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Assessing the nano scale variation of the ferritin and iron level following two months of progressively increasing interval physical activity

M. J. Pourvaghar

Department of Physical Education, University of Kashan, Kashan, I.R. Iran

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Variation of the serum blood ferritin and iron level leads to considerable changes in the body metabolism that eventually results in decrease of vital activity in the body. The purpose of this research was to examine the changes in iron level and its stored form, ferritin, in the subjects measured in nano scale level after participating in two months of physical activity. For this purpose, 20 healthy male subjects were randomly assigned to two groups of experimental and control groups. The subjects' fasting blood sample was collected. They participated in two months of progressively increasing aerobic exercise twice per week. Following two months of exercise, blood sample was collected again. The results of analysis showed that there was a significant difference between the mean values of iron serum blood level of the subjects after two months of interval training (P=0.003). There was also a significant difference between the control and the experimental group after two months of interval training (P=0.005). In addition, there was a significant difference between the mean values of ferritin serum blood level of the subjects after two months of interval training (P=0.019). There was a significant difference between the control and the experimental group after two months of interval training (P=0.04). It was concluded that 8 weeks of interval running activity can mobilize ferritin from its local store, that is, liver, bone marrow and muscle and as a result increase the level of serum ferritin and following that increase the iron level in the blood.

Keywords: Ferritin, Iron, Increasing Intensity Interval Exercise.

INTRODUCTION

Minerals are essential for a wide variety of metabolic and physiologic processes in the human body. Some of the physiologic roles of minerals important for the athletes are their involvement in: muscle contraction, normal hearth rhythm, nerve impulse conduction, oxygen transport, oxidative phosphorylation, enzyme activation, immune functions, antioxidant activity, bone health, and acid-base balance of the blood [1].

Iron is one of the most critical minerals with implications for sports performance. Iron is a component of hemoglobin, myoglobin, cytochromes, and various enzymes in the muscle cells, all of which are involved in the transport and metabolism of oxygen for aerobic energy production during endurance exercise [1].

Ferritin has been the most frequently used indicator of iron stores in the body. Low ferritin levels are an indication of decreased or exhausted iron stores. Namely, ferritin is an acute phase protein and may thus cover actual iron deficiency [2, 3].

About 30% of the body's total iron in a healthy young adult male (and about 10% in females) is stored in the form of ferritin (known as storage iron) located in such areas as the liver, bone marrow, muscle, and other body organs. From these locations, iron is transported throughout the body via the blood stream [4]. Serum ferritin levels in the range of 20–30 nanograms per milliliter have been considered markers of iron deficiency [1].

Iron deficiency is fairly common in athletes, especially in the endurance athletes [5, 6]. It commonly appears in latent form, the iron deficiency-induced anemia being, however, infrequent [5, 7, 8, 9, 10, 11]. Detecting the deficiency in physically active individuals is difficult due to possible exercise-induced changes in iron metabolism indices, especially ferritin. Increased ferritin levels were reported immediately post-exercise states [12] and even several days following strenuous exertions [12]. The detection of latent iron deficiency in athletes is not easy and requires the use of appropriate indices [12]. Although ferritin is the basic indicator of iron stores, its use as the single index of iron status may not be sufficient, especially in disorders, due to the fact that ferritin is an acute-phase protein [5, 13, 14].

* To whom all correspondence should be sent:
E-mail: vaghar@kashanu.ac.ir.

Serum ferritin concentrations decrease during training, and it has been assumed that this reflects an induction of iron deficiency following physical activity. Although serum ferritin concentrations in elite athletes are usually low, frank iron deficiency is unusual; nevertheless, obligatory daily iron losses are often increased, but this is usually compensated by enhanced absorption of dietary iron [15].

The purpose of this research was to examine the changes in iron level and its stored form, ferritin, after participating in two months of physical activity. The likely variations in such change will be associated with disruption of oxygen carrying activity, carbon dioxide, metabolic activity, performing physical activity and other metabolism events.

