



# CARE's Technical Report on Anemia



Iron Deficiency Anemia (IDA) is the most prevalent micronutrient deficiency in the world, affecting an estimated 2 billion people worldwide. This document will serve as a reference for program managers working in maternal and child health and reproductive health, who wish to address the serious consequences of IDA in the populations that they serve.

- [Introduction / Credits](#)
- [Table of Contents](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



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Site Search

Feedback

Site Map

## CARE Reacts to President Bush's Speech to Congress

U.S. President George W. Bush addressed Congress Thursday night with a message for the United States and the world, proclaiming that hope, freedom and justice will prevail in the battle against terrorism.

At CARE, we join the president and millions of others in mourning the senseless loss of life on September 11, 2001, and we support the president's call to bring the perpetrators to justice.

President Bush rightly pointed out that this was indeed an international tragedy, affecting many nationalities, races and religions. It is a tragedy, as he said, that should build international solidarity, as well as international understanding.

"We have seen the decency of a loving and giving people who have made the grief of strangers their own," said the president.

That spirit of generosity is one we know well at CARE. We've seen it again and again - not only in times of crisis, like after the earthquake in Gujarat, India, earlier this year, but also in the willingness of our donors to invest in long-term solutions to poverty.

As the world struggles to come to terms with the recent attacks, CARE applauds the president's call to temper our outrage with the respect and tolerance we as a nation hold dear. CARE agrees that as we seek justice, we must protect from harm the many innocent, peace-loving people who happen to share the same nationality as alleged terrorists, or who practice a form of the same religion. In keeping with CARE's mission, we are concerned about the fate of innocent civilians who live in poverty. Any action seeking justice should take care to avoid civilian casualties.

Significantly, the president made a distinction between the innocent and the accused in the country on which the world is now focusing.

"The United States respects the people of Afghanistan -- after all, we are currently its largest source of humanitarian aid," the president said.

As a provider of that humanitarian aid, CARE emphatically echoes the president's call to respect the innocent civilians who already have endured so many years of hardship, exacerbated by a crippling drought during the past three years. CARE is preparing to provide assistance and help save lives in the event that the humanitarian crisis in the region worsens.

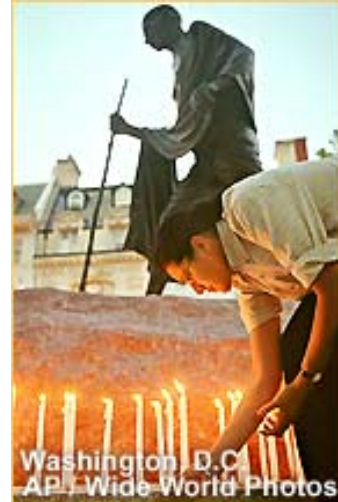
In the weeks, months and years ahead, CARE will remain committed to working with poor communities around the world to overcome poverty. In doing so, we hope to end suffering, increase opportunity and contribute to advancing global peace.

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CARE's Technical Report on  
**Anemia**  
Introduction / Credits

Iron deficiency anemia (IDA) is a problem of serious public health significance that impacts mental and physical development, health maintenance, and work performance. It is the most prevalent nutritional problem in the world, affecting about 2 billion people in developing and developed countries. Iron deficiency occurs when there is insufficient iron absorbed to meet the body's needs. There may be several reasons for insufficient iron, including: inadequate dietary intake, poor iron absorption, increased need for iron, or chronic blood loss. Prolonged iron deficiency leads to iron deficiency anemia.

Infants, preschool children, adolescents, and women of childbearing age (especially pregnant women) are at greatest risk for iron deficiency anemia. Adult males may also be at risk, especially if their dietary intake of iron is very low, or if they have chronic parasitic infections.

Treatment of iron deficiency anemia usually involves administration of medicinal iron; in severe cases blood transfusion may be warranted. However, it is best to prevent such severe anemia from developing in the first place. A good anemia prevention program includes multiple approaches, as applicable: supplementation of highest risk groups, de-worming, improving food availability and dietary diversification through agriculture and education, malaria prevention, and improved water and sanitation. Although the ultimate set of interventions is integrated across multiple sectors, there are basic interventions that can be effectively applied through primary health care.

## Table of Contents

# Credits

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This web site and accompanying manual was developed for CARE, by the Program Against Micronutrient Malnutrition (PAMM), at the Rollins School of Public Health of Emory University, Atlanta, GA

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July, 1997

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[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



## **Chapter 1 What is Anemia?**

[Definition of anemia](#)

[Iron absorption and physiology](#)

[Magnitude of the problem](#)

[Causes of anemia](#)

## **Chapter 2 Dangers/Outcomes of Anemia**

[Child behavior and development](#)

[Increased maternal and child mortality](#)

[Work capacity and productivity](#)

[Economic implications of iron deficiency](#)

## **Chapter 3 Anemia Assessment**

[Conducting a preliminary assessment](#)

[Methods of assessing anemia](#)

[Criteria for anemia](#)

[Assessing individual iron status](#)

[Population level iron assessment](#)

## **Chapter 4 Types of Interventions**

[Food based approaches](#)

[Fortification](#)

[Iron supplementation](#)

[Iron needs of targeted groups](#)

[Delivery system](#)

[Other public health measures](#)

[Information, education, and communication](#)

## **References**

## **Appendices**

[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)





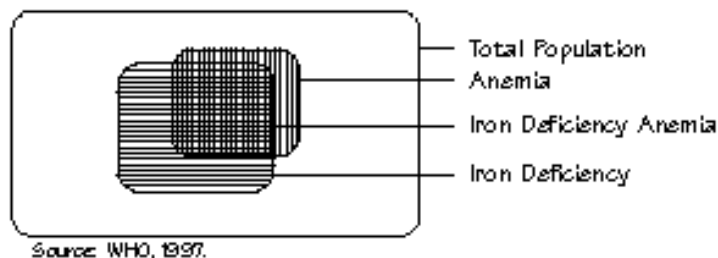
## Definition of anemia

Anemia occurs when the total volume of red blood cells (and/or the amount of hemoglobin in these cells) is reduced below normal values (as defined by healthy populations). Anemia can result from one or more of the following processes: impaired red cell production, increased red cell destruction, or blood loss.

It is important to understand the differences between anemia, iron deficiency, and iron deficiency anemia (IOM, 1993):

- **Anemia** - Hemoglobin or hematocrit less than the 5th percentile for healthy individuals of the same sex, age, and stage of pregnancy (low functional iron in blood).
- **Iron deficiency** - Iron stores low enough to impair red-cell production but not to the point of reducing hemoglobin or hematocrit levels (low iron stores, but not enough to reduce functional iron in blood).
- **Iron deficiency anemia (IDA)** - Anemia together with additional indicators of low iron status (low functional iron due to depleted iron stores).

In any given population, the prevalence of iron deficiency is about twice the prevalence of IDA.



## Iron absorption and physiology

Iron is absorbed in the upper intestine (duodenum and jejunum), carried to the bone marrow and liver where it is stored, and then delivered to the developing red blood cells (RBCs). The body regulates iron absorption according to iron status: as iron stores decrease, absorption at the intestinal level increases. Most of the iron from degraded red blood cells is recycled into new red blood cells (DeLoughery, 1996).

