European Journal of Physical Education and Sport Science
ISSN: 2501 - 1235
ISSN-L: 2501 - 1235
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.1158788 Volume 4 │ Issue 1 │ 2018

ANALYSIS OF ACUTE RESPONSES OF LACTACIDEMY IN DIFFERENT STRENGTH TRAINING METHODS IN TRAINED MEN[i]

Henrique Miguel[1ii],
Marcus Vinícius de Almeida Campos[2],
Rafael Dramis Calixto[3],
Marcos Tadeu Tavares Pacheco[4]
[1]Centro Regional Universitário de Espírito Santo do Pinhal –
Departamento de educação física;
Professor de educação física (especialista);
Poços de Caldas; MG; Brasil
[2]Faculdade Euclides da Cunha - Departamento de educação física;
Professor de educação física (especialista); Mococa; SP; Brasil
[3]Faculdades Pitágoras - Departamento de educação física;
Professor de educação física (mestre);
Poços de Caldas; MG; Brasil
[4]Universidade Camilo Castelo Branco –
Departamento de pós-graduação e pesquisa; Engenheiro elétrico (PhD);
São José dos Campos; SP; Brasil

Abstract:
Introduction: Strength training (ST) is one of the most widely practiced forms of exercise today, for individuals of different ages, of both sexes and with different levels of physical fitness. There are several reasons arising from the TF practice, however, there is a large component dedicated to aesthetics, especially to muscle hypertrophy. **Objective:** To analyze the acute responses of blood lactate (LAC) in different strength training methods. **Methods:** We evaluated 12 men with experience in strength training (age 27 ± 1.2 years, body mass 80.15 ± 6.5 kg and practice time of 4.5 ± 1.4 years). The study protocol was given by:1) anamnesis and explanation of the research; 2) 1RM test for the bench press exercise; 3) familiarization with the training protocols; 4) perform of isodynamic method (ISO), 5) perform of negative repetitions method (NGT); 6) perform of decreasing pyramid method (PRD); 7) perform of decreasing interval method (ITD); 8) perform of the rest-pause method (RST); 9) perform of wave method (OND). For the analysis of LAC in the methods, they were observed pre and post exercise which was

[i] ANÁLISE DA RESPOSTA AGUDA DA LACTACIDEMIA FRENTE
A DIFERENTES MÉTODOS DE TREINAMENTO DE FORÇA EM HOMENS TREINADOS
ANÁLISIS DE LA RESPUESTA AGUDA DE LA LACTACIDEMIA EN MÉTODOS DIFERENTES DE ENTRENAMIENTO DE LA FUERZA EM HOMBRES ENTRENADOS
[ii] Correspondence: email prhmiguel@gmail.com

removed 0.1 ml of blood from the right ear lobe of individuals and measured using a calibrated portable device. **Results:** it was observed that the acute response was statistically significant after the exercises ($p < 0.05$), however there was no difference between exercises and types of stress induced by the same (Metabolic, Tension and Mixed - $p > 0, 12$). **Conclusion:** Acute responses after realization of different training methods for muscle hypertrophy increased significantly LAC. Regarding the types of stress induced by exercise (TEM, TE and MIS), the LAC was no significant difference between them; however, it was observed that the methods that induce metabolic stress had greater changes in LAC.

Keywords: strength training, lactate, training methods

1. Introduction

The physiological responses verified in relation to strength training (TF), whether acute or chronic, aid in the process of understanding the efficiency of workloads, recovery times, time under tension and other factors that act in a stressful way in the body. These adjustments lead to changes in the values of several physiological parameters, which seek to verify the optimization of the training component for a specific individual [1, 2, 3, 4].

The development of strength training for hypertrophic responses should follow the guidelines defined by the literature [5, 6, 7, 8], and it recommends that training loads for healthy individuals should be between 70 to 85% of 1RM (one maximal repetition), ranging from 3 to 4 series with 8 to 12 repetitions and intervals between series that can range from 60 to 90 seconds.

