

# Iron Deficiency in Young Children in Low-Income Countries and New Approaches for Its Prevention<sup>1,2</sup>

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## Abstract

Anemia resulting from severe iron deficiency (ID) is the most prevalent and widespread nutrition-related health problem in infants and young children in low-income countries and has proven very resistant to prevention through public health interventions. Accumulative evidence from animal and human studies suggests that such deficiencies are associated with large adverse effects on child cognitive and motor development. Therefore, effective interventions to improve iron status will have large health benefits. Action to reduce young child ID would benefit from overarching policy and programmatic guidance that informs decision makers about what to do, when to do it, and how to do it. The impetus for new approaches to prevent ID in young children reflects growing recognition of the need to intervene early and often and for better vehicles to deliver iron. Prevention of ID requires strong delivery systems that enhance consumer demand and promote compliance. When this occurs, the prevalence of anemia is greatly reduced. *J. Nutr.* 138: 2523–2528, 2008.

## Introduction

Anemia resulting from severe iron deficiency (ID)<sup>3</sup> is the most prevalent and widespread nutrition problem in infants and young children in the developing world (1) and has proven very resistant to prevention through public health interventions. Accumulated evidence from animal and human studies suggests that such deficiencies are associated with adverse effects on child cognitive and motor development (2–4). Therefore, effective interventions to improve iron status will likely have important health benefits.

Action to reduce young child ID would benefit from overarching policy and programmatic guidance that informs decision makers about appropriate intervention(s) or *what to do, when to do it*, and also addresses appropriate delivery models or *how to do it*. Most policies do not consider the role of maternal iron status or birth practices in the etiology of ID; supplementation for pregnant women is recommended for maternal health and not as a broader strategy to also improve newborn iron status. Interventions that could protect iron status at birth and during the first 6 mo of life, such as delayed umbilical cord clamping (5) and promotion of exclusive breast-feeding are rarely considered. In some settings,

deworming is also a useful intervention to consider (6). The opportunities for different and mutually reinforcing interventions to prevent ID in young children need to be harnessed.

In this introductory article, I discuss how ID and iron deficiency anemia (IDA) are defined and present anemia prevalence and trend data. I also summarize how new approaches to prevent ID in young children reflect a number of factors, including the recognition of the multiple opportunities where intervention is possible and the development of new vehicles to deliver iron. I close with a description of why attention to delivery systems and monitoring and evaluation is so important and a success story to illustrate how the prevalence of young child anemia can be greatly reduced.

## Diagnosis, prevalence, and trends

WHO estimates that half of all anemias are caused by ID and that the prevalence of ID in developing countries is ~2.5 times that of anemia (7). Anemia is defined as insufficient hemoglobin (Hb) or red blood cells. Additional causes include other nutritional deficiencies (vitamins B-12, B-6, and A, riboflavin, and folic acid), chronic disease and inflammation, conditions that cause blood loss or hemolysis (e.g., parasitic infections such as hookworm or malaria or hemorrhage) and hemoglobinopathies. Anemia caused by ID is referred to as IDA. Although there is disagreement about the appropriate cutoff values for the diagnosis of ID and IDA in infants (8,9), the commonly used indicators and values for diagnosis recommended by WHO are Hb <110 g/L and serum ferritin <10–12  $\mu$ g/L for infants 6–12 mo of age (10). Alternative cutoff levels for insufficient Hb have been proposed as <105 g/L for infants 4 and 6 mo and <100 g/L

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<sup>3</sup> Abbreviations used: Hb, hemoglobin; ID, iron deficiency; IDA, iron deficiency anemia.

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for infants 9 mo of age (8). Other laboratory criteria for IDA include low Hb together with other indications of ID; these include low erythrocyte mean cell volume, low serum ferritin, high zinc protoporphyrin, and/or high soluble transferrin receptors. However, the cutoff values for these indicators are even less well developed than those for Hb and serum ferritin.

Only indirect estimates of the prevalence of ID and IDA are available. Representative data for infants and young children measure anemia using simple field-based measurement techniques that do not require venous blood, but such techniques are not available to measure ID, ferritin, or other indicators of iron status. However, because WHO estimates that IDA represents ~50% of all anemias and that ID is 2.5 times the prevalence of anemia, prevalence estimates of anemia provide an indication of the magnitude of ID, although they may be an underestimation (7).

