Faculty of Medicine
Blood and Lymphatic System

Epidemiology, risk factors and prevention of Anemia

By
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12- 3-2017
# Presentation outline

<table>
<thead>
<tr>
<th>Topic</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction and Definition of Anemia</td>
<td>12:00 to 12:10</td>
</tr>
<tr>
<td>Epidemiology of Anemia: globally and locally</td>
<td>12:10 to 12:20</td>
</tr>
<tr>
<td>Anemia health effects and risk factors</td>
<td>12:20 to 12:30</td>
</tr>
<tr>
<td>Prevention and Control of Anemia</td>
<td>12:30 to 12:40</td>
</tr>
<tr>
<td>Screening for Anemia (IDA)</td>
<td>12:40 to 12:50</td>
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</tbody>
</table>
Anemia: Définitions

• Anemia is defined as reduction in the oxygen carrying capacity of blood, as observed by reduced levels of hemoglobin concentration and red cell mass (Hematocrit) leading to tissue hypoxia.

• Anaemia can be defined as a reduction in the haemoglobin in the blood below normal range for age and sex.
Anemia: Definition

- Anemia from the Greek word (ναιμία)(an-haîma) meaning "without blood", is a deficiency of red blood cells (RBCs) and/or hemoglobin

- Definition:
  Anemia is a symptom of disease that requires investigation to determine the underlying etiology.

It is defined as a decrease in red blood cell mass but in practice it is defined by haemoglobin concentrations below:

- Males 13.0 g/dL (WHO)
- females 12.0 g/dL (WHO)
Anaemia

• Prevalence
  – Widespread public health problem with major consequences for human health and socio-economic development
  – WHO estimates 2 billion people are affected worldwide
  – >50% due to iron deficiency
THE GLOBAL PREVALENCE OF ANAEMIA IN 2011

• Globally, the mean blood haemoglobin concentration was 111 g/L in children,
• 126 g/L in non-pregnant women,
• and 114 g/L in pregnant women, indicating that, on average, all population groups were above the threshold for mild anemia (110 g/L for children and pregnant women and 120 g/L for non-pregnant women)
The prevalence of anemia as a public health problem is categorized as follows:

- <5%, no public health problem;
- 5–19.9%, mild public health problem;
- 20–39.9%, moderate public health problem;
- ≥40%, severe public health problem.

### Table 3. Number of countries\textsuperscript{a} categorized by public health significance of anaemia, 2011

<table>
<thead>
<tr>
<th>Category of public health problem\textsuperscript{b}</th>
<th>Children (6–59 months)</th>
<th>Non-pregnant women (15–49 years)</th>
<th>Pregnant women (15–49 years)</th>
<th>All women of reproductive age (15–49 years)</th>
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<tbody>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mild</td>
<td>32</td>
<td>44</td>
<td>2</td>
<td>42</td>
</tr>
<tr>
<td>Moderate</td>
<td>84</td>
<td>109</td>
<td>146</td>
<td>110</td>
</tr>
<tr>
<td>Severe</td>
<td>69</td>
<td>32</td>
<td>37</td>
<td>33</td>
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</table>

\textsuperscript{a} The prevalence of anemia as a public health problem is categorized as follows:

- <5%, no public health problem;
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- 20–39.9%, moderate public health problem;
- ≥40%, severe public health problem.
Table A3.4 Country estimates for all women of reproductive age (15–49 years), continued

