Iron—is an Essential Trace Element, but Not a Safe One

Iron is an essential trace element with many important functions in human physiology. In North America hundreds of thousands of people, predominantly women during menstruation, suffer from "iron deficiency anemia". Although not usually fatal, iron deficiency anemia is reputed to be one of the leading causes of sickness and debility among North American premenopausal women.

Iron was one of the first essential trace metals discovered. It has long been known that iron is a critical element for carrying oxygen in the blood. It is the central metal in the oxygen carrying heme complex. Oxygen attaches to heme iron and is transported in this form to various body tissues where it is released to support oxidative metabolism. For this reason, a lack of heme iron results in depressed tissue oxygenation, causing the condition of "iron deficiency anemia."

Because iron deficiency anemia is so common in the target population (menstruating women), public health officials have promoted the addition of iron to many of the most commonly consumed foods, i.e., nutrition supplements, flour, breads, pastas, and breakfast cereals. Despite this practice, iron deficiency anemia remains prevalent in the people who are supposed to be helped by the fortification programs.

In addition to its important function in carrying oxygen, iron is a critical element in numerous enzymes, where it promotes normal metabolism. Iron is also important in the iron-sulfur clusters that facilitate transport of electrons in mitochondria. However, iron deficiency is not known to affect levels of iron-sulfur clusters or enzymes, unless the deficiency is very severe.

Although essential to life, iron is a very toxic metal. Most people are familiar with the highly publicized toxic metals such as lead, mercury, cadmium, manganese, aluminum, and arsenic. However few people know that iron is responsible for a great deal more sickness and death than all of these other toxic metals combined! We have been mesmerized into thinking that iron is somehow different from other metals, simply because it is essential.

Human Iron Balance

The RDA for iron for women from 19 years to 50 years is 18 mg/day; for pregnant women it is 27 mg/day, and during lactation, 10 mg/day. The RDA for all other adults is 8 mg/day. The UL (tolerable upper intake) for dietary iron is 45 mg/day.

According to the Food and Nutrition Board, one half of ingested iron comes from fortified foods, although this may be an underestimate. Some cereals contain 24 mg iron per 1-cup serving. Most all grain products have varying amounts of iron added—this means virtually all flour, all pastas, all bread, all cereals. Iron supplements
The inability to excrete iron is the primary problem—we can excrete only around 1.2 mg per day no matter how much we absorb. Once iron has been absorbed in excess of the body's need, it is very difficult to remove it. Much of the excess will be stored in the liver in ferritin. When ferritin is saturated, hemosiderin is released into the liver and can lead to all of the damaging effects of iron to liver cells.

**Excess Dietary Iron That is not Absorbed May Generate Oxygen Radicals in the Intestine, Resulting in Colon Cancer**

"The most dangerous feature of iron is that it is attracted to, and deposits in, damaged tissue."

The iron that we consume that is in excess of the amount we absorb is carried through the intestines and excreted in the feces. This iron can be very dangerous since it can exist in free form and generate oxygen radicals resulting in intestinal damage and colon cancer. Colon cancer has been induced in laboratory animals given large excesses of iron. Certain food factors can prevent this kind of damage—in particular phytates that are abundant in plant food.

**Iron Fortification of Food—A Failed Experiment with Disastrous Results**

Iron is currently added to most all grain products, including many found in Natural Food stores. In the 1990s, the U.S. Food and Nutrition Board, Institute of Medicine, considered the controversy over iron fortification of food. A number of nutritionists desired to increase the amount of iron added to grain products because "iron-deficiency anemia" was still prevalent in spite of the iron fortification program that had been initiated in the early 1940s.

It was clear even then that the iron-fortification program initiated in the 1940s had failed. The purpose of iron fortification was to eliminate or at least control "iron deficiency anemia" which was prevalent among pre-menopausal women. Unfortunately, the addition of iron to food was unsuccessful. "Iron deficiency anemia" was still endemic among pre-menopausal women in 1990. Instead of acknowledging that the food iron-fortification program had failed, some members of the Food and Nutrition Board desired to increase the amount of iron added to food.

The simple fact is that "iron deficiency anemia" is **not a nutritional deficiency disease**. There are dozens of very diverse factors that can cause the conditions generally referred to as "iron deficiency anemia". **Chronic "iron deficiency anemia"**, no matter what it's origin may be, is a medical problem, not a nutritional problem.

Several iron toxicologists expressed their opinions to the Food and Nutrition Board that iron should be treated like all other metals that accumulate with age in the human body. These specialists suggested that we should **minimize** iron intake, except under conditions that require additional iron. Otherwise iron can do serious damage to any and every tissue of the human body. The comments of several of these experts are given here:

1. Randall B. Lauffer, PhD., Harvard Medical School warned the Food and Nutrition Board that iron should be treated like all other metals that accumulate with age in the human body. These specialists suggested that we should **minimize** iron intake, except under conditions that require additional iron. Otherwise iron can do serious damage to any and every tissue of the human body.
How Has the Food and Nutrition Board Responded to Reports of Iron Toxicity?

Since "iron-deficiency anemia" among pre-menopausal women has not been controlled by the food fortification program, and since fatal illnesses due to iron overload are well documented, it seems unreasonable to continue the iron fortification of food. However, the Food and Nutrition Board basically ignored information regarding iron's toxicity, and all grains marketed in North America continue to be "fortified" with iron.

The Food and Nutrition Board, Institute of Medicine, is directly responsible for the food fortification program, and has issued two major statements regarding iron fortification of food.


The most dangerous feature of iron is that it is attracted to, and deposits in, damaged tissue.