Various causes of anemia interrupt this cycle: low dietary iron or iron availability reduce the amount of iron that is available for RBC formation, and eventually reduce iron stores as well. Chronic infections suppress hemoglobin formation. Malaria causes RBC destruction, but the amount of iron reabsorbed from this is unclear. Intestinal parasites such as hookworm cause direct blood loss through the intestinal lumen.

**Table 1 Dietary Sources of Iron**

Type of Iron	Source of Bioavailability
1) Heme Iron	High bioavailability: 20-25% Found in meat and animal products (beef, chicken, goat, pork, fish, shellfish).
2) Non-heme Iron - food iron	Lower bioavailability: 1-8% Found in vegetable sources (dark leafy greens, legumes, etc). Other foods may be locally available.
- contamination iron	Found in soil, dust water, iron pots, etc.
- fortification iron iron	Various iron compounds sometimes added to processed foods, such as flour and sugar.
- supplemental iron	Medicinal iron: tablets or oral solution

\* Absorption of non-heme iron can be improved by enhancers like vitamin C, or it can be made worse by inhibitors like tannin (found in tea), calcium, and soy protein (OMNI, 1995). See Table 4 for more information on enhancers and inhibitors of iron absorption.

## Magnitude of the problem

“The occurrence of iron deficiency is not confined geographically, although it is most prevalent in countries and among populations where economic and social deprivation prevail. WHO estimates that more than two billion people of both sexes and all ages are affected by some level of inadequacy. In many countries, on average 40% or more of women of reproductive age are anemic, and a similar prevalence of iron deficiency is estimated to occur among preschool-age children” (UNICEF-WHO, 1995). Anemic women are 5-10 times more likely to die in childbirth than non-anemic ones (UNICEF, 1994). Anemia prevalence data for WHO regions and some specific countries are presented in [Appendix 1](#).



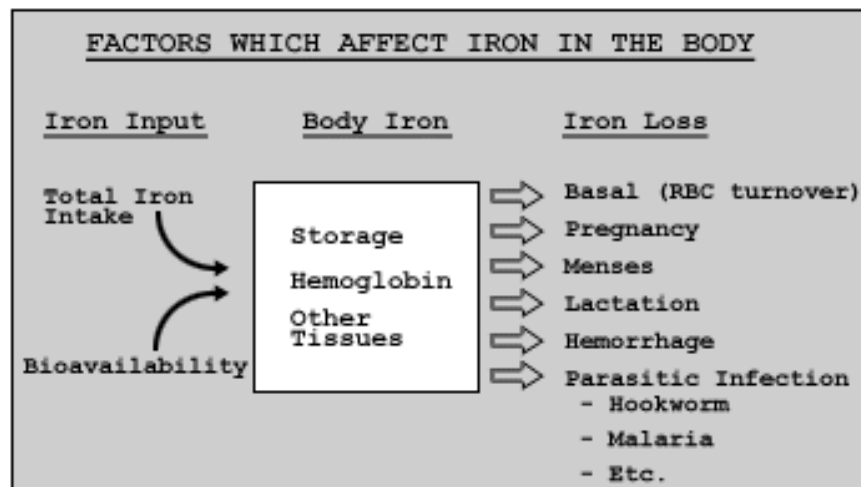
[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



## Causes of anemia

There are often multiple causes for anemia. The main cause, however, is low iron stores (iron deficiency) due to inadequate dietary intake, low dietary bioavailability, or iron loss.



Nutritional deficiencies of other nutrients such as folic acid, vitamin C, and vitamin A can also contribute to anemia. Parasitic infections such as hookworm and malaria contribute to anemia in areas where the parasites are endemic. Chronic infections (including HIV) and genetic conditions (thalassemia and sickle cell) may also cause anemia. The proportional contribution of these potential causal factors varies and can best be determined through site-specific situational analysis. In summary, iron deficiency is the main cause of anemia everywhere, and in developing countries it is frequently associated with other factors (UNICEF-WHO, 1995).

*Women and children are at highest risk for iron deficiency anemia because of risk factors like pregnancy, menstruation, and rapid growth, which increase the body's iron requirements.*

The following section lists the major causes of anemia and provides suggestions for what your program can do to address them. In addition, it suggests partners with which your program can work to make that intervention successful.

### 1. Hookworm

Hookworm causes iron deficiency anemia through increased intestinal blood loss. The degree of infection is directly related to the amount of blood loss (more worms = more grazing = more blood loss). A moderate

hookworm infection of 80 worms can cause daily iron loss of 1.1 to 2.3 mg, depending on the species of worm (Stephenson, 1987). In certain areas where hookworm is endemic, roughly one-third of anemia can be attributed to hookworm infection (Roche and Layrissé, 1966; Bakta, 1993). In areas where a high percentage of men are anemic as well as women and children, hookworm is probably the cause. Heavy infestations of trichuris and ascaris (other helminths) may also lead to anemia through intestinal blood loss.

**Program response:** Anti-helminths with iron supplementation; water and sanitation interventions (including hygiene education).

**Partnership with:**

- schools (education)
- primary health care (PHC) system (anti helminth distribution)
- water/sanitation agencies
- government and industry

## 2. Malaria

The malaria parasite causes destruction of red blood cells (hemolysis) in infected people. Malaria is clearly a main cause of anemia in areas where the parasite is endemic, especially for pregnant women and young children, who have lower malaria specific immunity (OMNI, 1995). However, even though infection with malaria clearly reduces hemoglobin levels in the blood (anemia), it is not clear whether or not the iron that is released into the blood stream during hemolysis can be reabsorbed into the body's iron stores. Thus, the extent to which malaria contributes to iron deficiency is unknown.

**Program response:** Appropriate anti-malarial drugs along with iron supplementation; insecticide impregnated bed nets; IEC about vector control and correct use of anti-malarials.

**Partnership with:**

- PHC system
- national malaria control agency

## 3. Vitamin A deficiency

A substantial amount of research has shown that vitamin A supplementation combined with iron supplementation is more effective in reducing anemia than just iron supplementation alone (Bloem, 1995). Although vitamin A deficiency has traditionally been considered a problem for pre-school children, recent evidence suggests that is also widespread among women of reproductive age (Bloem, 1994), and vitamin A supplementation alone could reduce anemia by 35% in certain areas among pregnant women (Bloem, 1995). Since iron deficiency anemia and vitamin A deficiency are two of the most prevalent nutritional problems in developing countries, dual supplementation has potential for widespread impact.

**Program response:** Women and children are target groups for dual vitamin A/iron supplementation, as they are both the most likely to be deficient, and the most vulnerable to consequent effects. Home garden projects can promote food sources which contain vitamin A and non-heme iron (leafy greens). Sugar, weaning foods, and snacks can also be fortified with vitamin A and iron.

**Partnership with:**

- PHC system
- schools
- home garden projects
- government and industry (fortification)

#### 4. Folate and vitamin B12 deficiency

Folate and B12 deficiencies interrupt the production and maturation of red blood cells. There are no accurate estimates of the prevalence of anemia due to folate or vitamin B12 deficiency. For individuals who are concurrently iron deficient and folate or vitamin B12 deficient, hemoglobin levels do not respond to folate or B12 supplementation unless iron is also supplemented. Since folate requirements are particularly high in periods of rapid cell reproduction, pregnant women are especially vulnerable to folate deficiency. For this reason, folate deficiency may be a significant cause of anemia in pregnant women (FAO/WHO 1988). An added benefit of folic acid supplementation is that it reduces the risk of neural tube defects for the infant.

