Iron and Athletic Performance

Monique Ryan, MS, RD • Personal Nutrition Designs, Evanston, IL

ATHLETIC TRAINERS and therapists should know that elite and recreational athletes, especially female and adolescent athletes, are at risk for depleting iron stores and developing anemia. Hard training increases iron needs and the body's iron turnover. When undetected and untreated, iron depletion can lead to iron-deficiency anemia, which will significantly slow down even the fittest athlete. Even without full-blown anemia, athletes with iron deficiency can also experience adverse physiological effects that negatively affect training and performance.

Iron depletion and iron deficiency can develop for a variety of physiological and nutritional reasons. That is why it is essential for dedicated athletes to have their iron status monitored regularly and to practice sound nutritional strategies to prevent iron depletion. Recovery from iron-deficiency anemia can be slow; therefore, prevention is key.

Iron and Athletic Performance

Iron is a mineral that plays many important roles in exercise metabolism. Both hemoglobin and myoglobin require iron for optimal formation. Hemoglobin transports oxygen throughout the body via the blood, and myoglobin carries oxygen in the muscle. Many muscle enzymes involved in metabolism require iron. Other iron-containing compounds facilitate oxygen use at the cellular level. About 70% of the iron in the body is involved in oxygen transport, and 30% is stored iron. Ferritin is the body's stored form of iron.

Iron depletion can impair training in two ways. First, a body low on iron cannot produce optimal amounts of hemoglobin. Low hemoglobin levels result in decreased oxygen uptake, and delivery of oxygen to body tissues and muscles also decreases. Inadequate iron also limits the capacity of the muscles to use oxygen to produce energy and form ATP, thus compromising aerobic metabolism. When anemia develops, exercising muscles receive less oxygen and produce more lactic acid for a given intensity and, consequently, fatigue sooner than usual during training. In fact, the only symptom of mild anemia might be fatigue during strenuous training.

Monitoring Athletes' Iron Stores

Because of menstrual iron losses, female athletes are at greater risk for developing iron deficiency and anemia than male athletes are. Overall, athletes have a higher prevalence of iron deficiency than the general population, with estimates ranging from 10% to 30%. The incidence of reported full-blown anemia is closer to that of the general population, at 6%.

To obtain a more complete picture of an athlete's iron status, serum ferritin, as well as hemoglobin and hematocrit levels, should be monitored. Obtaining these values preseason can establish baseline data and enable athletic trainers and therapists to monitor blood-value changes in relation to an athlete's training program and competitive season. Monitoring blood values over time also enables athletic trainers and therapists to catch low iron levels before anemia develops, because iron stores become depleted in three distinct stages (Table 1).

Iron depletion occurs in the first stage. This is characterized by a drop in serum ferritin levels to less than 12 mg/dl while other indicators of iron deficiency remain normal. In Stage 2, there is iron deficiency

TABLE 1. STAGES OF IRON DEPLETION

Stages of Iron Depletion	Stage 1	Stage 2	Stage 3
Serum iron	decreased	decreased	decreased
Serum ferritin	decreased	decreased	decreased
Transferrin saturation	normal	decreased	decreased
Erythrocyte protoporphyrin	normal	increased	increased
Hemoglobin concentration	normal	normal	decreased

without anemia, also referred to as iron-deficiency erythropoiesis. Iron transport and production of red blood cells are adversely affected. As in Stage 1, hemoglobin levels remain normal, but serum iron, serum ferritin, and transferrin saturation are decreased and there is an increase in erythrocyte protoporphyrin. Erythrocyte protoporphyrin, a precursor of hemoglobin, will increase when there is too little iron available for hemoglobin synthesis. When Stage 3 occurs, there is iron-deficiency anemia, and hemoglobin levels fall. Normal hemoglobin levels for men are 14–16 mg/dl, with anemia classified at less than 13 mg/dl. The normal hemoglobin range for women is 12–14 gm/dl. Anemia occurs in women when hemoglobin is less than 12 gm/dl.

Iron Blood Values and Training Factors

What sports-medicine physicians have now come to appreciate is that *anemia* is often a relative term, especially in female athletes. For example, even though anemia is diagnosed at a hemoglobin level of less than 12 gm/dl in women, some female athletes might be functionally anemic at this level and respond to iron therapy with an increase in hemoglobin. If this occurs, it indicates that higher hemoglobin might be optimal and "normal" for that individual. For this reason, female athletes in particular can benefit from regular screening of iron stores to determine whether iron supplementation is needed.

Other training-related factors can affect blood-iron values. If blood is drawn when an athlete is not adequately hydrated, values can be falsely elevated. Living and training at high altitude can elevate hemoglobin and hematocrit levels. An athlete's blood work can also be affected by another condition referred to as sports anemia. This is not a true anemia but rather a "dilutional" anemia that does not have an adverse effect on an athlete's performance. This condition actually reflects an increase in blood volume that occurs with training. This increased volume means that the heart can pump more blood to the working muscles, enhancing oxygen delivery. What distinguishes sports anemia from true anemia is that red blood cells are normal in color and size, and the low hemoglobin does not respond to iron therapy.

In the next *Nutrition Notes*, this column will continue the discussion of iron and athletic performance with tips for preventing and treating iron deficiency in athletes. ▮

Monique Ryan is a sports nutritionist in Evanston, IL. She is the author of two books published by VeloPress: *Sports Nutrition for Endurance Athletes* and *Complete Guide to Sports Nutrition*. More information on her publications and services can be found at www.moniqueryan.com