

Iron Assessment in Elite Athletes

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Abstract

Asymptomatic iron deficiency is frequently observed in competitive athletes and an impaired iron metabolism may lead to abnormal haemoglobin and myoglobin production limiting endurance capacity. Iron supplementation could improve blood biochemical measures and increases work capacity but the use of iron supplements should be a judicious choice based on a careful hematological evaluation since an unjustified treatment may lead to possible health risks as well as performance decrease. When considering competitive athletes, serum ferritin, commonly used to evaluate iron status, may not be always considered as an effective marker. Several studies suggested that hepcidin assessment may represent an alternative method to define the real necessity of iron supplementation in specific conditions such as in competitive athletes.

Background

With the exception of pregnant women, Competitive Athletes represents the group of subjects with the highest iron demand [1]. Within this population, iron requirements are increased by approximately 70% [2] since iron is an essential element for the formation of oxygen carrying proteins, namely hemoglobin and myoglobin, as well as for the activity of enzymes involved in energy production [3]. Thus, an impaired iron metabolism may lead to abnormal haemoglobin and myoglobin production limiting endurance capacity [4]. For this reason, in iron-deficient athletes, iron supplementation improves blood biochemical measures and increases work capacity, as evidenced by an increased oxygen uptake, reduced heart rate, and decreased lactate concentration during exercise [5]. Currently, no standardized guide-lines for iron administration are available and the decision of administering iron to an athlete is mainly based on empiric recommendations or on performance enhancing hopes. With this regard, while the recommendation to pay particular attention in maintaining an adequate consumption of dietary iron would be always advisable, the use of iron supplements should be a judicious choice based on a careful hematological evaluation, mainly because of the possible health risks deriving from an unjustified treatment [6]. Indeed, the excess of iron has several deleterious consequences including the potential oxidative damage [7], as well as the risk of inducing hemochromatosis in individuals homozygous for the widespread C282Y polymorphism of the HFE gene [8].

When considering non-anemic subjects, the evaluation of the iron status, is usually based on the analysis of serum ferritin (SF) levels [9]. Values lower than 12 µg/L, undoubtedly, represents a condition of iron deficiency requiring supplementation [9]. However, in competitive athletes, SF levels ranging between 12 and 30 µg/L, reflecting an iron deficiency without anemia, are frequently observed. Within this SF range, which does not appear to affect athletic performance, the real

usefulness of an iron supplementation is still matter of debate. In order to better evaluate the iron status, several biochemical parameters have been studied including serum iron, total iron binding capacity [10], transferrin saturation, transferrin receptor concentrations and transferrin receptor-ferritin ratio [11]. However, none of these variables has been identified as an effective marker for deciding when to start a justifiable iron supplementation in competitive athletes and the evaluation of SF levels still represent the golden standard for the study of iron metabolism. When considering the population composed by competitive athletes, it has to be taken into consideration that ferritin is an acute phase protein [12] and that exercise evokes an acute phase response, resulting in post exercise pro-inflammatory cytokines levels comparable to those seen during bacterial infection and/or inflammatory disorders [13]. Consequently, SF may not be always considered as an effective marker of the iron status in competitive athletes. To overcome this issue, several studies evaluated the possibility of investigating the iron status of athletes through the analysis of hepcidin levels [4,14]. Hepcidin is a circulating peptide hormone that regulates the entry of iron into plasma [15]. Hepcidin, primarily released by the liver, negatively regulates iron egress from intestinal cells and macrophages by altering the expression of the cellular iron exporter ferroportin [16]. Therefore, hepcidin acts as the key regulator of the total body iron, by modulating intestinal iron absorption, as well as iron availability for erythropoiesis by affecting the efficiency of macrophages mediated iron recycle [17]. These studies suggested that hepcidin assessment may represent an alternative method to define the real necessity of iron supplementation in specific conditions such as in competitive athletes. Moreover, these studies, confirmed that SF below 30 µg/L indicates an asymptomatic iron deficiency condition inhibiting hepcidin expression. Conversely, SF above 30 µg/L indicates adequate iron stores inducing the up-regulation of hepcidin to prevent unnecessary iron absorption. The immediate clinical consequence of these findings relies in the conclusion that an iron supplementation would be useful when administered to athletes with SF below 30 µg/L in whom hepcidin levels are low to promote iron absorption. On the contrary, it would be not indicated in athletes with SF exceeding 30 µg/L in which hepcidin levels are consistent with sufficient body iron.

Conclusion

To contrast the alarming behaviour of athletes assuming iron supplements with a poor understanding of the purpose, it is necessary to provide accurate information [18]. Supplementation is not without consequences: the use of high doses of supplemental iron is often associated with gastrointestinal distress and constipation and a subsequent decline in the subject compliance and performance as well as with potential detrimental effects on both performance and health. Hepcidin assessment may represent an alternative method to verify the real necessity of iron supplementation in specific conditions in which

SF evaluation may not reflect the real iron demand. It is well known that this analysis is not largely applicable, mainly because of the elevated costs and the diurnal variability of this hormone both in serum and urine [19]. Nevertheless, hepcidin may play an important diagnostic role in athletes referring symptoms that occur in overreaching and overtraining syndromes. This approach may reduce the possible contraindication and side effects linked to improper iron supplementation, especially in athletes to whom an incorrect supplementation may negatively affect the performance rather than improve it.

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