**Program response:** Iron/folate or iron/B12 supplementation of pregnant women. Information, education, and communication (IEC) activities toward dietary diversification. Dietary sources of folate include liver, yeast, sweet potatoes, leafy vegetables, legumes, and some fruits, including oranges. Vitamin B12 is found in all animal products, but only in plant products which have been fermented.

**Partnership with:**

- PHC system
- antenatal care services
- national maternal and child health (MCH) program

#### 5. Vitamin C deficiency

It has long been known that vitamin C (ascorbic acid) enhances iron absorption (Vilter, 1946). A recent study of an Ethiopian refugee population in Somalia surviving on rations poor in vitamin C and iron found scurvy (vitamin C deficiency) and iron deficiency to cause high levels of anemia in women, children, and men (Yip, 1994).

**Program response:** A recommended intervention for the Ethiopian refugee population was provision of rations fortified with iron and vitamin C (Yip, 1994). Vitamin C foods should be eaten along with iron

rich foods to aid iron absorption and prevent anemia. Vitamin C is found in various fruits and vegetables (citrus fruits, guava, tomatoes, peppers, broccoli, cauliflower and potatoes, for example) which are commonly consumed in many areas of the world. Since vitamin C breaks down when heated, vitamin C foods should be eaten fresh whenever possible.

***Partnership with:***

- PHC system
- information, education, and communication (IEC) campaigns
- industry
- schools

## 6. HIV

Persons infected with HIV can be anemic for multiple reasons. HIV infection itself leads to decreased production of red blood cells through multiple direct effects on the bone marrow. Other opportunistic infections can also infect the marrow, as well as the gastrointestinal tract, which is the target of many infections, and consequently a portal of blood loss (DeLoughery 2, 1996). Anemia is not the most immediate concern for persons with HIV. But good nutrition (including adequate iron intake) can maximize the ability of a person with HIV or AIDS to resist infection, have a more favorable response to medication (by decreasing incidence of adverse drug reactions), and lead a longer and more productive life (Calderon, 1990).

***Program response:*** HIV education and prevention; nutrition education and supplemental food programs for infected persons.

***Partnership with:***

- PHC system
- PVOs
- churches
- schools
- governmental national programs

## 7. Chronic disease

The mechanism by which chronic disease leads to anemia is most likely a suppressed hemoglobin production. Malignancies, inflammatory disorders, and alcoholism can all lead to anemia (DeLoughery, 1996a).

***Program response:*** Treatment for chronic disease; supplementation only if necessary.

***Partnership with:***

- PHC system
- Ministry of Health (MOH)
- universities
- PVOs

## 8. Genetic Factors

Thalassemia and sickle cell anemia are two genetic diseases which can cause anemia by altering the genetic formation of red blood cells. These traits generally affect only a small percentage of the population (relative to the percentage of the population affected by other causes), but in affected people it may be the main cause of anemia. Thalassemia is present in populations from the Mediterranean region to Southeast Asia, while sickle cell is most prevalent in Africa, and among persons of African descent.

**Program response:** Diagnosis of suspected cases.

**Partnership with:**

- PHC system
- MOH
- universities
- PVOs

## 9. H. pylori

Helicobacter pylori is a bacteria that lives in the stomach and may be the primary cause of gastroenteric ulcers. It is estimated that perhaps 40% of the world's population is infected with H. pylori, and about 20% of infected persons have duodenal ulcers (Parsonnet, 1996). Infection with H. pylori is associated with stomach cancer (Parsonnet, 1991), and anemia in the presence of bleeding due to ulcers (Yip, 1996). The relation of H. pylori infection to anemia without ulcers is not yet well understood.

**Program response:** The current drug regimen for treatment of H. pylori is not affordable in most developing country settings. For children, this treatment includes metronidazole, amoxicillin, and bismuth; for adults, metronidazole, tetracycline, and bismuth (iron supplements inhibit the absorption of tetracycline, and tetracycline is contraindicated in children). Improved household hygiene may reduce H. pylori transmission.

**Partnership with:**

- PHC system
- MOH
- universities
- PVOs
- private medical sector

[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)





*The functional consequences of anemia impact children, women, men, communities, and countries. Some of these consequences are discussed here.*

## Child behavior and development

“In recent years, the relationship between iron nutritional status and the cognitive development of younger children has been the focus of active research. Consistently, children with iron deficiency anemia perform less well in psychomotor development tests compared to iron sufficient children. Although short term iron treatment has been shown to reverse some aspects of the cognitive effect, the few existing long term studies suggest that moderately severe iron deficiency in early childhood can lead to irreversible developmental disadvantage. For this reason, control of childhood iron deficiency anemia should be based on primary prevention, rather than relying on the detection of anemic children after significant iron deficiency has occurred” (Yip, 1994).

## Increased maternal and child mortality

Iron deficiency in childbearing women increases maternal mortality, perinatal infant loss, and prematurity. Forty percent of all maternal perinatal deaths are linked with anemia. Anemic mothers have normal birth weight babies 30-40% less often than non-anemic mothers. Low birth weight babies born to anemic mothers require more iron than supplied by breast milk at an earlier age than infants of normal birth weight (WHO 1997). Furthermore, if pregnancy-induced iron deficiency is not corrected, women suffer all the consequences of anemia described below, and their children as well may have impaired development and be more at risk of infection.

## Work capacity and productivity

The World Health organization summarizes the documented impact of anemia on work capacity and productivity worldwide: “A linear relationship was reported between iron deficiency and work capacity for agricultural workers in Colombia, Guatemala, Indonesia, Kenya and Sri Lanka. Work capacity returned rapidly to normal with iron supplementation. Road workers and rubber tappers in Indonesia, tea pickers in Indonesia and Sri Lanka, agricultural workers in India, Guatemala and Colombia, industrial workers in Kenya, China and other countries increased their work output with iron

supplementation. Gains in productivity and take-home pay ranged from 10-30% of existing levels. Compared with non-anemic women, anemic female workers in China were 15% less efficient in performing work, spent 6% less energy at out of work activities, had 4% lower maximal work capacity and had a 12% lower overall productivity than achieved after anemia was corrected by iron treatment for 4 months” (WHO, 1997). Based on this evidence, the impact of anemia on economic output may be substantial for some countries (Yip, 1994).

## Economic implications of iron deficiency

As with other micronutrient programs, the benefits of iron deficiency interventions exceed their costs. IDA control programs can have profound impact on the health of individuals as well as on the economic and social development of a nation. In a study of anemic laborers, researchers found that iron supplementation of these workers yielded a 20% increase in worker productivity. IDA control has the greatest impact on (1) improving worker output, and (2) improving aptitudes through increased school attendance and capacity to focus attentions (Fishman, 1995).