Another important point to be emphasized in the development of training is the type of exercise-induced muscle stress that is gaining evidence on a daily basis between strength training surveys [9]. The types of stress can be defined according to the magnitude of the work that is developed. The mechanical stimulus is defined by the amount of weight lifted in each repetition performed while the metabolic stimulus is defined by a greater number of repetitions, with relatively low loads, leading to a longer exercise under tension [10]. In addition, other authors still mention a third stimulus, which is performed with parameters of tension stress added to the parameters of the metabolic stress, which receives the name of mixed stimulus [11, 12, 13].

Being different stimuli, each one of them has certain particular metabolic and physiological factors, and the acute responses to the training depend on the variables that are manipulated, indicating its effectiveness or not in the process of inducing muscle hypertrophy [14].

Some authors [15] cite that the pyruvate that originates at the end of the glycolytic pathway is dependent on the intensity of the exercise that is performed. When in aerobic conditions it is oxidized in mitochondria. When in anaerobic conditions, pyruvate is transformed into lactate, which is responsible for the regeneration of NAD + coenzyme (nicotinamide adenine dinucleotide), which receive NADH electrons, allowing the glycolytic pathway to function. When ATP is hydrolyzed, the enzyme lactate dehydrogenase assists in the catalysis of hydrogen protons (H +), potentiating the reoxidation of NADH maintained in the energetic substrates of the second phase of the glycolytic pathway, aiding in the regeneration of ATP.

According to Ide [16] the lactate produced at the end of the glycolytic pathway in high intensity exercise helps to produce energy from ATP in muscle contraction. The intensity of the training contributes directly to increase the transport capacity of H + and lactate, where the MCT transporters can be modified according to the intensity of the work. Then they adapt to the responses of lactate production, transport, and elimination during exercise. Thus, the objective of this study was to verify the acute response of lactacidemy in different strength training methods for muscle hypertrophy.

2. Methods

2.1 Sample

Twelve male subjects, aged 25 to 29 years, with more than two years of practice in strength training and knowledge in different training methods for hypertrophy and increased muscle strength participated in this study. The sample number was determined by analyzing 1RM data in a pilot study conducted previously in a group of individuals with characteristics similar to the participants of this study. The level of significance of 5% and test power of 95% were used [17]. The general data of the volunteers can be observed in table 1. The present study was approved by the Ethics and Research Committee of the Santa Cecília University (UNISANTA - SP Brazil), with opinion number 964.904. The methodology used was elaborated respecting the resolutions 196/96 of the National Health Council.

Table 1: Study sample

Variante	**Média±DP**
Idade (anos)	27±1,2
Massa (kg)	80,15±6,5
Altura (m)	1,76±0,04
IMC	25,7±2,0
1RM (kg)	149±6,5
Tempo de prática (anos)	4,5±1,4

2.2 Experimental draw

The subjects carried out nine visits to the research site. The division of tasks was carried out as follows: in the first visit (week I), the volunteers pre-selected according to the inclusion criteria, responded to the anamnesis form, where any controversial situation that could prevent the participation in the study was verified of the study. After that, a general explanation was given about the purpose of the study, as well as its possible benefits or risks for individuals. At the second visit, the participants were divided into two groups with equal amounts and performed the 1RM test (one maximal repetition) for the bench press exercise. These groups performed the test on day 2 and day 3, respectively. At the third visit, still divided into two groups, there was familiarization with the strength training protocols that were used during the research. The groups performed familiarization on days 4 and 5, respectively. At the 4th visit (week II) with the individuals being randomly chosen to perform the exercise, the training methods were started, where the Isodynamic method was used, with pre and post exercise collections. In the 5th visit and in the 6th visit, the same protocol was used, where the Negative and Decreasing Pyramid method were performed, respectively. In the 7th visit (week III), as well as in the 8th and 9th visits, the Decreasing Rest, Rest-pause and Ondulatory methods were performed in this order, where the data collected with the volunteers were completed. The visits of weeks II and III were performed with 48 hours between them, allowing the individuals' physiological parameters to be recovered between sessions.

