International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 10, 2020
ISSN: 1475-7192

The effect of Critical Speed Training on Iron Responses and Lactic of Runners

[1]Karrer Hussien fadhel, [2] Prof.Alyaa Haussien Dahham,, [3] Prof. Mokhalad Muhammed Jassim

Abstract:
In the study, a critical swim speed (CSS) training program was put for runners using a rated equation. Also, study the effect of these training on iron and lactic responses. Running distances rated by extracting one-eighth of the real race distance and applying the equation according to the CSS principle. Training applied to a group of trained running men (17-18 years). The homogeneity of the sample considered using standard techniques. The iron, hepcidin , ferritin, interleukin-6 and lactic were measured.
The results showed that there is a difference in all responses related to iron and lactic for post and pre-test (during rest and after effort). It was observed that there was an increase in the levels of hepcidin, lactic, interleukin-6 and iron after the effort, while the ferritin decreased after the effort. After 3 months of training and because of the adaptations, the levels of lactic, hepcidin and iron increased as well as the ferritin, and the percentage of interleukin-6 decreased. From the results, it became clear that all these changes were with the normal ranges.

Key words; *CSS, iron, hepcidin , ferritin, interleukin-6 , lactic.*

---

1. Introduction

Achieving a good achievement requires search and study in various methods, which depend on modern training methods. The 1500m running competition is considered the basis for discovering this modernity in sports training. Which affected all elements of physical fitness, physiological and biochemical aspects through the development of the work of muscles, body systems and its reflection on the physical side of the competition [1]. The swimmer critical speed index is based, it was done by (Ginne). He applied the test on a 400m freestyle swimmer and called it critical swim speed (CSS) [2]. This test was used as a training principle and applied to the runners due to the convergence of the two competitions in terms of time and energy system. An equation was developed for the runners according to the principle of critical speed and extracting ratios that can be adopted according to specific parts of the race distance in a 1500m run with the aim of developing aerobic and anaerobic abilities.

Stable instructions were applied and practically applied to the rated partial distances according to the principle of critical speed, and they were measured by conducting several field experiments on the rate of the heart and lactic acid according to the principle used in swimming.

According to the swimming equation, where the distance of 50m is 1/8 of the distance of 400m free swimming. The distance in the water is four times the dryland. Therefore, 1/8 of the 1500 m distance has been extracted in a new formula for the 1500 m race. This ratio reached 187,5m, after which time for the two distances was extracted and the new equation

[1] *Faculty of Physical Education and Sports Sciences / University of Babylon, Iraq. Kararhussen40@gmail.com*
[2]*Faculty of Physical Education and Sports Sciences / University of Babylon, Iraq. phy.alyaa.h@uobabylon.edu.iq*
[3]*Faculty of Physical Education and Sports Sciences / University of Babylon, Iraq. phy.mokhalad.m@uobabylon.edu.iq*

was applied as a method for codifying the critical speed according to the aerobic and anaerobic energy system. Iron and its responses were also measured iron, interleukin-6, ferritin, hepcidin.

This test in order to find out the level of these responses to the diagnosis of mechanisms related to iron deficiency in athletes and muscle pain from exercising pre and post training. In addition, did the contestants suffer from anemia before entering the training program, or did the practice of speed training exercise the latest positive adaptation for the runners.

2. Material and Method

2.1 Subject

In this study, 20 trained male runners were participated. Age (17-18 years), BMI = 23.27 kg / m^2, their lengths are 174.31 cm. They were divided into two equally groups: control and experimental.

The training period was 3 months, with 3 training sessions per week at the Olympic Najaf Stadium.

2.2 Experimental overview

Running distances rated during a special equation:

$CCS = D_2 – D_1 / t_2 - t_1$

by adopting the ratio (0.125), which corresponds to one-eighth of the second distance in the CSS equation for swimmers

1500 - 187.5 / 257.22 - 23.68 = 5.62 minutes / second

This time was set as a target time on which to train running.

1200 / 5.62 = 213.52 second = 3.55 minutes

The maximum time is 1200 by the critical speed.

