Acute Response of Some Iron Indices of Young Elite Wrestlers to Three Types of Aerobic, Anaerobic, and Wrestling Exercise

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ABSTRACT The present study was conducted to investigate the acute responses of some iron indices of young elite wrestlers to three types of aerobic, anaerobic, and wrestling exercises. A total of 24 elite volunteer wrestlers were randomly categorized into three groups (n=8) aerobic, anaerobic, and routine wrestling exercises. The exercises were conducted during three non-consecutive sessions within one week. The aerobic exercises included 35 min of continuous running with 130 beats per minute (BPM) on a treadmill; the anaerobic exercises included 15 min circuit movements and 15 min rest with 160 BPM, and the wrestling training included routine wrestling exercises. Blood sampling was done in the first and third sessions in order to study the acute responses which included four stages of 1 h before, immediately, 3 h, and finally 24 h after exercises. The study of the acute response to the first session showed that the type of exercise had no effect on serum iron (p=0.57). Furthermore, the serum ferritin (p=0.012) and TIBC (p=0.006) affected was affected by type of exercise. The study of the acute response to the second session showed that the type of exercise had no effect on serum ferritin (p=0.731) and TIBC (p=0.231), rather the serum iron was affected by the type of exercise (p=0.01). Conclusively, the study of acute response showed that wrestling exercises led to a decline in iron stores during exercise and reduced total iron binding capacity during a 24-h recovery period. The study of acute exercise after a short adaptation period showed that despite the fact that serum iron had no change in anaerobic and wrestling exercises over the passage of time, it changed during aerobic exercise and 24-h recovery periods. Furthermore, the progress of iron deficiency was only observed in the first stage which prevented its progress to the next stage.

KEY WORDS Iron, Ferritin, Total Iron-Binding Capacity, Aerobic, Anaerobic, Wrestling, Exercise.

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IRON INDICES OF YOUNG ELITE WRESTLERS IN RESPONSE TO TYPES OF EXERCISE
http://mjssm.me/?sekcija=article&artid=126

Introduction

The metabolic reactions that are active during body activities require special regulators to control heart muscle activity, body contraction, the transmission of nerve impulses, and acid-based balance. The chemical structure of these regulators contains several minerals, including iron, which directly affects body activities (Hinton, Giordano, Brownlie, & Haas, 2000). It seems that body iron status varies due to several factors during the implementation of physical activities and muscle contractions (Sinclair & Hinton, 2005). Karamizrak et al. (1996) reported that the level of iron stores in athletes is about 3% lower than the normal range, which may even reach 50% among women (Karamizrak et al., 1996). Sport haematology has progressed significantly over the last four decades and has become a specific branch of science (Tayebi, Agha Alinejad, Kiadaliri, & Ghorbanalizadeh Ghaziani, 2011). As a phase of sports hematology, iron deficiency is currently one of the most controversial topics in sports medicine (Shaskey & Green, 2000). There are abundant contrary data and conflicting insights in the review of the literature. The key role of iron in oxygen transport makes it a vital

Accepted after revision: June 24 2016 | First published online: March 01 2017

Conflict of interest: None declared.

element for sports performance (DellaValle, 2013; Hinton, 2014). It is also a cofactor for many of the intracellular enzymatic processes engaged in mitochondrial electron transport and oxidative phosphorylation (DellaValle, 2013). Iron deficiency, with or without anaemia, is a common phenomenon in non-sporting communities, and the contradiction initiates when a prevalence comparison is made between public community and athletes. This concern is the most common disease arising from the inadequacy of nutrition around the world, affecting almost 15% of the world population (Beard & Tobin, 2000).