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



*In most countries of the developing world, it can be assumed that anemia is a problem of public health significance among women and children. The presence of multiple causes is generally indicative that anemia is present and negatively impacting health (especially women and children's health). Therefore, the question is rarely "Is there anemia?", but more often "How much anemia is there?" and "What is causing anemia in this population?"*

### HOW TO CONDUCT A PRELIMINARY ASSESSMENT OF IRON DEFICIENCY (HKI, 1997)

Step 1	Check the World Health Organization listing of the prevalence of anemia in women in the country where the project is located.
Step 2	Consult with national and other experts to obtain recent information (Ministry of Health, UNICEF, WHO, MotherCare, OMNI, local agencies and universities).
Step 3	Find out about local knowledge of anemia. Do villagers have terms to describe symptoms of anemia?
Step 4	Collect case evidence about anemia in your project area. You can interview health workers and laboratory technicians about cases of severe anemia or request permission to review records on severe anemia.
Step 5	Collect information on factors that may contribute to iron deficiency: <ul style="list-style-type: none"> <li>● Parasitic infections</li> <li>● Vitamin A deficiency</li> <li>● Exclusive and prolonged breastfeeding</li> <li>● Availability, cost, and consumption of foods rich in iron, fortified foods, foods that enhance iron absorption, and foods that inhibit iron absorption</li> </ul>

If a preliminary assessment indicates that anemia is a problem in your area, conduct a more thorough assessment of the iron situation. This chapter describes common methods of assessing anemia. Appendix 4 is a decision tree which will help health workers at various levels use information from their assessment to decide what they can do about anemia.

# Methods of assessing anemia

## *Clinical examination*

In settings where anemia prevalence is very high, immediate action may be necessary to prevent the death of severely anemic individuals. Individuals having severe anemia can be recognized by simple clinical examination of the eyelids, the tongue, nail beds, and palms for evidence of significant pallor. This type of examination is extremely useful for identifying younger children and pregnant women who are at highest risk of complications of severe anemia (such as heart failure). WHO suggests that examination of palmar pallor is preferred to eyelid pallor in young children, since conjunctivitis (common in children) can cause redness even in anemic subjects (WHO, 1997). Clinical screening should only be used in situations where even simple anemia assessment methods (such as copper sulfate and Talqvist) are not available, to identify severely anemic individuals in need of immediate medical attention.

**Clinical examination can detect severe anemia where no lab equipment is available!**

## *Laboratory screening for iron deficiency*

Laboratory tests are those that require blood sampling. The most common laboratory screening tests for anemia are hemoglobin and hematocrit measurements. Other more specific tests (like serum ferritin, erythrocyte protoporphyrin, and transferrin saturation) can provide detailed information about an individual's iron status, but are more likely to be conducted for special research in resource adequate settings. Regardless of how simple or complex a procedure may be, proper training, supervision, and quality control of testing procedures are needed to achieve the most accurate results possible.

## *Quantitative tests for anemia*

**Hemoglobin (Hb)** - Hemoglobin concentration is defined as grams of hemoglobin [the oxygen-carrying molecule in red blood cells] per volume of blood (expressed as g/dL). There are several methods for quantitative measurement of hemoglobin. A commonly used field instrument is the HemoCue photometer. Another method, the HbCN photometric method is highly accurate and considered the gold standard of hemoglobin measurement, but is not practical for routine field use.

**HemoCue** - "The HemoCue system consists of a battery operated photometer and disposable cuvette coated with dried chemical (sodium azide) which also serves as a blood collection device. This one step blood collection that uses a cuvette but does not require wet reagents makes this system uniquely suited for rapid field

surveys. It is easy to train non-laboratory personnel to operate the device, and it is not dependent on electricity. In addition to the operational features, laboratory evaluation using standard methods found the HemoCue system to have satisfactory accuracy and precision. Long term field experience has also shown the instrument to be stable and durable. The availability of the HemoCue system has made the routine inclusion of hemoglobin measurements possible in nutrition surveys. Even though this is a suitable instrument for field surveys, the relatively high cost of the disposable cuvette makes it unlikely to be widely used for routine clinical services in primary health care clinics in developing countries. However, there are other potential applications of the HemoCue system in developing country settings such as its use for anemia surveillance at selected sentinel sites to monitor changes or to evaluate the impact of programmes for iron nutrition” (WHO, 1997).

**Hematocrit (Hct)** - Hematocrit measures the mass of red blood cells per fixed volume of blood (usually g/dL, sometimes g/L or mmol/L). The most common way to measure hematocrit is to spin blood in a centrifuge; this procedure is referred to as “spun hematocrit”. Hematocrit measures red blood cells as a percentage of total blood volume. The majority of the hematocrit centrifuges require electricity but are relatively maintenance-free. In field settings where electricity is dependable and users are unlikely to have significant laboratory training, Hct by centrifuge is a suitable testing procedure because of low operational cost after the initial purchase of the centrifuge. The hematocrit centrifuge requires a steady electrical supply to give a true result, and also has a relatively high power consumption. Since trapped plasma can compromise accuracy, the hematocrit should be measured soon (within 6-8 hours) after the blood is drawn.

The advantages of the Hct centrifuge are that (1) it is a simple procedure, and (2) it is useful at the level of district hospital or health center. The limitations are that (1) the initial cost of the centrifuge is high, and (2) it consumes a lot of energy and requires a steady supply.

### *Semi-quantitative tests for anemia*

There are several less precise, semi-quantitative tests for detecting anemia. Two of these tests are the copper sulfate test and the Tallqvist test. The copper sulfate test involves the observation of a drop of blood which is dropped into a copper sulfate solution of a specific concentration; failure of the drop to sink indicates anemia. The Tallqvist test involves comparing the color of a dried blood spot on filter paper to a standard color chart. These methods are practical for detecting severe anemia, but because of their subjectivity and lack of precision, neither is recommended as adequate for anemia screening.

More information about these and other methods, or information about purchasing supplies can be obtained from:

[PATH - Program for Appropriate Technology in Health](#)

4 Nickerson Street Seattle, WA 98109-1699

USA

tel: (206) 285-3500

email: [info@path.org](mailto:info@path.org)

fax: (206) 285-6619

website: <http://www.path.org>



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



CARE's Technical Report on  
**Anemia**

**Chapter 3      Anemia Assessment**

## Criteria for anemia

“Normal” levels of blood iron vary according to age, sex and stage of pregnancy. Proper interpretation of Hb or Hct values requires the application of appropriate cutoffs. The following are the values of hemoglobin and hematocrit which correspond to anemia, as currently defined by WHO (WHO, 1997).

Age/sex/group	Hemoglobin (g/dL)	Hematocrit (%)
Children under 5 years	< 11.0 g/dL	< 33%
Children 6 to 11 years	< 11.5 g/dL	< 34%
Children 12 to 14 years	< 12.0 g/dL	< 36%
Non-pregnant women	< 12.0 g/dL	< 36%
Pregnant women	< 11.0 g/dL	< 33%
Men	< 13.0 g/dL	< 39%

Source: WHO, 1997

Age/sex/group	Mild	Moderate	Severe	Very Severe
Pregnant women and children 0.5-4.9 years	10.0-10.9	7.0-9.9	4.0-6.9	< 4.0
Children 5.0-11.9 years	10.5-11.4	7.5-10.4	4.5-7.4	< 4.5
Children 12-14 years and non-pregnant women	11.0-11.9	8.0-10.9	5.0-7.9	< 5.0
Men > 15 years	12.0-12.9	9.0-11.9	6.0-8.9	< 6.0
Clinical signs (pale eyelids, tongue, palms, and nailbeds) become more evident as Hb decreases	<u>Mild to moderate:</u> Clinical examination not effective in identifying anemia (signs not always evident)		<u>Severe to very severe</u> Clinical examination 80-100% sensitive (signs usually evident and correctly diagnosed 80-100% of the time)	

## Assessing individual iron status

Hemoglobin and hematocrit are commonly used to determine the presence of anemia. But since iron deficiency anemia represents only the severe end of the spectrum of iron deficiency, detection of anemia alone will miss milder cases of iron deficiency and underestimate the prevalence of iron deficiency. Hemoglobin and hematocrit are limited in their inability to distinguish IDA from other causes of anemia. Anemia in many areas may also be caused by intestinal parasites, other nutrient deficiencies, malaria, or chronic infection.

