Danone Nutricia Campus

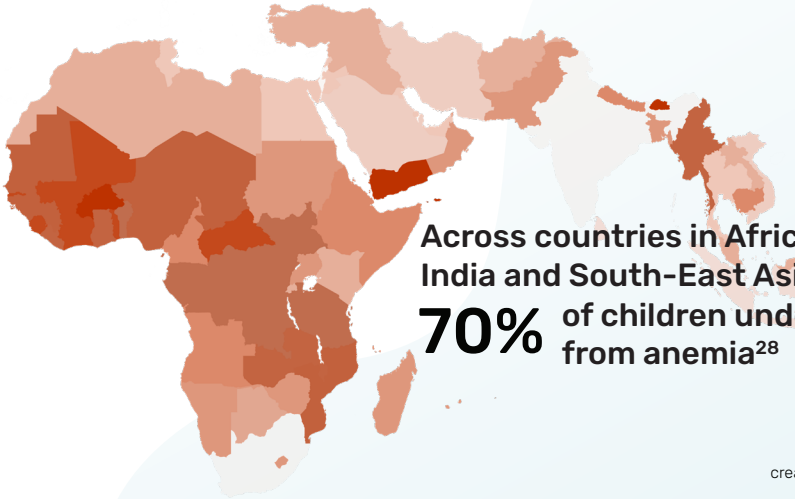
Nutrition Essentials: Iron Deficiency

Strategies for pregnant women and infants

Iron deficiency anemia: A global health concern

- Iron plays an important role in blood health, cognitive function and immune responses.[1]
- However, iron deficiency is the most common micronutrient deficiency in the world.[2]
- Africa, Middle-East, India and South-East Asia have some of the highest prevalence of anemia due to iron deficiency.[3]

Globally,
1 in 3 people are estimated to be iron deficient[2]



Across countries in Africa, Middle-East, India and South-East Asia, as much as 70% of children under 5 may suffer from anemia[28]

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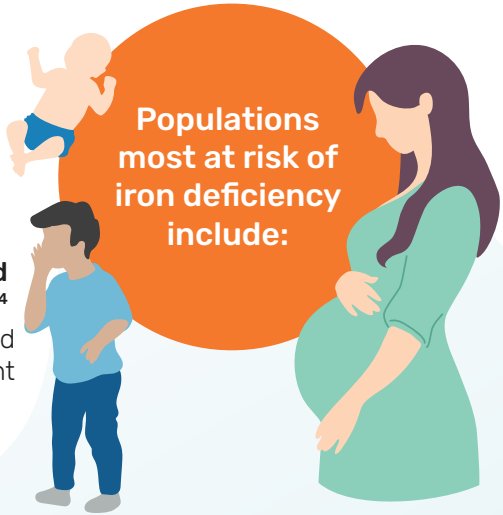
Iron deficiency anemia: A risk to healthy development and maternal health

Iron deficiency anemia is a critical health issue that can hinder development across various stages of life, particularly in infants, children, adolescents, and pregnant women. It's important to identify and address this early to ensure optimal physical and cognitive growth and to mitigate health risks for mothers and their babies.

Infants[4]

