Thoughts and comments on long-distance training, injuries, and more from a student of the sport

WEDNESDAY, NOVEMBER 9, 2011

Ferritin, hemoglobin, and iron deficiency in distance runners

When a distance runner begins to struggle early on in workouts and races, suffers from excessive fatigue, and often feels there's no "gas in the tank" in the final half of hard efforts, iron deficiency anemia should be one of the first problems to rule out. Having adequate iron stores is essential to any endurance sport, as your ability to run (or swim, or row, or ski, etc.) is predicated by your ability to get oxygen to your muscles, which is accomplished by your red blood cells. Iron deficiency anemia impedes the body's ability to manufacture red blood cells, and causes a marked decrease in performance. Red blood cells are comprised almost entirely of a protein called **hemoglobin,** and at the core of that protein is an iron atom. Oxygen binds to hemoglobin by binding with the iron atom at its center. And hence, if there isn't enough iron available to make

red blood cells, there aren't enough red blood cells to carry oxygen to the muscles. And no oxygen means no high-level performance. Today I'm going to go in-depth on the issue of iron and iron-deficiency anemia, because it is often misunderstood, even within the medical profession. Technically, ***anemia*** only refers to low hemoglobin, but as we'll soon see, it's possible (and very common) to have low iron stores but *not* have low hemoglobin. There is mounting evidence that even iron deficiency *without* anemia is harmful to endurance performance. We're about to cover all of this in depth.

Introduction: the biology of red blood cells

As usual, though, we need a crash-course instructional first. This time, in blood physiology. As mentioned above, red blood cells are the oxygen-carriers of the bloodstream and are comprised mostly of hemoglobin, which in turn contains iron. Any old red blood cell circulating in the blood stream "lives" about three or four months before it's resorbed or destroyed. Your body always tries to keep enough red blood cells in reserve to meet the demands you put on it. So, when you go for several sessions of hard training, your body responds in turn by synthesizing more red blood cells. They are made in bone marrow, and their synthesis is stimulated by the hormone EPO. More red blood cells (generally) means better performance. Illegal dopers boost their red blood cell levels by injecting recombinant EPO; Alberto Salazar's runners boost their red blood cell levels by sleeping in altitude tents, and the Kenyans (unwittingly) boost their red blood cell levels by living and training at high altitude.

The actual steps in synthesizing red blood cells and the hemoglobin they contain are massively complicated, but it suffices to say that iron is necessary. And the iron used to make hemoglobin ultimately comes from your diet. But it can't just go straight from your steak dinner into red blood cells; otherwise, you'd have no way to make red blood cells when you *weren't* actively absorbing iron, like at night. So the body stores iron that's absorbed from your diet using a protein called **ferritin**. Ferritin circulates in the bloodstream, and can release iron for red blood cell synthesis or other bodily requirements when needed.

So, what happens after a period of hard training? The body synthesizes new red blood cells by releasing EPO into the bloodstream, which stimulates the bone marrow to draw iron from ferritin in the bloodstream, create hemoglobin, and manufacture new red blood cells. It's important to note that much of the stimulus to create more red blood cells is due to the fact that they are actually *destroyed* by hard training; the repeated trauma of forceful muscular contractions and footstrikes against the ground crush red blood cells, requiring new ones to be made. This situation can manifest as **march hemoglobinuria** (named for military recruits who would notice blood in their urine after long marches in hard boots), where crushed red blood cells are filtered out of the blood

and excreted in urine. Hemoglobinuria can contribute to anemia, as it increases the iron turnover in an athlete. Much of the new red blood cell synthesis happening in your bone marrow is just to break even from blood cells lost during exercise. Even if iron stores and intake are adequate for a sedentary life or a moderately active one, a bout of hard training can increase the body's demand for red blood cells—both for increasing the blood's overall oxygen-carrying capacity and for replacing red blood cells destroyed in training, and result in iron deficiency.

Dietary iron

The iron stored in ferritin comes from the iron that's absorbed from the food you eat. Many cases of iron deficiency are due to inadequate dietary iron intake. Indeed, a 1997 study by Looker et al. found that about 10% of adolescent and adult women are **iron deficient** (meaning they had inadequate ferritin levels in their blood), as are about 1% of adolescent and adult men. Women tend to be at higher risk for iron deficiency both because they tend to eat less iron-containing foods and because of the menstrual cycle. Of the women who were iron deficient, about 2-5% of the 10% had true **anemia** (low hemoglobin).

Iron is most readily absorbed from red meat, since it is already bound into a biologically-available form (called **heme iron**). Iron in vegetables, however, is more difficult to absorb because it is not bound in the "heme" form (and is therefore called **non-heme iron**). Sources differ on the magnitude of this difference, but it is significant. According to one study, about 8-16% of ingested iron will be absorbed if the source is heme-iron (meat); only 3-8% will be absorbed if the source is non-heme (vegetables and dairy). Another study pegged non-heme iron at 5% and heme iron at 37%. The numbers tend to vary widely because other factors, like what else a meal contains, can significantly influence iron absorption. Of these factors, three deserve individual mention. Vitamin C can boost iron absorption by two to ten-fold, depending on the dose. Calcium does the opposite: it *diminishes* iron absorption by 50-60%. The effect is large enough so that there is a significant difference in iron absorbed from a cheeseburger vs. a hamburger! Finally, tea has a potent effect on iron absorption, but *only* of *non-heme* iron. The tannins found in tea, which give it its color, bitterness, and many of its health benefits, strongly chelate with unbound iron from vegetable sources (this includes iron in supplements), preventing its absorption. Heme iron is already bound up, so it isn't affected. Many other factors modestly influence iron absorption and are too numerous to list here. None of these factors, however, *completely* block iron absorption, so having a cheeseburger is better than having no iron at all.

