Facts About Dietary Supplements

Clinical Nutrition Service, Warren Grant Magnuson Clinical Center • Office of Dietary Supplements • National Institutes of Health

Iron

As a consumer, you need information you can trust to help you make thoughtful decisions about eating a healthful diet and using vitamin and mineral supplements. Registered dietitians at the Warren Grant Magnuson Clinical Center, the clinical research hospital at the National Institutes of Health (NIH) in Bethesda, MD, developed this series of Fact Sheets in conjunction with the Office of Dietary Supplements in the Office of the Director of NIH to provide responsible information about the role of vitamins and minerals in health and disease and to help guide your decisions on the use of vitamin and mineral supplements. Each fact sheet in this series received extensive scientific review by recognized experts from the academic and research communities.

The information is not intended to be a substitute for professional medical advice. It is important that you seek the advice of a physician about any medical condition or symptom. It is also important to seek the advice of a physician, registered dietitian, pharmacist, or other qualified health care professional about the appropriateness of taking dietary supplements and their potential interactions with medications.

Iron: What is it?

Iron is an essential mineral and an important component of proteins involved in oxygen transport and metabolism (1,2). Almost two-thirds of the iron in your body is found in hemoglobin, the protein in red blood cells that carries oxygen to your body's tissues. Smaller amounts of iron are found in myoglobin, a protein that helps supply oxygen to muscle, and in enzymes that assist biochemical reactions in cells. About 15 percent of your body's iron is stored for future needs and mobilized when dietary intake is inadequate. The remainder is in your body's tissues as part of proteins that help your body function. Adult men and post-menopausal women lose very little iron except through bleeding. Women with heavy monthly periods can lose a significant amount of iron. Your body usually maintains normal iron status by controlling the amount of iron absorbed from food (1,3).

What foods provide iron?

There are two forms of dietary iron: heme and nonheme. Iron in meat, fish, and poultry is found in a chemical structure known as heme. Heme iron is absorbed very efficiently by your body (1,3-4). Iron in plants such as lentils and beans is arranged in a different chemical structure called nonheme iron. Nonheme iron is not as well absorbed as heme iron (1,3-4). Flours, cereals, and grain products that are enriched or fortified with iron are good dietary sources of nonheme iron (5). The addition of iron to infant formulas, cereals, and grain products has been credited with improving the iron status of millions of infants, children, and women. The tables of selected food sources of heme and nonheme iron suggest many dietary sources of iron.

What affects iron absorption?
Iron absorption refers to the amount of dietary iron that your body obtains from food. Healthy adults absorb about 15 percent of the iron in their diet, but your actual absorption is influenced by your body's iron stores, the type of iron in the diet, and by other dietary factors that either help or hinder iron absorption (1,3,6-9).

The greatest influence on iron absorption is the amount stored in your body. Iron absorption significantly increases when body stores are low. When iron stores are high, absorption decreases to help protect against iron overload (1,3).

Absorption of heme iron is very efficient and not significantly affected by the composition of your diet (1). Only 1 percent to 7 percent of the nonheme iron in vegetable staples such as rice, maize, black beans, soybeans and wheat is absorbed when consumed as a single food (3). However, dietary factors can significantly improve nonheme iron absorption (1,3, 6-9). Meat proteins and vitamin C will improve the absorption of nonheme iron (1,10). Diets that include a minimum of 5 servings of fruits and vegetables daily, as recommended by the Food Guide Pyramid, should provide plenty of vitamin C to boost nonheme iron absorption. Calcium, polyphenols and tannins found in tea, and phytates, which are a component of plant foods such as legumes, rice and grains, can decrease the absorption of nonheme iron (1,11-15). Some proteins found in soybeans also inhibit nonheme iron absorption (1,16). Most healthy individuals can maintain normal iron sores when the diet provides a wide variety of foods as suggested by the Food Guide Pyramid. It is most important to include foods that enhance nonheme iron absorption when total daily iron intake does not meet the RDA, when iron losses are exceptionally high, or when no heme iron is usually consumed.