Children and adolescents[4]
risk impaired physical and cognitive development

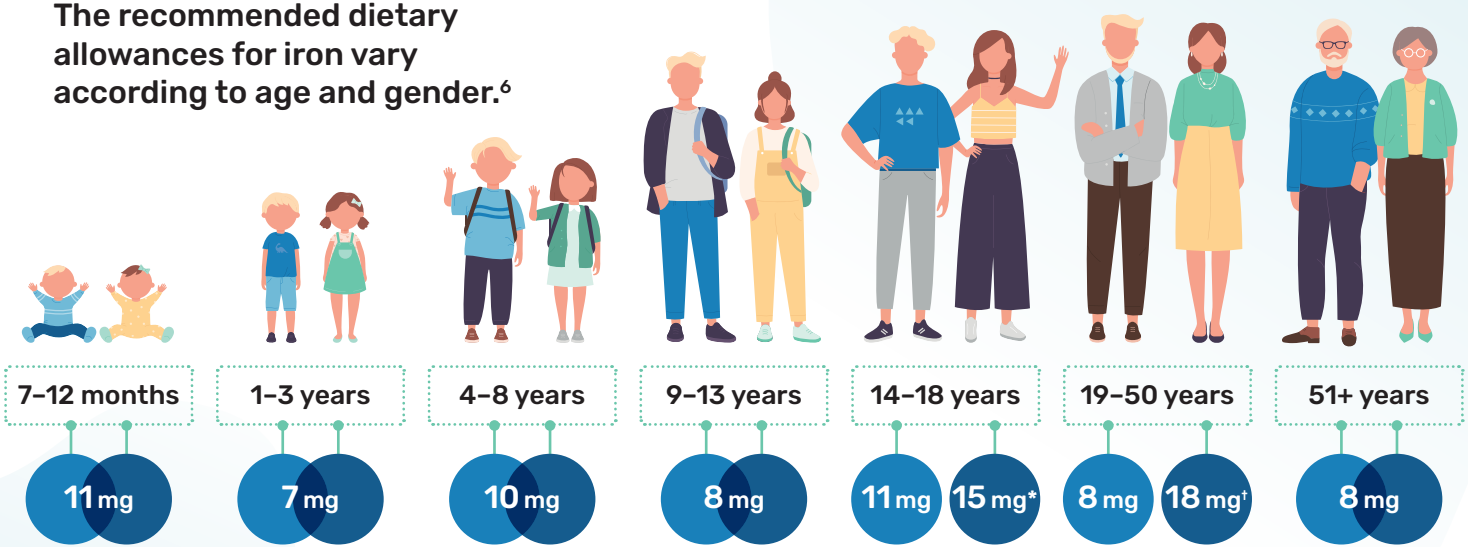


Women, particularly pregnant women, since iron deficiency presents a:[5]

- Higher risk of **mortality and morbidity** for the mother and the baby
- Higher chance of **miscarriage**
- Higher chance of **premature birth**

Recommended iron intake

The recommended dietary allowances for iron vary according to age and gender.[6]

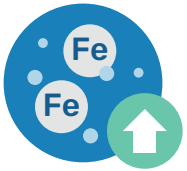


*RDA is 27 mg and 10 mg during pregnancy and lactation, respectively.
†RDA is 27 mg and 9 mg during pregnancy and lactation, respectively.

RDA, recommended dietary allowance.

Iron deficiency anemia: Causes

In developing countries, the causes of iron deficiency include:



Increased iron requirements in certain stages of life (such as infancy, menstruation, pregnancy)[7]

Insufficient iron intake due to malnutrition or special diets[7]

Decreased intestinal iron absorption due to chronic diseases (such as thalassaemia and sickle cell disease) or parasitic infections (such as malaria or helmints)[7]

The impact of iron deficiency

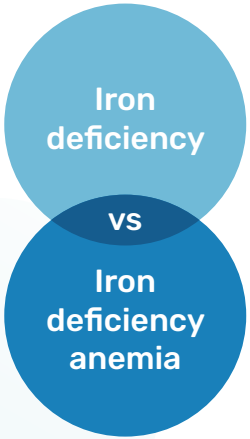
Iron deficiency can lead to:

- Iron deficiency anemia[1]

- Impaired cognitive, behavioural, immune, motor and physical development in infants and children[1]

- Increased susceptibility to infections, poor appetite, tiredness, irritability and compromised learning ability in infants and children.[8–11]

- Poor quality of life[1]



Iron deficiency and iron deficiency anemia are often used interchangeably.[12] However, **iron deficiency is a broader term that refers to low iron stores** and **can occur without anemia**.[12] Iron deficiency anemia represents the late stage of the problem when hemoglobin levels fall below a certain threshold.[12]

It is important to identify and treat iron deficiency before it progresses to iron deficiency anemia.

