California Food Guide

Iron Deficiency

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What's New?

The National Academy of Science has released new Dietary Reference Intakes for iron and addresses special needs (see page five).[1]

Public Health Implications

Healthy People 2010 Objectives:[2]

- Eliminate disparities in the incidence of iron deficiency to five percent among children aged 1-2 years, one percent among children aged 3-4 years, and seven percent among non-pregnant females aged 12-49 years.

Among children iron deficiency is found in:

6% of Whites	In each ethnic group are subgroups where iron deficiency is much higher, especially among 6-24 month old infants and toddlers.
10 % of African Americans	
17% of Hispanics	

Among pregnant women the prevalence of iron deficiency is greater among low-income pregnant women in their third trimester than among children.

In 2003 in California 13.7 percent of children less than five years recorded low hemoglobin or hematocrit tests.[3] In that age group the highest prevalence of iron deficiency anemia (IDA) was for black, not Hispanic children with a prevalence of 17.7 percent. Among 5-20 year olds the prevalence of low hemoglobin or hematocrit was 12.7 percent with the highest prevalence of IDA among black, not Hispanics registering 22.3 percent.

In infants and preschool children, iron deficiency anemia may cause: • poor growth • lower mental and motor test scores • behavioral disturbances, and • increased susceptibility to lead poisoning.[1]	**In pregnant women,** iron deficiency anemia may increase the risk for: • preterm delivery, • low birth weight infant, • maternal mortality, and • infant mortality.[1]

Definition

Iron deficiency is the most common known nutrient deficiency and is most frequently found in children and pregnant women.[4] Iron is a major component of hemoglobin that carries oxygen to all parts of the body, including the brain. Iron also has a critical role within cells assisting in oxygen utilization, enzymatic and signaling systems especially for neural development and overall cell function everywhere in the body. Therefore iron deficiency affects all body functions, above and beyond its manifestations through anemia, which appear late in the process of tissue iron deficits.

The continuum from iron deficiency to IDA has many associated consequences, depending on the severity of iron depletion. Using sensitive techniques, recent studies show that iron deficiency, without anemia, has important discernable outcomes that result in reduced work capacity, particularly endurance and in other subtle functional limitations.

As deficiency progresses to anemia further consequences become more evident including changes in behavior and, intellectual performance, reduced resistance to infection, increased susceptibility to lead poisoning, loss of appetite, tachycardia, and cardiomegaly. In pregnant women, iron deficiency anemia, particularly early in gestation, is associated with adverse effects for both the mother and fetus, including increased prenatal complications, premature delivery, and low birth weight.

Low hemoglobin or hematocrit tests do not necessarily mean iron deficiency so this condition should be confirmed with a test for serum ferritin or a mean corpuscular volume (MCV) or an erythrocyte protoporphyrin (EP) test to help discriminate iron deficiency from other forms of anemia. However, when the prevalence of anemia in the population group reaches higher than 20 percent, then iron deficiency is the culprit in more than 75 percent of the cases and may co-exist with other causes in the majority of anemic cases.[3]

Burden

The median financial cost of productivity loss due to iron deficiency anemia is estimated to be around four dollars per capita. On a per capita basis, losses are greatest in affluent countries, where wages are highest.[5] In the United States, where the population is more than 300 million, the cost may be more than 1.2 billion dollars. The loss from poor growth rate associated with other health consequences resulting in lower productivity, impaired immunity, and increased susceptibility to heavy metal toxicity are not included in these estimates.

The Center for Disease Control and Prevention (CDC) revised standards for identification of IDA in l998.[4] Adjustments for smoking and altitude are found in the CDC publication.

Table 1: Cutoff values for Iron Deficiency Anemia in Children, Women of Childbearing Age, and Pregnant Women.[4]

	Hemoglobin (≤g/dL)	Hematocrit (≤%)
Children (Age in Years)		
1-<2	11.0	32.9
2-<5	11.1	33.0
5-<8	11.5	34.5
8-<12	11.9	35.4
Non-pregnant women and lactating women (age, in years)		
12-<15	11.8	35.7
15-<18	12.0	35.9
≥18	12.0	35.7
Pregnant women (Weeks' gestation)		
12	11.0	33.0
16	10.6	32.0
20	10.5	32.0
24	10.5	32.0
28	10.7	32.0
32	11.0	33.0
36	11.4	34.0
40	11.9	36.0
First trimester	11.0	33.0
Second trimester	10.5	32.0
Third trimester	11.0	33.0

