Micronutrient Deficiencies in Ethiopia, Present situation and way forward

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DRD MI Africa
Introduction

Micronutrient deficiency
(Vitamins & Minerals Deficiency VMD)

• A “new” old problem
• Known for several decades – anemia, cretinism, spina bifida and blindness

• Last decade: the importance/impact of intermediate levels of deficiencies without overt manifestations

• Mild levels of VMD: are extremely common in almost all countries
The Copenhagen Consensus

Books published from 2004 Consensus

2008 Consensus cost $2m, funded by Danish Ministry of Foreign Affairs
Eight world-renowned economists


* Denotes Nobel prize winner
10 Development Challenges

- Diseases
- Malnutrition and Hunger
- Air Pollution
- Sanitation and Water
- Conflicts
- Subsidies and Trade Barriers
- Education
- Terrorism
- Global Warming
- Women and Development
# Top solutions – renowned economists

<table>
<thead>
<tr>
<th>Solution</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Micronutrient supplements for children (A&amp;zinc)</td>
<td>Malnutrition</td>
</tr>
<tr>
<td>2 The Doha development agenda</td>
<td>Trade</td>
</tr>
<tr>
<td>3 Micronutrient fortification (iron and salt iodization)</td>
<td>Malnutrition</td>
</tr>
<tr>
<td>4 Expanded immunization coverage for children</td>
<td>Diseases</td>
</tr>
<tr>
<td>5 Biofortification</td>
<td>Malnutrition</td>
</tr>
<tr>
<td>6 Deworming, other nutrition programs in school</td>
<td>Malnutrition</td>
</tr>
<tr>
<td>7 Lowering the price of schooling</td>
<td>Education</td>
</tr>
<tr>
<td>8 Increase and improve girl’s schooling</td>
<td>Women</td>
</tr>
<tr>
<td>9 Community-based nutrition programs</td>
<td>Malnutrition</td>
</tr>
</tbody>
</table>
EXPERT PANEL FINDINGS 2012
Copenhagen, Denmark

What are the best ways of advancing global welfare, and particularly the welfare of developing countries, illustrated by supposing that an additional $75 billion of resources were at their disposal over a 4-year initial period?

The goal of Copenhagen Consensus 2012 was to set priorities among a series of proposals for confronting ten of the world’s most important challenges. These challenges were examined:

- Armed Conflict
- Chronic Disease
- Education
- Infectious Disease
- Population Growth
- Biodiversity
- Climate Change
- Hunger and Malnutrition
- Natural Disasters
- Water and Sanitation
The expert panel allocates its budget of $75 billion over four years as follows:

<table>
<thead>
<tr>
<th>Solution</th>
<th>Amount Allocated Per Year, in $US Billion Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundled Interventions to Reduce Undernutrition in Pre-Schoolers</td>
<td>3.0</td>
</tr>
<tr>
<td>Subsidy for Malaria Combination Treatment</td>
<td>0.3</td>
</tr>
<tr>
<td>Expanded Childhood Immunization Coverage</td>
<td>1.0</td>
</tr>
<tr>
<td>Deworming of Schoolchildren</td>
<td>0.3</td>
</tr>
<tr>
<td>Expanding Tuberculosis Treatment</td>
<td>1.5</td>
</tr>
<tr>
<td>R&amp;D to Increase Yield Enhancements</td>
<td>2.0</td>
</tr>
<tr>
<td>Investing in Effective Early Warning Systems</td>
<td>1.0</td>
</tr>
<tr>
<td>Strengthening Surgical Capacity</td>
<td>3.0</td>
</tr>
<tr>
<td>Hepatitis B Immunization</td>
<td>0.12</td>
</tr>
<tr>
<td>Acute Heart Attack Low-Cost Drugs</td>
<td>0.2</td>
</tr>
<tr>
<td>Salt Reduction Campaign</td>
<td>1.0</td>
</tr>
<tr>
<td>Geo-Engineering R&amp;D</td>
<td>1.0</td>
</tr>
<tr>
<td>Conditional Cash Transfers for School Attendance*</td>
<td>1.0</td>
</tr>
<tr>
<td>Accelerated HIV Vaccine R&amp;D</td>
<td>0.1</td>
</tr>
<tr>
<td>Information Campaign on Benefits From Schooling*</td>
<td>1.34</td>
</tr>
<tr>
<td>Borehole and Public Hand Pump Intervention</td>
<td>1.89</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$18.75</strong></td>
</tr>
</tbody>
</table>
## Hunger and Malnutrition: Costs of all five solutions