EXPERIMENTAL

The present research was a quasi experimental research in which 20 healthy male volunteer subjects were randomly assigned into two equal groups (n=10) of experimental and control conditions. The subjects completed a health questionnaire form. The subjects did not consume any medication within the last month nor had a history of participation in a heavy regular aerobic physical activity. Such activity can disrupt iron and ferritin metabolism regulation within the body [16]. In addition, a physician performed a general physical examination in order to approve physical and mental readiness of the subjects to participate in the project. The presence of any infection or inflammation was also ruled out since such condition result in increase in the ferritin level [16]. The systolic and diastolic blood pressure as well as Body Mass Index (BMI) of the participants was measured. Other characteristics of the subjects are presented in Table 1.

Table 1: Characteristics of the exercise and control groups.

Variables	Experimental		Control	
	Mean	Standard deviation	Mean	Standard deviation
Age (Yr.)	22.23	3.2	21.5	2.5
Height (Cm)	174.5	4.6	175.3	4.8
Systolic blood pressure(mm/Hg)	110	2.6	115	2.1
Diastolic blood pressure(mm/Hg)	76	2.2	85	2.7
Maximum oxygen consumption (VO_{2max}), ($ml.min^{-1}.kg^{-1}$)	49.06	4.4	48.4	3.2
Body Mass Index (BMI), (kg/m^2)	24.3	3.3	25.2	4.3

For the purpose of having a homogenous group of participants, Maximum Oxygen Consumption (VO_{2max}) of the subjects was measured by running-walking test [17]. The running-walking program was employed to measure it a week prior and one week after the termination of the protocol in order to eliminate the effect of training protocol on the VO_{2max} of the participants.

TRAINING PROTOCOL

The fasting subjects in both groups attended the pathology lab at 8 am. Four milliliters of elbow venous blood sample was collected. The exercise protocol included increasing interval running program at a track and field path. They ran 4 consecutive distances of 200 meters with rest interval between each distance in the first week. Then, on the second week, 400 meters was added to the running distance on the first week. Such increase continued weekly and finally at the eighth week, the subjects ran approximately 35 Km. The running intensity was set to 60 to 75 percent of reserved heart rate [18] monitored by a polar watch provided to the subjects. At the end of 8th week, fasting blood sample was collected and analyzed by the same lab. The ferritin and iron were measured to see whether ferritin serum is released in interval physical activity in two months to supply blood iron. After reduction, iron changes to iron (II) and makes the colorful complex of ferrozine, which can show iron level [16]. These elements were analyzed by biochemistry analyzer Hitachi 717 machine. The amounts of serum iron concentration was measured according to nanogram per micro liter (ng/mic l), and ferritin level was measured according to nanogram per milliliter (ng/ml).

SPSS: PC 13.0 was used to analyze the data. Paired as well as independent t-test was used to compare the means of the pre test and post test results as well as the control and the experimental groups.

RESULTS

Kolmogrov-Smirinov was used to test the normality of the independent variables of this research. The results indicated that the variables of iron and ferritin showed normal distribution; therefore, parametric statistical procedures such as dependent and independent t-test were employed to analyze the data. These results are presented in Table 2 and Figs 1, 2.

The means and standard deviations of serum blood ferritin and iron is presented in Table 2.

Table 2: Comparing the mean values of iron (ng/micl) and ferritin (ng/ml) levels of the exercise and control groups in pre and post test

Variables-stage	Condition	Stage: Pre test Mean± (SD)	Stage: Post test Mean± (SD)	t-valve	P-value
Iron (ng/micl)	Experimental	1.105±0.152	1.417±0.210	3.97	0.003
	Control	1.186± 0.153	1.174±0.119	0.806	0.44
Post test-Iron	Experimental	–	1.417±0.210	3.17	0.005
	Control		1.174±0.119		
Ferritin (ng/ml)	Experimental	30.94±10.94	39.86±8.33	2.86	0.019
	Control	32.76±8.56	32.29±6.89	0.166	0.872
Post test- Ferritin	Experimental	–	39.86±8.33	2.213	0.04
	Experimental		32.29 ±6.89		
Weight (Kg)	Intermittent	82.7±4.2	78.4±4.7	2.15	0.044
	control	81.5±4.6	82.9±4.16	0.63	0.53
	Intermittent	-	78.4±4.7	2.26	0.035
	control	-	82.9±4.16		