Incidence and Prevalence

Among children the prevalence of iron deficiency in the United States declined between the years 1976-80 and l988-94, to nine percent for 1-2 year old children and four percent for 3-4 year olds- it continues to be the most common nutrient deficiency in that age group.[2]

Data from the 2003 California Pediatric Nutrition Surveillance System Trend Analysis are based on hemoglobin with no confirming blood analysis. It shows 13.7 percent of 500,508 low-income children examined were anemic.[6] Disproportionate prevalence of anemia occurred among Black, nonHispanic children under age five, where the percent was 17.7 percent, and among 6-11 month olds, where the prevalence recorded was 19.9 percent. However, it must be appreciated that these data are based solely on hemoglobin or hematocrit values, and thus not truly indicative of the prevalence of iron deficiency anemia.

Among non-pregnant females of childbearing age the prevalence of iron deficiency increased over recent decades. In l996, 29 percent of low-income pregnant women in their third trimester were anemic.[2]

Nutrition education and iron supplementation may reduce this prevalence.

Trends/Contributing Factors

Among the factors contributing to IDA is:

- Dietary choices low in iron and/or containing iron in forms that are poorly absorbed,
- Lack of nutrition knowledge,
- Lack of access to iron and vitamin C rich foods,
- Excessive milk intake by toddlers,
- Lack of nutrition education by health care providers and schools resulting in lack of attention to IDA and IDA's effects on brain development and cognitive function,
- Internal bleeding,
- Gestational iron deficiency of their moms, preterm birth, low birth weight, early umbilical cord clamping, early weaning, and lack of use of iron fortified products such as cereals, and
- Other medical conditions.

Dietary Reference Intakes (DRIs)

The National Academy of Sciences modeled the 2002 DRI's on evidence reviewed.[1] Recommendations are derived from body weight and estimated body iron loses. DRIs for gender and age groups are listed in Table 2.

Table 2: Dietary Reference Intakes[1]

Infants	**Iron (mg/day)**
0-6 mo	.27*
7-12 mo	11
Children	
1-3 yrs	7
4-8 yrs	10
Males	
9-13 yrs	8
14-18 yrs	11
19-30 yrs	8
31-50	8
50-70	8
>70	8
Females	
9-13 yrs	8
14-18 yrs	15
19-30 yrs	18
31-50 yrs	18

Females(Table 2 Cont'd)	Iron (mg/day)
50-70 yrs	8
>70 yrs	8
Pregnancy	
≤18 yrs	27
19-30 yrs	27
31-50 yrs	27
Lactation	
≤18 yrs	10
19-30 yrs	9
31-50 yrs	9

*Adequate Intake

Full term infants are born with iron stores that meet iron requirements until 4-6 months of age, thus the DRIs for infants 0-6 months of age are relatively low.[1] The DRI for iron is 1.8 times higher for vegetarians due to the lower bioavailability of iron from plant foods.

The Dietary Reference Intakes address special needs:[1]

- As heme iron found in animal products is more bioavailable than iron found in plants, the iron requirement for vegetarians is 1.8 times higher than for omnivores.
- A reduced menstrual blood loss among women using oral contraceptives may result in a 60 percent reduction from expected blood loss, and an appropriate reduction in need for iron.
- Whereas postmenopausal women on Hormone Replacement Therapy (HRT) may experience uterine bleeding, especially during the first year of therapy, they may have higher iron requirements than women not on HRT.
- Blood donors may have lower serum ferritin concentrations and require supplemental iron.
- Athletes undergoing prolonged training may require 30 percent more iron.
- The gastrointestinal effects of supplemental iron appear to be reduced when taken with food.
- Accidental iron overdose is the most common cause of poisoning deaths in children under seven in the United States. Supplements should be kept out of reach of children.
- Different strategies may be needed to reduce iron deficiency in disparate groups.

Common Concerns/Strategies

Enriching white bread and flour with iron is required when the term *enrichment* appears on the label. Fortification of ready-to-eat cereals has increased, with many products, now supplying anywhere from ten to 100 percent of the DRI for iron.