In the Dietary Reference Intakes (DRIs 2001), the Food and Nutrition Board acknowledged an increased risk for hepatocellular carcinoma in individuals with hereditary hemochromatosis, and reviewed some of the evidence linking iron excess to coronary artery disease. However, there is no mention of the involvement of iron in neuron degeneration caused by iron deposits in the brain. The information linking iron deposits in the brain to Parkinson's, Alzheimer's, and other neurological diseases is compelling. How could the people responsible for the welfare of our entire population have ignored this information?

DRIs 2001: Risk Characterization for Iron

The Food and Nutrition Board made the following statement in a "Risk Characterization" paragraph stating that the possible cardiovascular and hepatic hazards make it "prudent to recommend that men and postmenopausal women avoid iron supplements and highly fortified foods." However, there was still no mention of the neurological risks. Also, since most all grains continue to be fortified with varying amounts of iron, the Food and Nutrition Board didn't offer any way for people to avoid these "highly fortified foods", nor has there been any attempt to inform people that they may be harmed by these foods.

Free Radical Generation—The Biochemical Basis of Iron Toxicity

Under healthy circumstances, iron is tightly bound to organic components. This binding is referred to as chelation. Chelation prevents iron from redox cycling. Hemoglobin and myoglobin are the most abundant mammalian hemoproteins, but there are also cytochromes and enzymes that utilize iron. In addition iron is present in iron-sulfur clusters that are important in electron transfer reactions.

However, when present in excess, iron poses a threat to cells and tissues. Iron exists as ferrous iron, Fe(II), or ferric iron, Fe(III). Free iron is able to be oxidized from ferrous iron to ferrous...
ric iron, and reduced from ferric iron to ferrous iron. This is known as redox cycling. When iron redox cycles, oxygen radicals are generated. The resulting superoxide and hydroxyl radical damage cell structures.

**IRON EXCESS CAN CAUSE OR EXACERBATE ANY CHRONIC ILLNESS**

Iron can accumulate in free form in any body tissue under conditions of iron overload. That is why iron excess causes such a wide variety of illnesses.

The most dangerous feature of iron is that it is attracted to, and deposits in, damaged tissue. Thus, the tangles of Alzheimer’s, the substantia nigra of Parkinson’s, the atherosclerotic plaques of coronary artery disease, the inflamed joints of arthritis, the pancreatic islet cells of adult-onset diabetics all display increased levels of free iron. There is no way to tell whether the iron initiates the disease or if the diseased tissue attracts the iron which then exacerbates the condition. But either way, free iron in any body tissue is dangerous.

As stated earlier, nearly every individual in North America displays some manifestation of iron poisoning with advancing age.

1. **Neurological Degeneration: Parkinson’s & Alzheimer’s**
   a. The brain is a major target for excess iron.
   b. Accumulation of iron in brain tissue either causes, or contributes to, neurological diseases such as Parkinsonism and Alzheimer’s disease.

2. **Cancer: Iron is a powerful carcinogen.**
   a. Excess iron is a well-documented cause of hepatocellular carcinoma.
   b. Elevated levels of iron predispose to breast cancer.
   c. Animals fed iron excesses develop colon cancer, believed to be the result of free radical generation by unabsorbed iron.

3. **Heart Disease:**
   a. Excess iron accumulates in the heart and arteries.
   b. Free iron as found in heart and arteries may provoke arterial damage.

4. **Diabetes:**
   a. In hereditary hemochromatosis, excess iron accumulates in the pancreas where it disrupts insulin secretion and causes adult-onset diabetes.
   b. Iron deposits are found in pancreatic islet cells in people with adult-onset diabetes.

5. **Joint Inflammation/Arthritis:** Iron is found in free form in arthritic joints.

‘…iron excess may be responsible for more sickness and death in North America than any other single factor…”

**PERSONAL COMMENTS**

My early training was in Nutritional Biochemistry. I worked for approximately 10 years in the laboratories of Roger J Williams, who discovered pantothenic acid and was first to crystallize folic acid and gave it its name. The Clayton Foundation Biochemical Institute where I worked is famous for having been responsible for the discovery of more B-vitamins and their variants than any other single laboratory.

At the time I left the Clayton Foundation, metal toxicology was assuming greater and greater importance. Historically, the time period from 1950 to 2007 might well be referred to as the Age of Metal Toxicology. Mercury poisonings were reported in Minamata Bay, Japan in 1953, and, during the 1960s in Quebec, Canada, the entire Ojibwe nation fell prey to the lethal effects of organic mercury. At the same time, cadmium poisoning resulting in Itai-Itai (Ouch-Ouch) disease was endemic in certain regions of Japan, and manganese was demonstrated to cause a type of amyotropic lateral sclerosis.

In 1980 I decided to return to an academic environment where I could pursue my interest in metal toxicology, and, in 1989, I received a PhD in Biochemical Toxicology from Simon Fraser University in British Columbia. At that time I was invited to join the British Columbia Hemochromatosis Research Group, where I learned first hand of the dangers of iron over absorption.

For the last 18 years I have accumulated much of the vast body of scientific information which indicates that iron excess may be responsible for more sickness and death in North America than any other single factor, with the possible exception of cigarette smoking.

**CONCLUSION**

The next article in this series will present more information on how much iron is present in fortified foods and supplements. Ideas on what to do about iron toxicity will be presented. In the meantime, read labels, buy grains that are not fortified, and avoid or limit iron supplementation unless medically necessary.

Subsequent articles will document the role of iron excess in a variety of common diseases.

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