While hemoglobin and hematocrit both measure volume of red blood cells, other tests, namely serum ferritin and erythrocyte protoporphyrin, assess iron status at different levels of iron metabolism. Although use of these methods lends greater insight into the causes of anemia in an area, the methods themselves are currently expensive, highly technical, and not considered practical for routine field use.

There are two generally accepted ways to diagnose iron deficiency after anemia screening. The first way is to measure the hemoglobin response ( $> 1.0$  g/dL) to oral iron supplementation. The second way involves a series of several biochemical tests of iron status, the application of which is not feasible for developing country settings due to limited resources.

An alternative approach which is practical and cost effective involves the use of hemoglobin distribution curves to determine if causes other than iron deficiency significantly contribute to anemia in the population.



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



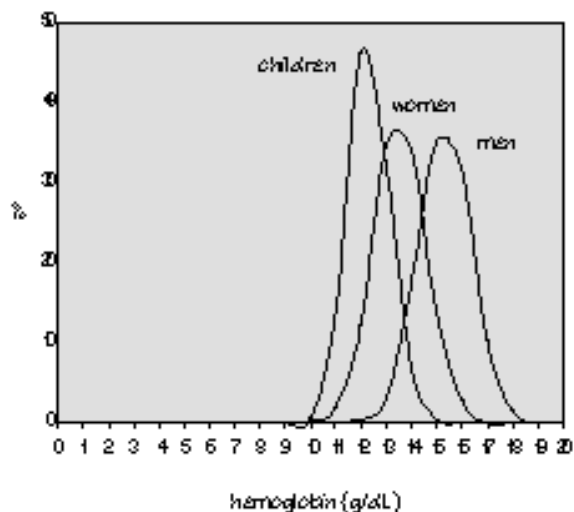
## Population level iron assessment

Population level iron nutrition status can be assessed in various ways. Typically, the prevalence of anemia is the most common measure: the percentage of the entire population who have a hemoglobin or hematocrit below the cut-off for anemia. In most developing countries, iron deficiency is the main cause of anemia, especially for women and children. Other factors are usually present as well, and it is important to differentiate whether high rates of anemia in the population are due to iron deficiency or to iron deficiency plus other factors. Comparison of hemoglobin distribution curves to those of a healthy reference population, along with information on factors related to anemia, is a valuable diagnostic model which can be used to prioritize potential causes of anemia and direct intervention responses.

Distribution curves can be helpful because: “When poor iron intake is the main etiologic factor present in the population, children and women are disproportionately affected, and the hemoglobin level of adult men is virtually unaffected. Other conditions, including other nutrient deficiencies and hookworm, are less likely to spare adult men. The comparison of the hemoglobin distribution from the sample under study with optimal hemoglobin distributions for children, women, and men allows inferences as to the etiology or etiologies responsible for a high prevalence of anemia” (Yip, 1994).



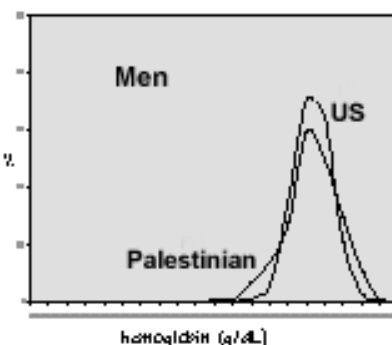
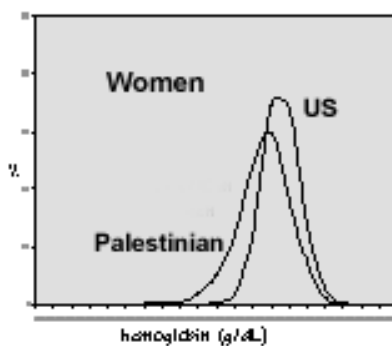
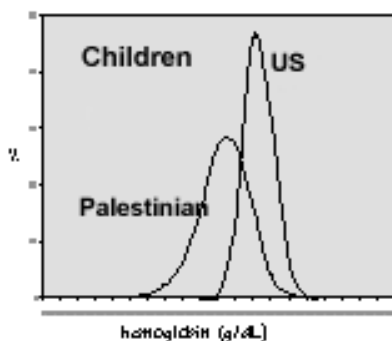
### Normal Hemoglobin Curves



Sources: Dallman, et al, 1984; Yip 1994.

### Using hemoglobin distributions to assess population iron status

#### Example #1



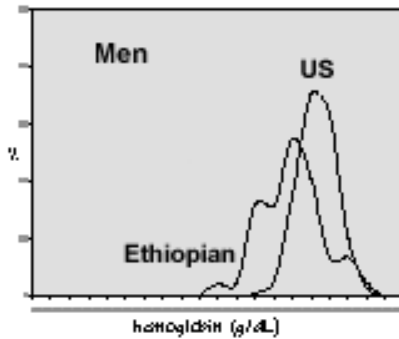
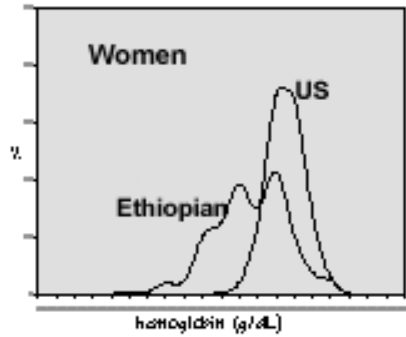
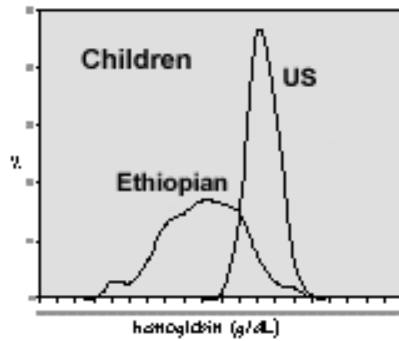
Source: Yip, 1994.

In the first example, iron deficiency was diagnosed as the main cause of anemia in a population of Palestinian refugees: the Palestinian distributions, when compared to US norms, are shifted down for women and children, while that of men is unaffected. A further investigation into this situation revealed that the Palestinian refugees did not have an adequate source of iron in the infant diet; consumption of meat was low due to low socioeconomic status, and tea consumption was common and started in late infancy. It was concluded that iron deficiency was the major cause of anemia in this setting (Yip, 1996). An appropriate program response might have included:

- universal iron supplementation for women and children;
- education campaigns about meal consumption patterns (e.g., drink tea separately from meals containing foods with iron); and
- promotion of a culturally appropriate and locally available iron rich weaning food.

