Iron Deficiency - Part One

Hey, everybody. In the next two presentations, we're going to discuss iron imbalance. We'll start with iron deficiency here, and then we'll move on to iron overload in the next presentation.

Iron imbalance is one of the most prevalent conditions in the world, and it has a significant impact on human health and disease. Nearly half of the world's population has a health concern caused or worsened by iron imbalance. Just think about that for a moment. The severity of symptoms caused ranges from unnoticeable or mild to severe and even fatal. The most widely recognized iron imbalance condition, of course, is iron-deficiency anemia, which affects a third of the global population, 2 billion people worldwide. Iron overload is less common, but it still affects 35 million people worldwide, and unfortunately, the vast majority of people with both iron deficiency and iron overload are undiagnosed or have been misdiagnosed because understanding of these conditions in primary care settings is extremely limited.

Iron is essential to life. Without it, most life on our planet would cease to exist. Plants would wither and die, and animals and humans would suffocate. Plants require iron to make chlorophyll. Humans require it to produce red blood cells and to make hemoglobin and myoglobin. Hemoglobin transports oxygen to the tissues and cells in the body. Myoglobin stores oxygen in the muscles, which allows them to do work.

Iron has other important functions in the body. Other protein groups aside from hemoglobin and myoglobin contain heme and, thus, iron, including cytochromes that supply energy and proteins involved in DNA synthesis and cell division. Iron is also involved in the conversion of blood sugar to energy, which allows muscles to work at their optimum during exercise or when competing. The production of enzymes, which play a vital role in the production of new cells, amino acids, hormones, and neurotransmitters, also depends on iron.

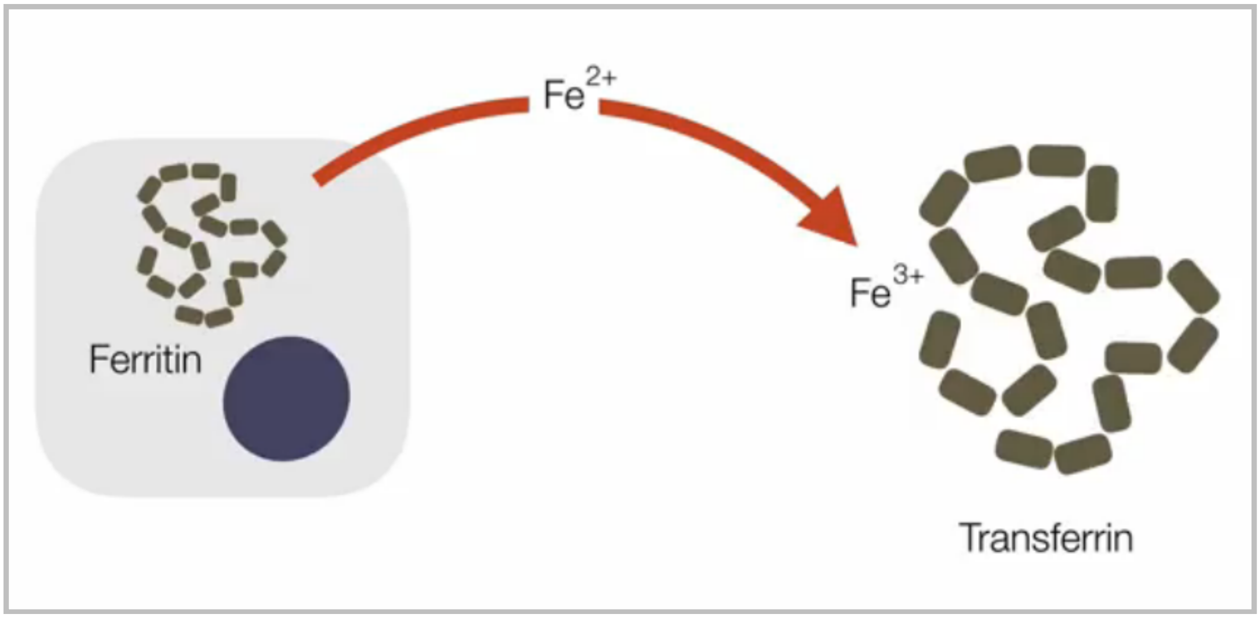
Our immune system is dependent on iron for its efficient functioning, and physical and mental growth requires sufficient iron levels, which are particularly important in childhood and pregnancy, where the developing baby solely depends on its mother's iron supplies.