<table>
<thead>
<tr>
<th>Solution</th>
<th>Numbers affected (million)</th>
<th>Cost/person/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Micronutrient supplements</td>
<td>58</td>
<td>$0.20 (vit A) $1.00 (zinc)</td>
</tr>
<tr>
<td>2. Micronutrient fortification</td>
<td>2500</td>
<td>$0.05 (salt) $0.12 (iron)</td>
</tr>
<tr>
<td>3. Biofortification (plant breeding)</td>
<td>36 countries</td>
<td>$0.75m/country</td>
</tr>
<tr>
<td>4. Deworming</td>
<td>53</td>
<td>$0.50</td>
</tr>
<tr>
<td>5. Nutrition education</td>
<td>114</td>
<td>$7.00</td>
</tr>
</tbody>
</table>

Priorities are to reach 80% coverage in South Asia and Sub-Saharan Africa, increasing from current coverage levels of 72% (vitamin A), negligible (zinc), negligible (iron), 64% (iodized salt), negligible (plant breeding), negligible (preschool deworming), very low (community nutrition education)
Interventions to Address Vitamin and Mineral Deficiencies
Phasing of Micronutrient Interventions

- Supplementation
- Public Health Measures
- Fortification
- Dietary improvement

Relative contribution of interventions to eliminate MND

2000 2005 2010
Central fortification

- With careful choice of the fortificant and target food and amount added, fortification can improve MN status of all at-risk groups
- Proven in developed countries over the last century
- Extremely cost-effective compared to supplementation
- With change in life style and food consumption habit fortification might be the only option to meet micronutrient requirement
- Penetration and reach depends on selection of target food
- There are few examples of widespread application of the approach in developing countries.
Home Fortification

- Home fortification mixtures with appropriate amounts of absorbable MN compounds can be formulated to improve or maintain the MN status of infants, children, pregnant and non-pregnant women.
- In children, highly effective at reduction Fe deficiency (RR 0.44 [0.22, 0.86]) and anemia (RR 0.54 [0.46, 0.64]).
- There is no evidence that home fortification is not safe, but no studies have focused on safety in malaria endemic areas.
Home fortification: MN powder

- **Guideline**: Use of MN powders for home fortification of foods consumed by infants and **children 6 – 23 months of age**

- **WHO recommendation**:
  - Home fortification of foods with MN powders is **recommended** to improve iron status and reduce anaemia among infants and children 6–23 months of age (**strong recommendation**)
Suggested scheme for home fortification with multiple micronutrient powders of foods consumed by infants and children 6–23 months

| Composition per sachet<sup>a</sup> | • Iron: 12.5 mg of elemental iron, preferably as encapsulated ferrous fumarate<sup>b</sup>  
| | • Vitamin A: 300 μg of retinol  
| | • Zinc: 5 mg of elemental zinc, preferably as zinc gluconate |
| Frequency | One sachet per day |
| Duration and time interval between periods of intervention | At minimum, for a period of 2 months, followed by a period of 3–4 months off supplementation, so that use of the micronutrient powders is started every 6 months |
| Target group | Infants and children 6–23 months of age, starting at the same time as weaning foods are introduced into the diet |
| Settings | Populations where the prevalence of anaemia in children under 2 years or under 5 years of age is 20% or higher |
Dietary Diversification & Modification

example - iron

- Bioavailability of MN impacts absorption - choosing Dietary Sources - there are two types of iron:

  ➢ Heme:
    - Found in meat, poultry and fish
    - Provides 1/3 of total daily iron that the body absorbs
    - Average ~15-35% absorption; not affected by dietary factors

  ➢ Non-Heme:
    - eggs and plant-based foods such as legumes, vegetables, fruits, grains and iron-fortified cereal products, nuts and seeds
    - Only 3-10% absorption; affected by enhancing or inhibitory dietary factors

- Including Vitamin C-rich fruit/vegetables with meals can double or triple iron absorption; reduces ferric (Fe3+) to ferrous(Fe2+)

Refer to HealthLinks BC Nutrition Series File #68d Iron in Foods
DDM...Iron

- Our bodies will typically absorb ~18% of iron from a mixed iron diet (heme and non-heme) with Vitamin C-rich foods.