Identifying individuals at risk of iron deficiency

- Since iron deficiency is a systemic disease, its symptoms can be non-specific, with a high probability of it being overlooked.[2,13]
- Anemia is the most common presentation of iron deficiency.[13]

Potential symptoms include:[13]

Pallor of skin | Tachycardia | Dizziness | Fatigue | Inability to concentrate

Clinical diagnosis of iron deficiency anemia

Early identification of children at risk of iron deficiency or iron deficiency anemia is very important and can be done through non-invasive screening tools and/or questionnaires.

An accurate diagnosis of iron deficiency anemia requires laboratory testing[7]

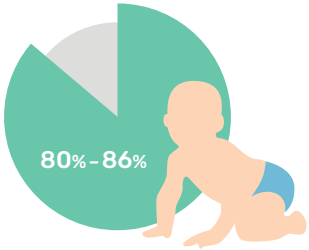
Test	**Hemoglobin[6]**	**Serum ferritin[7]**	**Transferrin saturation** (only necessary in diagnosing functional iron deficiency, when serum ferritin is unreliable)[7]
Cutoff values	6 months–5 years <110 µg/L 6 years–11 years <115 µg/L Non-pregnant women <120 µg/L Pregnant women <110 µg/L	5 years or younger <12 µg/L Children older than 5 years <15 µg/L In all age groups in the presence of infection <30 µg/L	<16%
Remarks	Low specificity and sensitivity when used alone	Key indicator of absolute iron deficiency	Transferrin plays a role in iron metabolism

Strategies to manage iron deficiency anemia

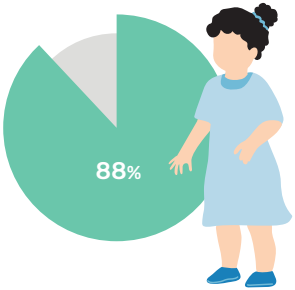
- Increase iron intake by **supplementation** or food-based approaches such as **dietary modification or fortification**.[1]
- **Supplementation** can be **useful in cases of acute** iron deficiency. However, it **may not address the root cause** of the deficiency.[1]

Iron supplementation: The evidence

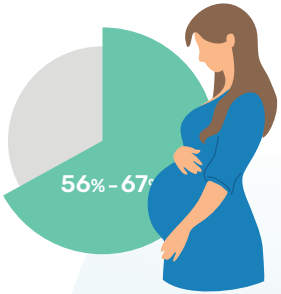
Extensive research on iron supplementation in infants, young children and pregnant women notes that:[14]



Daily iron supplementation (12.5–15 mg iron/day) in **infants** aged 6 to 23 months reduced the risk of iron deficiency anemia by **80%** to **86%**[14]



In **children** aged 2 to 10 years, **daily (5–400 mg/day)** or **intermittent (7.5–200 mg/week)** iron supplementation reduced risk of IDA by **88%**[14]



In **pregnant women**, **10–300 mg/day** iron reduced IDA risk by **56%** to **67%**[14]

Considerations for iron supplementation: Gastrointestinal side effects

Iron supplementation remains a common strategy for treating and preventing iron deficiency[15]

However, oral iron supplements often cause **gastrointestinal side effects** such as:

diarrhea, constipation and nausea[16]