The prevalence of anemia is higher during infancy and early childhood than at any other time in the life cycle, including pregnancy (11). Among children <5 y of age, the prevalence of

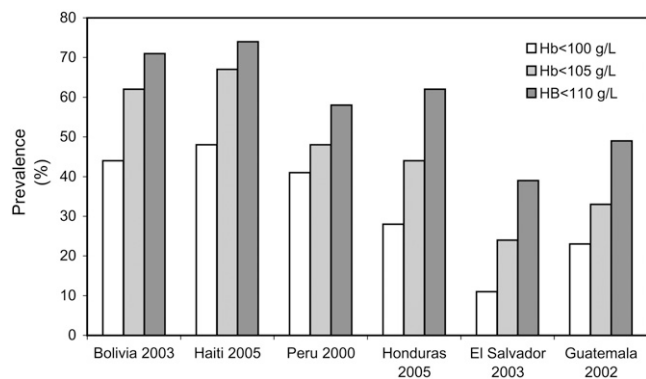
anemia (defined as Hb <110 g/L) ranges from ~35 to 90% in those countries where a Demographic and Health Survey conducted between 1996 and 2006 included Hb measurements (Table 1). Among infants, the prevalence ranges from 25 to nearly 100%, with the majority of countries in excess of 70%. Recent estimates put the global prevalence of anemia in young children at 41.8% (12).

Iron reserves of term, normal-birthweight infants, born to iron-replete mothers and who received delayed cord clamping at birth should be adequate to meet iron needs until 6 mo of age (13). However, the very high prevalence of anemia by this age indicates that infants are becoming anemic earlier than expected and that even more are likely to be ID but not yet anemic. Even if prevalence estimates were revised to use the more conservative cutoff levels suggested above, anemia would still be the most prevalent nutritional problem (Fig. 1). Trend data, from 8 countries show that reductions in anemia are generally occurring slowly, and for 3 countries (Armenia, Egypt, and Uganda), the prevalence of anemia increased (Fig. 2).

**TABLE 1** Prevalence of anemia (Hb <110 g/L) in young children<sup>1</sup>

	Age, mo						Total
	6–9	10–11	12–23	24–35	36–47	48–59	
Sub-Saharan Africa	%						
Benin 2001	90.5	86.0	88.6	81.3	79.0	74.5	82.2
Burkina Faso 2003	93.2	99.4	96.2	94.8	88.9	83.6	91.6
Cameroon 2004	85.4	79.9	82.2	67.6	61.9	53.3	69.4
Congo (Brazzaville) 2005	72.1	72.6	69.9	68.0	62.5	54.1	65.3
Ethiopia 2005	76.3	77.5	69.4	49.5	48.3	37.9	53.9
Ghana 2003	77.6	81.2	83.7	77.3	74.1	68.7	76.7
Guinea 2005	82.5	79.3	86.9	81.9	72.0	65.3	77.4
Lesotho 2004	63.8	64.9	59.0	52.8	41.6	34.0	50.0
Madagascar 2003/2004	87.6	84.6	78.4	67.6	63.2	59.2	70.2
Malawi 2004	91.5	88.0	83.5	74.1	61.9	63.4	74.1
Mali 2001	78.7	90.6	86.8	86.9	79.5	76.9	82.7
Niger 2006	88.5	88.8	92.7	86.5	81.8	74.5	84.9
Rwanda 2005	76.9	68.5	64.1	55.2	50.0	45.7	56.6
Senegal 2005	81.2	87.9	92.3	85.3	81.5	70.3	83.0
Tanzania 2004	83.2	87.3	82.6	74.1	62.3	58.9	72.3
Uganda 2006	92.2	91.9	85.0	71.3	67.0	55.5	73.2
Zimbabwe 2005/06	80.7	81.1	74.4	59.6	51.3	45.9	61.3
North Africa/West Asia/Europe							
Armenia 2005	74.2	65.8	46.1	32.6	23.4	26.7	36.8
Egypt 2005	61.0	66.9	57.1	48.8	41.1	40.8	48.7
Jordan 2002	48.0	64.7	50.6	31.4	22.1	18.2	34.2
Moldova Republic of 2005	45.9	57.5	44.0	30.9	25.6	15.9	32.5
Central Asia							
Kazakhstan 1999	23.2	42.4	66.8	47.5	25.4	15.2	37.6
Kyrgyz Republic 1997	52.8	40.5	61.1	44.9	—	—	52.2
Turkmenistan 2000	37.9	45.0	54.8	37.7	25.5	23.5	35.9
Uzbekistan 1996	59.3	64.0	61.5	58.9	—	—	60.5
South and Southeast Asia							
Cambodia 2005	84.8	81.6	76.9	57.5	50.8	47.7	61.4
India 1998/99	70.5	74.5	77.6	72.0	—	—	74.2
Nepal 2006	78.1	87.9	71.2	50.6	39.5	28.4	50.4
Latin America and Caribbean							
Bolivia 2003	71.4	87.8	76.0	51.5	38.4	34.8	51.6
Haiti 2005	74.9	74.6	74.7	62.7	53.3	49.7	62.6
Honduras 2005	63.1	68.8	53.1	37.3	27.4	21.1	37.8
Peru 2000	59.4	72.2	71.2	49.9	36.7	36.3	49.6