**Enhancers**

- **Vitamin C-rich foods**

  - Meat, poultry, or fish [MFP factor]

**Inhibitors**

- **Polyphenols**
  - coffee, tea (tannins), herbal teas, cocoa-containing beverages taken within 1 hour of meals

- **Phytates**
  - legumes (dried peas, beans, lentils), grains, rice, soybeans

- **Oxalates**
  - spinach, chard, beet greens, rhubarb, sweet potato

- **Calcium** intake at levels >300 mg
DDM Iron

Increased iron bioavailability of traditional foods

1. Germination (50 - 64% -↓ phytate)
2. Microbial fermentation (up to 90% -↓ phytate)
3. Soaking (47 - 98%- ↓ phytate)
4. Adding ascorbic acid containing foods
5. Use of iron cooking pots
   • generally unsuccessful at closing the Fe gap for young children
   • Fe-rich animal source foods are expense and often unavailable
   • Use of Fe pots has had limited success. Excess Fe content (e.g. fermented beverages) may be a risk.

Summary: It is unlikely that DDM strategies alone will be sufficient in most low-income populations.
Vitamin A - Introduction

Vitamin A was discovered in 1917 by Elmer McCollum at the University of Wisconsin–Madison, and Lafayette Mendel and Thomas Burr Osborne at Yale University.

In 1919, Steenbock (University of Wisconsin) proposed a relationship between yellow plant pigments (beta-carotene) and vitamin A.

Vitamin A can be found in different principal forms:
Dietary sources

Animal Sources of Vitamin A
The best food sources of pre-formed active retinol, which is most effectively used by the body, are animal foods. These include breast milk, egg yolks, organ meats such as liver, whole milk, and milk products, fish, cod liver oil, butter.

Plant Sources of Vitamin A
Plants contain beta-carotene that needs to be converted into retinol by the body. The best plant sources of vitamin A are dark orange or dark yellow fruits and vegetables such as papayas, mangos, carrots, sweet potatoes and dark green vegetables such as spinach, kale.
Deficiencies

One of the earliest and specific manifestations of vitamin A deficiency is impaired vision, particularly in reduced light – night blindness. Some ocular changes are referred to as xerophthalmia.

First there is dryness of the conjunctiva (xerosis) as the normal lacrimal and mucus-secreting epithelium is replaced by a keratinized epithelium.

This is followed by the build-up of keratin debris in small opaque plaques (Bitot's spots)

Eventually, erosion of the roughened corneal surface with softening and destruction of the cornea (keratomalacia) and total blindness
Supplementation

A meta-analysis of 43 studies showed that vitamin A supplementation of children under five who are at risk of deficiency reduces mortality by up to 24% (diarrhea, ARI, Measles).

The World Health Organization estimates that Vitamin A supplementation has averted **1.25 million deaths due to vitamin A deficiency** in 40 countries since 1998.
Supplementation- in Ethiopia

In Ethiopia, 1. Biannual high dose vitamin A capsules supplementation to children aged 6-59 months has been ongoing since 2004/05 through different programs as one of the key child survival interventions.