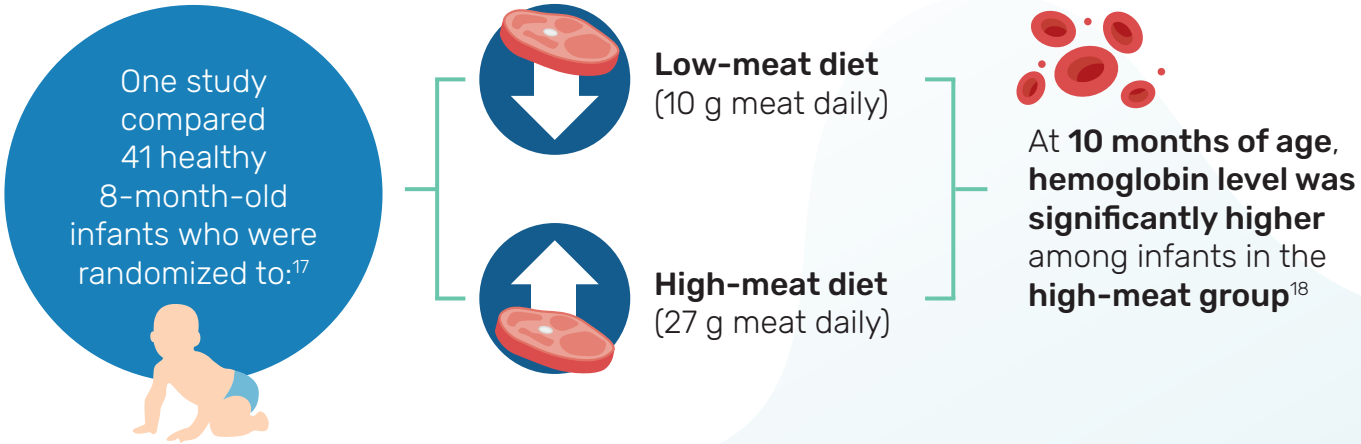
This can result in a lack of compliance to oral iron supplements, which can lead to treatment failure[16]

Consumption of iron supplements may also adversely impact the gut microbiome, resulting in the proliferation of harmful bacteria such as *Escherichia coli* or *Salmonella spp.*, and raise the risk of infections.[15,17]

Innovative preparations of iron supplements with low incidences of side effects could improve compliance[16]

Dietary modifications: The benefit of meat-based diet in infants

- Interventions aiming to improve dietary diversity and quality can vary widely.[14]
- Although dietary modifications are thought to have a long-lasting and sustainable impact on iron status, there is paucity of evidence regarding the efficacy of this strategy.[14]

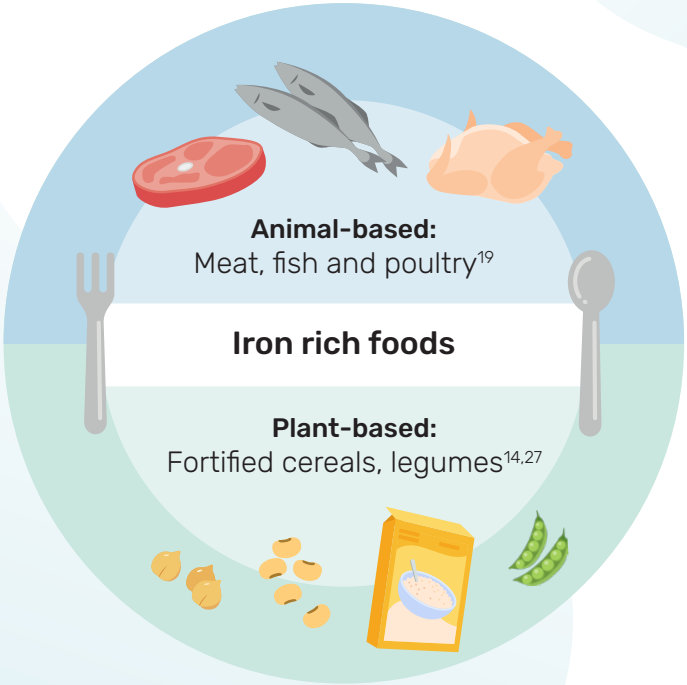


Considerations for dietary modification: Increasing iron-rich foods

- Increasing iron-rich foods in the diet is an important strategy to combat iron deficiency in people of all age groups who have iron deficiency.[19]
- **Different dietary sources** and forms of iron have **different bioavailabilities**.[19]