What is the Recommended Dietary Allowance for Iron?
The Recommended Dietary Allowance (RDA) is the daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97 to 98 percent) healthy individuals in each life-stage and gender group (1). The 2001 RDAs for iron (in milligrams) for infants ages 7 to 12 months, children and adults (1) are:

Age	Infants, Children	Males	Females	Pregnancy	Lactation
7 to 12 months	11 mg				
1 to 3 years	7 mg				
4 to 8 years	10 mg				
9 to 13 years		8 mg	8 mg		
14 to 18 years		11 mg	15 mg	27 mg	10 mg
19 to 50 years		8 mg	18 mg	27 mg	9 mg
51+ years		8 mg	8 mg		

Normal full term infants are born with a supply of iron that lasts for 4 to 6 months. Evidence is not available to establish a RDA for iron for infants from birth through 6 months of age. Recommended iron intake for infants from 0 to 6 months is based on an Adequate Intake (AI) of 0.27 milligrams (mg) per day that reflects the average iron intake of breastfed infants (1). Iron in human milk (breast milk) is well absorbed by infants. It is estimated that infants can use greater than 50 percent of the iron in breast milk as compared to typically less than 12 percent of the iron in infant formula (1). Cow milk is not only low in iron and poorly absorbed by infants, its use in infancy can cause gastrointestinal bleeding and iron loss from the body. For these reasons, cow milk should not be fed to infants until after age 1 (1). The American Academy of Pediatrics recommends that infants who are not breastfed or who are partially breastfed should receive an iron-fortified formula from birth to 12 months (1, 17). Formulas that contain between 4.0 to 12 milligrams of iron per liter of formula are considered iron-fortified (17)

Results of two national surveys, the National Health and Nutrition Examination Survey (NHANES III-1988-91) and the Continuing Survey of Food Intakes by Individuals (1994-96 CSFII) indicate that diets of most adult men and post-menopausal women provide recommended amounts of iron (18-19). Diets of females of childbearing age, pregnant women, and women who breast-feed generally do not provide recommended amounts of iron.

When can iron deficiency occur?

The World Health Organization considers iron deficiency the number one nutritional disorder in the world (20). It affects more than 30 percent of the world's population (21-22).

When your need for iron increases or a loss of iron from bleeding exceeds your dietary iron intake, a negative iron balance may occur. Initially this results in iron depletion, in which the storage form of iron is decreased while blood hemoglobin level remains normal. Iron deficiency occurs when blood and storage levels of iron are low and the blood hemoglobin level falls below normal (1).

Iron deficiency anemia may result from a low dietary intake, inadequate intestinal absorption, excessive blood loss, and/or increased needs (23). Women of childbearing age, pregnant women, older infants and toddlers, and teenage girls are at greatest risk of developing iron deficiency anemia because they have the greatest needs (20).

Individuals with renal failure, especially those receiving dialysis, are at high risk for developing iron deficiency anemia. This is because their kidneys cannot create enough erythropoietin, a hormone needed to make red blood cells. Iron and erythropoietin can also be lost with blood during dialysis, which can result in an iron deficiency. Extra iron and erythropoietin are usually needed to help prevent iron deficiency in these individuals (24 - 26).

Iron deficiency could also be caused by low vitamin A status. Vitamin A helps to mobilize iron from its storage sites, so a deficiency of vitamin A limits the body's ability to use stored iron. This results in an "apparent" iron deficiency because hemoglobin levels are low, even though the body can maintain normal amounts of stored iron (27,28). While uncommon in the U.S., this problem is seen in developing countries where vitamin A deficiency often occurs.

The anemia that may occur with inflammatory disease differs from iron deficiency anemia. It occurs in people who have chronic infectious, inflammatory, or malignant disorders (29,30). It is not associated with a shortage of dietary iron, and may not respond to iron supplementation (30,31). A physician should manage anemia associated with an inflammatory disorder.

Signs of iron deficiency anemia include feeling tired and weak, decreased work and school performance, slow cognitive and social development during childhood, difficulty maintaining body temperature, and decreased immune function, which may decrease resistance to infection (1,32-35). During pregnancy, iron deficiency is associated with increased risk of premature deliveries, giving birth to infants with low birth weight, (36,37) and maternal complications (1,37).

Who may need extra iron to prevent a deficiency?
Iron deficiency and iron deficiency anemia are relatively common in women of childbearing age, older infants and toddlers, and teenage girls (38), so they should periodically be screened for iron deficiency. Within these groups, iron deficiency is more common among women with heavy menstrual losses, women belonging to minority and low-income groups, and women who have had more than one child (38). Women taking oral contraceptives may experience less bleeding during their periods and have a lower risk of developing an iron deficiency while women using an intrauterine device (IUD) may experience more bleeding and have a greater risk of developing an iron deficiency. If laboratory tests indicate iron deficiency, iron supplements may be recommended. Many physicians routinely prescribe iron supplements during pregnancy because of the high incidence of iron deficiency anemia in pregnant women and the potential benefits for the mother and the fetus. Pregnancy increases a woman's need for iron due to increased blood volume, increased needs of the fetus, and blood losses that occur during delivery (1, 39).

