



Facts for Feeding

Meeting the Iron Requirements of Infants and Young Children

Iron deficiency disables many children early in life, with devastating consequences for survival, health, and future well-being. This issue of Facts for Feeding discusses the causes and consequences of iron deficiency in infants and young children (less than 2 years old) and recommends actions to prevent and treat it.

Iron is found in every cell of the body. It is essential for good health and mental and physical well-being. Iron deficiency in infants and young children is one of the greatest nutritional problems in the world today, affecting an estimated 40 percent to 60 percent of children in poor countries.

Consequences of Iron Deficiency

Although the consequences of iron deficiency are serious, the most common effects are hidden and go largely unnoticed. Iron deficiency:

- **Affects both mothers and newborns.** Women are at greater risk of iron deficiency than men because of monthly losses of iron-rich blood during menstruation and the transfer of large amounts of iron to the developing fetus during pregnancy. Iron deficiency in the mother reduces the amount of iron transferred to the fetus, so many newborns start life without adequate stores.

Iron deficiency increases the risks associated with blood loss by the mother during delivery, which is the primary cause of maternal death. It also increases the risk of low birthweight, prematurity, fetal loss, and neonatal death.

- **Reduces energy levels.** Iron is needed to make hemoglobin, the substance in blood that carries oxygen. Every cell in the body needs oxygen to use energy from food. When iron deficiency prevents

the body from making enough hemoglobin, iron deficiency anemia results. Anemia prevents the blood from carrying enough oxygen from the lungs to the muscles, brain, and other tissues. This causes weakness, fatigue, and reduced physical ability to work.

Iron deficiency is estimated to cause about half of anemia worldwide. Addressing the other causes is equally important. Malaria causes anemia by destroying red blood cells. Deficiencies of vitamin A, vitamin B12, and protein can also contribute to anemia.

- **Hinders mental and physical development of children.** Iron deficiency anemia slows intellectual and motor development, diminishing a child's ability to think and learn. These effects may be permanent. Adequate iron is essential for optimal development of the brain and nervous system.

Causes of Iron Deficiency

A number of dietary and other factors are known to cause iron deficiency. The main cause worldwide is a diet low in iron or high in inhibitors that prevent iron from being absorbed. There are also different kinds of dietary iron. Certain kinds, especially those from animal sources, are more bioavailable (easily absorbed) than others. In addition, infections may contribute to iron deficiency. For example, diarrhea can reduce iron absorption, and hookworms and other intestinal parasites can cause loss of blood, which is rich in iron.

Proven solutions that address the causes of iron deficiency are readily available, feasible, effective, and affordable.

Actions to Prevent Iron Deficiency

Actions are needed at all stages of the life cycle to prevent iron deficiency. Health workers should take advantage of routine health contacts (antenatal, delivery and early postpartum, family planning, immunization, growth monitoring, sick child consultations, and “health mobilization days”) to promote actions that will improve the iron status of pregnant women, infants, and young children.

Before and at Birth

Improve women’s iron intake and protect their iron stores

The best way to ensure that both mothers and babies have enough iron is to make certain women’s own iron stores are adequate in pregnancy. Newborns are entirely dependent on the transfer of iron from the mother during pregnancy. An iron-rich diet and supplementation with iron tablets is strongly recommended for all pregnant women (see table on page 4). Deworming to get rid of intestinal parasites in mothers can begin in the second trimester, and intermittent preventive treatment of malaria is recommended in certain settings. However, adequate iron stores are best achieved when women begin pregnancy with enough iron. All adolescent girls and women of reproductive age should have a varied and iron-rich diet, preventive supplementation with iron, and protection against parasites.

Reduce the risks of prematurity and low birthweight

Much of the iron that the infant is born with is transferred to the fetus during the last weeks of pregnancy. A baby born too soon (preterm) will therefore have reduced iron stores. Babies born with low birthweight (less than 2.5 kg) caused by preterm delivery or fetal growth retardation are also at increased risk of iron deficiency. Factors contributing to low birthweight are maternal malnutrition (including iron deficiency), low weight gain during pregnancy, teenage pregnancy, maternal malaria, excessive workload, and cigarette smoking. In addition to reducing the risk of iron deficiency in the early months of life, actions to address these causes of low birthweight will improve the overall health of the mother and infant.