However, the discussion will continue in the field of physical activities and iron status in the body. Studies conducted on iron status concentrated on the comparison between athletes and sedentary people (Sureira, Amancio, & Pellegrini Braga, 2012), the comparison between sport fields (Jackson, 2000; Karamizrak et al., 1996; Schumacher, Schmid, Grathwohl, Bultermann, & Berg, 2002), the examination of athletes during different training seasons (Ostojic & Ahmetovic, 2009), the impact of supplementation and exercises (DellaValle, 2013), the relation between iron status and type of performance (Dellavalle & Haas, 2012), the investigation of the impacts of long-term exercises (Pouramir, Haghshenas, & Sorkhi, 2004), and the effect of exercises on people suffering from thalassemia (Heidary, Bijeh, Hashemi Javahery, & Abrishami, 2011). However, a large gap regarding acute, short-term exercises and anaerobic exercises remain. Milic et al. (2011) reported that athletes who make use of the anaerobic energy system, as compared to the ones who depend on the semi-aerobic anaerobic energy system, possessed higher levels of serum iron and transferrin saturation (Milic, Martinovic, Dopsaj, & Dopsaj, 2011). The aerobic athletes had the highest range of reticulocyte hemoglobin content in comparison to anaerobic and semi-aerobic anaerobic athletes (Milic et al., 2011).

In contrast, wrestling is a sport that requires high anaerobic power, high anaerobic capacity, high muscular endurance, higher than average aerobic power, average pulmonary function, flexibility, a high level of leanness except heavy weights, and a somatotype focusing on mesomorph in a way that diverse exercise methods including anaerobic, endurance, and resistive exercises have been recommended to improve the general physiological profile of wrestlers (Horswill, 1992). Since one of the most important roles of iron is the preservation of acid-based balance (Hinton, 2014), and the acid lactic is the dominant system in this context, the investigation of iron status among wrestlers is a prominent issue. Several studies have been done concerning the iron status of wrestlers. Saygin (2014) compared some parameters of iron status in wrestlers of different weights and reported that serum iron and ferritin among light weight wrestlers are lower than average weight one and the serum ferritin of light-weight wrestlers is lower than that in heavy-weight ones; however, serum total iron binding capacity (TIBC) level has no difference (Saygin, 2014). The comparison between serum ferritin of wrestlers concerning diverse studies showed that there exists no difference, and they are not even influenced by rapid weight loss (Fogelholm et al., 1992; Fogelholm, Koskinen, Laakso, Rankinen, & Ruokonen, 1993; Jackson, 2000; Karamizrak et al., 1996). Hesar Koushki et al. (2013) reported the results of the study on 65 min of wrestling exercises, which showed that red cell distribution width (RDW) as one of the iron status factors was significantly decreased. This reduction was greater in afternoon exercises as compared to morning cycle. However, other iron indices such as haemoglobin and mean cell volume (MCV) had no significant change (Hesar Koushki, Mollanovruzi, & Rashidlamir, 2013).

It is reported that athletes who practice types of sport requiring diverse dominant energy systems demonstrate differences in hematological profile parameters, especially iron indices (Milic et al., 2011). Such differences may result from training for specific disciplines, sport acute effects, seasonal adaptations, and special training regimes such as endurance or strength types (Banfi et al., 2006; Di Santolo, Stel, Banfi, Gonano, & Cauci, 2008; Dopsaj, Sumarac, Novakovic, & Dopsaj, 2008; Schumacher et al., 2000). Considering the insufficient volume of studies performed on athletes' iron status, the results' contradiction and absence of adequate information about anaerobic exercises, and the effect of acute and short-term response on iron status responses, we decided to study the acute responses of some elite wrestlers' iron indices to three types of aerobic, anaerobic, and wrestling exercises.

Methods

Sample

Twenty-four elite volunteer wrestlers with 70±10 kg weight averages, 20±3 years ages, with a record of at least five years of wrestling exercises, and three wrestling exercise sessions per week. They participated in this field research on the condition of acquaintance with all the necessary research conditions, filling out a consent form, possessing physical health status, no severe anaemia, no usage of iron supplement pills, and medicines affecting iron metabolism. They were randomly categorized into three 8-people groups of aerobic, anaerobic, and routine wrestling exercises. The subjects' specifications are summarized in Table 1.