Additional fortification may be undesirable due to the danger of iron overload in a small group of people suffering from hemochromatosis.

Vegetarians, especially vegans, are vulnerable to iron deficiency as they do not consume meats which are the sources of heme iron that has a greater bioavailability and enhances the absorption of vegetable and cereal iron. Vegans should regularly include iron-enhancing foods in their meals such as fruits rich in vitamin C. They should also minimize iron-inhibiting foods, particularly tea and other herbal infusions, when consuming plant sources of iron rich food. Vegans may require an iron supplement, especially during pregnancy.

A reduction in the higher prevalence of iron deficiency among young children can be achieved by:

- Increasing the proportion of new mothers who breastfeed,
- Educating parents and caregivers to introduce iron rich solid foods and foods that enhance iron absorption after six months of age, and
- Reducing or eliminating the use of baby bottles after 12 months of age.

If combined with measures of iron status, changes in the prevalence of iron deficiency anemia over time can be used as indicators to evaluate the effectiveness of the programs' ability to decrease the prevalence of iron deficiency.

Strategies for reducing IDA include:

- Educating the public through the media, including television, about the need for preventing iron deficiency.
- Educating medical and health professionals and students on the need for accurately testing individuals at risk for IDA at the recommended ages, especially low-income women and children.
- Educating health care providers on appropriate treatment regimens, including best available prescription iron preparations, appropriate doses, length of therapy, and re-testing protocols. Encourage providers to emphasize with patients the need for adequate diet during and after treatment.
- Educating patients about the importance of taking iron prescriptions as told.
- Providing information about IDA and ways to stay healthy and prevent it in school health curricula.
- Referring all low-income women, infants, and children to their local WIC programs.
- Counseling individuals with low hemoglobin or hematocrit about permanently increasing iron rich food in their diets.
- Giving iron supplements to all individuals with confirmed IDA as a temporary measure while iron rich foods are being incorporated into the diet and retesting for IDA one to three months after treatment.

Iron Overload

Accidental iron overdose from the ingestion of excessive iron supplements may cause vomiting and diarrhea leading, in extreme cases, to death in children less than six years of age.[1] Iron supplements should be stored out of the reach of young children as they may be mistaken for candy.

A small group of people, especially those of Celtic extraction, absorb excessive amounts of iron from food and are subject to hemochromatosis with normal intakes of iron. Health care providers should screen for this condition.[1]

Due to a potential association between high iron intake and cardiovascular disease it is prudent that men and postmenopausal women, who have no medical indications for iron supplementation, avoid iron supplements and foods fortified with 100 percent of the daily requirement.[7]

Opportunities for Improvement

Steps that can help prevent IDA include:

- Prevent iron deficiency through education and food offered in day care, schools, government programs, and the media,
- Ensure education about iron deficiency in health education classes of all schools,
- Promote iron rich foods and education in the Food Stamp Program,
- Promote iron rich foods and education in food security programs such as food banks,
- Develop iron deficiency education posters, flyers, and food identification tags for school and childcare Foodservice programs,
- Support Contra Costa County's model for an Anemia Task Force in each county,[8]
- Require health care providers to test all low-income pre-menopausal women and children between 6 months and 5 years for iron deficiency, and
- Recommend that health care providers educate all individuals with iron deficiency about iron rich food and such food enhancers of iron absorption as heme and vitamin C.

Iron Rich Food

The Center for Disease Control and Prevention provided recommendations for preventing iron deficiency in infants and preschool children that appeared in the April 3, 1998 edition of the Morbidity and Mortality Weekly Report:[4]

- Encourage exclusive breast feeding for at least six months after birth,
- At about age six months or when the extrusion reflex disappears, introduce infants to plain, iron-fortified infant cereal or pureed meat products. (Two or more servings per day of iron-fortified infant cereal meet an infant's requirement for iron).

- By approximately age six months, encourage one feeding per day of foods rich in vitamin C (e.g., fruits, vegetables, or juice) to improve iron absorption, preferably with meals.
- After age six months, or when the infant is developmentally ready, introduce plain, pureed meats, fish, egg yolk, beans, and tofu.

The Institute of Medicine has provided recommendations for preventing IDA in women of childbearing age**,** in the l993 publication titled "Iron Deficiency Anemia":[7]

- Eat a varied diet and enhance iron absorption by including meat, ascorbic acid-rich foods (fruit juice or fruit), or both in meals. Avoid tea or coffee with meals.