Delay umbilical cord clamping/tying

Clamping or tying the umbilical cord immediately (within 30 seconds) after birth may reduce transfer of blood from the placenta, resulting in lower blood volume and increased risk of anemia. Considering the potential benefits of increased transfer of blood and iron to the newborn, especially when the risk of iron deficiency is high, some experts recommend delaying clamping or tying the cord until 30 to 120 seconds after birth.

First Six Months

Breastfeed exclusively for the first six months

Exclusive breastfeeding (without the addition of any other food or fluid, even water) is recommended for the first six months of life because it protects against infections, minimizes exposure to pathogens, and ensures optimum nutrition. For most infants, the iron from breastmilk and the iron stores acquired from the mother during pregnancy meet the infant’s iron requirements for the first six months. Breastfeeding also contributes to iron nutrition in many other important ways.

- For the mother, the hormonal effects of exclusive breastfeeding help protect her iron stores by delaying iron losses caused by menstruation and by another pregnancy.
- Animal milk consumed instead of (or in addition to) breastmilk by the infant under six months can cause small lesions in the gut, resulting in loss of blood and iron.
- The high levels of vitamin A and other nutrients in breastmilk are important for infant iron transport and metabolism.
- Exclusive breastfeeding strengthens immunity and protects the infant from exposure to gut infections that can reduce iron absorption and lead to iron deficiency.

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Actions to Prevent Iron Deficiency

Give iron supplements to vulnerable infants beginning at two months

Lower initial iron stores in preterm and low birthweight infants can soon be exhausted. Rapid postnatal growth in these infants places a particularly high demand on iron reserves. In these cases breastmilk by itself does not provide sufficient iron. To prevent iron deficiency under these conditions, low birthweight infants should receive syrup containing iron beginning at two months (see table on page 4). Adding other foods to the infant's diet before six months is not recommended.

Second Six Months

Provide iron-rich foods beginning at six months

Even for healthy infants who have normal iron stores at birth, these stores plus the iron in breastmilk are only adequate to meet their needs through the first six months. After this time they need additional iron, about 0.8 mg of *absorbed* iron per day. To supply this much absorbed iron and to account for variations in requirements, the National Academy of Sciences estimates a recommended dietary allowance (RDA) of 11 mg/day for infants aged 6–12 months. Suggested ways to improve iron status through diet are shown in the box on page 5.

Continue breastfeeding older infants (6–12 months old)

Despite its relatively low levels of iron, breastmilk is a rich source of vitamin A, which is needed for a healthy immune system and for iron transport and metabolism. Vitamin A, as well as many other factors in breastmilk, helps reduce infectious diseases and associated iron losses. Breastmilk is also a good source of vitamin C, which enhances the absorption and bioavailability of iron from other foods.

Give iron supplements to older infants (6–12 months old)

The daily recommended dietary allowance of iron for infants 6–12 months old is the amount of iron found in a quarter kilogram of beef or a half kilogram of chicken – more than most poor households can afford to provide and far more than can be consumed by an infant of this age. Although complementary foods rich in iron such as meat, liver, and fish can make an important contribution to the infant's increased iron requirements, a gap will almost always exist between the recommended amount and what the diet provides.

- **Supplements are generally recommended for infants 6–12 months old.** In populations where more than 40 percent of infants are anemic, supplementation should continue until the child is 24 months old (see table). Unfortunately, high rates of maternal iron deficiency, prematurity, low birthweight, and sub-optimal breastfeeding often push anemia rates well above this threshold.
- **Supplements may not, however, benefit all children.** Some studies suggest that if infants are not anemic, iron supplements can increase malaria and other infections and reduce weight gain. For these reasons it is important for health workers to follow local supplementation policies and protocols, which should be tailored to reflect local conditions. Integration of iron interventions with malaria control and other child health interventions provides an opportunity to ensure that such interventions are appropriately targeted.
- **Iron supplements in pill form can cause choking and are unsafe for young children.** Syrup is an alternative but is more expensive than pills, has a shorter shelf life, and is more difficult to give in the correct amount. Sweet iron syrup and pills need to be kept out of reach of children to prevent unsupervised over-dosing, which can cause death. Home fortificants that can be mixed into complementary foods are an alternative to supplements (see box on page 5).