The objective is to achieve and sustain 99% biannual coverage of vitamin A supplementation by 2015.
Supplementation - treatment other diseases

Treatment for Children with Severe Acute Malnutrition

Infants 6-11 months 100,000 I.U. One dose at first contact with health unit and then as to the management of severe acute malnutrition guideline

Children 12-59 months 200,000 I.U. One dose at first contact with health unit and then as to the management of severe acute malnutrition guideline
Supplementation-Cont’d

Treatment for Children with persistent diarrhea
Infants 6-11 months 100,000 IU One dose
Children 12-59 months 200,000 IU One dose

Treatment for Children With Xerophthalmia or Measles
Immediately on diagnosis
Next day
15 days later
VAS Delivery Mechanism Cont--

2. **Community Health Dsays (CHD):** The CHDs are quarterly events that are organized locally at kebele level by health extension workers. In CHDs vitamin A supplementation and de-worming are conducted every six months while nutritional screening of children 6-59 months and pregnant and lactating women is conducted every three months.

Currently delivered in 4 Agrarian regions (Tigray, Amhara, Oromia & SNNP)
3. **Routine Health Service (HEP):** The routine HEP modality is a daily service delivery of VAS which is mainly a mix of facility based, outreach and house to house delivery. Routine service delivery of VAS is complete integration of VAS delivery into the existing routine health system (HEP).

Currently delivered in 3 Urban regions (Addis Ababa, Diredawa & Harare)

Piloted in the 4 Agrarian regions
Transitioning Activities

Amhara, Oromia and SNNP regions have conducted planning and performance review meeting for the HEP implementing woredas and 2013 planned woredas.

In Tigray region sensitization workshop conducted at regional level.

VAS household message developed and currently on air (Radio).

Final routine monitoring tool developed and sent to regions.

VAS is integrated to IRT, ISS & HMIS.
Challenges

Shortage of VAC in Urban regions (distribution?)

Lack of the integration of VAC to the essential health commodity (PFSA)

Delay in reporting CHD/EOS coverage data

Implementation problem in routine VAS in Urban areas
The Way Forward

Scale up of routine HEP delivery of VAS to more woredas

Discuss with PFSA and resource mobilization directorate for integration of VAC into the logistic system

Conduct National performance review meeting

Support quarterly supportive supervision

Integration of VAS to LMIS and woreda based planning

Regular EOS transition TWG meeting
Iodine - Introduction

Iodine deficiency has serious effects on body growth and mental development.

Iodine deficiency is related to a number of adverse pregnancy outcomes, including abortion, foetal brain damage, congenital malformation, stillbirth, and prenatal death.

The principal cause of iodine deficiency is inadequate iodine in foods.

Fortification of salt with iodine is the most common method of preventing iodine deficiency.
USI program in Ethiopia

As far back as 1988, Ethiopia achieved almost 80% iodized salt coverage,
The 1998–2000 war b/n Ethiopia and Eritrean interrupted Ethiopia’s iodized salt supply and dropped as low as 5%
By 2011, the HH iodized salt usage was 15.4% (EDHS, 2011)
By January 2012, salt regulation #204/2011 makes it mandatory to iodize salt for human consumption
The coverage increased to
95% by 2013 (FMoH with a date at the production site)
86% by 2013 (ENGINE baseline survey)
Iodine status of children in Ethiopia

Limited data on iodine status of children in Ethiopia

A. Cherinet et al, 2000

A study in 10 villages of four regions on school children (6-12 yrs old)

Gross prevalence of goiter among school children was 53.3%.

Of the urinary measurements, 70% of the samples showed moderate and 30% mild iodine deficiency

N. Berhanu et al, 2004

A study to assess endemic goiter in School Children in Southwestern Ethiopia

The prevalence of goiter among the study population was found to be 27.4%
The way forward

More studies need to be conducted to estimate the current magnitude of the problem on children.

The USI program and the enforcement banning the sell of uniodized salt need to be strengthened.

The coverage of adequately iodized salt nationwide need to be assured.

