Foundations of Global Health

Importance of Nutrition

"We are guilty of many errors and many faults, but our worst crime is abandoning the children, neglecting the foundation of life. Many of the things we need can wait. The child cannot. Right now is the time his bones are being formed, his blood is being made and his senses are being developed. To him we cannot answer "Tomorrow". His name is "Today".

~ Gabriela Mistral, 1948

Learning Objectives

• Define key terms related to nutrition
• Describe the determinants of nutritional status
• Discuss nutrition needs at different stages of the life cycle
• Discuss the burden of nutrition problems globally
• Review the costs and consequences of the burden of nutrition problems
• Discuss measures that can be taken to address key nutrition problems in cost-effective ways
• Discuss important successes that countries have had in dealing with nutrition issues

Brief Review of HUMAN NUTRITION

• FOOD is a mixture of chemicals
• NUTRIENTS are essential chemicals in foods
• 6 classes of nutrients found in food:
  1. Carbohydrates
  2. Lipids
  3. Proteins
  4. Vitamins
  5. Minerals
  6. Water

New Food Pyramid

Macronutrients vs. Micronutrients

Macro
• Nutrients such as carbohydrates, fat, or proteins, that are needed in relatively large amounts in the diets

Micro
• Nutrients such as a vitamin or mineral that is needed in relatively small amounts in the diets
• Enables body to produce enzymes, hormones & other substances essential for proper growth and development
• Vitamin A, iodine & iron are most important in global public health terms

Changes With Age

• Nutrition changes throughout the life span
• Physiological demand for certain nutrients also differs by gender
Model Growth Chart

- Series of percentile curves of selected body measurements based on distribution in US children
- Used to track growth of infants, children, and adolescents since 1977
- Tool that contributes to forming an overall clinical impression for child

Body Mass Index

BMI score

- Underweight
- Normal
- Overweight
- Obesity

Body Mass Index (BMI) is a measure of weight in relation to height. It is calculated as follows:

\[ \text{BMI} = \frac{\text{body weight in kilograms}}{\text{height in (meters)}^2} \]

A person with a BMI over 25 kg/m² is considered to be overweight. A person with a BMI over 30 kg/m² is considered obese. The risk of heart attacks, strokes and diabetes increases as BMI increases. Ideally, the BMI should be maintained between 18.5 and 24.9 kg/m².

Table 8.3 Key Terms and Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Malnutrition: The Silent Crisis</td>
<td>Failure to achieve nutrient requirements which can impair physical and/or mental health</td>
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<tr>
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<td>May result from consuming too much or too little food, shortage or imbalance of key nutrients</td>
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<td>Two types:</td>
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<td></td>
<td>- Undernutrition</td>
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<td>- Overnutrition</td>
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Malnutrition: The Silent Crisis

“Encased in fat in youth, encased in a coffin in middle age.”

~Chinese proverb

Overnutrition: Obesity Epidemic

“Encased in fat in youth, encased in a coffin in middle age.”

~Chinese proverb
Overnutrition

- 1 billion adults worldwide overweight
  - 300 million obese
- Increased consumption of foods high in saturated fats and sugars, reduced physical activity
- Consumption of too many calories or too much of any specific nutrient

Nutrition Transition

- Transition from unprocessed to processed foods
- Already occurred in wealthy countries and among richer people in poor countries
- Spreading to developing countries
- Linked with growing trend toward diet-related non-communicable diseases

Changes in Calories per Day

As your weight increases to reach the "overweight" and "obesity" levels, your risks for the following conditions will also increase:

1. Coronary heart disease
2. Type 2 diabetes
3. Cancers (stomach, breast, and colon)
4. Gastrointestinal problems (abdominal pain, bloating)
5. Dyslipidemia (high low-density lipoprotein or low levels of high-density lipoprotein)
6. Stroke
7. Liver and gallbladder disease
8. Sleep apnea and respiratory problems
9. Osteoarthritis (degeneration of cartilage and joint surrounding bone)
10. Hypertension (high blood pressure)

Nutrition Transition: Rising incomes mean higher-fat diets

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As incomes rise, even poorer nations have access to diets relatively high in fat. A diet containing 20 percent fat corresponded with a GNP of US$ 1,479 in 1962. By 1999, that figure was only US$ 730.

Changes in Calories per Day:

1970 (2,110 calories)
- Meat, egg, & nuts: 563
- Grains: 432
- Dairy: 267
- Total: 1,322

2008 (2,673 calories)
- Meat, egg, & nuts: 561
- Grains: 623
- Dairy: 257
- Total: 1,441

Average daily calories per capita available from US food supply, adjusted for spoilage and other waste.