<sup>1</sup> Source: ORC Macro 2008 (37).

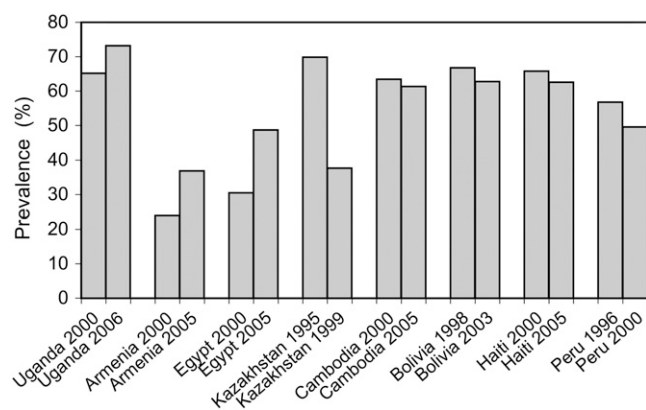


**FIGURE 1** Prevalence of anemia by different cutoff values in children 6–9 mo of age in selected Latin American countries with recent nationally representative data; constructed from primary analysis of Demographic and Health Survey data for each country and year represented.

### New approaches to prevention of ID

Current guidelines for iron supplementation in young children are based on the assumption that iron present at birth and in breast milk is sufficient to meet requirements for the first 6 mo of life. However, this assumption depends on a number of factors not often present in low-income countries: adequate maternal iron status, adequate birth practices that promote the transfer of a portion of the birth iron via placental blood (5,14), and exclusive breast-feeding that avoids pathological iron loss via damage to the integrity of the intestinal wall. Breast milk contains little iron, but it is in a form that is highly bioavailable (13). Introducing other liquid or solid foods during the first 6 mo of life can interfere with the absorption of the iron present in breast milk (15). Therefore, interventions to prevent ID in young children need to start early in their mother's pregnancy (by supplementing her) and continue at birth (by delayed umbilical cord clamping and promoting early initiation of breast-feeding).

After 6 mo, iron of adequate amount and bioavailability is necessary to prevent ID (16). Meeting iron requirements through food alone is nearly impossible, particularly between 6 and 12 mo of age, when requirements remain very high and infants consume relatively small amounts of food (17). It is during this



**FIGURE 2** Trends in anemia (Hb < 110 g/L) in children 6–59 mo of age in selected countries with nationally representative trend data available; constructed from data presented in Table 1, except for Bolivia 2003, which was calculated from primary analysis of the Demographic and Health Survey for children < 36 mo to be consistent with the age range reported in 1998.

period that universal supplementation is recommended, except in malaria-endemic areas (18). Until recently, many Ministries of Health in Latin America recommended daily supplementation with ferrous sulfate, which is highly efficacious in preventing and treating ID. Unlike vitamin A deficiency, however, which can be prevented through twice-yearly high-dose supplements and distributed via immunization campaigns, prevention and treatment of ID require routine supplementation (usually daily or weekly). Therefore, it has traditionally been delivered through routine, often weak, health services.