Actions to Prevent Iron Deficiency

Second Year (12–24 months)

Protect the iron status of young children (12–24 months old)

After the first year, the child's growth rate slows somewhat and the amount of iron needed drops, but care must still be taken to protect iron status.

- **Give iron supplements if needed.** Young children should continue receiving daily doses of iron in areas with an anemia prevalence of 40 percent or higher. After two years of age, supplementation should follow the guidelines for various age groups shown in the table.
- **Serve iron-rich foods.** By age one most children are eating family foods. Children 12–24 months old should be fed 3–4 meals per day and may be offered nutritious snacks 1–2 times per day as desired. They should receive a diversified diet that includes meat, fish, poultry, and other iron-rich foods.
- **Continue breastfeeding.** Breastmilk is a good source of vitamin A and vitamin C, both contributing to iron status. The immune factors in breastmilk protect against infections that can decrease food intake, reduce iron stores, and interfere with iron absorption.

Iron Supplementation Recommendations for Vulnerable Groups throughout the Life Cycle

Group	Iron/Folic Acid Doses*†	Duration
Low birthweight infants (< 2,500 g)	<i>Iron:</i> 12.5 mg/day <i>Folic acid:</i> 50 mcg/day	2-24 months of age
6- to 24-month-old children	<i>Iron:</i> 12.5 mg/day <i>Folic acid:</i> 50 mcg/day	6-12 months of age where anemia prevalence is <40% 6-24 months of age where anemia prevalence is ≥ 40%
24- to 59-month-old children‡	<i>Iron:</i> 20-30 mg iron	At least once/week for 3 months every year
School-age children (6-11 years)‡	<i>Iron:</i> 30-60 mg/day	At least once/week for 3 months every year
Adolescents/women of childbearing age‡	<i>Iron:</i> 60 mg/day <i>Folic acid:</i> 400 mcg/day for girls and women	At least once/week for 3 months every year
Pregnant and lactating women	<i>Iron:</i> 60 mg/day <i>Folic acid:</i> 400 mcg/day	6 months during pregnancy where anemia prevalence is < 40% 6 months during pregnancy and 3 months postpartum where anemia prevalence is ≥ 40% If it is not possible for women to take iron and folic acid for 6 months in pregnancy, supplementation should continue into the postpartum period or the dose should be increased to 120 mg/day.

* Doses are for elemental iron. The amount of iron-containing compound needed depends on the formulation.

† Like iron, folic acid is a micronutrient needed for blood formation and is usually included in iron supplements to treat and prevent anemia.

‡ The need for universal supplementation in these groups may change if there are iron-fortified foods targeted to them.

Adapted from: USAID, World Bank, UNICEF, PAHO, WHO, FAO, The Micronutrient Initiative. *Anemia Prevention and Control: What Works, Part II: Tools and Resources*. Washington, DC: USAID, June 2003.

Improving iron status through foods for children 6–24 months old

There are several dietary strategies to improve iron status. Assessments can identify local diets and feeding practices deserving support, test feasible and acceptable ways to improve traditional diets, and target audiences for specific messages. The following guidelines should be tailored to reflect local foods, practices, and conditions.

Feed adequate amounts of a balanced diet. At six months a child needs nutrient-rich complementary foods in addition to breastmilk. Iron intake is related to food intake. Young children have small stomachs, so they need to be fed frequently and with foods that are appropriate for their age.

Give foods rich in iron, including meat, fish, and poultry. Organ meats such as liver and kidney are particularly rich sources of iron and other nutrients. Meat, fish, and poultry contain “heme” iron, a form that is more easily absorbed than the non-heme iron found in cereals, vegetables, and other plant products. Whenever meat, fish, or poultry is available, infants and young children should always be fed generous portions. Despite common beliefs to the contrary, meat, poultry, and fish are excellent foods for babies if appropriately cooked and mashed. Liver is especially soft and easy to blend into infant foods.