Vegetarians in particular are at a very high risk for iron deficiency, due to the previously-mentioned problems with non-heme iron absorption. It's certainly *possible* to train at a high level and maintain a vegetarian diet, but it's very likely (especially if you're a woman) that you'll need supplemental iron. As my college coach has said, "nobody becomes a vegetarian because it'll

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make him a better athlete." If you do not eat meat, be sure you get your iron checked once or twice a year.

Iron deficiency anemia and pseudoanemia

If your iron intake is insufficient for a prolonged period of time, the first effect will be low serum ferritin concentrations. If your serum ferritin remains low, you may develop anemia, which is a decrease in the amount of hemoglobin in the blood. There is no disagreement among doctors and scientists that abnormally low hemoglobin levels will cause impaired performance (as well as other problems). But something that's not often well-known among the medical establishment is a phenomena called **pseudoanemia**. Endurance training can increase your blood plasma volume by 10-20%, and this effectively dilutes your blood. So, when the doctor runs a blood test, it can *appear* as though you have less hemoglobin than you really do. Say you have 30 trillion red blood cells in your body. If this number remains the same, but your blood plasma volume increases from 5 liters to 6 liters, a blood test which only measures the *concentration* (i.e. hemoglobin per unit volume of blood) of hemoglobin will falsely indicate that you have less than you really do. To compensate, two-time Olympic marathoner and coach Pete Pfitzinger (who, to his credit, also has a Master's degree in exercise science) says you ought to extend the low end "normal" range for distance runners by one gram per deciliter of blood. Speaking of units, the "normal" range of hemoglobin values is 14-17 g/dL (grams of hemoglobin per deciliter of blood) for men and 12-15 g/dL for women. Pfitzinger extends this to 13-18 g/dL and 11-16 g/dL for men and women, respectively. It's important to note that different laboratories use slightly different cutoffs for the ends of the normal range, hence the differences at the upper end. These values and others are recapped in a table a few screens below. From what I've read pseudoanemia does not seem to affect ferritin readings.

Iron deficiency *without* anemia and the "normal" range for ferritin

Very often, runners find they have low or nearly-low ferritin but normal hemoglobin values. Can this cause fatigue and performance problems? The normal range for ferritin, which is measured in nanograms per milliliter of blood, is quite large: 18-300 ng/mL for men and 12-150 ng/dL for women. Many doctors will tell you that it's not possible for a low ferritin level without a low hemoglobin level to negatively impact your performance. But emerging research is beginning to show what coaches and running specialists have suspected for a long time: that runners require higher ferritin levels than the general population, and low ferritin can impair performance, *even when hemoglobin levels are normal*. For many years, coaches have anecdotally connected ferritin levels below about 25 ng/dL with injuries and fatigue in their runners. A brief burst of studies evaluated and dismissed this argument. It was not possible, they argued, for iron

John Davis

I'm a recent (2011) graduate of Carleton College and a long-time student of distance running. My interests include elite training, biomechanics, injury prevention and treatment, supplemental exercises, training for younger runners, and coaching philosophies. Currently, I live in the Twin Cities, write, and coach at Edina High

depletion without anemia to affect performance. Not only did it not make sense (how could ferritin, which plays no active role in transporting oxygen, impact performance if hemoglobin levels were sufficient to meet performance needs?), but experiments seemed to show that iron deficiency without anemia does not affect endurance capacity. Some examples can be found here and here, but the best example is this one by Lamanca and Haymes, as it's representative of the issues that plague these types of studies. Eight "active" women with normal (>26 ng/mL) ferritin levels were paired with eight women with low (<12 ng/dL) ferritin. They all cycled at 80% of VO2 max as long as they could, and the results were compared. The low ferritin group cycled for 23.2 minutes, while the normal ferritin group cycled for 27.0 min, a difference of 14%. But because of the peculiarity of small-sample size statistics, this difference was not deemed statistically significant. A full explanation of the ins and outs of statistical significance will have to wait for another day, but it should suffice to say that it's not the whole story. If a group of eight runners completed an 8km course averaging 23:12 and another group of eight completed it in an average of 27:00, would you say there's a "significant difference"?

Of course you would (though it'd depend partially on the variation of times within the group, and that's where the statistics come in). But the small sample size isn't the only problem. Many scientists take issue with the use of "exercise to exhaustion" because it is unreliable and tends to be a better measure of motivation than fitness. But even that's not what bothers me most. It's the fact that these were merely "active women." I contend that there's a world of a difference between an "active" woman who visits the gym 3-5 times a week and a serious athlete who runs 50 or 60 miles a week. As famed coach Renato Canova says, high-level runners are a "different animal"—the demands of high level training are very different than those of a moderately-active lifestyle.

Fortunately, more recent and better-designed studies (like this one by Hinton et al.) are beginning to support the theory that low iron stores can affect performance even when hemoglobin is normal. Haas and Brownlie wrote a fairly good review article on the effects of iron deficiency with and without anemia, in which they bring up an interesting point: Iron deficiency without anemia (i.e. low ferritin) does not seem to affect VO2 max, but **does** seem to affect endurance capacity and efficiency. They connect this with the oxidative capacity of muscular tissue—in lay terms, the ability of the muscles to burn fuel for energy. So even if your blood has enough red blood cells to *deliver* oxygen to your muscles, the "power plants" deep inside your muscle fibers that actually use that oxygen to burn sugar and make energy **don't** have the iron they need.