| Country                  | Mean blood haemoglobin concentration (g/L) | Percentage of women with anaemia (blood haemoglobin concentration <120 g/L for non-pregnant women and <110 g/L for pregnant women) | Percentage of women with severe anaemia (blood haemoglobin concentration <80 g/L for non-pregnant women and <70 g/L for pregnant women) | Level of public health significance*
<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Estimate 95% CI</td>
<td>Estimate 95% CI</td>
<td>Estimate 95% CI</td>
<td>Estimate 95% CI</td>
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<tr>
<td>Iran (Islamic Republic of)</td>
<td>126 119 to 133</td>
<td>28 13 to 48</td>
<td>0.8 0.1 to 2.6</td>
<td>Moderate</td>
</tr>
<tr>
<td>Iraq</td>
<td>125 116 to 134</td>
<td>31 12 to 54</td>
<td>1.1 0.2 to 3.8</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ireland</td>
<td>129 122 to 135</td>
<td>17 8 to 40</td>
<td>0.5 0.1 to 2.2</td>
<td>Mild</td>
</tr>
<tr>
<td>Israel</td>
<td>129 121 to 134</td>
<td>17 9 to 40</td>
<td>0.4 0.0 to 1.7</td>
<td>Mild</td>
</tr>
<tr>
<td>Italy</td>
<td>128 121 to 134</td>
<td>19 9 to 43</td>
<td>0.6 0.1 to 2.5</td>
<td>Mild</td>
</tr>
<tr>
<td>Jamaica</td>
<td>128 119 to 136</td>
<td>24 9 to 51</td>
<td>0.9 0.1 to 3.0</td>
<td>Moderate</td>
</tr>
<tr>
<td>Japan</td>
<td>127 122 to 130</td>
<td>22 13 to 37</td>
<td>1.1 0.3 to 2.8</td>
<td>Moderate</td>
</tr>
<tr>
<td>Jordan</td>
<td>126 123 to 129</td>
<td>28 21 to 37</td>
<td>0.5 0.2 to 0.9</td>
<td>Moderate</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>126 119 to 132</td>
<td>30 13 to 50</td>
<td>0.9 0.1 to 3.0</td>
<td>Moderate</td>
</tr>
<tr>
<td>Kenya</td>
<td>131 116 to 141</td>
<td>25 6 to 57</td>
<td>1.6 0.4 to 3.7</td>
<td>Moderate</td>
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<tr>
<td>Kiribati</td>
<td>128 120 to 135</td>
<td>21 9 to 46</td>
<td>0.7 0.0 to 2.9</td>
<td>Moderate</td>
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<tr>
<td>Kuwait</td>
<td>129 121 to 136</td>
<td>22 9 to 43</td>
<td>0.5 0.1 to 2.0</td>
<td>Moderate</td>
</tr>
<tr>
<td>Kyrgyzstan</td>
<td>124 118 to 131</td>
<td>32 15 to 51</td>
<td>1.2 0.2 to 3.6</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Anemia: health effects

Effects on health

• Increased maternal and child mortality

• Decreased cognitive and physical development in children

• Decreased productivity in adults

• Increased risk of postoperative morbidity and mortality

• Others
Anemia and Maternal Health

• an underlying cause of maternal death and prenatal and perinatal infant loss
• premature delivery, placental hypertrophy, and reduced excretion of estriol (maternal hormone) have been observed to be more common in mildly anemic mothers than in nonanemic mothers
Effects of Anemia on Mental Performance

• impaired cognitive and intellectual performance,
• motor development,
• coordination,
• language development,
• and scholastic achievement
• Other effects include irritability, apathy, lack of attention, reduced learning capacity, and low school performance scores.
Anemia and Resistance to Infections

• Increases morbidity from infectious diseases

• iron supplementation has been shown to have a beneficial effect upon the incidence of infection

• The antibacterial affects of two iron-binding proteins, transferrin and lactoferrin, have been studied.

• These proteins prevent microorganisms from using iron and thereby limit the microorganisms growth.
Effect on Work Capacity

• direct relationship between hemoglobin concentration and the physical performance of agricultural workers

• the work capacity of anemic persons can be increased by iron supplementation
Other effects

- A recent document prepared by the Micronutrient Initiative on the Economic Consequences of Iron Deficiency analyzed relationships between anemia and several economically quantifiable factors, including
  - lower future productivity of children
  - lower current productivity of adults
  - costs for care of low birth weight and premature infants
  - cost of maternal mortality

other consequences on growth

- decreases in immunity and increased absenteeism due to infectious disease
  - increases in morbidity and mortality
  - greater susceptibility to heavy metal toxicity
Anemia: Symptoms

Signs depend on the severity of anemia
High risk population

- Infants, children, and adolescents who are growing quickly
- People who do not get enough iron in their diet
- People who use aspirin, ibuprofen, or other arthritis medicines long-term
- Pregnant or breastfeeding women who need extra iron
- Seniors
- Women of child-bearing age who have lost blood through heavy menstrual periods
Common Causes for Various Types of Anemia

1.) Hypochromic, microcytic:
   • Iron Deficiency
   • Thalassemia syndromes
   • Sideroblastic anemia
   • Transferrin deficiency

2.) Macrocytic:
   • Megaloblastic Anemias
   • (Folic acid/ B12 deficiencies)
   • Liver Disease
   • Reticulocytosis
   • Normal newborn
   • Bone marrow failure syndromes
   • Drugs (AZT, Trimethoprim sulfate)