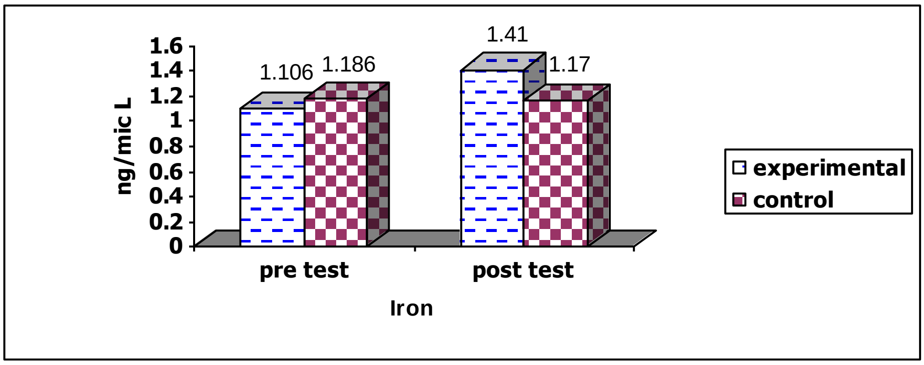

Figure 1: Comparing iron level changes (ng/micl) in experimental and control groups

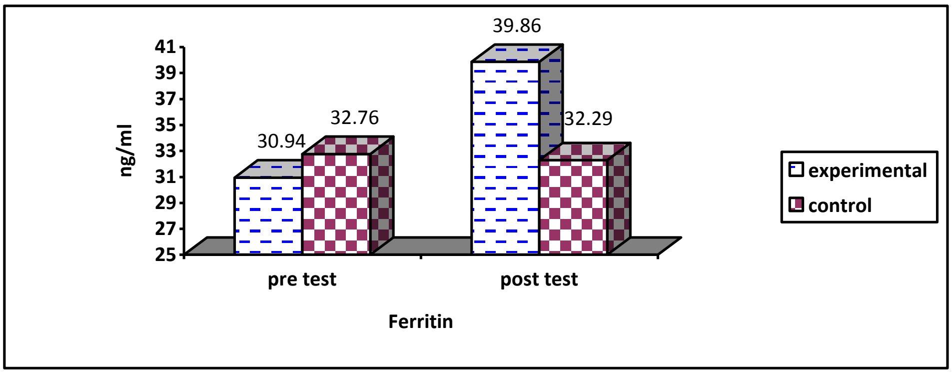

Figure 2: Comparing ferritin level changes (ng/ml) in experimental and control groups

The mean value of iron in the aerobic exercising condition prior to the start of the protocol was 1.105 ng/micl and increased to 1.417 ng/micl after two months of training. The results of analysis indicated that the increase was statistically significant (P=0.003). No significant changes was observed in the blood level of the control group after two months of their regular activity without participating in any exercise program (P=0.44).

Comparing the mean value of serum ferritin in the experimental and control condition indicated that there was a significant difference between these two groups (P=0.005).

In addition, the result of comparing the mean of pre test level of serum ferritin (30.94 ng/ml) with the post value of this variable after the aerobic intermittent activity (39.86 ng/ml) revealed that there was a significant difference between these two stages (P=0.019).

The result of comparing the mean of pre test level of serum ferritin (32.76 ng/ml) with the post test value of this variable in the control group (32.29 ng/ml) indicated that there was no significant differences between these two stages (P=0.872).

The result of analysis showed that there was a significant difference between the mean of serum ferritin of the control and the experimental group after the termination of the exercise protocol (P=0.04). In addition, the results of analysis using Pearson correlation test indicated that there was a significant association between the iron and ferritin of the subjects (r=0.63, P=0.04).

Also, participation in the exercise program resulted to a significant weight loss in the exercising group. The mean value of weight from the pre test condition (82.7 kg) decreased significantly (78.4 kg) - a 3.4 kg loss (P=0.44).

DISCUSSION

This study was designed to examine the changes in iron and ferritin level of serum blood measured in nano gram scale following two months of aerobic physical activity. The subjects participating in this research protocol performed two months of progressively increasing running exercise. The mean value of iron level of the subjects increased 0.313 ng/micl, a 28.23 per cent change that was also statistically significant. When compared this changes to the control group, the amount of increase was 0.243 ng/ micl equal to 20.7 percent rise. Thus, two months of aerobic running exercise resulted in a significant increase in the exercising group compared to the control group. The level of serum ferritin of the subjects changed from 30.94 to 39.86 ng/ml (28.82 percent increase) following the exercise program. The amount of increase in the exercise condition compared to the control group at the end of project was 23.63 percent.