2.3 Maximum Repeat Protocol (1RM)

The 1RM protocol for the bench press followed the Hollander [18] determinations which initially consists of heating from 5 to 10 replicates at random loading, not exceeding 60% of 1RM. Thereafter, there is a 3-minute interval of passive interval, before inserting an initial load close to the maximum execution capacity of a repetition in the exercise. If the individual can perform more than one repetition, the protocol is interrupted and the bar returns to the support. After an interval of 5 minutes, weights of 2 to 10 kilograms (~ 10%) are added, performing the same previous process, until only one cycle of movement is performed (one repetition maximum).

2.4 Strength Training Methods

a) Prevailing tensional stress (TE)

- Negative repetitions (NEG): the volunteer performs only the eccentric movement of the movement (negative phase) and has the aid of a companion in the concentric phase (positive phase). The load used was 110% of 1RM, and the exercise ends when the concentric failure occurs or there is an inability to support the weight in the braking of the movement. Four sets were performed, from 3 to 5 repetitions, with passive intervals of 120 seconds.
- Rest-Pause (RST): The volunteer performs 6-8 repetitions with 80% of the 1RM load. After that, rest for 10 seconds and repeat the movements until the concentric failure. After a further 10 seconds of interval, it carries out the movements again until the concentric fatigue, closing the series. Four series were performed with passive intervals of 90 seconds.

b) Prevailing metabolic stress (MET)

- Isodynamic (ISO): the volunteer performs an isometric movement of 20 seconds and then performs the movements of the exercise in complete cycles until the concentric fatigue. In this protocol 60% load of 1RM is used. Four series were performed, with 90 seconds of passive interval.

- Decreasing Rest (ITD): the volunteer performs 12 to 15 repetitions with a load of 60% of 1RM. The intervals between the series have decreasing times. In the protocol adopted in this analysis, 4 series were used and the interval times were 90 seconds, 60 seconds and 30 seconds.
c) Mixed stress - "metabolic + tensional" (MIS)
- Decreasing pyramid (PRD): the volunteer performs the exercise where, during the series, the repetition increases with the decrease of the load and the rest interval. 1st series: from 5 to 7 repetitions with 90% of 1RM and 120 seconds of interval; 2nd series: from 7 to 9 repetitions with 80% of 1RM and 90 seconds of interval; 3rd series: from 9 to 11 replicates with 70% of 1RM and 60 seconds of interval; 4th grade: from 11 to 13 replicates with 60% of 1RM.
- Ondulatory (OND): similar to the previous protocol, consists in realizing the series with load ripple. 1st series: from 7 to 9 repetitions with 80% of 1RM and interval of 90 seconds; 2nd series: 13 to 15 repetitions with 60% of 1RM and interval of 90 seconds; 3rd series: from 5 to 7 repetitions with 90% of 1RM and interval of 90 seconds; 4th grade: from 9 to 11 replicates with 70% of 1RM.

2.5 Analysis of blood lactate (LAC)
Blood lactate was collected immediately before and immediately after the execution of the strength training methods. For this, a device of the brand Roche (model Accutrend Plus), with straps of the brand Roche (model Accusport BM Lactate) was used. For puncture, a softclix lancet was used with disposable microlancets, collecting two drops of blood (~ 0.1ml) from the individual's right ear lobe, which were placed in the center of the reagent test strip for analysis of blood lactate concentration. This apparatus uses dry chemistry in the diagnosis of lactate, verifying concentrations ranging from 0.8 to 22 millimoles per liter (mMol / L).

2.6 Statistical analysis
At an initial moment, the same data were normalized and homogeneous using the Shapiro-Wilk test. In the pre- and post-exercise comparison, for LAC, the means comparison for paired groups was used through the T-Student test. For the verification of significant differences between the pre-exercise and post-exercise weighted difference, the One-way ANOVA followed by Bonferrony test was used to evaluate significance between the methods (paired analysis). We used the weighted difference, followed by the One-way ANOVA test, with Bonferrony test, to evaluate significant differences between the type of physiological stress of the training methods (MET x TE, MET X MIS, TE x MIS). The level of significance was set at $P \leq 0.05$. The GraphPad Instat 3.1 program was used to analyze the data.