Oxidative phosphorylation and proteins

Hemoglobin isn't the only thing in the body

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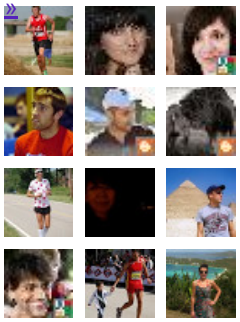

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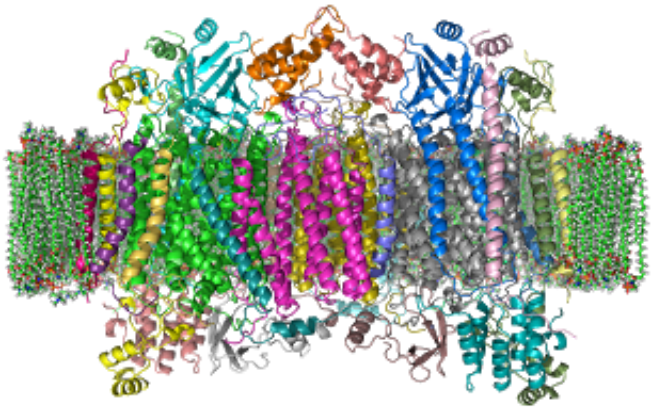


Cytochrome-c oxidase, an important iron-containing enzyme

that requires iron. An entire group of proteins, called cytochromes, rely on an iron-containing core to function properly. They have myriad uses, but some of the most important ones are enzymes involved in **oxidative phosphorylation**, the cellular process that turns nutrients into energy using oxygen and sugar. These proteins may play a role in cases of iron deficiency *without* anemia. If there isn't enough serum ferritin, the body may shut down production of additional cytochromes to conserve iron for red blood cell synthesis. This would impair endurance in a manner only noticeable by a high-level athlete, and it would not be connected to a shortage of red blood cells. Though this is all currently theoretical, it would provide a good explanation for the drop in performance many coaches have seen when their athletes have low ferritin but normal hemoglobin values. And I'm not alone with this opinion: Pete Pfitzinger reports that Dr. David Martin, who famously worked with Olympic champion Sebastian Coe and has advised many other elite runners, also believes that low ferritin without anemia can disrupt endurance performance by causing a shortage of cytochromes:

> Dr. Martin, however, believes that ferritin reflects the iron stores that can be utilized to make enzymes for oxidative energy production, and therefore has a direct impact on performance. Dr. Martin says that in his experience with runners, training and racing performances are usually affected when ferritin levels drop below 20 ng/ml, and that when those athletes increase their ferritin levels above 25 ng/ml they experience a rapid turnaround in performance.

Jeff Hess, head coach at South Eugene High School and contributor to Track and Field News, also reports that iron deficiency (and the concomitant drop in performance) is rampant among female high-schoolers and suggests that low ferritin is connected with a higher risk of injuries. I don't have the coaching experience or biochemical expertise to evaluate this point, so I'll defer to Jeff Hess on this one. If true, it may also be a result of changes in cytochrome biology.

Test, results, and dealing with doctors

From all this, it shouldn't be a surprise to you that I recommend that all serious runners (and particularly women) have their iron levels checked once per year, as well as any time there is an inexplicable

stretch of poor performances or fatigue. Hemoglobin levels are checked as part of a routine Complete Blood Count, but **serum ferritin** is not regularly checked. You'll have to specifically ask for it. However, it's a simple blood test, so it's a relatively painless and inexpensive procedure. One important note about serum ferritin tests is that they should not be done while you're sick. Ferritin is an acute phase protein, meaning that it will be elevated during an illness, hence giving you a falsely high reading.

Once you've actually gotten the test, you need to ensure that the doctor **gives you the numeric results** and doesn't just tell you your iron levels are "normal" or "low." Unfortunately, many clinics don't bother actually giving patients the results and instead simply let them know they're in the clear. As I've shown, however, a woman with a ferritin level of 15 ng/mL might be considered as "normal" by a clinic but seriously iron deficient by a coach. You should write these values down somewhere so you look at them again later.

Hemoglobin levels are measured in g/dL and serum ferritin is measured in ng/mL. Below is a table from one of my upcoming booklets showing the normal range for "regular" people and what I consider the normal range for an endurance athlete:

	Hemoglobin (g/dl)		Serum Ferritin (ng/ml)	
	Sedentary	Athlete	Sedentary	Athlete
Men	14-18	13-18	18-270	25+ (ideally 50+)
Women	12-16	11-16	18-160	25+ (ideally 50+)

Normal hemoglobin and ferritin levels for sedentary males and females compared with normal levels for endurance athletes. Ferritin levels under 25 ng/ml will cause significant drops in performance and increase the risk of injury. You should have your doctor check your iron levels at least once a year. Sources: Hess, "Iron Depletion" and Pfitzinger, "Iron for Runners" (see p. 34 for full citations).

Although ferritin levels below 25 ng/mL are connected with performance drops and perhaps injury, I very much prefer that runners strive to keep their ferritin above 50 ng/mL to provide a "buffer zone" against iron deficiency. If you're riding the line at 25 or 26 ng/mL, you're only one missed hamburger away from iron deficiency, which isn't a good place to be.

Correcting iron deficiency

If your blood tests come back and show that you are indeed iron deficient, what can be done about it? If your hemoglobin is low, your doctor will likely outline a plan for iron supplementation to boost your hemoglobin back into the acceptable range. But if your ferritin is low or borderline low (by athletic standards) and your hemoglobin is normal, you'll usually feel set adrift without a solid plan on how to go forward. As I mentioned earlier, most primary care doctors are not familiar with the special iron needs of distance runners. Some are even opposed to iron supplementation, as (in sedentary people at least) it can increase oxidative stress over the long-term.

While dietary modification is important, and I don't doubt that eating more iron-rich foods like red meat and leafy greens (as well as various "tricks" like using cast-iron cookware) can correct mild iron deficiency, supplementation is the most rapid and effective method to restore iron reserves, especially if they are very low or you are in-season. There is an astounding variety of iron supplements available (and most advertisements for the various types are anything but helpful), so I'll briefly sort through the different types you might encounter on the shelf at the local drug store.