Special emphasis should be given to mother and children for adequate intake of iodized salt.
Iron - Introduction

- Anemia is a functional inability of the blood to supply the tissue with adequate $O_2$ for proper metabolic function.
  - decreased levels of Hb,
  - decreased packed cell volume HCT, and/or
  - decreased RBC count
- Hb concentration < 2 SD
- Age, Sex, altitude, lung disease & condition, smoking habit

### Table 1. Hemoglobin cutoffs to define anemia in people living at sea level

<table>
<thead>
<tr>
<th>Age or sex group</th>
<th>Hemoglobin below (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td></td>
</tr>
<tr>
<td>6 months to 5 years</td>
<td>110</td>
</tr>
<tr>
<td>5 to 11 years</td>
<td>115</td>
</tr>
<tr>
<td>12 to 14 years</td>
<td>120</td>
</tr>
<tr>
<td>Nonpregnant females &gt; 15 years</td>
<td>120</td>
</tr>
<tr>
<td>Men &gt; 15 years</td>
<td>130</td>
</tr>
</tbody>
</table>

Normal RBCs

Anemic RBCs
Causes of Anemia

- Iron deficiency
- Anemia

- Hookworm
- Malaria
- Chronic infections: TB, HIV/AIDS

- Vitamin B12, folate & Vitamin A

- Anemia of Inflammatory Conditions

- Hemoglobinopathies
  - Sickle cell anemia
  - Sideroblastic anemia…

Solutions for hidden hunger
# Relevance of anemia in Ethiopia

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>28%</td>
<td>20%</td>
</tr>
<tr>
<td>mild Anaemia</td>
<td>21%</td>
<td>21%</td>
</tr>
<tr>
<td>moderate Anaemia</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Sever Anaemia</td>
<td>3%</td>
<td>3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCBA</td>
<td>17%</td>
<td>8%</td>
</tr>
<tr>
<td>mild Anaemia</td>
<td>13%</td>
<td>3%</td>
</tr>
<tr>
<td>moderate Anaemia</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>Sever Anaemia</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>
WIFS...

- WHO position statement on “WIFS in WRA: Its Role in Promoting Optimal Maternal and Child Health” was produced, and posted on the WHO website, January 2009.


## Suggested schemes for intermittent iron supplementation in preschool and school-age children

<table>
<thead>
<tr>
<th>Target group</th>
<th>Preschool-age children (24–59 months)</th>
<th>School-age children (5–12 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplement composition</td>
<td>25 mg of elemental iron(^a)</td>
<td>45 mg of elemental iron(^b)</td>
</tr>
<tr>
<td>Supplement form</td>
<td>Drops/syrups</td>
<td>Tablets/capsules</td>
</tr>
<tr>
<td>Frequency</td>
<td>One supplement per week</td>
<td></td>
</tr>
<tr>
<td>Duration and time interval between periods of supplementation</td>
<td>3 months of supplementation followed by 3 months of no supplementation after which the provision of supplements should restart. If feasible, intermittent supplements could be given throughout the school or calendar year.</td>
<td></td>
</tr>
<tr>
<td>Settings</td>
<td>Where the prevalence of anaemia in preschool or school-age children is 20% or higher</td>
<td></td>
</tr>
</tbody>
</table>
Summary: Woman-Mother-Newborn-Young Child Continuum of Care

Pre-conception

Fortification
- ↑ iron intake
- Treat hookworm
- IPT, ITN for malaria

High risk of iron deficiency

Focused ANC
- ↑ iron intake
- Treat hookworm
- IPT, ITN for malaria

Anemia
- ↑ maternal mortality
- ↑ LBW
- ↑ neonatal and child mortality
- Constrained productivity
- Less well baby

Birth & Colostrum
- Delivery & Newborn Care
- Delayed Cord Clamping

Breast Feeding

Complementary Feeding

IYCF
- ↑ iron intake
- ITN

Anemia
- Altered development and behavior

www.micronutrient.org
Zinc for treatment of diarrhea

Introduction

In Ethiopia, Micronutrient deficiencies are one of the major issues with regards to malnutrition.

The health and vitality of human beings depends on diets that include adequate amounts of vitamins and minerals to promote effective physiological processes including reproduction, immune response, brain and other neural functions, and energy metabolism.

Approximately 30% of the world’s population is unable to use their full mental and physical potential as a result of micronutrient malnutrition.
zinc deficiency is recognized as an important and widespread public health problem globally

Zinc is a bluish white metallic element (atomic number 30), which makes up about 0.02% of the earth's crust and is the 23rd most abundant element
Benefits of Zinc

Zinc is a very essential micronutrient required for good health, proper growth and development, and functioning of the human body,

Zinc is associated with more than 50 distinct metallo-enzymes, which have a diverse range of functions, including the synthesis of nucleic acids and specific proteins, such as hormones and their receptors.