3.) Normocytic, normal morphology:
   • Hemorrhage or blood loss
   • Unstable hemoglobins
   • Infections
   • Chronic disease

4.) Normocytic, abnormal morphology:
   • Hemoglobinopathies, (SS, SC, CC)
   • Hereditary Spherocytosis
   • Autoimmune hemolytic anemia
   • Some enzymatic deficiencies
Clinical and Lab
These questions can be answered using a few readily available clinical tests:

• 1.) Is the patient anemic? Complete blood count (CBC), Hb, Hct

• 2.) Is there decreased RBC production, increased RBC destruction, or RBC loss? Reticulocyte count

• 3.) Is the anemia micro, macro, or normocytic? RBC Indices

• 4.) Is the anemia hypo or normochromic? RBC Indices

• 5.) Is the RBC morphology normal or abnormal? Peripheral blood smear
<table>
<thead>
<tr>
<th>AGE</th>
<th>Hb (gm%)</th>
<th>RBC (m/L)</th>
<th>HCT %</th>
<th>MCV (cu. mm)</th>
<th>MCH (pg)</th>
<th>MCHC %</th>
<th>Reticulocyte %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>18.0</td>
<td>5.14</td>
<td>61</td>
<td>119</td>
<td>36.0</td>
<td>31.6</td>
<td>32</td>
</tr>
<tr>
<td>4 weeks</td>
<td>14.2</td>
<td>4.0</td>
<td>43</td>
<td>106</td>
<td>35.5</td>
<td>33.5</td>
<td>0.6</td>
</tr>
<tr>
<td>1 year</td>
<td>11.6</td>
<td>4.6</td>
<td>35</td>
<td>77</td>
<td>25.0</td>
<td>33.0</td>
<td>0.9</td>
</tr>
<tr>
<td>10-12 years</td>
<td>13.0</td>
<td>4.8</td>
<td>39</td>
<td>80</td>
<td>27.0</td>
<td>33.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Adult-Men</td>
<td>16.0</td>
<td>5.4</td>
<td>47</td>
<td>87</td>
<td>29.0</td>
<td>34.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Adult-women</td>
<td>14.0</td>
<td>4.8</td>
<td>42</td>
<td>87</td>
<td>29.0</td>
<td>34.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Anaemia

Two general reasons for anaemia

– decreased red cell production
– increased red cell destruction

• Causes

– Nutritional deficiencies
  • Iron, B12, Folate, Vitamin A

– Infectious diseases
  • Malaria, helminth infections (hookworm and schistosomiasis), HIV
  • Thalassaemias, sickle cell, haemolytic anaemia, leukaemia

– Cancer, chronic renal disease, diabetes, heart disease, rheumatoid arthritis, gastrointestinal disease
– Chemotherapy, radiotherapy
There are **four basic causes of anemia**

- loss,
- destruction,
- sequestration
- and hypoproduction.

**Major causes**

- Iron deficiency (1300-2200 m)
- Hookworm (876 m)
- Vitamin A deficiency (300 m)
- Malaria infection (300 m)

**Other Important causes**

- Chronic infections: TB, HIV
- Other vitamins
- Genetic defects
Deficiency of vitamins may cause anemia

- RBC production (erythropoeisis)
- Protect mature RBC free radical oxidation
- Fe mobilization
- Fe absorption

- VA, FA, B12, B6, riboflavin
- VC, VE
- VA, VC, riboflavin

Fishman, Christian and West et al, PHN 2000
• These major micronutrients, provided in a balanced diet, are iron, vitamin B\textsubscript{12} and folate.

• A deficiency in any one of these micronutrients can result in anaemia through impaired red cell production within the bone marrow.
Developing a Strategy for Anemia Prevention and Control

• **Know the problem**
  - Determine the prevalence of anemia and identify priority target groups (those with the highest anemia and who suffer most from the consequences of anemia); collect available information on the causes of anemia; and programs to prevent and control it.
  - Determine what people know about anemia and their experience with anemia prevention and control.