The changes of iron level was associated with the changes of ferritin level and this association was evident in the correlation coefficient equal to 0.63 (P=0.04).

The findings of the present research was in agreement with the results of researches conducted by Chatard (2002) and Roecker (2002) to examine the changes in iron level following the participation of their subject in aerobic endurance activity [5, 6]. However, the result of this research did not support the findings of Zoller and associates (2004) that reported a decrease in the value of ferritin and consequently iron in athlete subjects [15]. Such discrepancy in the findings may be attributed to the fact that the participants in the present research were sedentary subjects whereas the subjects in Zoller et. al were athletes.

Gray and associates (1993) examined the density of serum ferritin in male athletes following an interval exercise program. They reported that no significant change occurred in the ferritin value whereas the level of iron increased [19]. In this regard, the findings of the present research are similar to the alteration in the iron changes but not to the changes in ferritin value since iron in both researches increased.

Iron is stored in the form of ferritin in muscles, bone marrow, liver, and other body organs. When there is no infection or inflammation within the body, an individual uses iron for particular needs such as physical activity for the purpose of carrying oxygen, muscle contractions, nerve impulse conduction, enzyme activity, immune functions and acid-base balance [1]. On the other hand, the energy required during physical activity originates the mitochondrial iron centers. The cells may use their ferritin and iron to make mitochondrial used by mitochondrial.

Therefore, ferritin can compensate for the insufficiency of iron during the interval physical activity programs. In this research, it seemed like the iron in the serum blood was mobilized for physiological purpose and its value increased in the subjects engaged in physical activity. Such condition resulted in the release of ferritin storage including muscle and bone marrow in the blood stream. This condition in turn increased the value of ferritin in blood significantly. Following this release and increase of ferritin, iron concentration increased as well. This chain of associated changes was statistically evident. The correlation coefficient between iron and ferritin was 0.63, (P=0.04). Apparently, various types of physical activity can cause different responses in the concentration of mineral substances such as iron and ferritin. In addition, different intensity of exercise program, different durations or different volumes of physical activity can produce different research results. Thus, the research findings in any research may be explainable in regard to the type of responses produced by the participants.

In summary, the findings of this research indicated that participation in two months of intermittent physical activity covering approximately 35 kilometers can increase significantly the concentration of iron and ferritin of serum blood to carry oxygen, perform muscle contraction, enhance enzyme activity and immune responses and produce anti oxidation activity during the physical activity.

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ОПРЕДЕЛЯНЕ НА НИВАТА НА ФЕРИТИН И НА ЖЕЛЯЗО В НАНОМАЩАБИ СЛЕД ДВУМЕСЕЧНО ПРОГРЕСИВНО ФИЗИЧЕСКО НАТОВАРВАНЕ

М. Дж. Пурвагар

Департамент по физическо възпитание, Университет в Кашан, Кашан, Иран

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(Резюме)

Измененията на феритина и желязото в кръвния серум води до значителни промени в телесния метаболизъм, водещи в крайна сметка до намаляване на жизнената активност. Цел на тази работа е се изследват измененията на нивото в наномащаби на желязото и неговата съхранена форма (феритинът) при хора след двумесечна физическа активност. За тази цел двадесет здрави мъже-доброволци бяха разделени на две групи (тестова и контролна) на случаен принцип. От тях са взимани кръвни проби на гладно. Те участваха в продължение на два месеца в прогресивно нарастващи аеробни упражнения два пъти седмично. Бяха взимани кръвни проби след два месеца. Резултатите от анализите показват, че е налице значителна разлика между средните концентрации на желязото в доброволците след двумесечни тренировки (P=0.003). Освен това е налице и значителна разлика между контролната и тестовата група след двумесечните тренировки (P=0.005). Освен това, налице е и значима разлика между средните стойности на феритина преди и два месеца след упражненията (P=0.019). Има и значима разлика между показанията на контролната и тестовата група два месеца след упражненията (P=0.04). Следва изводът, че 8 седмици на физическа дейност могат да мобилизират феритина от неговите естествени депа, като черен дроб, костен мозък и мускули. В резултат се повишава нивото на серумния феритин и следващото повишаване на нивото на желязото в кръвта.