3. Results

According the acute alteration of blood lactate (LAC) against the different strength training methods used in this study, a significant increase was observed in this variable (mean of 5.36 mM), and, after statistical analysis, a significant difference for all methods under pre and post exercise conditions ($p < 0.05$), as shown in figure 1.

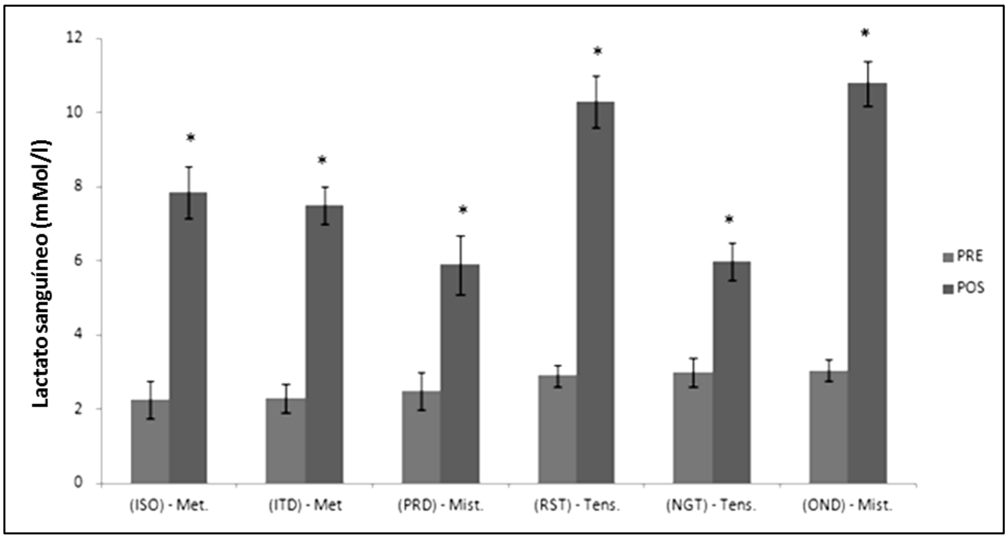

Figure 1: Mean and standard deviation of the LAC between the different strength training methods in pre and post exercise conditions (* $p < 0.05$)

Accordind the type of exercise - induced muscle stress imposed by the training method, using the mean of the weighted difference (post - pre / pre), there was no statistically significant difference when compared to each other: MET x TE ($p = 0.204$); TE x MIS ($p = 0.237$); MET x MIS ($p = 0.123$). These data are shown in figure 2.

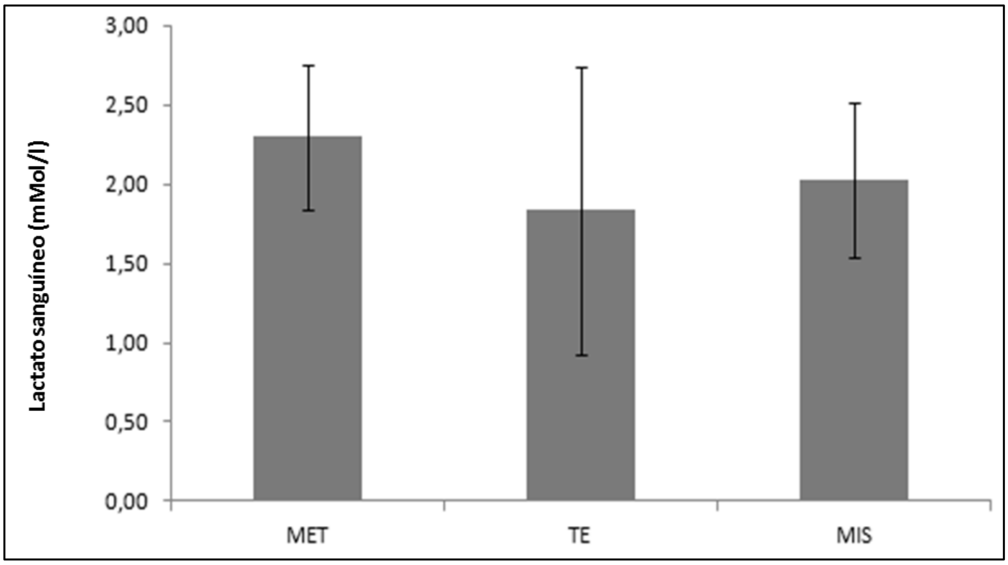

Figure 2: Mean of the weighted difference compared to the Metabolic (MET), Tension (TE) and Mixed (MIS) methods in relation to the LAC