Iron Salts

Iron salts are tablets or pills in which iron is paired up with another atom or molecule to form a soluble salt, much like table salt. Table salt is sodium chloride; the sodium (a metal) is bound up with chloride to form a salt, which is soluble in water. Likewise, an iron salt like ferrous sulfate is just an iron ion bound up with a sulfate ion. Once dissolved in water, the iron and sulfate ions (or sodium and chloride) separate from each other and become biologically available for the body to absorb. There are three types of iron salts commonly available as iron supplements: **ferrous sulfate**, **ferrous fumarate**, and **ferrous gluconate**. All three are relatively inexpensive and widely available. While they are different chemical compounds, they all accomplish the same thing once they've dissolved in your stomach. There are some differences in solubility (ferrous gluconate and sulfate are more soluble than ferrous fumarate in neutral water), but in the highly acidic environment inside your stomach, these differences are essentially null. Any of the three common iron salt supplements are a good choice if you need an iron supplement

When examining the label of an iron supplement, it's easy to get confused, as advertisers often conflate the dosage of the *salt* and the *iron content* of the salt. So, if you look at a package of ferrous sulfate tablets (SlowFe and other brands), it will say "ferrous sulfate 142 mg," but on the supplement facts box, it will say "Iron (elemental): 45 mg (250%)." What gives? Each tablet contains 142 mg of ferrous sulfate, but remember, ferrous sulfate is iron combined with sulfate ions. So only 45 mg of the 142 mg is actually iron; the rest is sulfate. This makes for a nice introductory chemistry lesson on molar mass, but fortunately you don't have to do the math yourself. Just compare the %DV per tablet, as this always corresponds to the actual iron content, not the salt.

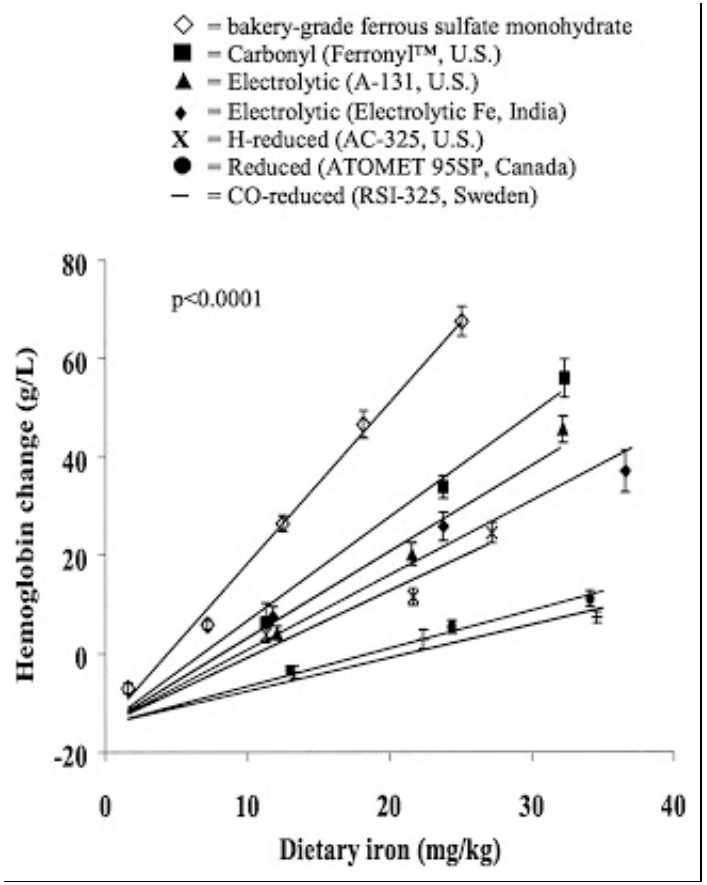
Another difference among pills containing iron salts is that some are designed to be "slow release." This isn't a chemical difference per se—a "slow release" ferrous sulfate tablet has just as much ferrous sulfate in it as a regular one—but the other contents of the tablet are designed to make the ferrous sulfate dissolve slower. This can reduce gastrointestinal problems like constipation. The downside of slow release tablets is that they will be more likely to experience interference with things like tea or calcium intake, since they hang around longer in your stomach. If you're taking your iron before bed, that's not a problem.

Finally, some iron salts are available as **liquid iron**, which comes in a bottle with hundreds of doses which must be measured out by hand. Some people tout that liquid iron is "more absorbable" than tablets or pills, but as a chemist, I don't see any validity in this claim. As long as the iron you are ingesting is reasonably solid in acidic water (as ferrous sulfate, fumarate, and gluconate are), there won't be a big difference in how much is absorbed. Liquid iron is just an iron salt (usually sulfate or gluconate) that's been dissolved in water. Often manufacturers will add any number of sweeteners, herbs, or other extracts, either for marketing purposes or for taste. Liquid iron is usually more expensive per dose than tablets, and is more difficult to measure out precise dosages (how many people have precision pipettes at home?). Additionally, you are often paying for bizarre and unnecessary ingredients like rose hips, carob extract, and ocean kelp (I'm not making this up). For these reasons, I do not recommend using liquid iron.

Reduced Iron

A less-common form of iron for supplementation is the various types of "powdered" or "reduced" iron. This is iron in its simplest form: unbound, elemental iron. There's a classic chemistry experiment that uses a magnet to extract the "reduced iron" in common fortified breakfast cereals. Now, it's not quite as bad as "eating nails for breakfast" because the elemental iron available in these types of supplements is purified, but it shifts the burden of dissolving the iron to your body's stomach acid. Whereas iron salts will dissolve quickly in your stomach, elemental iron has to be dissolved by the hydrochloric acid in your stomach. This results in reduced iron being less bioavailable than iron salts. There are various names for elemental iron supplements, and they are related to how the iron was obtained. These include **Carbonyl iron**, **H-reduced iron**, **CO-reduced iron**, and **electrolytic iron**. If you're curious, carbonyl iron comes from decomposing an organometallic compound called iron pentacarbonyl, $Fe(CO)5$. H-reduced and CO-reduced iron is the elemental iron that's left over when jets of hot hydrogen or carbon monoxide gas are passed over iron ore. The gasses strip the oxygen from the iron and carry it away, leaving elemental iron. Electrolytic iron is grown by passing electricity through a solution of iron ore. These methods all produce high-purity iron very cheaply. But when ingested, reduced iron is less bioavailable than iron salts (see the graph below—this study was done in rats, but results are similar to those found in humans). This is sometimes touted as a benefit, as it's harder

to accidentally overdose on reduced iron, but because iron salts are better absorbed and more controllable via slow-release treatments, I do not recommend using reduced iron, even though it may be cheaper.