By making up for the time heavily the chosen exercise (90%)

213.52 / 0.90 = 237.24 second

This is a run time of 1200m with a intensity of 90% of the critical speed and in the same way the rest of the distances are rated. A intensity of 105 – 110% was used for training distances from 200 to 800 because the critical speed ratios of the real distance are not affecting in shorter distances. New speed equations were used in the seventh week according to the principle of adaptation by a critical speed test and heart rate monitoring during and after training, it was tared according to the speed of 5.67.

2.3 Experimental procedures

The blood lactic acid concentration was measured after the effort, that is, after completing the 1500 m running test. After (5) minutes, a blood sample was taken from the laboratory during the use of the skeptic, through which the finger of the hand is pricked, and then we press it so that we can take the blood drop. Lactic ratio is shown on the device screen (Lactate Pro2) [3].

Both hepcidin and ferritin were measured before performing the effort, then blood samples were taken at a rate of (5 c.c) after the effort and after 3 hours. The samples were placed in special coolers for the purpose of transferring them to the chemical analysis laboratories that separated the serum. All of these variables examined in the Al-Harithiya Horizons laboratory, and they were analyzed and the results of iron, hepcidin and ferritin were extracted on the same day except for interleukin-6, so it was measured after 24 hours of effort in order to know the persistence of inflammation and the feeling of muscle pain.

Interleukin-6 was measured by taking (1) ml of serum after (24) hours after a 1500m run test and samples were left on ice for one hour to allow clotting. After that it was treated with interleukin-6 chemicals (kits). The concentration of interleukin-6 in the blood was determined using (ELISA, a high-sensitive enzyme-linked immunosorbent assay (R&D Systems, Minneapolis, MN, USA) technique) [4].

Hepcidin concentration was measured using CUSABIO [5]. By ELISA technique where the previously taken serum 1: 100 was diluted with a dilution solution. Next, dilute the wash solution with distilled water in a 1:10 ratio. Samples and control samples shall be placed in the drilling of the Microtiter plate. Cover (Microtiter plate) with a plastic cover and incubate at room temperature for 60 minutes, then wash the plate with washing solution. Enzyme (conjugate) solution is added to each hole. The plate is incubated 30 minutes at room temperature and then washed. TMB substrate solution is added to each hole and the plate is incubated for 20 minutes. Finally, the reaction is stopped by adding TMB stop solution to each hole and quietly shake the plate and read the results with a device Spectra photo meter along a wavelength of 450 nm.

Ferritin measured by treating (0.5) ml of serum in two models (standard solution and control solution) separately, i.e. we need 1 ml of serum. The treatment is carried out chemically with iron ion materials (ketas). After waiting for 20 minutes,

the absorbance is read at a wavelength of 595 nm in the spectra photo meter [6]. The result is taken to enter a statistical treatment according to the following formula: -

Fe Cons = a sample / a standard x 200 mg / 100 ml

Iron tested by the mini vidas was used as an advanced and modern device that is characterized by accurate results and fast performance [7]. 1 ml of serum is placed in a strip that contains 10 pits

1 = sample well

2, 3, 4, 5 = empty wells

6 = conjugate well

7, 8, 9 = wash buffer

10 = substrate

A small conical tube was used that works as a pipette called SPR. As the SPR contains anti-antibody, it sucks out the serum in the first hole, so the antigen in the serum interacts with the antibody in hole 6 associated with the enzyme. Certainly not all molecules interact. The SPR suction the wash solution from one of the holes (7, 8, 9) and returns it to one of the empty holes (2, 3, 4, 5) in order for the conjugated antigen & antibody to remain only in the spr. This process is repeated several times. In the sixth hole Antibody + conjugate enzyme

The unreacted is removed by washing solution by aspirating it from one of the pits and then returning it to the empty pits. The components of the spr interact with the fluoride in the last hole where only the enzyme associated with the substrate remains and then the flash lamp is projected. According to the phosphorescent theory, these molecules take 370 energy and emit 450 energy that the device records as results of the analysis.

3. Results and Discussion

Table (1) shows the arithmetic mean, the standard deviations, the calculated value (t) of the correlated samples, the test significance level, and the difference in significance of the tests.