Iron is an essential micronutrient, but the body only requires small amounts of iron to function properly, about 1 mg per day. On the other hand, iron is so deadly that as little as 250 mg can poison a small child. Iron cannot be absorbed by the body. It must be oxidized to ferric oxide first, then exposed to an acidic environment, hydrochloric acid in the stomach, to be turned into ferrous iron, which can be absorbed. Ferrous iron is absorbed primarily in the duodenum. In a person with normal iron metabolism, unabsorbed iron, which is about 90 percent of what is obtained through a typical diet, is excreted in the feces, and we'll come back to this in more detail when we talk about iron overload.

Iron distribution

Location	Amount
Hemoglobin	70%
Myoglobin and enzymes	15%
Ferritin	14%
In transit in serum	1%

At any given time, males have about 4 g of iron in their body, females about 3.5 g, and children 3 g or less. These are distributed throughout the body in hemoglobin, tissues, bone marrow, blood proteins, enzymes, ferritin, and hemosiderin and transported in plasma. I put a table here on the slide illustrating the distribution of iron throughout the body. As you can see, the vast majority of it is in the hemoglobin, 70 percent; 15 percent is in myoglobin and enzymes; 14 percent is in ferritin, which is a large molecule, it's a long-term storage form of iron; and only 1 percent is in transit in serum.



Transferrin is the main transport protein of iron. Others include DMT1, divalent metal transporter 1; ferroportin; and ceruloplasmin, which is a protein that binds with copper. Normally, transferrin saturation is 25 to 35 percent. That means 25 to 35 percent of the transferrin protein is saturated with iron in normal conditions. When it's working normally, transferrin binds to iron and transports it to all of the tissues, vital organs, and bone marrow, so normal metabolism, DNA synthesis, and red blood cell production can take place.

Absorbed iron that isn't needed for these functions is placed within cells and ferritin, again the long-term storage form of iron. Ferritin is produced in nearly every cell in the body. It's a huge molecule. One ferritin molecule can hold up to 4,500 atoms of iron. Ferritin serves as a containment device for iron when it's in ample supply or when it has the potential to be harmful.

U.S. RDA for iron

Life Stage	Age	Males (mg/day)	Females (mg/day)
Infants	0-6 months	0.27 (AI)	0.27 (AI)
Infants	7-12 months	11	11
Children	1-3 years	7	7
Children	4-8 years	10	10
Children	9-13 years	8	8
Adolescents	14-18 years	11	15
Adults	19-50 years	8	18
Adults	51 years and older	8	8
Pregnancy	all ages	-	27
Breast-feeding	18 years and younger	-	10
Breast-feeding	19 years and older	-	9

Adapted from: http://lpi.oregonstate.edu/mic/minerals/iron

In most cases, excluding pregnancy and growth spurts where larger amounts are needed, we need about 8 to 12 mg of dietary iron daily. I've put a table on this slide here with specific requirements segmented by population. You'll notice that pregnant women need as much as three times the amount that other populations need.

Normal daily excretion of iron happens through the urine, vaginal fluid, sweat, feces, and tears, and it is about 1 to 1.5 mg per day. When normal regulatory processes are working and intake is sufficient, iron balance is maintained.

Now, although the average adult requires 8 to 12 mg of iron per day, remember only about 85 to 90 percent of that is absorbed, so we're absorbing about 1 to 1.5 mg of iron per day, and we're excreting about 1 to 1.5 mg of iron per day, and that is what allows us to maintain iron balance, but if regulatory processes malfunction, iron overload will occur.