Strategies to prevent early childhood ID need to include interventions beyond the typical one of starting medicinal iron supplements at 6 mo (2 mo for low-birthweight infants), taking advantage of the full range of interventions and contact with mother-infant pairs. Its prevention requires policy and programmatic guidance that informs decision makers about *what to do*, *when to do it*, and also addresses appropriate delivery models or *how to do it*. It also requires addressing the multiple opportunities available for prevention; pregnancy, at birth, the immediate postnatal period, and during the first 24 mo of life, as illustrated in Table 2.

The recognition of a lack of impact of ferrous sulfate on anemia prevalence when delivered through health services has coincided with a growing understanding of the importance of other micronutrients for young child nutrition, which has led to the development of other vehicles (19). These include micronutrient sachets, fortified cereal-based complementary foods, and fat-based spreads. All contain multiple micronutrients, although not necessarily the same ones. The fortified complementary foods and fat-based spreads also provide macronutrients because of their importance for improving other outcomes such as growth. Programs to distribute cereal-based supplements fortified with iron and other micronutrients (20,21) and iron-fortified milk (22,23) through health services have been shown to be effective in reducing anemia. Some of these programs have also shown benefits to child nutrition beyond anemia reduction (19). Micronutrient-fortified fat-based spreads are also efficacious in reducing ID and well accepted by young children (24). They have also shown improved linear growth and motor development (25). Micronutrient sachets are very efficacious in preventing and treating ID (26–29). They appear to be highly acceptable to both mothers and children because of their ease of use and are effective in reducing anemia (30).

There is growing interest by health ministries in Latin America in new vehicles to replace supplementation with ferrous sulfate. For example, the Ministry of Public Health in Bolivia has replaced ferrous sulfate with micronutrient sachets (“Chispitas”) and included their purchase as part of its Universal Maternal and Child Health Insurance (Seguro Universal Materno Infantil) for both pregnant women and young children. In many other countries in Latin America, such micronutrient sachets are also being introduced. Many countries in Latin America provide fortified complementary food to low-income young children to improve both micronutrient status and growth.

### The importance of delivery

Prevention of ID in public health programs requires attention to a number of factors related to the delivery systems, which are often weak in settings of high anemia prevalence, and to compliance by the target population (31). On the delivery side, there needs to be an adequate supply of supplements. This requires an adequate budget, a system of ordering supplements based on anticipated need, and a mechanism for distribution so

**TABLE 2** Prevention of ID in young children: what, when, and how

When (intervention period)	What (recommended practices)	How (specific) for each intervention period	How (general) for all intervention periods
Pregnancy	<ul style="list-style-type: none"> <li>● Medicinal iron supplementation</li> <li>● Deworming (trimesters 2 and 3)</li> <li>● Iron-rich foods</li> </ul>	<ul style="list-style-type: none"> <li>● Improve distribution of supplements and deworming medicines</li> <li>● Counseling on importance of supplement use and possible side effects</li> <li>● Promote intake of animal-source and/or iron-fortified foods</li> </ul>	<ul style="list-style-type: none"> <li>● Fortification of staple foods with a bioavailable form of iron (to benefit maternal iron status)</li> <li>● Develop advocacy materials including information on the recommended practices and their evidence base, and why prevention of ID in young children is so important</li> </ul>
At birth	Delayed cord clamping (until pulsations cease, ~2 min)	<ul style="list-style-type: none"> <li>● Coordinate with maternal health efforts to ensure implementation of delayed cord clamping within active management of stage 3 of labor protocols</li> </ul>	<ul style="list-style-type: none"> <li>● Revise and update national and professional norms and protocols</li> <li>● Integrate recommended practices with maternal, neonatal survival and Integrated Management of Childhood Illness protocols protocols, etc.</li> </ul>
Immediate postnatal period	Skin-to-skin contact to facilitate early initiation of breast-feeding	<ul style="list-style-type: none"> <li>● Expand implementation of the Baby Friendly Hospital Initiative</li> <li>● Reorganize delivery care services to facilitate immediate and continued contact</li> <li>● Delay weighing and bathing for 1 h</li> <li>● Offer assistance, if necessary with first breast-feed</li> </ul>	<ul style="list-style-type: none"> <li>● Update information in medical, nursing, midwifery, and nutrition textbooks</li> <li>● Develop (based on formative research and behavioral change theory) and conduct in-service training on recommended practices</li> <li>● Include sessions on the recommended practices in professional conferences</li> </ul>
Birth-6 mo	<ul style="list-style-type: none"> <li>● Exclusive breastfeeding (avoidance of liquids/foods that could cause microscopic blood loss).</li> <li>● Iron supplements for low- birthweight infants</li> </ul>	<ul style="list-style-type: none"> <li>● Home visit during first week, if possible, to address concerns/problems</li> <li>● Counseling on benefits of exclusive breast-feeding</li> </ul>	<ul style="list-style-type: none"> <li>● Publish lay articles on the importance of the recommended practices in newspapers and women's magazines</li> </ul>
6–24 mo	<ul style="list-style-type: none"> <li>● Iron-rich complementary foods</li> <li>● Micronutrient supplements (e.g., medicinal iron supplements,<sup>1</sup> micronutrient sachets,<sup>1</sup> fortified complementary foods, lipid-based spreads)</li> <li>● Deworming</li> </ul>	<ul style="list-style-type: none"> <li>● Promote intake of animal-source and/or iron-fortified foods</li> <li>● Improve distribution of supplements and deworming medicines</li> <li>● Social programs to provide fortified complementary foods, fortified food-based supplements, and micronutrient powders</li> <li>● Social marketing of fortified complementary foods, fortified food-based supplements, and micronutrients</li> </ul>	