Zinc plays a central role in cellular growth, differentiation, and metabolism.

Rate of regain of lean body mass is related to the level of dietary zinc provision.
Dietary Sources of Zinc

Oysters, lobster and red meats, especially beef, lamb and liver have some of the highest concentrations of zinc in food.

Major plant sources of zinc include cooked dried beans, sea vegetables, fortified cereals, soy foods, nuts, peas, and seeds.

Phytates in many whole-grains and fiber in many foods interfere with zinc absorption.
Zinc Deficiency

Zinc deficiency is usually due to insufficient dietary intake, but can be associated with malabsorption, acrodermatitis enteropathica, chronic liver disease, chronic renal disease, sickle cell disease, diabetes, malignancy, and other chronic illnesses.

Zinc deficiency is enormous in children in developing countries and this is significantly related to inadequate zinc intake due to limited access to zinc-rich foods (animal products) or poor absorption of zinc from the diet due to the zinc inhibitors, such as phytates, that are common in plant-based diets.

Zinc Deficiency causes growth retardation, diarrhea, localized skin lesions, loss of appetite, hair loss, slow sexual development, and mental lethargy.
Zinc Deficiency-Cont’d

Diagnosing Zinc Deficiency is persistently a challenge

Stunting rate $\geq 20\%$ is indicative of an elevated risk of zinc deficiency in a population.

According to the 2011 EDHS the stunting rate in Ethiopia is about 44%, which is quite above the cut-off point for risk of zinc deficiency.

Besides, the dietary pattern is low in animal products indicating the possibility of elevated risk for zinc deficiency in Ethiopia.

In Ethiopia although the predisposing factors for zinc status exists, information on the prevalence of zinc status is still not available.
Zinc Supplementation status in Ethiopia

Ethiopia is one of the countries with highest child mortality rate; U5MR: 88 per 1000 live births.

Diarrheal diseases are common causes of childhood morbidity and mortality; diarrhea accounted for 20% of U5MR.

It is shown that supplemental zinc lead to a 25% reduction in the prevalence of diarrhea.

ORS is also remains the very essential components of diarrhea management, its benefits can’t be replaced by Zinc.
Zinc Status in Ethiopia-Cont’d

Considering the public health importance of zinc, the Ethiopian National Child Survival Strategies includes zinc as an adjunct treatment for diarrhea and malnutrition management.

Furthermore, the National Nutrition Program highlights the importance of zinc with low osmolarity ORS for management of acute diarrhea to be key, cost-effective as a child survival intervention.

Zinc is already included in the list of essential drugs for health centers and health posts.

In Ethiopia Zinc is introduced as an integral part of diarrhea treatment, Zinc tablets are being distributed to health facilities.
Zinc acetate Tablets

- Zinc acetate is a 20 mg zinc dispersible tablets complement to the treatment of child diarrhea in connection with low osmolarity Oral Rehydrating Salts.

10 to 14-day course of treatment can reduce the duration and severity of diarrheal episodes and may also prevent future episodes for up to three months.
Interventions to prevent and control Zinc deficiency

**Supplementation:**
- In children, pregnant and lactating mothers
- Adding Zinc to Iron, or a multivitamin

**Dietary Diversification**
- Consumption of foods
  - rich in Zn and bioavailable
  - that enhances zinc absorption
- Plant breeding (Agronomy):
  - increase concentration of zinc in the plants
  - reduce amount of phytates
  - raise levels of s-amino acids (methionine, lysine & cysteine)

**Fortification:**
- Using Zinc sulfate, Zinc oxide or Zinc gluconate
Emerging MN problems for public intervention

Calcium and Vitamin D deficiency in Ethiopia children

Existing situation and the way forward
**Vitamin D**

**SOURCES OF VITAMIN D:**
1. Exposure to sunlight
2. Few foods naturally contain vitamin D, including oily fish such as salmon, mackerel, and herring and oils from fish, including cod liver oil.