Highly bioavailable heme iron is two to three times more absorbable than non-heme iron and is less influenced by inhibitory factors in the diet.[1,9] Examples of these foods are found in Table 3.

Table 3: Heme Sources of Iron and Iron Content[10]

Heme sources of Iron:	Iron Content (mg) 3 oz. Portion
Chicken liver & other organ meats*	9.3
Sardines & other fish with bones	2.5
Beef, lean including ground	2.5
Shrimp, drained solids	2.3
Turkey, light meat	1.1
Chicken, light meat	1.0
Egg	1.0
Pork, lean	0.9

*high in cholesterol
From USDA Nutritive Value of Foods Home and Garden Bulletin 72. 2002.
http://www.nal.usda.gov/fnic/foodcomp/Data/HG72/hg72_2002.pdf.[10]

Non-heme iron is found in both plant and animal sources but is less absorbable than heme iron.[9] Other food constituents affect iron bioavailability.
Enhancers of the absorption of iron in non-heme foods include:

- The presence of a heme food. For example a stew/soup made with beans, tomatoes, and a small amount of meat would maximize iron absorption from this dish compared to beans alone,
- Vitamin C-rich foods such as orange juice, tomatoes, bell peppers, strawberries, cantaloupe, cabbage, or broccoli.

Inhibitors of non-heme iron absorption include:

- Phytates, (found in grains);
- Soy protein and soy fiber; oxalates (found in spinach);
- Polyphenols in tea[7]

Table 4: Non-heme sources of Iron, Serving size, and Iron Content[10]

Non heme sources of Iron:	Serving size	Iron Content (mg)
Pumpkin seeds (Pepitas)	1cup	18
Cream of wheat	1 cup	10.3
Lentils, dry, cooked	1 cup	6.6
Walnuts, English	1 cup	5.3
Soybeans, green cooked, drained	1 cup	4.5
Enriched cereals	1 cup	4.5-18 (read the label)
Cashew	1 cup	5.3
Sunflower seed kernels	1 cup	4.3
Almonds, shelled & sliced	1 cup	4.1
Peas, cooked from frozen	1 cup	3.8
Beans, black, brown, lima, pinto, red cooked	1 cup	3.6-4.5
Chickpeas or garbanzos, canned	1 cup	3.2
Raisins, seedless	1 cup	3.0
Potato baked with skin	1 potato	2.7
Rice, white, enriched, cooked	1 cup	1.9
Apricots, dried, sulfured	10 halves	1.6
Oatmeal, cooked	1 cup	1.6
Peaches, dried	3 halves	1.6
Tofu	2 1/2 x 2 3/4 x 1"	1.3
Prunes, dried, pitted	5 prunes	1.0
Rye bread	1 slice	0.9
Spinach, raw, chopped	1 cup	0.8
Enriched breads	1 slice	.8 (read the label)
Parsley	10 sprigs	0.6
Peppers, hot chili, red	1 pepper	0.5

From USDA Nutritive Value of Foods Home and Garden Bulletin 72. 2002. http://www.nal.usda.gov/fnic/foodcomp/Data/HG72/hg72_2002.pdf.[10]

Other sources of iron are foods cooked in iron cookware and iron-fortified breads and cereals. Although the quantity of iron ingested from these sources may be significant, the iron is generally in a form that is poorly absorbed. However, breads and cereals are frequently eaten in large enough amounts that they may be an important daily source of iron.

Iron absorption can vary greatly from person to person, increasing significantly with low body iron stores. It can also vary from meal to meal. Coffee or tea or other herbal infusions taken with a meal can reduce absorption as much as 50 percent.

Iron deficient persons should be advised to eat or drink vitamin C rich food such as tomatoes or orange juice with their meals containing iron.

Clinical Implications

Health care providers can help prevent and control iron deficiency by counseling individuals and families about the need for iron rich foods and by monitoring iron status. With continued attention and education we may meet the 2010 national health objectives.

References

***** Photo source: *Health Canada web site and Media Photo Gallery*, Health Canada, http://www.hc-sc.gc.ca Reproduced with the Permission of the Minister of Public Works and Government Services Canada, 2005.

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