10' and begins to rise to 20' reaching the level of homeostasis and maintains up to 30'. Analyzing this result it was found a significant difference at 10 '(p = 0.034) and 20' minutes (p = 0.001) respectively.

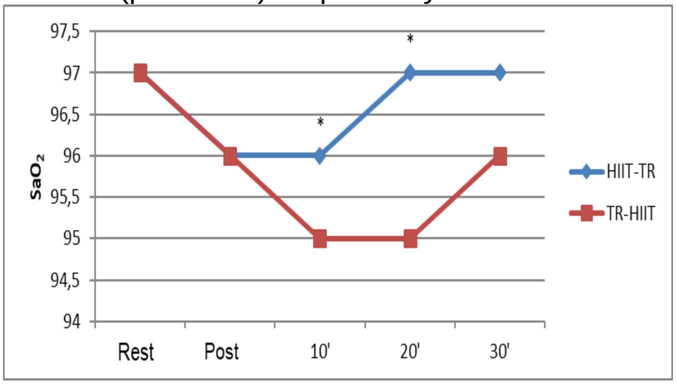

Figura 3. Acute adaptations of SaO_2 in HIIT-RT and RT-HIIT.

*Note: Saturation of oxigen (SaO_2); High intensity interval training (HIIT); Resistance traning (RT); * significance (p <0,05).

DISCUSSION

The findings demonstrated that when compared to the training involving the HIIT-RT or RT-HIIT stimuli the second showed higher values in all hemodynamic variables in the post-training and this result may be associated with the last exercise performed in the series that HIIT is usually worked with cyclic exercises as the case of the present study requiring greater cardiovascular capacity and increasing the blood demand to the organism causing the HR to increase and consequently raise the pressure values SBP, DBP and MBP. Regarding SaO_2, it was observed the difficulty in keeping it at the homeostatic levels during the training, but it was observed that in one of the stimuli (HIIT-RT) the SaO_2 returned to the resting parameter. To be clear, this was the first study conducted in healthy youngsters in cross-over format with the stimuli employed. Thus the need for more work involving HIIT inserted in the RT involving a larger sample besides presenting chronic data is highlighted.

In relation to heart rate, it was found a significant difference shortly after training and it is emphasized that it remained high during the recovery until the 30 'minutes, which corroborates with the study by Siqueira et al[12] where the HR remained elevated compared to the initial parameters in the HIIT protocol and according to Lovato, Anunciação e Polito[13] this factor can be caused due to the high sympathetic response and the declining parasympathetic to try to balance post-exercise BP decrease. The results showed a significant elevation of HR shortly after training in both stimuli this phenomenon may happen due to the requirement of blood flow to the body during the training, which corroborates with the study by Wickwire et al.[14], who found difference in HR after traditional vs. super slow training (i.e. super slow consists of a slow training method, both concentric and eccentric).

HIIT-RT presented a more expressive short-term hypotensive effect on systemic arterial pressure, even though RT-HIIT expressed higher acute responses during post-protocol and 10', 20' and 30' of recovery when compared to each other. These results diverge from the study by Lovato, Anunciação and Polito[13] as they did not find significant cardiovascular and autonomic differences within aerobic protocols and weight training, the protocols used in the cited research were not the same as those used in this study, and because this factor may have occurred the divergence between the studies. Regarding the hypotensive response in the pressure values found, they occur from 10’ and follow up to 30’ post-protocol which diverge from the study by Siqueira et al.[12] who found a hypotensive response from the 40’ post-protocol.

Taking into account the hypotensive responses found in both SBP and DBP in both stimuli these are explained in the study by Umpierre and Stein[15] in which they emphasize that systolic and diastolic hypotensive responses are adaptive reactions from exercise, and these can be reached in a chronic or acute way. According to the results both stimuli promoted an acute reduction in post-training pressure values, which corroborates with recent studies[11] that found a significant acute decrease in post-training BP when evaluating normotensive individuals submitted to resistance training.

Throughout any exercise a body's difficulty in maintaining oxygen saturation at homeostatic levels is noted as described by Sousa et al.[16], who aimed to evaluate SaO_2 during the training and observed a body difficulty in maintain optimum Oxygen Saturation levels even after the intervention, which is observed in the current study. In other hemodynamic variables, it is believed that the greater acute response of HIIT is due to the nature of the interval exercise, since, when compared to the conventional RT, it has a higher demand and a shorter duration[16], same efficiency[17,18] in relation to hemodynamic adaptations. Therefore, hemodynamic responses are interconnected with each other as the central nervous system receives the stimuli and triggers the sympathetic system to meet the demand imposed by the exercise[18-20], where the organism seeks the adaptations necessary to achieve the physiological balance, that is, the necessary adjustments occur according to the imposed stimulus, involving all the hemodynamic responses that were presented in this research.

CONCLUSION

The stimuli order changes the acute hemodynamic responses. When the orders were analyzed (HIIT-RT, RT-HIIT) the one that presented the best results was HIIT-RT, because besides presenting changes during exercise, they presented better responses after exercise.