<sup>1</sup> Except in malaria endemic areas.

that clinics always are well stocked (32). It requires clinics to be open when pregnant women and those with young children are most likely to visit. It also requires staff who are motivated, well informed, and approachable not only to provide the supplements but to counsel about why these are important and how to use them. Staff need to know basic counseling techniques such as greeting the mother, showing empathy, asking about child feeding and encouraging her to talk, explaining the desired behavior, and asking “checking questions” to make sure the mother understands (33). They need to be motivated and to remain motivated to

implement iron interventions as a part of virtually all their interactions with pregnant women and caretakers of young children.

Creating consumer demand can also help to ensure delivery of the intervention by health staff and compliance with the intervention by recipients. Consumer demand can be developed through advocacy and education of key stakeholders in the community about the importance of preventing anemia and the intervention being implemented. Adequate coverage of the interventions and compliance with them are necessary to achieve

impact. Both can be achieved with good delivery systems and consumer demand. Large-scale evaluations that measure both the process of implementation and the impact of the intervention are needed before it can be assumed that a delivery vehicle more attractive to consumers has the desired impact.

Although guidelines to supplement with iron sulfate starting at 6 mo of age are common in Latin America, few countries monitor compliance with this treatment regimen or evaluate its effectiveness. An important exception is Nicaragua, which rigorously monitors and reports on nutritional indicators through its Integrated System of Nutritional Surveillance (34,35). These reports show that the prevalence of anemia among children aged 6 to 59 mo has fallen from 33.5% in 2000 to 25.9% in 2003 and again to 17.0% in 2004. This decline has been particularly dramatic among older infants, where the prevalence of anemia fell from 65.1% in 2003 to 27.4% in 2004.

Several key aspects of the iron supplementation program in Nicaragua contributed to its success. A very high percentage of women received iron supplements during pregnancy for 6 mo or more. In addition to providing iron supplements to young children through public health services, the providers also distributed these during national vaccination days (34,35). Nicaragua also has a large network of community health workers who work closely with families in their respective communities to strengthen preventive actions in child health and nutrition. It is likely that these workers also help to create consumer demand and enhance compliance.

In conclusion, ID is the most prevalent and widespread nutrition problem in infants and young children in low-income countries, is associated with large adverse effects on cognitive development, and has been difficult to prevent through traditional public health approaches. Its prevention requires overarching policy and programmatic guidance that inform decision makers about what to do and when to do it and also address appropriate delivery models or how to do it. This also requires addressing the multiple opportunities available for prevention: pregnancy, at birth, the immediate postnatal period, and during the first 24 mo of life. New vehicles to deliver iron as well as other micronutrients and in some cases macronutrients are efficacious in reducing anemia and appear to be more acceptable to mothers and children. However, to reduce national prevalences of anemia, the many challenges of delivery through the public health systems must be overcome.

Other articles in this symposium include references (37–39).

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