### Example #2

In the second example, high rates of anemia were found in children, women, and men. Malaria and hookworm were not expected due to the very dry climate, but the refugees had survived on rations low in both iron and vitamin C for several years. It was determined that anemia was due to a combination of iron and vitamin C deficiencies. The suggested program response to this situation was to supply rations fortified at their source with iron, vitamin C, and other essential micronutrients (Yip, 1994).



Source: Yip, 1994.



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)





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#### General iron references

#### Iron interventions

#### Women and children

#### Helminths and other parasites

#### HIV

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[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)





*Anemia prevention is complex and often requires a broad approach, rather than a vertical intervention focusing only on one aspect. Communities, governments and NGOs must collaborate within the agriculture, health, education, industry and communication sectors to achieve sustainable reductions in iron deficiency (and overall improvements in health). The World Health Organization states that, “iron deficiency and anemia, like most deficiencies of public health concern, are an outgrowth of poverty. Targeted efforts are needed to reduce poverty, improve access to diversified diets, improve health services and sanitation and promote better care and feeding practices. Such efforts are fundamental elements of programs to improve nutritional well being in general, and iron status in particular” (WHO, 1997).*

This chapter describes indications for and implications of various interventions to prevent anemia. It concludes with recommendations for determining appropriate interventions for specific projects and country situations.

## Food based approaches

Food based strategies are desirable methods to achieve sustainable long-term impact on the nutrition status of individuals and communities. The two main concerns of dietary iron sufficiency are quantity of iron consumed and its bioavailability. Since many populations consume (but do not necessarily absorb) adequate amounts of iron, the greatest promise of impact is improving the iron bioavailability. Therefore, the goal of dietary modification is behavior change that: (1) increases the intake of heme-iron, (2) increases the intake of vitamin C, an enhancer of iron absorption, or (3) reduces the intake of inhibitors of iron absorption (Stoltzfus, 1994). Sustainable diet changes are challenging

because foods with optimal iron bioavailability are generally expensive (e.g. meat products) and more commonly available foods (e.g., legumes) tend to contain iron that is less bioavailable.

### Surveys

Surveys of dietary patterns and iron-containing food availability are feasible and provide useful information to establish food-based intervention programs to improve iron status. Household surveys and women's focus groups can help generate such information as food preferences, food availability and cost, preparation techniques, food distribution patterns within the family and weaning food quality. In addition, market surveys, such as interviews with vendors, can help obtain a list of important foods in a community, food seasonality and quantities usually purchased by families.

**Table #4**  
**Enhancers and Inhibitors of Iron Absorption**  
**and How to Make Them Work**

Enhancers of Iron Absorption	Inhibitors of Iron Absorption
Presence of any form of meat, fish, or seafood	Calcium, partially from milk and milk products
Asorbic acid (vitamin C) present in fruits, juices, potatoes and some other vegetables (tomatoes, cauliflower, cabbage, peppers, etc.)	Tannins (iron-binding phenolic compounds): foods that contain the most potent inhibitors, resistant to the influence of enhancers include tea, coffee, cocoa, herbal infusions in general, certain spices (e.g., oregano) and some vegetables
Some fermented or germinated foods and condiments, e.g., sauerkraut, soy sauce. (Cooking, fermentation, or germination of food reduces the amount of phytates.)	Phytates (a natural chemical) present in cereal bran, cereal grains, high extraction flour, legumes, nuts, and seeds.

### *Examples of effective alterations in meal patterns that enhance absorption*

- Separate drinking tea from mealtime. One or two hours later the tea will not inhibit absorption since most of the food will have left the stomach.
- Include in the meal an orange or other fruit juice or good source of vitamin C, such as tomatoes, cabbage, peppers or cauliflower.
- Consume milk, cheese or other dairy products as a between meals snack rather than at mealtime.
- Consume foods containing inhibitors at meals lowest in iron content, e.g. a breakfast of low-iron cereal (bread or corn tortilla) consumed with tea or milk products. This meal pattern can supply adequate calcium without hampering iron nutrition.

### ***Approach to dietary modification***

The following approach can be used in many local settings at the household level.

1. Assess eating practices and describe a typical daily meal plan for each of the family members.
2. Estimate amount of iron in diet and potential enhancers and inhibitors (see Table 4).
3. Determine how the situation can be modified: Educational strategies should promote increased consumption of locally available foods rich in micronutrients, such as eggs, papayas, or other yellow fruits and vegetables, dark-green leafy vegetables, as well as animal products. In addition, educational strategies should include preparation and preservation, such as drying and fermentation techniques that overcome seasonal factors and guarantee a supply of micronutrient rich foods.
4. Develop and implement dietary intervention.
5. Choose indicators to monitor program such as surveys to identify changes in knowledge, attitudes and practice, and on a longer term basis, improvement of Hb levels.

## **Fortification**

Food fortification programs are typically the most cost-effective long term methods to improve the iron status of populations. Although a single fortified food cannot meet the entire iron requirements of a population, it's reasonable to expect a fortification program to provide 20-40% of the daily requirement through a single food item (Yip, 1996). In areas where foods fortified with iron are accessible and affordable, they should especially be promoted to vulnerable target groups of that population.

### ***Fortification interventions for infants and young children***

Fortification of weaning foods to reach young children at high risk of anemia can be done commercially or at the local level. In most developing countries where commercially produced foods are not available to many families, an iron fortificant can be added to locally produced weaning foods, or iron rich vegetables can be added into homemade weaning gruels (via recipe trials and education campaigns). Intermediately developed countries can successfully fortify marketed weaning foods, or milk powders for after weaning. These fortified foods should not be marketed in a way that undermines breastfeeding or appropriate local feeding customs. Older children can be reached by distribution of fortified foods (cookies, for example) in schools (Yip, 1996).

### *Fortification interventions for adults*

Iron fortification of centrally processed and widely consumed staple foods such as flour or sugar is an effective (and cost effective) way of reaching all segments of the population (except infants). These initiatives depend on a proper food vehicle for fortification as well as political and industry commitment. Often a fortification approach has limited potential in subsistence farming areas of developing countries where few people consume commercially made products (WHO, 1997). Currently, wheat flour is the most likely vehicle for iron fortification. National wheat flour fortification programs have been very successful in raising population iron status in developed countries. A sugar fortification trial in Guatemala was successful in raising iron stores in the intervention community (Viteri, 1995).



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



## Iron Supplementation

Currently, iron supplementation is the most common strategy for controlling iron deficiency in developing countries. Until the more long term interventions of fortification and dietary improvement are achieved, programs must rely upon targeted supplementation.

### *Supplementation of women*

The main target groups for supplementation are pregnant and lactating women because they are relatively easy to reach through the health system with a package of services, and because of the potential short and long term benefits for both mother and child. In countries where 50% or more of pregnant and lactating women are iron deficient, or 20% or more have iron deficiency anemia, universal supplementation is recommended without a need for screening, except to determine severe cases of anemia for treatment. Prevalence estimates of anemia among pregnant women in various countries are given in [Appendix 1](#), (WHO, 1997).