Variables	Groups	Units	Pre		Post		T	Sig	Indication of differences
			Arithmetic mean	standard deviation	Arithmetic mean	standard deviation			
Lactic acid	Control	ml/mol	12.50	0.547	14.16	0.752	3.953	0.011	moral
	Experimental	ml/mol	12	0.894	16.5	1.643	4.881	0.005	moral
IL-6	Control	ng/L	1.338	0.349	1.020	0.020	2.274	0.072	moral
	Experimental	ng/L	1.346	0.325	0.683	0.147	3.924	0.011	moral
Hepcidin at rest	Control	ng/mL	3.733	0.121	3.783	0.194	0.473	0.656	immoral
	Experimental	ng/mL	3.716	0.147	3.850	0.054	2.000	0.102	immoral
Hepcedin after load	Control	ng/mL	4.075	0.126	4.250	0.151	3.156	0.024	moral
	Experimental	ng/mL	4.243	0.217	5.816	0.479	7.198	0.001	moral
Ferritin at rest	Control	ng/mL	98.33	2.16	83.33	1.63	9.66	0.000	moral
	Experimental	ng/mL	97.33	1.86	150.16	2.13	50.502	0.000	moral
Ferritin after load	Control	ng/mL	75.5	2.16	68	3.03	5.23	0.003	moral
	Experimental	ng/mL	74.66	1.63	106.16	1.94	25.57	0.000	moral
Iron	Control	ng/L	22.133	1.396	25.416	2.836	2.258	0.074	moral
	Experimental	ng/mL	22.041	0.682	29.736	1.362	14.375	0.000	moral
Achievement	Control	Second	4.287	0.009	4.244	0.010	6.133	0.002	moral
	Experimental	Second	4.294	0.032	4.209	0.023	5.703	0.002	moral

The reason for the high level of lactic acid between the first and second measurements is that the critical speed training were of great importance to developing biochemical capabilities in order to achieve the best possible level. Partial distance training with a higher speed than the speed of the race helped to develop the non-oxygenic lactic capacity by causing significant biochemical changes. This is confirmed by the development of the level of performance by increasing the energy produced from the decomposition of glucose and the production of lactic acid. Therefore, when the lactic concentration in the muscles is increased to the maximum, the individual cannot continue the muscle work or performance for a long time. However, improving the athlete's efficiency, his ability to continue performing, improving his achievement level, as well as increasing the amount of energy spent during the competition in proportion to the achievement achieved, despite the increase in lactic acid as metabolic waste for the anaerobic energy liberalization process, but it represents an image of the image of correct scientific training [8].

The reason for the high concentration of lactic acid in the blood after the effort is due to the adaptation to accepting the accumulation of lactate in the blood and continuing to exert effort for longer periods and at higher speeds. Because the critical speed training targets the lactic threshold for the athlete, which makes them delay their entry to the lactic threshold due to the adaptation resulting from the training. Changes also occurred in the post-test, which was examined lactic after the pre-test for runners, as these changes are the ones that led to an increase in lactic acid in the blood after the post-test and the most important (low test time, increased speed rates). This, in turn, increased the intensity of the effort on the athletes, thus increasing the rates of lactic accumulation as a result of increasing the anaerobic energy productivity more than the work requirements in the pre-test. Where the more work requirements lead to an increase in energy productivity (energy production time) associated with anaerobic muscle glycogen, which in turn leaves greater residues than its previous residues.

As shown in the table (1) interleukin-6 increase due to the fact that the critical speed training as a result of the constant effort according to the same speed of the competition concerned and at different distances created a continuous muscle contraction of a neuromuscular character that led to a burden on the nervous and muscular system. Also, the shrinking skeletal muscle itself is one of the main sources of IL-6 in the circulatory system in response to exercise [9].

Furthermore, regularity in training according to the principle of critical speed may reduce IL-6 production as a result of IL-6 response to training by encountering several possible triggers for IL-6. Accordingly, the low IL-6 plasma concentration at rest as well as response to the exercise appears to characterize the natural adaptation of the training.

The training according to the principle of critical velocity has caused adaptations in interleukin-6 present in the muscles due to the high inflammation with lactic acid. Since critical speed training target the lactic threshold, the inflammation remains stable. The post-test also significantly reduces the accumulation caused by inflammation due to the pre-test within the contracting skeletal muscle.