• **Raise awareness and develop partnerships**
  - Raise awareness about the costs to individuals and countries of not addressing anemia and the integrated package to prevent and control anemia within health teams and across sectors: advocate and educate.
  - Build partnerships in health, agriculture, food, and pharmaceutical sectors among government ministries and agencies, nongovernmental organizations (NGO), donors, industry, and commerce.
  - Delivering an integrated package, in most countries, requires a multi-sectoral response

• **Develop interventions and implementation plans**
  - Identify priorities, responsibilities, and timeframes.
  - Identify specific objectives.
  - Identify potential collaborating groups (universities, government agencies, NGOs, civic groups, commercial entities).
  - Review existing programs and determine and develop anemia prevention and control activities.
  - Determine and secure staffing, funding, and other resources for implementing activities.
  - Develop a monitoring and evaluation plan.
Important contributing factors that reduce the prevalence of anemia include:

- preventing adolescent pregnancies,
- increasing birth intervals,
- and limiting the number of pregnancies and births.

Exclusive breastfeeding for about 6 months followed by breastfeeding with complementary feeding into the second year of life could also benefit the iron status of women.

Dealing with obstetric and gynecologic complications are also important since they may cause bleeding and consequent iron loss.
ANEMIA CONTROL AND PREVENTION

Integrated Anemia Control and Prevention Strategy:
• dietary improvement through education to encourage selection of iron-rich foods to improve iron content and bioavailability
• fortification (adding iron to common foods) and fermentation (reducing inhibitors of iron absorption)
• iron supplementation and deworming; distributing pills by means of the health system
• malaria control
• linking intervention strategies to related health and nutrition programs
IRON DEFICIENCY

Iron deficiency is the most common micronutrient deficiency in the world affecting 1.3 billion people i.e. 24% of the world population.

In comparison only 275 million are iodine deficient and 45 million children below age 5 years are Vitamin A deficient.
IRON DEFICIENCY /2

Iron deficiency can range from sub-clinical state to severe iron deficiency anemia.

Different stages are identified by clinical findings & lab tests.

Anemia is defined as a hemoglobin below the 5th percentile of healthy population.

Most studies showed this cutoff point to be around 11 g/dl (-2SD below the mean).
AT RISK GROUPS

- Infants
- Under 5 children
- Children of school age
- Women of child bearing age
## PREVALENCE OF ID

<table>
<thead>
<tr>
<th>Region</th>
<th>0-4yr</th>
<th>5-12yr</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Asia</td>
<td>56%</td>
<td>50%</td>
<td>58%</td>
</tr>
<tr>
<td>Africa</td>
<td>56%</td>
<td>49%</td>
<td>44%</td>
</tr>
<tr>
<td>Latin Am</td>
<td>26%</td>
<td>26%</td>
<td>17%</td>
</tr>
<tr>
<td>Gulf Arabs</td>
<td>40%</td>
<td>36%</td>
<td>38%</td>
</tr>
<tr>
<td>Developed</td>
<td>12%</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>World</td>
<td>43%</td>
<td>37%</td>
<td>35%</td>
</tr>
</tbody>
</table>
ETIOLOGY

- Inadequate intake of iron & of food, which enhances iron absorption.
- High intake of inhibitors of iron absorption
- Hookworm infestation.
- Blood loss (heavy menses & use of aspirin & NSAID).
- High fertility rate in women.
- Low iron stores in newborns.
Consequences of Iron Deficiency

- Increase maternal & fetal mortality.
- Increase risk of premature delivery and LBW.
- Learning disabilities & delayed psychomotor development.
- Reduced work capacity.
- Impaired immunity (high risk of infection).
- Inability to maintain body temperature.
- Associated risk of lead poisoning because of pica.
Prevention Of IDA

• **Primary prevention** involves **counseling at routine health supervision visits from infancy through adolescence** to help ensure that ingestion of dietary iron is adequate.

• **Secondary prevention** involves **regular screening, prompt diagnosis, and appropriate treatment of iron deficiency**.

• Hgb and Hct are the most commonly used screening tests for iron deficiency.
Prevention of Iron Deficiency

• **Dietary modification**
  – Breast feeding and appropriate weaning diet
  – Iron rich food
  – Increase ascorbic acid
  – Decrease inhibitors

• Food fortification
• Iron supplemetation
Prevention of Iron Deficiency

• Dietary modification

• **Food fortification**
  – Salt fortification by NIN

• Iron supplementation
Prevention of Iron Deficiency

• Dietary modification
• Food fortification

• Iron supplementation
  – Preterm and LBW babies-10-15 mg/day iron
  – Iron supplementation during puberty
Prevention