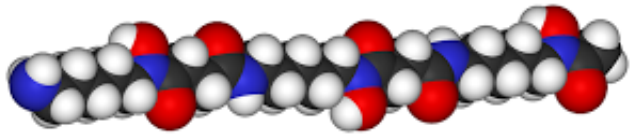


Ferrous sulfate, an iron salt, is better absorbed than the various types of reduced/elemental iron. Graph from Swain et al.

Chelated Iron

Finally, chelated iron supplements offer iron that is tightly bound by large organic complexes. Chelated forms of various minerals are often touted as "better" or more bioavailable by naturalistic vendors. You're more likely to find chelated forms of iron at the co-op than the drug store. However, simply the label "chelated" is *woefully* inadequate when talking about this type of iron supplement. What matters is *what ligand* (the ligand is the large organic complex that "grabs" the iron atom) is used to chelate the iron. Typically, a chemist or a doctor uses a chelating agent to get rid of unwanted metals. For example, if you were to poison yourself by drinking an entire bottle of liquid iron, a doctor would pump your stomach and administer deferoxyamine (below), a chelating ligand that binds iron so strongly that the body can't pry it out and absorb it. Also, recall earlier that tannins in tea block iron absorption by chelating with non-heme iron. But a ligand that

binds iron less strongly may be more available. Chelated iron forms like iron *bis*-glycinate and sodium iron (III) EDTA have attracted scientific attention mostly due to their application as a fortification agent in malnourished areas, particularly in meals with high levels of iron-inhibiting ingredients (like calcium). The idea is that, by making the iron harder to get at, it can "outlast" the inhibitory agents in the stomach and eventually be absorbed later. Relatively little research is dedicated to iron chelates as standalone supplements for anemia or iron deficiency. The only studies that show chelated iron to be superior to iron salts, either in availability or in the occurence of gastrointestinal side-effects are these two, both published in obscure Latin American journals and both funded by a company which makes chelated iron supplements. Again, as a chemist, I am highly suspicious that chelated forms of iron are in any way better than iron salts, at least for direct use as an iron supplement. Chelation is usually designed to *stop* metals from being absorbed, not promote it. One thing is certain, though: chelated iron supplements *are* more expensive than iron salts. Their efficacy is much less certain, and because of these doubts, I can't recommend chelated iron either. But if you have tried iron salts and found that, even in slow-release form, they cause gastrointestinal problems, chelated iron may be worth a shot. Right now, the most-studied chelating ligand is *bis*-glycine, which binds iron to form iron *bis*-glycinate.



Deferoxyamine, an iron-chelating agent

Dosage and timing

As I said earlier, virtually all primary care doctors should be knowledgeable about treating iron deficiency anemia (low hemoglobin). Not all will be in-tune with the latest research on ferritin, though. In general, doctors familiar with iron deficiency without anemia (low ferritin and normal hemoglobin) prescribe 45 or 65mg of iron (250-360% of Daily Value—remember, not all of this non-heme iron will be absorbed) once a day, along with 250 or 500mg of vitamin C to boost absorption. However, if an athlete's ferritin level is very low, a doctor may be prescribed two or three times this much in order to restore iron reserves as rapidly as possible, especially if the athlete is in-season. Obviously, you need to consult with your doctor regarding your supplementation decisions.

If you only take iron once a day, the best time to take it is immediately before bed. This way, absorption won't be hindered by anything else in your stomach. If you also take a calcium supplement (which is not a bad idea, especially for women), don't take it within a few hours of

taking your iron. If your doctor directs you to take iron more than once per day, you'll need to do a bit of thinking about when the best time to take it would be.

Non-supplemental sources

Finally, through some nutritional tricks, you can juggle your diet around to boost your iron intake and absorption. Do be careful not to *eliminate* foods that inhibit iron absorption, like milk, yoghurt, and tea, as these are very healthy parts of a complete diet. But perhaps you can load up on calcium and tea in the morning, but eat more red meat, leafy green vegetables, and citrus fruits (which contain vitamin C) in the evening. Using cast-iron cookware—particularly with acidic foods like spaghetti sauce—can boost iron intake too, as the food dissolves a tiny amount of the iron in the cookware. Yummy! These tricks are nice to know, but it's hard to gauge their benefit, as you can't really tell how much additional iron you're getting by cooking in a cast iron pot or eating more spinach at dinner.

Too much of a good thing?

Should everyone take iron? The short answer is "no," because there are drawbacks to taking iron long-term if you don't need it. Some studies indicate that high iron intakes are linked to a higher risk of colon cancer, as having excess iron promotes the generation of free radicals. Keep in mind, however, that 1) many things you encounter in everyday life like automobile traffic, air pollution, gasoline, and even sitting at your computer are linked to an increased risk of cancer, heart disease, and mortality, and 2) these studies are done on sedentary, elderly people over very long periods of time. As I said earlier, distance runners are a "different animal." I know of one sports physician who says he has *never* seen a distance runner with iron levels that were too high, probably due to the very high red blood cell turnover rate in serious endurance athletes and the loss of dietary iron through sweat, urine, stool, and march hemoglobinuria. Regardless, if you don't take iron now and your blood tests come back with a healthy level of hemoglobin and ferritin, there's no need to take iron (though you should continue to monitor your iron levels in the future if you significantly increase your training or do any extended bouts of altitude training).