As the rated training according to the principle of critical speed resulted in the adaptation of the muscle cells as a result of the training exercise during a period of 3 months. This reflected an increase in glycogen content in the remaining skeletal muscle and an improved ability to oxidize fats, as the shrinking muscle becomes less dependent on plasma glucose as well as able to perform more mechanical work before reducing glycogen levels dramatically

The reason for the increase in hepcidin is due to the fact that it is a protein that is affected by two important factors: the first is the inflammation condition in the body, and the second is the increased iron in the blood. Therefore, the training have led to an increase in the inflammatory condition as a result of muscle stress and led to a high rate of IL-6 and thus increased the rate of hepcidin.

On the other hand, although hemolysis has been traditionally associated with the mechanical effect resulting in some types of exercise (such as running). Other exercise patterns (such as swimming, biking, or canoeing) have also been shown to promote erythrocyte degradation. Thus, the amount of red blood cells that the exercise causes determines the rupture of these cells, in a process that allows the release of iron. Since the high concentrations of free iron stimulate hepatic production and excretion of hepcidin. Therefore, it increased it [10].

One of the reasons for changing the ratios of ferritin is the presence of inflammation in the body. but despite the high rate of interleukin-6 as a result of the training that it did not lead to an increase in the proportion of ferritin as shown in table (1). Ferritin is one of the proteins that rise when the inflammation rises in the body [11]. The researcher attributes this behavior to the fact that the body's need for iron and its depletion from the stores was overshadowing the slight increase in IL-6 after the effort. So, ferritin decreased while the iron increased.

As a result of the body's need for iron more, it has been depleted from its stores, especially after the body has adapted to absorb more iron from food and store it in warehouses (ferritin) as well as its use in the process of energy exchange.

Table (2) : Shows the arithmetic mean, the standard deviations, the calculated value (t) of the correlated samples, the test significance level, and the significance of the differences for the dimensional tests for the specific tests of the control and experimental groups.

Variables		Units	Control		Experimental		T	Sig	Indication of differences
			Arithmetic mean	standard deviation	Arithmetic mean	standard deviation			
	Lactic acid	ml/mol	14.166	0.752	16.50	1.643	3.162	0.010	moral
	Il-6	ng/L	1.020	0.020	0.683	0.147	5.565	0.000	moral
	Hepcidin at rest	ng/ml	3.783	0.194	3.850	0.0547	0.810	0.437	immoral
	Hepcedin after load	ng/ml	4.250	0.151	5.816	0.479	0.634	0.000	moral
	Ferritin at rest	ng/ml	83.33	1.63	150.16	2.13	60.86	0.000	moral
	Ferritin after load	ng/ml	68	3.03	106.16	1.94	25.96	0.000	moral
	Iron	ng/L	25.416	2.836	29.736	1.362	3.363	0.007	moral
	Achievement	Second	4.249	0.010	4.209	0.023	3.810	0.003	moral

Iron comes to the body from food and supplements. It is absorbed by the duodenum of the small intestine and transported throughout the body by a protein produced in the liver called transferrin [12].

The rated training led to muscle adaptations, which led to a decrease in the rate of interleukin-6 as shown in Table 2. Adaptations also included improved hormonal and enzymatic activity [13].Although hepcidin is affected by two important factors (interleukin-6 and iron content) [14]. However, he has maintained this ratio despite the low level of interleukin-6 .

So, this increase due the of increased proportion of iron absorbed from food and the increased need for iron from the muscles as a result of energy exchange

The table also shows the return of ferritin to its normal level. The reason is attributed to the increase in energy production stores in the muscle cells and consequently to the increase in the two periods. This is a result of the regularity of training and the adoption of critical speed training .

The researcher attributes the iron increase to the size of blood vessels and the development of iron absorption because of the critical speed training of the experimental group [15]. As for the control group, the training that were applied needed more iron as a result of the energy stores remained the same and the iron stores did not develop, but remained low, within the normal limits. It is normal to exhaust iron stores quickly or very slowly. This depends on the balance between iron consumption and iron requirements. Therefore, the experimental group was the largest iron percentage due to the regularity of the loads on the muscles and thus the energy exchange was more systematic. In addition, lactic acid is one of the strongest boosters for iron absorption from food, and since the experimental group had higher proportions of lactic acid, this explains the increase in iron.

It is worth noting that all the ratios of the biochemical variables were within the normal limits after the training program for the experimental group.

That is, the training focused on developing the capabilities and skills of the players without the players being exposed to iron deficiency (anemia) or any disturbances in physiological variables and this is one of the important goals of the training program applied to the experimental group.