WHO recommends that when pregnant and lactating women are effectively reached through iron supplementation, then programs can expand to include infants, children from pre-school to adolescence and girls and fertile women from age 10 to 45 years, in that order of priority (WHO, 1997).

### *Supplementation of children*

Oral iron drops or syrups are the preferred supplement for young children, but dissolved ferrous salt tablets can also be used. Universal supplementation for young children is costly (iron drops are expensive for developing countries) and involves operational difficulty, but it may be the best option for improving iron status in this age group. Dissolved ferrous tablets may be a more affordable option, and care should be taken to give the correct dosage (see Dosage Schedule, Appendix 2). When anemia prevalence is high, supplementation of *all* 6-12 month olds is recommended.

## Iron needs of targeted groups

There is variation in iron requirements with age and sex ([see Appendix 3](#)). Consensus exists on the absolute amounts required but factors that affect absorption are confounding, such as dietary inhibitors and intestinal parasites. The following discusses reasons for targeted groups' iron requirements, and outlines recommendations for supplementation.

### ***Pregnant women***

About 1000 mg of iron are needed to cover iron requirements of mother and fetus during pregnancy, mostly during the second half, especially during the last trimester. Dietary iron absorption is reduced during the first trimester, and increased during the latter half of pregnancy (WHO, 1997). WHO recommends a prophylactic schedule of 120 mg elemental iron daily from mid-pregnancy to term. In areas where anemia prevalence is less than 20%, it is recommended that women take 60 mg of elemental iron daily. These schedules should raise hemoglobin levels to at least 110g/l. Folic acid supplements of at least 250 ug should also be given (WHO, 1997).

### ***Infancy and childhood***

Young children require adequate amounts of iron for optimum health and physical and cognitive development. They are at high risk of iron deficiency anemia because their iron needs are increased during rapid growth, and weaning diets in developing countries are commonly low in iron. Breast-fed infants should receive complementary foods rich in iron around 6 months. Breast-fed infants who do not receive adequate iron from other food sources after 6 months are at risk for iron deficiency by 9 months of age (Pizarro, 1991). This risk becomes even greater by one year, and continues until around 24 months, when the diet is likely to include a greater variety of foods containing iron. Although infant formulas are frequently fortified with iron, they are not recommended in most developing country settings due to the increased risk of diarrheal disease.

Low birth weight and pre-term babies are at considerable risk for IDA because they are born with low iron stores. Without iron supplements, these infants are bound to become iron deficient by 2 or 3 months old, even if they are satisfactorily breast-fed (OMNI, 1995).

WHO recommends 1-2 mg/kg/day of elemental iron for infants, pre-school, and school age children. Treatment duration and treatment of severe anemia varies depending on age. A recent intervention trial in Java showed that 30 mg of oral iron administered by mothers once weekly reduced anemia without major involvement of health staff (Palupi, 1997).

**Table #5**  
**Side Effects of Iron Supplementation**

Side Effects/Contraindications	Remarks

- High initial dose of iron (particularly beyond 100mg/day) may cause epigastric discomfort, nausea, diarrhea or constipation. In this case continue the treatment or prevention at a reduced dosage.
- Black color of the stool may be reported by patients taking more than 2 tablets per day. This does no harm. Treatment should be continued.
- All iron preparations inhibit the absorption of tetracyclines, sulfonamides and trimethprim; iron should not be given together with them.
- Iron administration is contraindicated in hemolytic anemia, chronic pancreatitis and cirrhosis. In these cases, referral to a treatment center is required.
- Oral preparation (tablets or solution) preferably should be given before meals, to enhance absorption. In case of serious side-effects, taking preparations with meals will reduce these effects.
- Taking supplements before bedtime with a snack will reduce nausea and discomfort.
- For infants, tablet preparations can be crushed and mixed with food if a solution is not available.
- For prevention and treatment, iron should be taken for 1-3 months after the Hb level has become normal, to overcome the still-existing iron deficiency and to build up iron stores.
- A positive response is a 1 g/dL increase in Hb after 4 weeks of treatment

Source: WHO, 1995.

For more information on iron supplements [click here](#).



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



## Delivery system

The success of an iron supplementation program depends on the delivery system. The health system, with its nurses, TBAs, community health workers etc., serve as a good framework to provide iron supplementation. Maternal and child health and other primary health care services have the potential to provide integrated health services that address iron deficiency and anemia. But, a substantial gap exists between coverage for the infant and mother and the school-age child. Programs need to examine ways in which they can reach these vulnerable populations.


Programs should be community-based with community support and participation. Schools, community health workers, and women's groups can serve as resources to help with awareness, education and supplementation delivery.

### *Many successful examples of community mobilization exist!*

- In one program, school children between the ages of 10 and 15 years were responsible for distributing iron tablets to one preschool child in their neighborhood. "School children have been found to be much more convincing educators to their family than health or nutrition educators" (OMNI, 1995).
- A recent community based intervention in Java showed that 30 mg of oral iron administered by mothers once weekly reduced anemia without major involvement of health staff (Palupi, 1997). The exciting thing about this intervention was that it was effective in real-life community conditions, and not a closely supervised field trial.

### *Commodity management*

In order to maintain an adequate supply of iron tablets, an effective system of commodity management should be established. Factors which should be considered for commodity management are: supplement selection, procurement, forecasting and storage. Selection of supplier involves choosing a supplier who has a good past performance with delivery, costs, and quality control standards. Forecasting involves determining how many tablets will be needed based on monitoring of clinic records and anemia prevalence.



Delivery of iron supplements to young children, adolescent girls, and women of childbearing age... “There are very few, if any, effective daily iron supplementation programs for such groups anywhere in the world. In a situation in which health facilities are overburdened it appears unlikely that they would be able to cope with distributing large quantities of daily supplements to these groups. Alternatives to the health system could be found to deliver weekly supplements. For example, newly married women could be given a supply of 30 ‘weekly’ iron tablets at the time of marriage. Where a high proportion of adolescent girls are in school, a weekly iron tablet, or a weekly drink of an iron tonic, could be provided on the first or last day of the school week. Pre-school children could be given a bottle of iron syrup at the time of measles immunization, which would last for six months, until the time of EPI boosters” (Alnwick, 1995).

### *Issues to consider*

**Daily vs. weekly supplementation** - Typically, daily, low-dose supplements are recommended. Yet, recent studies suggest that weekly or twice-weekly dosing with iron supplements serve as an effective alternative to daily dosing (OMNI, 1995). “The present consensus seems to be that, in a situation where daily iron supplementations will not be taken, women should start taking 120 mg iron, as iron sulfate, once a week from the time pregnancy is recognized to term and through lactation” (Alnwick, 1995).

**Compliance** - Irregular consumption of tablets may be related to side-effects and cultural perceptions of iron tablets. The most common side effects are those associated with the upper gastrointestinal tract, which occur immediately after oral iron intake and include nausea, vomiting and epigastric discomfort. It has recently been suggested that 60 mg daily ferrous salt may be as effective as 120mg, and may also improve compliance by reducing side effects. In addition to improved therapies, appropriate educational materials about why taking iron is important help to improve compliance. Since first trimester morning sickness and anorexia may decrease daily tablet compliance, supplementation is not necessary until the second trimester, when Hb levels begin to decrease (Alnwick, 1995).