- Breast feeding and appropriate weaning diet
- Iron rich food
- Increase ascorbic acid
- Decrease inhibitors
- Salt fortification by NIN
- Preterm and LBW babies - 10-15 mg/day iron
- Iron supplementation during puberty
  - *Deworming*
  - *Foot wear use*
  - *Safe drinking water*
DIETARY IRON

- There are 2 types of iron in the diet; haem iron and non-haem iron
- Haem iron is present in Hb containing animal food like meat, liver & spleen
- Non-haem iron is obtained from cereals, vegetables & beans
- Milk is a poor source of iron, hence breast-fed babies need iron supplements
IRON ABSORPTION

- Haem iron is not affected by ingestion of other food items.
- It has constant absorption rate of 20-30% which is little affected by the iron balance of the subject.
- The haem molecule is absorbed intact and the iron is released in the mucosal cells.
The absorption of *non-haem iron* varies greatly from 2% to 100% because it is strongly influenced by:

- The iron status of the body
- The solubility of iron salts
- Integrity of gut mucosa
- Presence of absorption inhibitors or facilitators
INHIBITORS OF IRON ABSORPTION

- **Food with polyphenol compounds**
  - Cereals like sorghum & oats (ذرّة والشوفان)
  - Vegetables such as spinach and spices (السبانخ والتوابل)
  - Beverages like tea, coffee, cocoa and wine.
  - **A single cup of tea taken with meal reduces iron absorption by up to 11%**.

- **Food containing phytic acid** i.e. Bran, cereals like wheat, rice, maize & barely. Legumes like soya beans, black beans & peas.

- **Cow’s milk due to its high calcium & casein contents**.
INHIBITION-HOW?

- The dietary phenols & phytic acids compounds bind with iron decreasing free iron in the gut & forming complexes that are not absorbed.
- Cereal milling to remove bran reduces its phytic acid content by 50%.
Promoters of Iron Absorption

- Foods containing **ascorbic acid like** citrus fruits, broccoli & other dark green vegetables because **ascorbic acid reduces iron from ferric to ferrous forms, which increases its absorption.**

- Foods containing **muscle protein** enhance iron absorption due to the effect of cysteine containing peptides released from partially digested meat, which reduces ferric to ferrous salts and form soluble iron complexes.
IRON ABSORPTION (3)

Some fruits inhibit the absorption of iron although they are rich in ascorbic acid because of their high phenol content e.g. strawberry, banana and melon.

Food fermentation aids iron absorption by reducing the phytate content of diet.
LAB FINDINGS IN IDA

- Microcytic hypochromic anaemia
- Low Hb level (< 11.0 g/dl)
- Low MCV, MCH, MCHC
- Low serum ferritin
- High RWD
- High iron binding capacity
- High erythrocyte protoporphyrin
PREVENTION OF IDA

- **Short term approach:**
  - supplementation with iron tablets.

- **Long-term approach:**
  - food fortification with iron either for the whole population (blanket fortification) or for specific target groups like infants. It requires no cooperation from users unlike taking iron supplements.
Thalassemia Syndromes

• **inherited** mutations that decrease the synthesis of either the α-globin or β-globin chains that compose adult hemoglobin, HbA (α2β2)

• endemic in the Mediterranean basin, the Middle East, tropical Africa, the Indian subcontinent,
• β-thalassemia is inherited in an autosomal recessive manner
• β-thalassemia is one of the major inherited disorders in Jordan, with the carrier rate for the disease estimated at 24%-
• Premarital Screening-- obligatory premarital screening for β-thalassemia, in 2007
• Prenatal Diagnosis- chorionic villus samples
Beta-thalassemia in Jordan

- The carrier prevalence rate of beta thalassemia in Jordan is around 4%.
- The birth incidence for beta thalassemia is about 1 in 2500 livebirths
- The registered number of beta thalassemia patients in the Kingdom is around 1200
- It is estimated that without a control program, 80-90 new cases of beta thalassemia will be born annually
Beta-thalassemia premarital screening program

- **Education of the public**
- **Training of health personnel**

**Pre-screening Counseling**

**Screening test**

**Interpretation of test**

- Both or one non-carrier
- Both are carriers

Report that test was done
Both are carriers

Confirmatory Test

Both are carriers

Counseling by Specialist

Both or one non-carrier

Report that test was done

Non-stigmatization
Confidentiality
Autonomy of decision

Report that test was done