Excluding all meat and meat products, poultry, and fish from your diet may reduce your total iron intake and will decrease your intake of heme iron, which is easily absorbed by your body. It will also influence your iron status because animal proteins can improve the absorption of nonheme iron found in plant foods. Vegetarians who exclude all animal products from their diet may need twice as much dietary iron because the intestinal absorption of nonheme iron is lower in plant foods (1). Vegetarians should also consider consuming nonheme iron sources together with a good source of vitamin C, such as citrus fruits or certain vegetables, to enhance absorption of nonheme iron.

Some facts about iron supplements:
Iron supplementation is indicated when an iron deficiency is diagnosed and diet alone cannot restore bodily iron content to normal levels within an acceptable timeframe. Iron in supplements comes in two forms: ferrous and ferric. The ferrous form is better absorbed and is usually the preferred form when iron deficiency has been diagnosed (40-42).

Supplemental iron may cause gastrointestinal side effects such as nausea, vomiting, constipation, diarrhea, dark colored stools, and/or abdominal distress (43). To minimize these side effects, start with half the recommended dose, gradually increasing to the full dose. Taking the supplement in divided doses and with food also may help limit these symptoms (44).

Who should be cautious about taking iron supplements?

Iron deficiency is uncommon among adult men and postmenopausal women. These individuals should only take iron supplements when prescribed by their qualified health care provider because of the risk of iron overload. Iron overload is a condition in which excess iron is found in the blood and stored in organs such as the liver and heart. Iron overload is associated with several genetic diseases including hemochromatosis, which affects approximately 1 in 250 individuals of northern European descent (45). Individuals with hemochromatosis absorb iron very efficiently, which can result in a build up of excess iron in organs and can cause organ damage such as cirrhosis of the liver and heart failure (1,3,46-48). This condition often is not diagnosed until the excess iron stores have damaged an organ. Iron supplementation may accelerate the effects of hemochromatosis, an important reason why adult men and postmenopausal women who are not iron deficient should not take iron supplements. Individuals with blood disorders who require frequent blood transfusions are also at risk of iron overload and should not take iron supplements.

What are some current issues and controversies about iron?

Iron and Heart Disease

Several observations have led researchers to examine the association between high iron stores and coronary heart disease. It appears that rates of heart disease among women increase when monthly periods stop, a time when levels of stored iron increase. Also, some researchers have suggested that lower rates of heart disease among people living in developing countries may be due to low meat (and iron) intake, high fiber diets that inhibit iron absorption, and gastrointestinal (GI) parasite concentrations that result in gastrointestinal blood (and iron) loss, all of which contribute to low iron stores in this population (49-53). In addition, a 1980s study of Finnish men linked high iron stores with increased risk of heart attacks (54). However, not all studies have supported this relationship (1, 55), including a 1999 review of 12 studies that failed to show a strong association (56). It is also true that older women have a greater prevalence of traditional cardiovascular disease risk factors such as high blood pressure and elevated blood cholesterol. Currently, available data do not provide convincing support for an association between high body iron stores and increased risk for coronary heart disease (1).

Iron and Cancer

Individuals with hereditary hemochromatosis are at increased risk for liver cancer (1). This increased risk is associated with an accumulation of iron in the liver, which can result in increased production of free radicals. Free radicals are by-products of normal metabolism that can damage your body's cells. There is inconclusive evidence that iron status is associated with the incidence of cancer in those who do not have hereditary hemochromatosis.

Iron and Intense Exercise
Many men and women who engage in regular intense exercise have marginal or inadequate iron status (1,57-60). Researchers have estimated that daily iron loss increases in those who engage in regular exercise. Research also indicates that iron has a shorter biologic half-life in highly trained runners. For these reasons, the need for iron may be 30 percent greater in those who engage in regular intense exercise (61).

Iron fortification and absorption of other nutrients:
Some researchers have raised concerns about the effects of iron fortification and supplementation on the absorption of other nutrients such as zinc, calcium, and copper. Research studies have shown that supplemental iron may decrease the absorption of these nutrients, but generally only when the supplement is taken on an empty stomach. Absorption of these nutrients is generally not affected when supplementary iron is taken with food (1,62,63).

What is the health risk of too much iron?
Iron has a moderate to high potential for toxicity because very little iron is excreted from the body. Thus, iron can accumulate in body tissues and organs when normal storage sites are full.

In children, acute toxicity can occur from overdoses of medicinal iron. Ingestion of as few as five or six high-potency tablets can provide amounts of iron that can be fatal to a child of 22 pounds. Consuming 1 to 3 grams of iron can be fatal to children under six and lower doses can cause severe symptoms such as vomiting and diarrhea (64). **It is important to keep iron supplements tightly capped and away from children's reach.** Any time excessive iron intake is suspected, immediately call your physician or Poison Control Center, or visit your local emergency room. In adults high intakes of iron supplements are associated with constipation, nausea, vomiting, and diarrhea, especially when the supplements are taken on an empty stomach (1).