TABLE 1 Demographic characteristics of elite young wrestlers

Groups \ Variable	Age (year)	Weight (kg)	Height (m)	BMI (kg/m²)	BF (%)
Aerobic	17.62±0.94	72.87±4.33	1.73±0.02	24.05±0.87	15.75±0.64
Anaerobic	18.75±0.81	71.12±4.01	1.72±0.03	23.65±0.62	14.37±0.59
Wrestling	18.25±0.97	72.25±3.95	1.73±0.01	23.95±0.80	14.62±0.73

Legend: BMI - Body Mass Index, BF - Body Fat.

UDC 796.81:612.126

Protocol

The subjects participated in two sessions of public instruction classes to become familiar with the procedures. The exercises were conducted within a week during three con-consecutive sessions. Aerobic exercise included 35 min of continuous running with 130 beats per minute (BPM) on a treadmill (Fitness Vision, Taiwan); anaerobic exercises included 15 min circuit exercises, 15 min rest with 160 BPM, and wrestling exercises included routine wrestling exercises (warm up (20-30 min), techniques range (with resistance 50-90%, 30-45 min), 1-2 competition with champion style, cool down (20-30 min)). Blood sampling was done in the first and third sessions. Each sampling session included four stages of 1 h before, immediately, three h, and 24 h after exercise conducted in a sitting position and from the brachial vein with vacuum bottles containing EDTA anticoagulant substance and a venoject needle. The samples were taken to the laboratory and were transferred to a -70 ^{o}C freezer after centrifuging and serum separation. Iron measurement was done with an iron kite (Pars Azmoon, Iran), ferritin measurement with a Vitros kite (Ortodiagnosting, America) and the IRMA method, TIBC measurement with a TIBC kite (Pars Azmoon, Iran) and the Magnesium Carbonate Precipitating method.

Statistical methods

The average descriptive statistics and standard error were applied to describe the collected data. The repeated measured analysis of variance was applied to analyse the acute response for the first and third sessions of exercise. The analysis was performed using SPSS at p<0.05 of significance level.

Results

To examine the acute response to the type of exercise, the four blood samples of the first session were measured. Its related data is available in Table 2. The level of serum iron with observance of sphericity assumptions and the effect of TIME over was significant ($F_{3,63}$=5.53, *p*=0.002, η^2=0.21), and it was a linear significance type ($F_{1,21}$=11.05, *p*=0.003, η^2=0.345); however, the GROUP effect and interaction effect of GROUP × TIME over were not significant (respectively ($F_{2,21}$=0.62, p=0.55, η^2=0.055) and ($F_{6,63}$=0.81, p=0.57, η^2=0.07)). In other words, the type of exercise had no effect on serum iron, but only the acute physical exercise could establish significant changes in a way that it meaningfully (p=0.015) decreased to 7.04 μg/dl within 24 h after exercise. Since the amount of sphericity assumption was not estimated in the analysis of serum ferritin, the Multivariate Tests with Roy's Largest Root were applied, in which the TIME over effect and GROUP effect were insignificant (respectively ($F_{3,19}$=1.644, *p*=0.21, η^2=0.2) and ($F_{2,21}$=0.02, *p*=0.98, η^2=0.002)), but the interaction effect of GROUP × TIME over were significant ($F_{3,20}$=4.76, *p*=0.012, η^2=0.42). In other words, the aerobic and anaerobic exercises groups had similar behaviour and minimal reduction from the beginning until 3 h after exercises, but in the anaerobic group, this reduction continued during 24 h after exercises, although it returned to the basic levels in the aerobic group. Although the wrestlers' exercise group was higher than the two other groups in basic levels, it was identical with the other groups after a level of reduction and had similar behaviour with the anaerobic exercises group at other times. Moreover, the level of serum TIBC with observance of sphericity assumptions and TIME over effect and GROUP effect were insignificant (respectively ($F_{3,63}$=1.83, *p*=0.15, η^2=0.08) and ($F_{2,21}$=1.12, *p*=0.15, η^2=0.17)), but the interaction effect of GROUP × TIME over were significant ($F_{6,63}$=2.61, *p*=0.025, η^2=0.2) and it was a cubic significance type ($F_{2,21}$=4.91, *p*=0.018, η^2=0.32). In other words, the TIBC changes in the anaerobic and aerobic groups were identical until 3 h after exercise. Although the changes had minimal increase and decrease in these two groups till 24 h after exercise, they were insignificant. In contrast, in the wrestling exercises group and in all the behavioural stages, the changes were contrary to both groups in a way that the TIBC level had no change under the influence