Two primary causes of iron deficiency

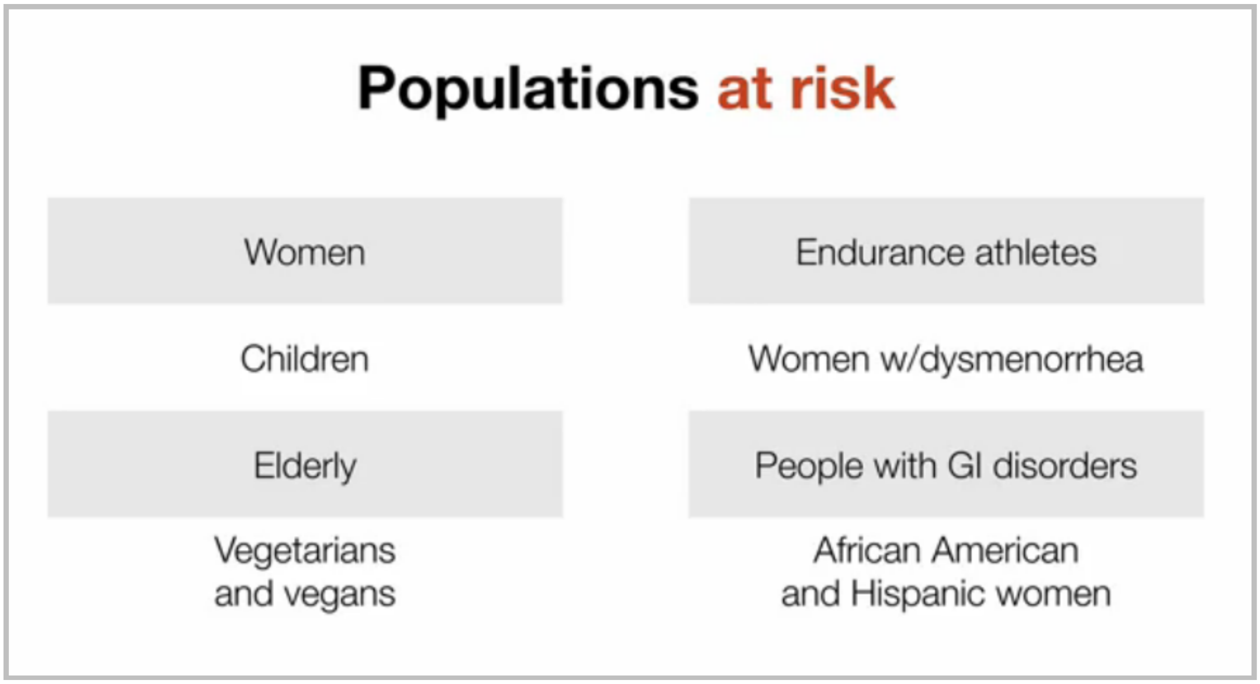
Increased demand	Decreased intake/absorption
Heavy menstruation	Plant-based diets
Pregnancy	Foods that inhibit iron absorption
Fibroids	Medications (e.g. PPIs)
GI bleeding	Low stomach acid
Surgeries and accidents	Low intrinsic factor
Excessive blood donations	Celiac disease
Medications & supplements	Crohn's disease
Alcohol abuse	Autoimmune disease
Lead/metal poisoning	Hormone imbalance

On the other hand, there are a variety of processes that can cause iron deficiency. Causes of iron deficiency are numerous, but they fall into two categories: increased demand and decreased intake or absorption. Increased demand means things such as blood loss from heavy menstruation; pregnancy; frequent or excessive blood donation; fibroids; digestive tract disease, including infections as well as surgeries and accidents; certain medications; some dietary supplements or substances that cause bleeding such as pain relievers with aspirin; and also as a result of poisoning from lead, toxic chemicals, or alcohol abuse.

Things that decrease intake or absorption include plant-based diets that don't include heme iron, which is the form that is found in animal products, organ meat and shellfish in particular, which is far better absorbed than plant-based forms of iron. Certain foods and medications can interfere with the absorption of plant-based iron, which include dairy products, coffee, tea, chocolate, eggs, and fiber. Calcium is the only nutrient currently known to decrease both heme iron absorption and nonheme, or plant-based, iron.

Disease conditions can also limit iron absorption. This can happen as a result of insufficient stomach acid; lack of intrinsic factor, which is a hormone needed to absorb B12, which can occur in conditions such as pernicious anemia; celiac disease; inflammatory conditions such as Crohn's disease; in autoimmune diseases; and in hormone imbalances.

Medications and supplements that inhibit iron absorption include antacids such as proton pump inhibitors and calcium supplements.



Populations that are most at risk for iron deficiency include women; children; the elderly; people on vegetarian and vegan diets; endurance athletes or those who perform intense exercise; women with heavy menstruation or fibroids; patients with inflammatory bowel disease, celiac, and atrophic gastritis; long-term PPI users; and alcoholics.

Women are at greater risk due to blood loss from menstruation. Kids are at greater risk from increased demand from growth; the elderly from low stomach acid, gastritis, and increased prevalence of Helicobacter pylori infection. Vegetarian and vegan diets, as I mentioned, do not contain heme iron, the form of iron found in animal products. Athletes perform intense exercise, which increases microscopic bleeding from the GI tract or increased fragility and hemolysis of red blood cells. For example, I once had a long-distance runner as a patient who was suffering from a condition called foot-strike hemolysis, so the constant striking of the feet on the ground hemolyzed red blood cells and was leading to a pretty severe case of anemia.

African-American and Hispanic women and their children are particularly vulnerable, possibly because of different hemoglobin needs. Men are less commonly iron deficient. They tend to suffer more, in my practice at least, from iron overload, but when they are iron deficient, it is often due to diseases that affect iron absorption such as celiac, Crohn’s disease, or alcohol abuse.