**Supply** - One major reason for poor compliance may be irregular supply of tablets and low awareness of importance (low demand). An effective IEC program can improve compliance.

**Toxicity** - The question of overdosing is always important with iron supplements. In excessive dosages iron is toxic, particularly to young children. It takes only one 1 g of iron to kill a child from toxic effects, which is usually related to liver damage and hemorrhagic manifestation (OMNI, 1995). As with all drugs, precautions should be taken to minimize the risk of children accidentally ingesting multiple doses of iron supplements (Alnwick, 1995).

**Liquid preparations** - An oral syringe for measuring the exact dose is available for young infants. Mothers should be taught how to measure to avoid

toxicity.

### **Potential reasons for poor treatment outcomes**

1. Lack of control in the use of the iron supplement: In a family with more than one child, the iron drops may also be given to the other children.
2. Anemia may not be caused by iron deficiency: Other factors such as malaria and intestinal parasites may have a greater impact on anemia than diet alone.
3. Supplement dose and treatment duration: The average dose used may be too low to normalize hemoglobin levels and replenish iron stores. A significant improvement in hemoglobin status may require longer supplementation.



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)



## Other public health measures

Prevention goes far beyond what is generally considered to be prevention for anemia. WHO states that, for maximum effectiveness of tackling IDA root causes, “integration should be sought with malaria prophylaxis, hookworm control, immunization and environmental health programs as well as programs for prevention of micronutrient malnutrition and community-based primary health care” (WHO, 1997).

### *Deworming*

The major types of hookworm control measures include anti-helminth drugs, improved sanitation, and health education (Stoltzfus, 1994). Periodic deworming has been shown to bring down the prevalence and severity of intestinal parasitic infection and helps to increase and sustain Hb levels for 3 to 3.5 months. Furthermore, concurrent supplementation with iron and vitamin A has a synergistic effect on improving Hb levels (OMNI, 1995).

Anthelmintic drugs are safe and inexpensive (approximately US \$0.025 to \$0.20 per treatment), and periodic delivery of them through a school system, EPI program or PHC system may prove to be feasible interventions in many situations (Stoltzfus, 1996). Only tentative conclusions have been drawn to suggest that it is probably safe to use selected benzimidazole drugs for women who are of child bearing age, pregnant and/or lactating (WHO, 1994).

Iron supplementation without deworming in areas where hookworms are endemic is like trying to fill a leaking container. Deworming may be a necessary intervention to prevent intestinal blood loss.

### *Malaria prophylaxis*

Malaria control has been recognized as an important element in the reduction of childhood anemia. Research in Tanzania suggests that the prevalence of anemia can be reduced, in malaria endemic areas, by 40 to 50% after 12 months with the use of insecticide-impregnated bednets (OMNI, 1995). The main programmatic challenge is obtaining bednets and impregnating them on a 6 month cycle.

Anti-malarial drugs have also been shown to improve hemoglobin levels (Ettling, 1995). The CDC supports that, “treatment of parasitic children with an effective antimalarial drug that clears the parasitemia is critically

important to allow these children to return to normal hematologic status” (CDC/USAID, no date).

Although the positive impact of malaria control on anemia has been documented, criteria for effective malaria chemotherapy have not been well defined. It has been suggested that, “since children may become anemic because of malaria without being febrile, criteria are needed to identify children with malaria-associated anemia. A broader case definition to establish which children need antimalarial treatment therefore requires both an assessment of fever and a systematic evaluation for anemia” (CDC/ USAID, no date).

### ***Breast feeding and weaning***

WHO and UNICEF support good breastfeeding and weaning practices in part through the Baby Friendly Hospital Initiative. This initiative trains maternity staff to support and educate mothers on the how-to’s of breastfeeding and timely weaning. WHO recommends strict breastfeeding until 6 months, after which complementary foods should be added to the infant’s diet. Even in rural areas where breastfeeding is common, optimal weaning practices should be promoted. Weaning foods can be made with locally available foods high in iron, or liquid iron preparations can also be added to weaning foods.

### ***Water and sanitation***

Control of hookworm and other helminths through water and sanitation interventions can reduce parasite load and improve iron status. Educational campaigns to promote wearing sandals, washing hands, and proper preparation of foods can also reduce transmission of helminths.

## **Information, education and communication (IEC)**

“Consumers can improve the nutritional quality of their diets if they are guided by well-designed communications and have ready access to micronutrient-rich foods that are affordable and acceptable” (World Bank, 1994). Social marketing is a form of communication used to persuade people to adopt new behaviors that might be more favorable than competing alternatives. Social marketing techniques have successfully promoted and enhanced nutritional programs around the world. Such programs “have employed social marketing to design and promote products and services creatively, based on insights from qualitative research with the beneficiaries themselves. They take a broad approach to project planning that includes advocacy and training. Communication tactics have included community-based skits, adult literacy classes incorporating nutrition themes, group counseling and storytelling, and child-to-child approaches; large scale efforts have effectively used radio, theater, and television for advocacy” (Fishman, 1995).

Effective IEC at the clinic and household level is also integral to the

success of IDA control efforts. Health providers must understand and appreciate the causes, consequences, prevention and treatment of iron deficiency and anemia. Health workers can serve as effective educators and help women to modify their diets and educate them about iron supplement side-effects and ways to minimize them. Also, appropriately trained health workers can detect signs of moderate and/or severe anemia, dispense treatment, and refer patients to district level hospital as needed.



[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)

[Appendix 1](#)

Appendix 2 (not available)

[Appendix 3](#)

Appendix 4 (not available)

[Appendix 5](#)[Glossary](#)

## Appendix 1

### Prevalence of Anemia Among Pregnant Women in USAID Child Survival Eligible Countries

Africa Region	Prevalence of Anemia Among Pregnant Women
Benin	50-59%
Ethiopia	40-49%
Ghana	50-59%
Guinea	50-59%
Kenya	40-49%
Madagascar	40-49%
Malawi	40-49%
Mali	50-59%
Mozambique	40-49%
Senegal	50-59%
S. Africa	30-39%
Tanzania	40-49%
Uganda	40-49%
Zambia	40-49%
Zimbabwe	40-49%

Asia/Near Esat Region	Prevalence of Anemia Among Pregnant Women
Bangladesh	70-79%
Cambodia	60-69%
Egypt	50-59%
India	70-79%

Morocco	50-59%
Nepal	70-79%
Phillippines	60-69%
Tajikastan	no data

Latin America Region	Prevalence of Anemia Among Pregnant Women
Ecuador	30-39%
El Salvador	30-39%
Guatemala	40-49%
Haiti	50-59%
Honduras	40-49%
Nicaragua	40-49%
Peru	30-39%



To see the full size version of the map, click on the map

[Table of Contents](#) | [Chapter 1](#) | [Chapter 2](#) | [Chapter 3](#) | [Chapter 4](#)  
[References](#) | [Appendices](#) | [Introduction/Credits](#) | [Anemia Report Home](#)

[HOME](#) | [SITE MAP](#) | [FEEDBACK](#) | [WHAT'S NEW](#) | [SITE SEARCH](#)  
[PROGRAMS](#) | [INFO CENTER](#) | [INTERNATIONAL](#) | [SUPPORT](#) | [MARKETPLACE](#)