Overview of Impact of Flour Fortification with Iron

Althea M Grant, PhD
Chief, Epidemiology and Surveillance Branch, Division of Blood Disorders, NCBDDDD, CDC

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The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention
• Overview of physiological functions of iron and consequences of iron deficiency
• Iron Fortification:
  • Forms of iron used, types of foods fortified, and amount of iron needed
• Impact of flour fortification with the iron
  • Countries that fortify wheat flour with iron
  • Impact of iron fortification on iron deficiency
Iron

- **Essential micronutrient**
  - Hemoglobin needed to carry oxygen through the blood
  - Cellular proteins
    - Myoglobin
    - Cytochromes – energy-producing redux reactions
    - Others proteins – DNA synthesis, cell division
    - Connective tissues, neurotransmitters, and immune system

- **Most contained in red blood cells and recycled**
- **No mechanism for excretion**
- **Loss only through blood loss or sloughing**
  - Normally lose 1 mg per day
  - Menstruation – 10 mg per cycle (more for heavy bleeders)
  - Blood donation 250mg
Iron Absorption

- Iron levels controlled by absorption
- Absorption is ~ 5-10% of dietary intake
- Heme iron - animal sources (hemoglobin, myoglobin)
  - Form best absorbed
  - Mechanism of absorption not well understood
- All other iron (nonheme)
  - Absorption is affected by:
    - Precipitation in pH >7.0
    - Tannins and phytates
    - Vitamin C

Iron Deficiency Anemia

- Leading cause of anemia
- Most prevalent nutritional deficiency in the world
  - affecting approximately 2 billion persons
- Effects
  - Delay normal infant motor function or mental function
  - During pregnancy can increase risk preterm births
  - Fatigue that impairs the ability to do physical work in adults
  - Iron deficiency may also affect memory or other mental function in teens
## What Leads to Iron Deficiency Anemia?

<table>
<thead>
<tr>
<th>Increased Iron Needs</th>
<th>Decreased Iron Intake and Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rapid growth</td>
<td>1. Lack of heme iron sources in the diet (e.g., vegetarian diets)</td>
</tr>
<tr>
<td>2. Pregnancy</td>
<td>2. Low absorption</td>
</tr>
<tr>
<td>3. Blood loss</td>
<td>• Taking antacids or other medications</td>
</tr>
<tr>
<td>• Heavy menstrual periods</td>
<td></td>
</tr>
<tr>
<td>• Frequent blood donation</td>
<td></td>
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<tr>
<td>• Some stomach and intestinal conditions</td>
<td></td>
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<tr>
<td>(food sensitivity, hookworms)</td>
<td></td>
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</tbody>
</table>
Who is most at risk of iron deficiency anemia?

- **Young children**
  - 6 month to 3 yrs
  - Babies who were born early or small.
  - Babies given cow's milk before age 12 months.
  - Some breastfed babies
  - Formula-fed babies who do not get iron-fortified formulas.
  - Children aged 1–5 years who get more than 24 ounces of cow, goat, or soymilk per day.
  - Children who have special health needs, for example, children with chronic infections or restricted diets.

- **Pregnant women.**

- **Adolescent girls and women of childbearing**
  - Menstruation
# How much dietary iron do we need?

Recommended Dietary Allowance (RDA) for iron by age and sex.

<table>
<thead>
<tr>
<th>Age/Group</th>
<th>Life Stage</th>
<th>Iron (mg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>0–6 months</td>
<td>0.27*</td>
</tr>
<tr>
<td></td>
<td>7–12 months</td>
<td>11</td>
</tr>
<tr>
<td>Children</td>
<td>1–3 years</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>4–8 years</td>
<td>10</td>
</tr>
<tr>
<td>Males</td>
<td>9–13 years</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>14–18 years</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>19 or over</td>
<td>8</td>
</tr>
<tr>
<td>Females</td>
<td>9–13 years</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>14–18 years</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>19–50 years</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>51 and over</td>
<td>8</td>
</tr>
<tr>
<td>Pregnant Women</td>
<td>14 and over</td>
<td>27</td>
</tr>
<tr>
<td>Lactating Women</td>
<td>14–18 years</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>19–30 years</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>31–50 years</td>
<td>9</td>
</tr>
</tbody>
</table>

*Dietary Reference Intakes, Institute of Medicine, Food and Nutrition Board*
Strategies to Reduce Iron Deficiency

- Iron supplementation with pharmacological doses
- Iron fortification of industrially manufactured food
- Dietary diversification to improve iron bioavailability
- Selective plant breeding or genetic engineering to increase the iron content or to reduce absorption inhibitors in dietary staples

Types of Food Fortified with Iron

- **Flour**
  - Wheat
  - Corn

- **Rice**

- **Seasoning Powder**

- **Salt**

- **Sugar**

- **Curry Powder**

- **Fish Sauce**

Daily fortification iron consumption required for a satisfactory impact (results from controlled field trials)

- Sodium iron EDTA: 4.6 mg
- Ferrous sulfate or ferrous fumarate: 7.1 mg
- Electrolytic iron (elemental iron): 10 mg
- Ferric pyrophosphate: 10 mg
- Reduced iron (elemental iron): no significant impact

When to Consider National or Regional Wheat Fortification with Iron

- Iron deficiency anemia > 5%

Goal:
- Decrease prevalence of iron deficiency < 10% and iron deficiency anemia < 5% by 2-3 years after start of fortification

Determining appropriate level of fortification to reduce iron deficiency

- The chemical form of the fortification iron being added
- The level of addition
- The vehicle consumption rate
# Recommended Wheat Flour Fortification Levels Based on Trials

<table>
<thead>
<tr>
<th>Flour Consumption (g/day)</th>
<th>NaFeEDTA (ppm)</th>
<th>Ferrous sulfate or ferrous fumarate (ppm)</th>
<th>Electrolyte iron powder (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;300</td>
<td>15</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>150-300</td>
<td>20</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>75-149</td>
<td>40</td>
<td>60</td>
<td>Not recommended</td>
</tr>
<tr>
<td>&lt;75</td>
<td>40</td>
<td>60</td>
<td>Not recommended</td>
</tr>
</tbody>
</table>

Wheat Flour Fortification Status

May 2012: Fortifying with at least iron and/or folic acid

Mandatory wheat flour fortification
Effectiveness of Wheat Fortification Program

- Only 9 national programs could expect to have the desired nutritional impact
  - Millers do not follow Cuernavaca or WHO guidelines
  - Fortification with atomized and hydrogen-reduced elemental iron powders
  - Use of fortification levels that are too low based on consumption patterns

Summary and Recommendations

- Iron fortification is efficacious for reducing iron-deficiency (based on trials)
- In order for iron fortification to be effective
  - Using recommended iron compounds
  - Use adequate concentration based on consumption patterns
Thank You

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333
Telephone, 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: www.cdc.gov

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