If you *do* have low iron, work with your doctor to figure out a plan to get back to a healthy level, having your blood iron levels checked every 4-6 weeks until you get back to a healthy level. You'll probably need some type of "maintenance" supplementation to ensure you don't slide back into iron deficiency in the future.

Finally, if your iron seems stuck at a low level even after supplementation, you should talk with your doctor about possible causes. Some conditions, like celiac disease and hypothyroidism, can impair the absorption of iron in the gut, so even if you are consuming more than enough, you

won't be able to absorb it. These conditions also cause problems that will affect your performance (and overall health) in their own right.

Conclusion

Thanks in large part to the efforts of many concerned coaches and parents, iron deficiency is a relatively well-known problem within the running community. But there's still a disconnect between the knowledge about iron deficiency among runners themselves (as an experiment, ask a female DI runner how many of her teammates are on iron) and most primary care doctors. In their defense, however, serious endurance athletes probably make up less than one percent of their patients. As usual, I've managed to whip up a 13-page monstrosity that's wholly unfit for printing and showing to your doctor. Instead, if you need a concise article to **show your doctor**, I highly recommend this one by South Eugene High School coach Jeff Hess. It's not as heavy on the science as this post, but it is a very good first-hand look at the effects of iron deficiency and it fits neatly on three pages. If you're still having trouble working with your doctor, **ask other people in the running community**, either at a road race, track meet, or your local running store, about who they see for their iron issues.

Managing and avoiding iron deficiency is only one piece in the larger puzzle of how to run your best, but it's an important one. **Get your hemoglobin and serum ferritin checked** once or twice a year, and if necessary, **talk with your doctor** about taking an iron salt supplement (ferrous sulfate, fumarate, or gluconate), perhaps in a slow-release form, to boost your ferritin and avoid iron deficiency. Remember that even if your hemoglobin is normal, your running can still be affected if you have low ferritin. If your ferritin is only a tad on the low side, or you just want to increase your "buffer" between your current level and the 25 ng/mL level that seems to start causing problems, **eat more red meat** and **separate calcium-containing meals from iron-containing meals**. Recovering from iron deficiency can take many weeks since it takes your body time to build back its iron reserves. But the bright side is that once you've got a healthy store of iron, you have built up a large safety buffer against iron deficiency and anemia in the future.

21 comments:

Andrea November 9, 2011 at 11:49 AM

Great information. Thank you for posting!

Reply

Anonymous November 9, 2011 at 12:40 PM

Thanks for putting this great article together. I think there is one important item that you have left out. There is a recessive genetic disorder called Hemochromatosis that will cause an individual to absorb iron 10x more readily than everyone else. I had a ferritin level of 30ng/dl and unknowingly decided to start taking iron to boost my levels. After taking the supplements for a few months (admittedly too long) I was up to 400 ng/dl with 95% iron saturation. This causes quite a bit of trouble in the short and long term and consequently I have to remove this iron from my system through bloodletting. They'll be taking 1 pint of blood from my system SIX separate times this winter to reduce my iron levels back to normal. Obviously I am NOT excited about the temporary reduction this is going to have on my performance. I recommend getting the genetic test for Hemochromotosis before you take any iron supplements to avoid any complications.

http://www.mayoclinic.com/health/hemochromatosis/DS00455

Reply

John Davis November 11, 2011 at 9:17 AM

Thanks for the comment! I haven't heard of hemochromatosis before, sounds like a real pain! Something to watch out for.

Reply

▾ Replies

Anonymous January 14, 2015 at 10:01 PM

John, BEFORE you recommend anyone to take iron supplements, you should research HEMOCHROMATOSIS, as it is a VERY common illness among people of European ancestry.
It is highly dangerous for the millions of people who have this disease to take any sort of iron supplements.
Hemoglobin numbers in people with Hemochromatosis may appear normal although their ferritin levels can be high, but untested, but, this is a better indicator of high iron levels in the bloodstream.
Multiple phlebotomies(bloodletting), over weeks or months may be required, in order to

get iron levels in check, and it is VERY common for them to continue throughout an individual's lifetime, whether they are an athlete or not. Not doing so can create MANY negative effects, and ALL organs are at risk for early failure.
I must repeat that this is a VERY COMMON disease, but is highly underdiagnosed, due to lack of knowledge of it by many family practitioners.
Some of your recommendations could easily put lives at risk!

Anonymous March 11, 2015 at 11:28 PM

John, your admission that you haven't heard of HEMOCHROMATOSIS, is not surprising, since people with this disorder have averaged about 7 years, after symptoms showed up, before they were properly diagnosed.
However, it just happens to be THE MOST COMMON METABOLIC DISORDER IN THE COUNTRY, BUT IS PROBABLY THE MOST UNDERDIAGNOSED!!!.
Due to the unwarranted assumption that iron levels can be boosted with no consequences, iron levels can just continue to rise, and your body has no way of reducing them, short of being bled.
This accumulated iron can cause liver cancer, cirrhosis, pancreatic cancer, early heart failure, extreme fatigue, extreme joint pain, diabetes and a multitude of other diseases, which American doctors are just beginning to wake up to.
Some of the symptoms, you ma notice, are the same as iron deficiency anemia, which has led to misdiagnosis and deaths.
The simple fact that breakfast cereals can contain more than 100% of a daily dose of iron, and its virtually impossible to purchase bread not iron containing supplements, makes for difficult choices for hemochromatosis sufferers.
Additionally, just drinking a glass of orange juice with a meal, can magnify the iron absorption levels, in HC patients, to almost 100% of the iron in a meal, while normal individuals may absorb less than 10% of that.
BUT, what really puts their lives at risk, is being advised, by well intentioned but misinformed individuals, that they should be taking IRON SUPPLEMENTS OF ANY KIND, because the high concentrations cause such rapid rise of iron levels, in HC sufferers..
Its not unheard of for this disorder to show symptoms when an individual is in his/her teens, and there are documented cases of deaths of those young individuals, which were only discovered to have been caused by iron loading, by their autopsies.
I will repeat what a previous post stated:
THIS IS A VERY COMMON ILLNESS, which a normal blood test for iron, will not catch.
I would sincerely suggest that you do a bunch of research about this disorder(The Iron Disorder Institute is but one of the organizations that can provide valuable information), before you promote the ingestion of iron supplements, for ANY reason.
They also have an excellent cookbook, containing valuable diet information and recipes

Many forms of anemia can be inconvenient, but HEMOCHROMATOSIS CAN, AND DOES, KILL PEOPLE!!!