TABLE 2 Serum Iron Status of Elite Wrestlers in the First Acute Effects of Three Types of Training

		Mean ± SE				Within Group Effects		Between Group Effects
Variables	**Groups**	**60min preTest**	**Immediately postTest**	**180min postTest**	**24h postTest**	**TIME**	**TIME × GROUP**	**GROUP**
Iron (mg/dL)	Aerobic	122.5±9.01	126.87±12.43	121.62±11.49	113.75±9.04	F=5.53 P=0.002**	F=0.812 P=0.565	F=0.616 P=0.55
	Anaerobic	109.25±12.03	108.37±10.91	107.25±12.06	105.12±11.82			
	Wrestling	109.75±10.34	107.37±11.29	105.50±10.34	101.50±8.82			
Ferritin[a] (mg/dL)	Aerobic	68.75±8.82	69.50±8.23	65.50±7.74	69.25±6.69	F=1.64 P=0.213	F=4.757 P=0.012*	F=0.016 P=0.98
	Anaerobic	68.87±16.30	69.00±15.79	67.00±13.84	65.25±11.88			
	Wrestling	75.12±5.97	70.00±6.46	69.37±7.49	65.75±7.49			
TIBC (mg/dL)	Aerobic	337.75±3.35	333.75±3.05	337.87±3.90	340.25±2.55	F=1.83 P=0.15	F=2.61 P=0.025*	F=0.212 P=0.145
	Anaerobic	346.50±2.57	341.25±2.44	347.12±2.80	317.50±2.71			
	Wrestling	340.00±3.24	339.75±5.28	332.50±2.09	342.87±3.44			

Legend: *- Significant level at p<0.05; a - statistics of TIME and TIME × GROUP getting from Multivariate Tests, Roy's Largest Root method.

of exercises. However, it had a significant decrease during the first 3 h of recovery, and a significant increase during 24 h as compared to 3 h after exercises, such that it changed to the pre-exercise basic levels.

The four blood sampling measurements of the third session were applied to study the acute response after short-term adaptation to two non-consecutive sessions of three types of exercises, and the related data are available in Table 3. In the level of serum iron with the observance of sphericity assumptions, TIME over effect and GROUP effect were not significant [respectively ($F_{3,63}$=2.83, p=0.08, η^2=0.32) and ($F_{2,21}$=1.47, p=0.25, η^2=0.12)], but the interaction effect of TIME × GROUP were significant ($F_{6,63}$=3.125, p=0.01, η^2=0.23) and it had both linear and cubic significance (respectively ($F_{2,21}$=5.4, p=0.013, η^2=0.34) and ($F_{2,21}$=4.07, p=0.03, η^2=0.28)). This means that serum iron in two groups of anaerobic and wrestling exercises after a short-term adaptation to two con-consecutive sessions and in acute response to one exercise session had a similar descending linear process. However, the aerobic group exercises in the 24 h recovery stage after exercise increased as compared to the hours before, immediately and 3 h after exercise which was precisely contrary to the two other groups. In contrast, the level of serum ferritin with the observance of sphericity assumptions, TIME over effect was significant ($F_{3,63}$=5.1, p=0.003, η^2=0.2) and it was a linear significance ($F_{1,21}$=11.11, p=0.003, η^2=0.346), but the GROUP effect and the interaction effect of TIME × GROUP were not significant (respectively ($F_{2,21}$=2.82, p=0.08, η^2=0.21) and ($F_{6,63}$=0.6, p=0.73, η^2=0.054)]. This means that the type of exercise had no effect on serum ferritin, but only the acute physical exercise after two sessions of short-term adaptation could exert significant changes. This is done in a way that it had significant decline to 6.42 μg/L during 24 h after exercise (p=0.021). Moreover, the level of serum TIBC with observance of sphericity assumption and effect of TIME over, GROUP effect and the interaction effect of TIME × GROUP was not significant (respectively ($F_{3,63}$=1.78, p=0.16, η^2=0.078) ($F_{2,21}$=1.85, p=0.18, η^2=0.15) and ($F_{6,63}$=1.4, p=0.23, η^2=0.12)).