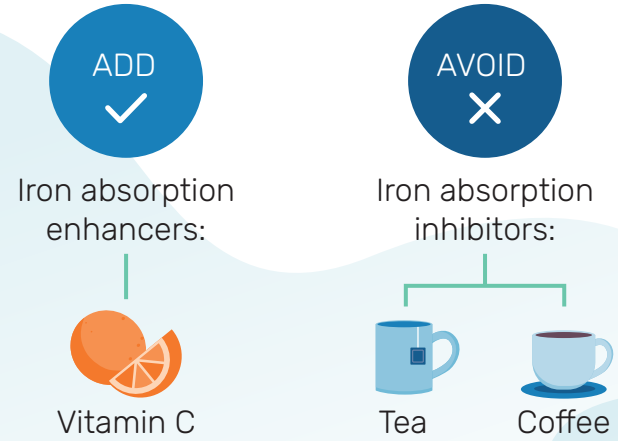
Heme iron found in **animal-based** products have a **high bioavailability of 25% to 30%**[14]

Non-heme iron in **plant-** and **animal-based** products range from **1% to 10%**[14]

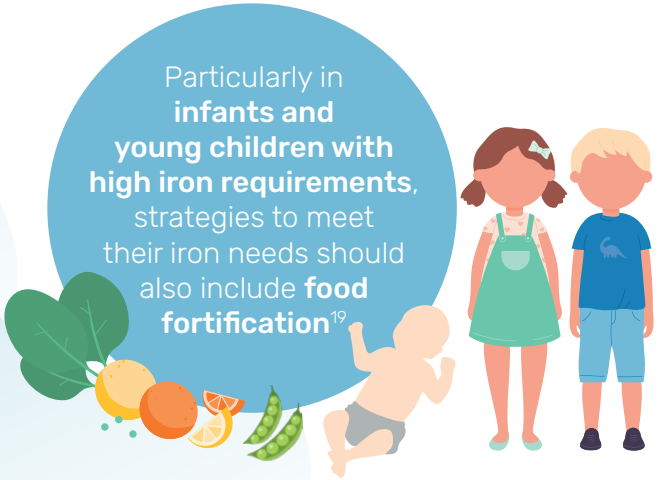


Considerations for dietary modification: Iron absorption inhibitors and enhancers

Adding or avoiding certain foods in meals can also increase iron absorption.[14,19]



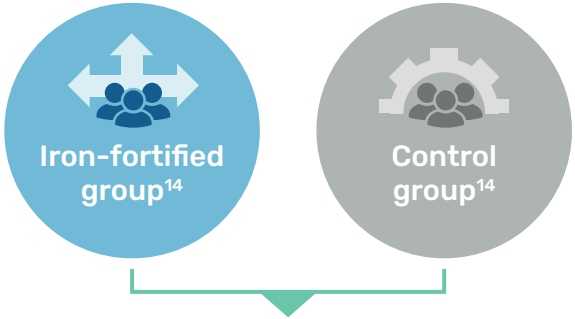
The **WHO has recommended** adding to the diet **fruits and vegetables** that are **rich in vitamin C**, such as citrus fruits, to **increase the absorption of iron,** in all age groups.[18]



WHO, World Health Organization.

Food fortification: The evidence

A review assessed **60 randomized controlled trials (RCTs), cluster-RCTs and quasi-RCTs** involving **20,827** participants in:

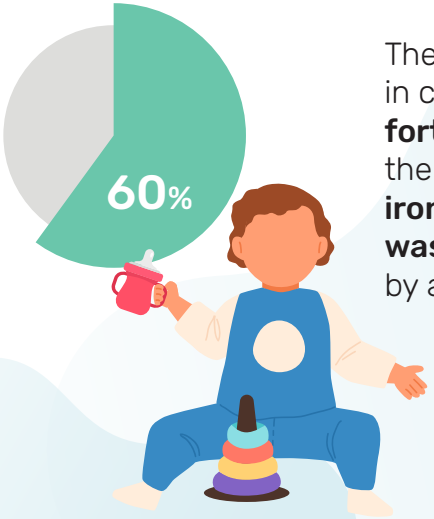


Participants in the **non-fortified control groups**

were twice as likely to have iron deficiency

compared with those receiving iron-fortified foods[14]