Reply

Jrunnr February 27, 2013 at 1:04 PM

I found the article extremely interesting & informative, and want to comment. As anonymous said, you want to be very careful with iron supplements. High iron levels have some similar effects as low iron - symptoms include: fatigue, lack of energy, abdominal pain, hair loss, lack of labido...As a runner who has been running 35 - 40 mi/week for over 3 years straight, I hit a point where I had no more energy - as it's been said, my body was out of gas. I just couldn't run long distance anymore with no excuses. I had my blood work done and they found my iron level was high 202 ug/dL with a 63% saturation(high)with a ferritin of only 37 ng/mL with normal Hgb at 15.9g/dL & hemocrit 45.1%. I had taken an iron supplement for 63 days prior to the test which i attribute to my high iron level, but my ferritin level wasn't excessively high. I was told to stop the supplement, and 4 weeks later after a follow up blood test, my iron was down to 99 ug/dL! to me that seems like an amazing drop. Unfortunately my ferritin wasn't re-tested, and it probably should have been. My running performance is suffering, and this article - iron deficiency without anemia is something I will be discussing with my dtr. Thanks for putting this together!!!

Reply

Mitch June 5, 2013 at 12:23 PM

Thanks for the great article. There is something I don't understand about increasing ferritin levels using supplements or diet. Ferritin levels are given in ng/ml (nanograms per milliliter of blood). This is equivalent to ug/l (micrograms per liter of blood).

A person has about 5 liters of blood.

A typical amount of iron supplement might be 200 mg (milligrams) per day. Looking at only one day, let's assume that 10% of the iron in the supplement is absorbed (the low end of the percentage believed to be absorbed). That would be 20 mg which is 20,000 ug. With 5 liters of blood, that is 4,000 ug/l or 4,000 ng/ml. This is a large number compared to the typical ferritin level range between 15 and 300 ng/ml.

What is the explanation for why iron supplements don't cause ferritin levels to increase rapidly? Either the iron is going someplace else in the body after being absorbed or the percentage of iron believed to be absorbed from supplements or food is wildly too high. Or there is something I'm not

understanding.

Reply

Replies

Anonymous March 12, 2015 at 11:28 AM

Mitch, The absorption rate of iron is not linear.
As dosage of supplements are increased, the rate of absorption may be reduced, in normal people, but an individual will still be absorbing more iron than normal, when supplements are ingested.
Those with hemochromatosis will just absorb many times more than normal people, however.
Its difficult to portray, with enough urgency, just how far behind, so far as knowledge of this disorder is concerned, the knowledge of the American medical institutions are.
With a population containing more than 30,000,000 individuals who have the genetic tendencies which can cause this disorder, and which produces a HUGE number of deaths, the reasons for which go undiagnosed until autopsies are performed, it is almost amazing that so few doctors have awakened to its widespread dangers.
Recommendations for dietary and supplemental iron increases, by individuals who are totally unaware of the huge numbers of people with full blown hemochromatosis, and the even more vast numbers who can be pushed into iron loading by such recommendations, are simply irresponsible at worst and unnecessary at least.
Little or nothing, in many of these recommendations, even mentions the simple blood tests that can quickly finger this disorder, and NOTHING is ever put forward to encourage the quick genetic tests that can give a heads up to those with the genetic mutation themselves, and to all their potential offspring, and their subsequent offspring, for all future generations.
HEMOCHROMATOSIS IS THE MOST COMMON HERIDITARY METABOLIC DISORDER IN THE USA, and its even more common in other European countries.
The Geritol advertisements, of past years, have produced generations of iron addicts who believe that a little more iron can only be good for them, with NO side effects.
They don't know that, once that iron is in their bloodstream, the body simply has NO WAY of getting rid of it, and it can be absorbed into ALL ORGANS, EVEN THE SKIN, to the point that magnetic screening detectors at airports, will detect it in various locations of the body
I've had my left knee set off detectors TWICE, in foreign airports, which caused authorities to pull me aside and rescan me several times and question me for some time.
At that time, I had no symptoms and had never heard of hemochromatosis, but that has since changed.
DO SOME RESEARCH BEFORE YOU CONTINUE THESE RECOMMENDATIONS!!!!!

PLEASE!!!!!

Reply

John Davis June 12, 2013 at 4:46 PM

Not all of the ferritin that's in your body is freely circulating in your blood—just a small portion of it. Also keep in mind that your body has a LOT of hemoglobin to maintain—a healthy level of 15g/dL and 5 liters of blood would mean 750g of hemoglobin—all of which requires iron!

Reply

Anonymous August 8, 2013 at 3:59 PM

Another thing to consider (that I learned the hard way): hereditary hemochromatosis (genetic mutation that causes higher than normal iron absorption) occurs in roughly 1 out of 200 people of European descent. Since as the article states, ferritin levels are not routinely tested, most cases of hemochromatosis go undiagnosed--as mine did. Testing for serum iron is not as routine as it once was either; when diagnosed, I looked over copies of bloodwork I'd had done the prior 14 years and iron levels were not on any of them.