Authors' contributions: SGS: Study design, data collection, data analysis and interpretation of results, writing of the manuscript. FS: Data analysis and results interpretation, writing of the manuscript. IOS: Study design, data analysis and interpretation of results, writing of the manuscript.

Financial support: Nothing to declare.

Conflict of interest: Nothing to declare.

REFERENCES

1. Silva JPS, Alves PHM, Andrade LC, Gomes RJ, Teixeira CVLS. Percepção subjetiva de esforço e nível de afetividade no treinamento intervalado de alta intensidade: comparação entre dois protocolos populares. RBFEX. 2017;11(68):596-601.
2. MacInnis MJ, Gibala MJ. Physiological adaptations to interval training and the role of exercise intensity. J Physiol. 2017;595(9):2915-2930.
3. Curiel-Regueros A, Fernández-Lucas J, Clemente-Suárez VJ. Effectiveness of an applied high intensity interval training as a specific operative training. Physiol. Behav. 2019;201:208-211.
4. Naves JPA, Viana RB, REBELO ACS, De Lira CAB, Pimentel GD, Lobo PCB, et al. Effects of high-intensity interval training vs sprint interval training on anthropometric measures and cardiorespiratory fitness in healthy young women. Front physiol. 2018;9:1738.
5. Riddell MC, Pooni R, Yavelberg L, Li Z, Kollman C, Brown RE, et al. Reproducibility in the Cardiometabolic Responses to High-Intensity Interval Exercise in Adults with Type 1 Diabetes. Diab res clin practice. 2019;149:137-143.
6. Dalpiaz MR, Dorneles GP, Souza MP, Peres A, Monteiro MB, Souza MP. Treinamento Intervalado de Alta Intensidade: quebrando paradigmas na reabilitação cardiovascular. RBPFEX. 2016;10(57):16-28.
7. Abreu ES, Alves JO, Santos ACC, Ferraz ASM, Ceccatto VM. Performance física e hipertrofia ventricular relacionada ao treinamento aeróbico contínuo e intervalado em ratos. RBPFEX. 2015;9(53):269-276.
8. Kraemer WJ, Deschenes MR, Fleck SJ. Physiological adaptations to resistance exercise. Sports medicine. 1988;6(4):246-256.
9. Cintineo HP, Freidenreich DJ, Blaine CM, Cardaci TD, Pellegrino JK, Arent SM. Acute Physiological Responses to an Intensity-And Time-Under-Tension-Equated Single-vs. Multiple-Set Resistance Training Bout in Trained Men. J Strength Cond Res. 2018;32(12):3310-3318.
10. Fleck SJ, Kraemer WJ. Resistance training: physiological responses and adaptations (Part 3 of 4). The Phys Sportsmed. 1988;16(5):63-76.
11. Trevizani GA, Seixas MB, Benchimol-Barbosa PR, Vianna JM, da Silva LP, Nadal J. Effect of resistance training on blood pressure and autonomic responses in treated hypertensives. J Strength Cond Res. 2018;32(5):1462-1470.
12. Siqueira GDJ, Maioni LL, Soares V, Lima WA. Efeito hipotensor subagudo de uma sessão de treinamento intervalado de alta intensidade (HIIT). Cinergis. 2017;18(2):114-120.
13. Lovato NS, Anunciação PG, Polito MD. Pressão arterial e variabilidade de frequência cardíaca após o exercício aeróbio e com pesos realizados na mesma sessão. Rev. Bras. Med. Esp. 2012;18(1):22-5.
14. Wickwire PJ, McLester JR, Green JM, Crews TR. Acute heart rate, blood pressure, and RPE responses during super slow vs. traditional machine resistance training protocols using small muscle group exercises. J Strength Cond Res. 2009;23(1):72-79.
15. Umpierre D, Stein R. Efeitos hemodinâmicos e vasculares do treinamento resistido: implicações na doença cardiovascular. Arq. Bras. Cardiol. 2007;89(4):256-82.
16. Sousa B, Medeiros J, Coelho V, Telles J. Comparação da frequência respiratória e saturação periférica do oxigênio antes e após atividade física. Rev. Cient. do Unisalisiano. 2015.
17. Belmiro WO, Navarro AC. O efeito do treinamento intervalado de alta intensidade para redução de gordura corporal. RBONE. 2016;10(59):224-230.
18. Foster C, Farland CV, Guidotti F, Harbin M, Roberts B, Schuette J, et al. The Effects of High Intensity Interval Training vs Steady State Training on Aerobic and Anaerobic Capacity. J Sports Sci Med. 2015;14(4):747–755.
19. Conceição M, Santos I, Pedral R, Leite S, Silva F, Gomes L. Duplo-produto, pressão arterial e frequência cardíaca em diferentes posições corporais no exercício resistido. Cien. Biol. e de Saúde. 2016;3(2):35-48
20. Mcardle WD, Katch FI, Katch VL. Fisiologia do Exercício. 7ª. Ed, Rio de Janeiro: Guanabara Koogan. 2013;285-289.