Similarly, a randomized, double-blind controlled trial compared the **effects of young-child formula fortified with iron, vitamin D** and **prebiotics GOS/FOS**, with **non-fortified cow's milk** in **children aged 1 to 3 years**.[20]



The trial found that in children receiving **fortified formula**, the **probability of iron deficiency was decreased** by almost **60%**[20]

GOS, Galacto-oligosaccharides; FOS, Fructo-oligosaccharides

Considerations for food fortification

WHO guidelines (2016) recommended **fortification of maize flour and corn meal** with **iron to prevent iron deficiency**, particularly vulnerable groups such as children and women.[21]

Iron fortification of infant formula can also be a useful strategy to prevent iron deficiency in young children[18]

According to **ESPGHAN**, **formula-fed infants** up to 6 months of age should receive:

Iron-fortified infant formula, with an iron content of 4 to 8 mg/L (0.6–1.2 mg/kg/day)[18]

Follow-on formulas should also be iron-fortified between 3.6 and 14 mg/L[18]

WHO, World Health Organization; ESPGHAN, The European Society for Paediatric Gastroenterology Hepatology and Nutrition

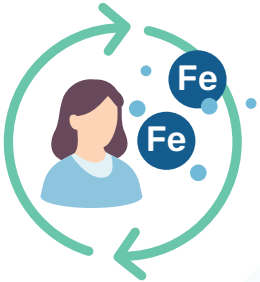
The role of prebiotics in iron deficiency

- **Iron supplements** and **iron-fortified foods** used to combat iron deficiency can cause **detrimental effects** to **gut microbiota**, resulting in constipation, diarrhea, abdominal pain, nausea and heartburn.[17]
- **Prebiotics** are **substrates** selectively utilized by host microorganisms to **modulate gut microbial balance** and confer benefits to the host.[22,23]
- **Prebiotics**, including galacto-oligosaccharides (GOS) and fructo-oligosaccharides (FOS), have been shown to **increase iron absorption by 60%.** Notably, Inulin:lcFOS blends **enhance iron bioavailability by 48%** compared to control IMF, through colonic fermentation and SCFA production**,** while also exerting a **protective effect** on intestinal microbiota.[22,27,29]

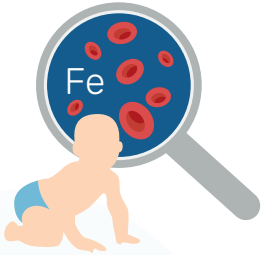
Including prebiotics as part of supplementation and fortification strategies could produce more favorable results[23]

IMF, Infant milk formula

Comprehensive strategies to manage iron deficiency



Preventing iron deficiency during **critical periods of the life cycle** is becoming an increasingly popular approach[24]



Evidence suggests that the **most effective interventions** to prevent iron deficiency should **begin early in life,** highlighting the need for **early screening** using (non-invasive) tools[25]

Health education and **nutritional interventions** should be integrated to provide a comprehensive approach to **iron deficiency management**[26]

Providing **fortified foods** or **supplements** could be helpful for people with iron deficiency. The addition of ingredients such as **vitamin C and prebiotics** can **enhance iron absorption**[18,27,29]

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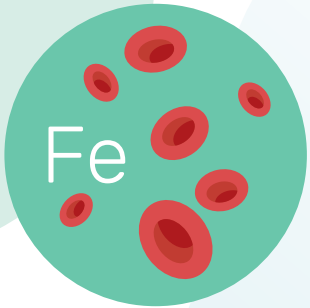

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