4. Discussion

It was observed that blood lactate levels (LAC) increased significantly after all training methods (pre- and post-exercise), and the negative repetition method obtained the lowest increase in this metabolite (increase of 50%), a fact that can be explained by this method does not seek the induction of significant metabolic stress, having recovery intervals greater than the others (120 seconds) and a shorter execution time of series [1, 6]. Gentil et al. [19] verified the same situation in front of the super slow method, which is performed through a repetition with high load and concentric action time of 30 seconds and eccentric action of 30 seconds. In the study in question, the authors observed that the super-slow method obtained the lowest elevation of LAC in relation to the other three methods analyzed. These results show that exercises with long periods of execution in concentric / eccentric actions can influence LAC levels. In order to emphasize this hypothesis, the research of Buitrago et al. [20] shows that the performance of concentric and eccentric actions with greater time, shows lower values of blood lactate post exercise.

When the means of increase of the CAL were analyzed, it was observed that the exercises that induce muscular metabolic stress had greater differences in relation to the others, however, there were no significant alterations. With the same intention, Gentil et al. [19] verified the acute parameters of LAC in 7 active men in different training protocols and observed increase of this metabolite, however, there was no significant difference between the pre- and post-exercise moments, a fact that does not corroborate with the findings of this research. However, the authors argue that the small number of participants surveyed may have been an important component of varying expected outcomes. In contrast, Smilios et al. [1], found that the strength training methods that provide the greatest changes in LAC concentration are those that have a greater number of repetitions, a recovery time of less than 120 seconds and a workload of 40 to 60%. These data help to understand the parameters found in the mean of the methods that induce the metabolic stress used in this research.

In our study, methods that used smaller loads had a greater number of repetitions and also used reduced recovery intervals (metabolic stress methods). Therefore, there was a longer time on tension during these exercises. Even though no significant differences were observed between the stress, mixed and metabolic stress protocols, the latter showed higher parameters than the others. In this sense, Rahimi et al. [21] report that recovery intervals between the series are also important components for modifying the metabolic parameters of the organism. When the exercises have a longer duration in relation to their repetitions in the series (longer time on tension), the pauses help in the recovery of the energy metabolism, which avoids an effective intramuscular fatigue due to the occurrence of hydrogen ion accumulation and increase of the lactate concentrations. In hypertrophy protocols, metabolic stress can be a fundamental factor in muscle gains, precisely because it induces an increase in the concentrations of GH and IGF1, which are important anabolic hormones.

5. Conclusion

From the results verified in the present study, it was observed that the acute responses after performing different training methods for muscular hypertrophy, increased the LAC significantly; Regarding the types of exercise-induced stress (MET, TE and MIS), the LAC showed no significant difference between them, and it was also observed that the methods that induce metabolic stress had greater modifications in LAC. However, future studies are necessary to confirm these findings, analyzing a larger sample, verifying the subjective perception of effort, investigating the time on tension of each exercise and using chronic responses induced by the ST.

Acknowledgement
This research was carried out with the support of CAPES, a national agency focused on the optimization of scientific research.

Authors' contributions
Each author contributed individually and significantly to the development of the manuscript. HM (0000-0003-3455-8873)* participated substantially in the design of the work. HM (0000-0003-3455-8873)* and MTTP (0000-0002-1725-4803)* participated in the design of the work, acquisition, analysis and interpretation of data and writing of the article, contributed to the acquisition of collection management and instruction to volunteers; contributed to the acquisition and analysis of data, writing and final content review. All authors contributed to the study's intellectual concept.
* ORCID Number (Open Researcher and Contributor ID).