TABLE 3 Serum Iron Status of Elite Wrestlers in Second Acute Effects of Three Types of Training

		Mean ± SE				Within Group Effects		Between Group Effects
Variables	**Groups**	**60min preTest**	**Immediately postTest**	**180min postTest**	**24h postTest**	**TIME**	**TIME × GROUP**	**GROUP**
Iron (mg/dL)	Aerobic	105.12±5.15	107.50±7.72	100.25±7.40	113.62±7.82	F=2.28 P=0.088	F=3.125 P=0.01**	F=1.471 P=0.252
	Anaerobic	114.75±10.09	111.50±10.19	110.37±9.73	105.75±10.83			
	Wrestling	130.62±8.51	125.87±9.26	123.87±8.47	124.00±8.39			
Ferritin (mg/dL)	Aerobic	78.50±3.16	75.50±4.37	75.50±3.16	71.37±4.53	F=5.079 P=0.003**	F=0.597 P=0.731	F=2.819 P=0.082
	Anaerobic	81.62±5.03	79.50±4.51	74.87±3.50	72.50±4.46			
	Wrestling	63.62±7.17	63.50±6.21	62.50±6.51	60.62±6.04			
TIBC (mg/dL)	Aerobic	340.12±3.48	342.37±2.67	343.87±2.70	334.62±3.01	F=1.78 P=0.16	F=1.39 P=0.231	F=1.856 P=0.181
	Anaerobic	337.25±3.40	340.87±3.30	341.12±2.81	343.25±3.82			
	Wrestling	334.50±2.07	339.00±2.54	336.00±2.29	333.75±2.16			

Legend: * - Significant level at p<0.05; ** - Significant level at p<0.01.

Discussion

In the first investigation of acute effect, the one stage of aerobic, anaerobic, and wrestling exercise was observed. The serum iron changes in the effect of TIME over had no difference among the groups. However, the serum ferritin and TIBC changes were significant. This is done in a way that ferritin had a significant change in wrestling exercise, which was different with the two other groups. The aerobic exercise group after the continuous mild decline until 3 h after exercises returned to the baseline levels during 24 h of recovery period which was significantly higher than the two other groups. In contrast, the TIBC level in the wrestling exercise group had no significant change during exercises, but it decreased in the aerobic and anaerobic groups in such a way that it had a significant difference between these two groups. Moreover, the serum TIBC in the exercise group had significant decline within 3 h after exercise, while it increased in aerobic and anaerobic exercise groups and returned to the basic levels and had a significant difference between these two groups. The serum TIBC of the three groups returned to the baseline levels during 24 h after exercise in such a way that its changes difference in effect of TIME over in wrestling group was significant with the two other groups. In contrast, in the study of the acute effect of one stage of aerobic, anaerobic, and wrestling exercises after two non-consecutive sessions from that exercise, there were intergroup differences only in serum iron changes in the effect of TIME over. Therefore, the anaerobic and wrestling exercises had a similar procedure devoid of significant changes. However, its amount had a significant increase in the aerobic exercise group during a 24-h recovery period.