Reply

Anonymous January 6, 2014 at 10:02 AM

Thank you for explaining this ferritin/athlete relationship to us non-chemists. My 17 year-old daughter is or I should say was, a very competitive runner. This hard-charging, all American started to struggle just to finish races We had her evaluated where she was told her serum ferritin was a 10 with normal hemoglobin(although I do not know the number, you've prompted me to ask for that too). Her doctor thought the 10 was "maybe a little low for a jogger". Bless his heart for working with us, but he had no idea of the miles she was running or of the correlation between ferritin & endurance sports. So, she has been taking a heme (and very expensive)form of iron and her last 2 tests were frankly, disappointing. In the span of 3 months, she went from a 10 to a 17, back down to a 13. She is frustrated and getting very depressed at this point that there hasn't been better progress. We are now looking for another physician to help her manage this and get back to her prior fitness. She has dreamed of running at the collegiate level but feels that dream is slipping away until she can feel herself again.

Reply

▾ Replies

Anonymous October 10, 2014 at 11:26 AM

My daughter, a competitive athlete but not a runner, was found to have a ferritin of 4. She did not respond to oral iron therapy, which may be due to the type of iron she took. She received three infusions of Venafir and her ferritin went up to the 130's and has remained around 100 on little to no supplementation for close to a year.

Anonymous June 3, 2015 at 5:37 PM

I suspect your daughter may have continued training. Boosting ferritin levels and intense training are mutually exclusive. It can take a year or more to restore levels to the point where the athlete can gradually resume training. She may be able to aqua jog at low intensity and boost ferritin levels.

Reply

Allan Holtz March 15, 2014 at 6:26 PM

Does anyone know the impact of age on these issues? I am male age 64. I still run 100-mile races, or at least try to. I have run 2500-3000 miles a year for the last 20 years. Last week my blood work showed a 13.8 gm/dL hemoglobin level (which is very typical for me) and a 30 ng/ml ferritin level (first time ever tested). While "normal" albeit at the low end, I wonder if I should try to somehow increase my ferritin values some via iron supplements. I had a harder time finishing 100-mile races the last couple years. The last 4 months I have increased my red meat consumption some (previous 20 years VERY little if any red meat consumption - I only ate chicken breasts, turkey and fish along with lots of fruits, vegetables and whole grains). My last race was the end of October last year, so just training miles the last 4+ months. My daily multivitamin already contains 18 mg of iron as iron fumarate. I have been taking that with lots of calcium though.

Reply

Anonymous April 8, 2014 at 8:19 PM

Thank-you for writing this article!!! It was great. It's amazing the information you can find. I am an endurance athlete that was just diagnosed as a pre-diabetic. I received my lab work from my doctor today and found that I have a very low Ferritin of 1.7 ng/mL. Which could mean I am not in fact pre-diabetic yet due to my iron levels in my blood.I can't wait to show this article to my doctor tomorrow. Thanks so much for posting.

Reply

Lori Baird June 16, 2014 at 11:29 AM

Hiya,

I know this is an old post, but it comes up a lot in Google searches for ferritin and endurance running. Also, sorry this is longish.

My ferritin was very low (between 3 and 9) for years and years. I was taking iron supplements (sometimes 3 times a day) religiously to no avail.

For the last of three years I'd get through 6 or so weeks of marathon training and then I'd tank -- getting winded going up stairs. Three GPs told me that because my hemoglobin was normal that I wasn't technically anemic and "shouldn't feel tired." Which was obviously bullshit.

I finally went to a hematologist and now I'm getting iron infusion by IV. It has made a world of difference. I had the first infusion (100mg InFed) 2 weeks ago and my ferritin went from 7 to 60 in 7 days. I got a second infusion last Friday and I can't wait to see my results.

Haven't discovered yet why my intestines aren't absorbing iron, but I don't have to suffer anymore not being able to run long.

If your ferritin won't budge, don't waste time with your GP. See a hematologist.

One last interesting note: My haptaglobin is also low, which, hematologist tells me is a result of hemolysis. It seems that one way people who run a lot lose iron/red blood cells by crushing them under our feet as we run.

Reply

CS November 12, 2014 at 3:39 PM

Useful to know

Reply

Anonymous December 12, 2014 at 9:09 AM

If your body doesn't absorb iron, consider getting tested for celiac disease. It will decrease your body's absorption of all sorts of minerals and vitamins...

Reply

Cody White March 5, 2015 at 9:31 AM

That is so informative, John! I hope people who are susceptible to that condition will find this article useful. Iron-deficiency anemia is not something to be taken lightly. It poses a serious health risk, especially to pregnant women. The best way to prevent it is by including iron-rich food and vitamin C in your diet, and of course, consulting with your doctor for the best advice. Thanks for sharing that! All the best to you!

Cody White @ Dr. Chris Fraser's Clinic

Reply

Maryana Korolis April 24, 2015 at 8:00 AM

Thank you very much for the article. I am a long time female runner. This week, I was diagnosed with iron-deficient anemia.

Reply

Anonymous August 17, 2015 at 9:21 PM

I am a 41 year old woman suffering from hair loss. I lose a lot of hair for unknown reasons. When I went to check my Ferritin, it was 13ng/ml so I knew this was low. Still within the normal range, but low normal. My hgb was 14.8. I started taking Iron supplements 65mg (325 MG FERROUS sulfate) The doctor told me to take two pills a day. The HGB is going up, but the Ferritin level is low. From 13 ng/ml, it only went up to 16 ng/ml for one month. I am afraid my HGB would be overdosed, but ferritin level would still be low. Can you please comment on this. It's depressing to have a hair loss, but it's scary to have so high HGB.

Reply

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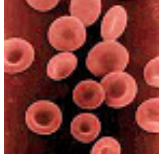

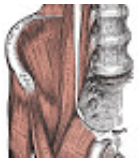

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