**Vitamin D Metabolism**
Vitamin D -cutaneous synthesis from the precursor 7-dehydrocholesterol upon ultraviolet B (UVB) irradiation of the skin or from dietary intake.

Mitochondrial enzyme 25-hydroxylase in the liver

25-hydroxyvitamin D
Active form: 1,25(OH)₂ Vitamin D (calcitriol)
Vitamin D Deficiency

The main risk factors of vitamin D deficiency are those that inhibit the body’s production of vitamin D in the skin, including:

- dark pigmentation,
- too little exposure to sunlight,
- clothing that limits exposure of skin to sunlight,
- living in latitudes above 40° (both north and south), the season of the year, environmental pollution, use of sunscreen and ageing,
- dietary consumption of vitamin D and factors affecting its absorption or metabolism,
- and obesity
Vitamin D deficiency & children

Recent epidemiology studies have observed the association between inadequate vitamin D concentrations and hospitalization and/or respiratory infection among children.

86% of children infected with TB (n=64) found to have inadequate Vitamin D status.

A hospital-based case-control study from Egypt showed that acute respiratory infections were present in 81% of children with rickets, compared with 58% of controls.

A cohort study of hospitalized infants with respiratory diseases and found a higher incidence of nutritional rickets.

In India, a private hospital study also found a link between subclinical vitamin D deficiency and increased risk for severe Acute Lower Respiratory tract infections.
Ethiopia Situation

Like most African countries, in Ethiopia well established health consequences of vitamin D deficiency include rickets, osteomalacia, and susceptibility to infectious disease especially respiratory infection.

- A study in Jima town also found 4% of children aged 6-59 months have rickets (11% occurred in infants).

- A case-control study in Ethio-Swedish hospital found a strong positive correlation between vitamin D deficiency and respiratory compromise.
  - 13 fold higher incidence of rickets among children with pneumonia than controls (13.37 [95% CI 8.08—24.22], p< 0.001).
Causes and Risk factors:

Vitamin D deficiency in Ethiopian children is related to protein energy malnutrition (PEM) and lack of sunlight exposure. Low dietary calcium intake in older toddlers and children (4-16 years) proposed as a primary cause of rickets elsewhere in Africa. Low maternal 25(OH)D level: A study to assess the vitamin D status of lactating women in two rural community in rural Ethiopia(latitude 7 degree N) found that only 15% of women had optimal serum 25(OH)D level (higher or equal to 80 nmol/L)
Calcium

Physiological functions:
- Blood coagulation
- Muscle contraction
- Neuromuscular transmission
- Skeletal growth and mineralization

Source
- Milk, dairy products, and fortified foods.
- Supplements form: (good bioavailability) in the form of carbonate, citrate, lactate or Gluconate

Calcium regulation
Calcium Deficiency

**Dietary Calcium deficiency:** inadequate intake

**Hypocalcemia:** Low levels of calcium in the blood due to taking of medications (diuretics) and also diseases process (renal failure).

**Populations at risk:** pregnant women (especially in the last trimester), lactating women, postmenopausal women, and, possibly, elderly men

During pregnancy: can lead to adverse effects both to mother and Fetus.

- osteopenia, tremor, paraesthesia, muscle cramping, tetany
- Pregnancy induced Hypertension (PIH)
- Delayed fetal growth, low birth weight and poor fetal mineralization.
Ethiopian Situation

In Ethiopian children with rickets and without had a low calcium intake as compared to the recommended daily allowance (Belachew et al. Jimma Hospital study, 2005).

The Ethio-Swedish hospital study concluded that calcium deficiency as one of the predisposing factors for pneumonia for under 5 children in developing countries.

In this study, 300 under 5 children seen at consecutive out patients 41% (n=122) had clinical signs of rickets.
The way for ward

Research areas
The role of vitamin D insufficiency/deficiency and/or low calcium intake in pediatric infection in Ethiopia - Sunlight exposure practice and serum Vitamin D status
Calcium supplementation to prevent morbidity and mortality from pneumonia in Ethiopian children ??
Vitamin D status women during pregnancy and their infants health outcome