In other words, in the comparison of the acute effects of the three types of exercise, the serum iron in the three types of exercise successively decreased the effect of TIME over even if there was no difference among the methods. The wrestling exercises led to a significant decline in iron stores during exercises and the decline in TIBC in recovery period within 24 h after exercises. The aerobic and anaerobic exercises were not in this situation, and these two types of exercises had similar behaviours. Furthermore, after a short time adaptation to two non-consecutive sessions from the three types of aerobic, anaerobic, and wrestling exercises, the acute effect of these three types of exercises was different from the initial acute effect. The descending process of serum iron in two anaerobic and wrestling groups was similar and identical, but it had a significant increase to the top level of initial levels in the aerobic method in recovery period within 24 h after exercises. The iron stores had continuous decline in the effect of TIME over with no difference in the type of exercises. It was determined that the type of machine supplying specific sport energy creates a different effect in the hematologic profile and iron indices (Milic et al., 2011) which resulted from training for specific disciplines, sport acute effect, seasonal adaptations, and special training regimes, such as endurance or strength training (Banfi et al., 2006; Di Santolo et al., 2008; Dopsaj et al., 2008; Schumacher et al., 2000).

Millic et al. (2011) reported that the athletes who apply anaerobic energy system had a higher level of serum iron and transferrin saturation as compared to athletes engaged in semi-aerobic anaerobic energy system. Furthermore, athletes practicing aerobic exercises possess the highest level of reticulocyte haemoglobin content as compared to anaerobic and semi-aerobic anaerobic systems (Milic et al., 2011).

The present study showed that in the short-term adaptation to two exercise sessions, the serum iron of wrestlers who had practiced aerobic exercises was significantly lower than those practicing anaerobic and wrestling exercise. In contrast, the serum ferritin of wrestlers who practiced aerobic and anaerobic exercises was higher than that of wrestlers who practiced wrestling exercises. The iron indices of elite wrestlers in short-term adaptation to three sessions had no difference in any of the exercise types.

The iron, TIBC, and ferritin levels are among the oldest biomarkers to examine the athletes during the training season (Fallon, 2008). Iron deficiency may have a negative effect on oxygen transport and immune defence and thus affects the sports performance (Peeling, Dawson, Goodman, Landers, & Trinder, 2008).

Iron deficiency progresses in three stages (World Health Organization & Centers for Disease Control and Prevention, 2007). Firstly, the iron stores in reticuloendothelial cells of the liver, spleen, and bone marrow decline, which is seen as a reduction in serum ferritin and is introduced as reduced iron stores. The second stage is demonstrated with red blood cell production (erythropoiesis) followed by a reduction in iron transport and iron preparation for cells. This stage is manifested by low serum iron, increased total binding capacity, and reduced transferrin saturation. These two stages of iron deficiency are introduced as "latent iron deficiency" pre-anaemia or "iron-deficient non-anaemia". In the last stage of iron deficiency, the haemoglobin synthesis reduces due to the insufficient preparation of iron which leads to anaemia (World Health Organization & Centers for Disease Control and Prevention, 2007). In other words, the present study and the first acute effect study showed that the first stage of iron deficiency was observed during wrestling exercises and the second stage was in the recovery period within 24 h after exercises. In the investigation of the second acute effect, all the three types of exercises led to the first stage of iron deficiency. Rahmaninia et al. (2015) observed that the serum ferritin level decreased to 16% after one session of the Bruce test which reached 7.4% after five rest days and conduction of the second Bruce test (Rahmaninia, Damirchi, & Masoumi, 2005). Malczewska et al. (2000) reported that the serum ferritin increase is observed within three to four days after a hard workout (Malczewska, Bach, & Stupnicki, 2000).