Give foods that enhance iron absorption. In addition to being good sources of heme iron, meat, fish, and poultry enhance the bioavailability of all forms of iron in the diet, including the non-heme iron in cereals and legumes. Vitamin C (ascorbic acid found in citrus fruits, guava, pineapple, papaya, tomatoes, and cauliflower) also enhances iron absorption. To be effective, enhancers must be eaten at the same meal as the iron. Health workers should help parents identify local foods that enhance iron absorption.

Eliminate or appropriately prepare foods that inhibit iron absorption. Inhibitors include phytates (found in cereals and legumes) and tannins (found in tea and coffee). The amount of phytates and tannins in foods can be reduced by soaking and/or fermenting, but the impact on iron bioavailability varies greatly. Infants and young children should not be given tea or coffee, especially with meals. Health workers should help parents identify local foods that are high in phytates, tannins, and other inhibitors so they can avoid or prepare them appropriately.

Use foods fortified with iron. Increased availability and purchase of commercial processed foods has led to greater emphasis on fortification as a strategy to reduce iron deficiency. Commercial complementary foods should always be fortified with iron and vitamin C, along with other nutrients. Fortified infant cereals are an excellent and relatively inexpensive way to help prevent iron deficiency. Instant preparations that require only the addition of clean water are preferable because they ease preparation and avoid excessive heating, which can destroy vitamin C.

Fortify foods at home. Complementary foods prepared at home can be fortified during preparation with powders (“sprinkles”), spreads, “foodlets” (a crushable nutrient-rich tablet that dissolves in water), and other preparations that contain iron and other micronutrients. Many suitable products are on the market or being tested, but their affordability and availability are limited.

Supporting Actions

Dietary interventions can be supported by other actions to prevent iron deficiency.

Explore alternative supplementation strategies

Interventions to provide pregnant women with iron supplements have been less effective than the smaller-scale research trials on which they have been based. This is usually attributed to inadequate supply of supplements by the health service and poor demand for supplements by potential beneficiaries. Ways of overcoming these problems are needed if mass routine supplementation is ever to become an effective strategy for women and children. To improve availability, supplements could be made available in the community rather than only from a distant clinic. Another proposal, where income levels are high enough, is to make supplementation a private sector activity. Profits might provide an incentive to fix product and supply problems, and advertising the benefits could stimulate demand across both public and private distribution systems.

Combat parasitic infections

Malaria and hookworms contribute to anemia by attacking red blood cells or causing loss of blood. Prevention and treatment of these common parasites can help control anemia among people of all ages. Comprehensive strategies that reduce the occurrence of these parasites in the rest of the population will help reduce anemia among mothers, thus benefiting their infants and reducing exposure.

- In malaria endemic areas, pregnant women, their infants, and children under five should sleep under bednets treated with insecticide and retreated every six months.

- For hookworm, wearing shoes and using latrines helps break the cycle of infection.
- Where malaria and hookworm are endemic, all pregnant women can and should be safely treated with antimalarial and deworming drugs after the first trimester using recommended protocols.

Improve overall nutritional status

Iron absorption, transport, and metabolism can be impaired by vitamin A deficiency or protein energy malnutrition. Other essential nutrients in the diet such as vitamin C and protein can enhance iron absorption. Iron is rarely the only nutrition problem that needs to be addressed in the population. Where possible, ways to improve iron nutrition should be integrated with other health and nutrition interventions, such as antenatal care, integrated management of childhood illnesses, multi-micronutrient supplementation, and complementary feeding.

Mobilize decision makers and educate the public

The most striking feature of iron deficiency among infants and young children is the gap that exists between the size of the problem and the awareness of it. This is true for policy makers, health care managers, health workers, community leaders, and parents themselves. All need to become much better informed about why iron deficiency is so common, why it matters, and what can be done about it. Policy analysis tools such as PROFILES have been developed for this purpose. PROFILES is a spreadsheet-based process for estimating the functional consequences of iron deficiency anemia and other nutritional problems (see: www.aedprofiles.org).



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