In 2001, the Institute of Medicine set a tolerable upper intake level (UL) of 40 mg per day for infants and children through age 13 and 45 mg per day for adolescents ages 14 to 18 years and adults 19 years of age and older (1). The upper limit does not apply to individuals who receive iron under medical supervision. There may be times when a medical doctor prescribes an intake higher than the upper limit, such as when individuals with iron deficiency anemia need higher doses of iron until their iron stores return to normal.

Selected Food Sources of Iron
As the 2000 Dietary Guidelines for Americans state, "Different foods contain different nutrients and other healthful substances. No single food can supply all the nutrients in the amounts you need" (65). The following tables suggest dietary sources of heme and nonhemem iron. As the table indicates, meat, poultry, fish and seafood are good sources of heme iron and beans are good sources of nonheme iron. In addition, many foods are fortified with iron. Some foods, such as cereals, may be fortified with 100 percent of the Daily Value (DV)* for iron. It is important for anyone who is considering taking an iron supplement to first consider whether their needs are being met by natural dietary sources of heme and nonheme iron and foods fortified with iron.

If you want more information about building a healthful diet, refer to the Dietary Guidelines for Americans and the Food Guide Pyramid.

Table of Selected Food Sources of Heme Iron (4,66)

Food	*Milligrams*	*% DV**
Chicken liver, cooked, 3 ounces	7.0	40
Oysters, breaded and fried, 6	4.5	25
Beef, chuck, braised, 3 ounces	3.2	20
Clams, breaded, fried, 3/4 cup	3.0	15
Beef, tenderloin, roasted, 3 ounces	3.0	15
Turkey, dark meat, roasted, 3 ounces	2.0	10
Beef, eye of round, roasted, 3 ounces	1.7	10
Turkey, light meat, roasted, 3 ounces	1.2	6
Tuna, fresh bluefin, cooked, dry heat, 3 ounces	1.1	6
Chicken, leg, meat only, roasted, 3 ounces	1.1	6
Crab, blue crab, flaked and pieces, 1 cup, cooked, moist heat,	1.1	6
Chicken, breast, roasted, 3 ounces	1.0	5
Halibut, cooked, dry heat, 3 ounces	0.9	5
Pork, loin, meat only, broiled, 3 ounces	0.8	4
Tuna, white, canned in water, 3 ounces	0.8	4
Crab, blue crab, cooked, moist heat, 3 ounces	0.8	4
Shrimp, mixed species, cooked, moist heat, 4 large	0.7	4

Table of Selected Food Sources of Nonheme Iron (4, 62)

Food	*Milligrams*	*% DV**
Ready-to-eat cereal, 100% fortified, 3/4 cup	18.0	100
Ready-to-eat cereal, 50% fortified, 3/4 cup	9.0	50
Soybeans, mature, cooked, boiled, 1 cup	8.8	50
Lentils, cooked, boiled, 1 cup	6.6	35
Grits, white, enriched, instant, 1 packet prepared	5.4	30
Oatmeal, instant, fortified, 1/2 cup	4.1	25
Kidney beans, cooked, boiled, 1 cup	5.2	25
Pinto beans, cooked, boiled, 1 cup	4.6	25
Lima beans, cooked, boiled, 1 cup	4.2	25
Navy beans, cooked, boiled, 1 cup	3.8	20
Black beans, cooked, boiled, 1 cup	3.6	20
Spinach, cooked, boiled, drained, 1/2 cup	3.2	20
Spinach, canned, drained solids 1/2 cup	2.5	10
Tofu, firm, 1/2 cup	1.8	10
Black-eyed-peas, cooked, boiled, 1 cup	1.8	10
Spinach, frozen, cooked, boiled, 1/2 cup	1.4	8

Table of Selected Food Sources of Nonheme Iron (4, 62)

Food	*Milligrams*	*% DV**
Whole wheat bread, 1 slice	0.9	5
Molasses, 1 Tablespoon	0.9	5
White bread, enriched, 1 slice	0.8	4
Raisins, seedless, 50	0.5	2

* DV = Daily Value. DVs are reference numbers based on the Recommended Dietary Allowance (RDA). They were developed to help consumers determine if a food contains a lot or a little of a specific nutrient. The DV for iron is 18 milligrams (mg). The percent DV (percent DV) listed on the nutrition facts panel of food labels tells adults what percentage of the DV is provided in one serving. Percent DVs are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs. Foods that provide lower percentages of the DV also contribute to a healthful diet.

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