References

1. Smilios I, Pilianidis T, Karamouzis M, Tokmakids SP. Hormonal Responses after Various Resistance Exercise Protocols. Med Sci Spor Exerc. 2003;35(4):644-654.
2. Campos GE, Luecke T. J. Muscular adaptations in response to three different resistance training regimens: specificity of repetition maximum training zones. Eur Jour Appli Physi.2002;88(1):50-60.
3. Prestes, J, Foschini D, Marquetti PH, Charro MA. Prescrição e periodização do treinamento de força em academias. 1st. ed. Manole, 2010.
4. American College of Sports Medicine. Diretrizes do ACSM para os testes de esforço e sua prescrição. 6. ed.Rio de Janeiro: Guanabara, 2003.
5. American College of Sports Medicine. Position stand: progression models in resistance training for healthy adults. Med Sci Spor Exerc. 2002;34(17):364-80.
6. Kraemer WJ, Ratames NA. Fundamentals of Resistance Training: Progression and Exercise Prescription. Med Sci Spor Exerc.2004;36(4):674-88.
7. Miguel H. Musculação: Manual teórico-prático para jovens profissionais. Jundiaí: Fontoura, 2015.

8. Frolinni AB. et al. Exercício físico e regulação do lactato: papel dos transportadores de monocarboxilato (proteínas MCT). Rev Educ Fís.2008;19(3):453-463.
9. Yasuda T, Fujita S, Ogasawara R, Sato Y, Abe T. Effects of low-intensity bench press training with restricted arm muscle blood flow on chest muscle hypertrophy: a pilot study. Clin Physi Funct Imag. 2010;30(5):338-343.
10. Gentil P, Oliveira E, Fontana K, Molina G, Oliveira RJ, Bottaro M. The acute effects of varied resistance training methods on blood lactate and loading characteristics in recreationally trained men. Rev Bras Medic Esp. 2006;12(6):406-413.
11. Schoenfeld BJ. The Mechanisms of Muscle Hypertrophy and Their Aplication to Resistance Training. Jour Stre Cond Res. 2010;24(10):2857-2872.
12. Schoenfeld BJ. Is there a minimum intensity threshold for resistance training-induced hypertrophy adaptations? Spor Medic. 2013;12(43):1279-1288.
13. Teixeira CVLS. Métodos avançados de treinamento para hipertrofia. 2 nd ed. CreateSpace, 2015.
14. Durand JR, Castracane D, Hollander BD, Trynieck LJ, Bamman MM, O´Neal S, Hebbert PE, Kraemer RR. Hormonal responses concentric and eccentric muscle contractions. Med Sci Spor Exerc. 2003:937-943.
15. Robergs RA, Ghiasvand F, Parker D. Biochemistry of exercise-induced metabolic acidosis. American Jour Physi Regul Integ Comp Phys. 2004;287(3):503-516.
16. Ide BN, Lopes CR, Sarraipa MF. Fisiologia do treinamento esportivo. Phorte editora, 2010.
17. ENG, J. Sample Size Estimation: How many individuals should be studied? Radiology. 2003;227(2):309-313.
18. Hollanger DB, Kraemer RR, Kilpatrick WM, Ramadan GZ, Reeves VG, Francois M, Hebert PE, Teyniecki LJ. Eccentric and concentric strength discrepancies between young men and women for dynamic resistance exercise. Jour Stre Cond Res. 2007;21(1):34-40.
19. Gentil P, Oliveira E, Bottaro M. Time under tension and blood lactate response during four different resistance training methods. Jour of Physio Anthrop. 2006;25(2):339-344(b).
20. Buitrago S, Wirtz N, Kleinoder H, Mester J. Mechanical load and physiological responses of four different resistance training methods in bench press exercise. Jour Stre Cond Res. 2013;27(4):1091-1100.
21. Rahimi R, Qaderi M, Faraji H, Boroujerdi SS. Effects Very Short Rest Periods on hormonal responses to resistance exercise in men. Jour Stre Cond Res. 2010;24(7):1851-1859.