The major mechanism of exercise-related iron loss in athletes includes haemolysis, haematuria, sweating, gastrointestinal bleeding, and chronic inflammation. The latest reports showed that hepcidin, a peptide hormone regulating iron, which is primarily formed in the liver, can organize the plasma concentrations of iron in response to inflammations (Peeling et al., 2009). Hepcidin regulates the iron concentration and distribution of tissue iron through the inhibition of intestinal absorption, release by macrophages, and mobilization of hepatic iron reserves (E. H. J. M. Kemna, Tjalsma, Willems, & Swinkels, 2008). Hepcidin levels increase from 3 to 24 h after exercise in response to interleukin-6 (IL-6), an initial regulating cytokine for hepcidine up-regulation which rapidly decreases the concentration of iron plasma (E. Kemna, Pickkers, Nemeth, van der Hoeven, & Swinkels, 2005; Nemeth et al., 2004; Peeling, 2010; Peeling et al., 2014). It was determined that acute exercise sessions increase the acute phase response and lead to the production of post-exercise cytokines (Nunes, Grotto, Brenzikofer, & Macedo, 2014). It is known that IL-6 derived from muscle as compared to its previous status, can increase up to 100 times during training (Petersen & Pedersen, 2005). Peeling et al. (2014) observed that after one session of acute running exercise with four diverse protocols in four groups possessing different levels of ferritin (lower than 30, 30-50, 50-100, and above 100), the serum ferritin, except in groups lower than 30 had significant increases (Peeling et al., 2014). The serum iron in all the groups except 30-50 group had a significant increase (Peeling et al., 2014). The IL-6 had a significant increase in all the groups (Peeling et al., 2014). Moreover, within 3 h after exercises, hepcidine-25 had a behaviour similar to post-exercise serum ferritin such that a strong, positive, and significant correlation was observed between these two groups (Peeling et al., 2014). Auersperger et al. (2013) reported that 71% of iron stores (serum ferritin) after eight weeks of long-term running had a long-term decrease (serum ferritin) (Auersperger et al., 2013). They were even not recovered over a 10-day recovery period and were still at a high level of 67% (Auersperger et al., 2013). Hepcidine had a behaviour similar to serum ferritin (Auersperger et al., 2013). Moreover, the serum TIBC and iron decreased due to the 8-week exercise period and had not changed in the recovery period (Auersperger et al., 2013). The present study did not investigate these mechanisms; however, the probability of their influence can be brought forth for discussion.

Conclusion

The present study showed that the three types of aerobic, anaerobic, and wrestling exercises had different acute effects on the iron indices of elite wrestlers in a way that wrestling exercises led to a decline in iron stores during exercise (the first stage of iron deficiency), decline in total iron-binding capacity during exercise (the second stage of iron deficiency), and during a 24-h recovery period. Moreover, even if these three types of acute exercises are studied after a short-term adaptation period, they probably will create different responses on the iron indices of elite wrestlers. The serum iron had no change in anaerobic and wrestling exercises over the passage of time, but it increased in aerobic and 24-h recovery periods. Furthermore, the iron deficiency only progresses in the first stage (serum ferritin decline in time passage with no impact of intergroup differences) and avoids its progress to the next stage (no TIBC change). It may be concluded that short-term aerobic training can cause positive adaptation of iron indices of elite wrestlers; the role of aerobic power in recovery from the acute effect of exercise in wrestlers has been proved.

Furthermore, serum TIBC had no significant changes in aerobic and anaerobic exercises in both study designs. It had a significant decrease in the wrestling exercise of the first study design in the 3 h recovery period that returned to baseline after 24 h. This may mean that it may be a recovery-dependent iron index. Therefore, it is recommended that elite wrestlers pay much attention to the type of field-specific training and related compatibilities in their workout schedule to avoid any exposure to iron deficiency, probable damage to their sports performance, and that they benefit from profitable recovery and nutrition plans. It is suggested that the effect of long-term adaptation to these exercises on acute responses be studied, and the nutrition status be recorded during any subsequent study.

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