4. Conclusion

Through the results, analysis and discussion, the researcher reached the following conclusions:

1. The rationing according to the principle of critical speed showed a contribution to the aerobic and anaerobic side through its reflection on physiological capabilities and achievement.
2. The rated of training for partial distances according to the critical speed, segmentation of distances and determination of stresses within that contributed to the development of special capabilities, biochemical variables and achievement.
3. The critical speed training used were the effect of increasing lactic acid concentration, delaying the emergence of lactic threshold, and increasing the maximum oxygen consumption.
4. Critical speed training helped to bring IL-6 level adaptations to runners.
5. Critical speed training increased the Iron level in the blood after the effort.
6. The results showed that the critical speed training contributed to the increase in the level of ferritin during rest of the experimental group and its decrease in the control group.
7. Critical speed training helped keep the hepcidin level high in order to regulate iron levels in the body.
8. The results showed critical speed training that kept the ratios (iron, ferritin , hepcidin) with normal limits.

References

[1] CHATTERJEE, P., et al. Critical swim speed and metabolic activities in trained male and female swimmers after 400 m free style swimming with their full effort. *Progress in Health Sciences*, 2016, 6.2: 46-50.

[2] Ginne, “The application of the critical power test to swimand swim training programmes. National Sports Research Centre. E. 1993, 2.4 ;30-68.

[3] DE LIMA, Tiago Buzatto, et al. Running Anaerobic Sprint Test, Lactate Minimum and Critical Velocity Protocol in Shuttle Futsal Testing. *Central European Journal of Sport Sciences and Medicine*, 2015, 12: 5-15.

[4] ELLINGSGAARD, Helga; HOJMAN, Pernille; PEDERSEN, Bente Klarlund. Exercise and Health–emerging roles of IL-6. *Current Opinion in Physiology*, 2019.

[5] Manolov, V., Atanasova, B., Vasilev, V., Tzatchev, K., & Velizarova, M. (2014). ELISA method for serum hepcidin quantification in Bulgarian population. *Acta Medica Bulgarica*, *41*(1), 22-29.

[6] Thompson, T. J. Serum Ferritin's Relationship to Training Reduction Among College Distance Runners. (2016).

[7] SKARPAŃSKA-STEJNBORN, Anna, et al. Effect of intense physical exercise on hepcidin levels and selected parameters of iron metabolism in rowing athletes. *European journal of applied physiology*, 2015, 115.2: 345-351.

[8] MIRANDA, M. C. P. C., et al. Comparison of the lactate minimum speed and the maximal lactate steady state to determine aerobic capacity in purebred Arabian horses. *New Zealand veterinary journal*, 2014, 62.1: 15-20.

[9] PEDERSEN, Bente K.; FEBBRAIO, Mark A. Muscle as an endocrine organ: focus on muscle-derived interleukin-6. *Physiological reviews*, 2008, 88.4: 1379-1406.

RIVERA, Seth, et al. Synthetic hepcidin causes rapid dose-dependent hypoferremia and is concentrated in ferroportin-containing organs. *Blood*, 2005, 106.6: 2196-2199.

[11] DOMÍNGUEZ, Raúl, et al. Effects of an acute exercise bout on serum hepcidin levels. *Nutrients*, 2018, 10.2: 209.

[12] HALON-GOLABEK, Malgorzata, et al. Iron Metabolism of the Skeletal Muscle and Neurodegeneration.

[13MORETTINI, Micaela, et al. A system model of the effects of exercise on plasma Interleukin-6 dynamics in healthy individuals: Role of skeletal muscle and adipose tissue. *PloS one*, 2017, 12.7.

[14] NEMETH, Elizabeta; GANZ, Tomas. The role of hepcidin in iron metabolism. *Acta haematologica*, 2009, 122.2-3: 78-86.

[15] FUJII, Takako; MATSUO, Tatsuhiro; OKAMURA, Koji. Effects of resistance exercise on iron absorption and balance in iron-deficient rats. Biological trace element research, 2014, 161.1: 101-106.

[16] Flayyih, H. H., Salih, J. I., Rahma, N. G. A., & Mohammed, Y. N. (2020). Earnings Management between the fact of manipulation and credibility of management procedures: a literature review. Social Science and Humanities Journal, 1898-1908.