Prevalence of obesity, ages 20+, age standardized

Women aged 20–49 in 57 low- to middle-income countries

Prevalence of underweight

Prevalence of overweight
Undernutrition

- Hunger has 3 meanings:
  - strong desire or need for food
  - discomfort, weakness, or pain caused by a prolonged lack of food
  - strong desire or craving

- "We know that a peaceful world cannot long exist, one-third rich and two-thirds hungry." ~ Jimmy Carter

- "If we can conquer space, we can conquer childhood hunger." ~ Buzz Aldrin

Undernutrition Defined

- Poor health resulting from depletion of nutrients due to inadequate nutrient intake over time
- Associated with poverty, alcoholism, & some types of eating disorders
- Measures include:
  - underweight for age
  - too short for age (stunted)
  - dangerously thin for height (wasted)
  - deficient in vitamins and minerals

The Nutritional State of The World

- Important progress in reducing malnutrition
  - Underweight
  - Micronutrient deficiency
- Remains deplorable
  - Nutritional problems remain fundamental cause of ill health, disability, and death for infants, children, and pregnant women

The Nutritional State of the World (infographic)

- Underweight and Micronutrient deficiency
- Important progress
- Remains deplorable

Hunger Example: Adult Man

- Malnourished man in Bolivia
- Needs 12,000 calories per day
- Whole diet is potatoes
- Not getting enough nutritious foods

Hunger Example: Adolescent Girl

- Poor diet and little exercise
- Not eating a balanced diet
- Not getting enough nutrients

Bolivian man

- Malnourished man in Bolivia
- Needs 12,000 calories per day
- Whole diet is potatoes
- Not getting enough nutritious foods

Pakistan adolescent girl

- Malnourished girl in Pakistan
- Needs 12,000 calories per day
- Whole diet is potatoes
- Not getting enough nutritious foods

Fighting Hunger Worldwide

- World Food Programs
- Hunger Map 2011

Pakistan

- Hunger remains a problem
- Malnutrition affects all ages
- Solutions needed
Key Nutrition Statistics

- 30% of children worldwide underweight or stunted
- 50% of young child deaths due to nutrition-related causes

Factors Contributing to Child’s Nutrition, 1990–1995 (percent)

Key Determinants

- Three underlying factors:
  - Household food security
  - Care for mothers & children
  - Health & environment
- Overall, nutrition is related to poverty
  - Basic determinants include political, economic & cultural structure

TABLE 8-2 Nutrition and the MDGs

Goal 1—Eradicate Poverty and Hunger
Link—Poor nutritional status is both a cause and a consequence of poverty. Improving income and nutritional status will improve health status.

Goal 2—Achieve Universal Primary Education
Link—Children who are properly nourished enroll in school at higher rates than undernourished children, attend school for more years, and perform better while they are there than undernourished children.

Goal 3—Promote Gender Equality and Empower Women
Link—Women suffer very high rates of some nutritional deficiencies, such as iron deficiency anemia, that constrain their health and their productivity. Improving the nutritional status of women will enhance their income earning potential and ability to be more productive in all of their work.

Goal 4—Reduce Child Mortality
Link—About half of all child deaths worldwide are associated with malnutrition. It will not be possible to make major strides in reducing child mortality without significant improvements in the nutritional status of young children.

Goal 5—Improve Maternal Health
Link—Maternal health and pregnancy outcomes are intimately connected to the nutritional status of the pregnant women.

Goal 6—Combat HIV/AIDS, malaria, and other diseases
Link—Poor nutritional status makes people more susceptible to illness and to being sick for longer periods of time. Good nutrition is especially important for people suffering some health conditions, such as TB and HIV/AIDS. Supplementation with some micronutrients, even in the absence of anti-retroviral therapy, can lengthen the time that HIV positive people can go without progressing to full-blown AIDS.

Progress: Underweight Prevalence

Source: http://www.unmillenniumproject.org/documents/HTF_Summary_FINAL.pdf

Progress Towards MDG 1
High Risk Hunger Groups

- **Rural poor**
  - majority live in poor, rural communities in developing countries
  - often produce food, cultivate crops on small plots of land, fish or raise animals
  - may not own land and work as hired hands, often work is seasonal & must move during the year

- **Urban poor**
  - produce little or no food, do not make enough money to purchase food
  - cities expected to double in size in next 20 years—access to affordable food will be a large challenge

- **Victims of catastrophes**
  - families forced to abandon homes and farms from natural disasters and armed conflicts
  - face threat of hunger and starvation

Fome Zero in Brazil

**Key elements of Brazil's Fome Zero (Zero Hunger) Project**

- Social programs
  - health, education
  - water, sanitation
  - access to affordable food
  - family farms

- Food security
  - basic nutrition
  - support for family farms
  - subsidies for staple crops
  - investments in rural infrastructure

Breast Milk Nutrition

- **Breast milk provides optimal nutrition** for a growing infant
  - Contains adequate minerals and nutrients, immune components, cellular elements and other host-defense factors that provide various antibacterial, antiviral and antiparasitic protection

- **WHO recommends exclusive breastfeeding** during 0-6 months
  - Continue to receive breast milk 7-12 months & during year 2

- **Non-breast fed babies have increased risk** of morbidity & mortality (diarrheal diseases & acute respiratory infections)

- In Brazil, infants <12 months that only had powdered or cow's milk:
  - 14x more likely to die from diarrheal disease
  - 4x more likely to die from acute respiratory infection


**TABLE 8-1 Selected Links Between Nutrition and the Health of Mothers and Children**

Good maternal nutrition is essential for good outcomes of pregnancy for the mother.

Exclusive breastfeeding for 6 months promotes better health for infants than mixing breastfeeding with other foods during that period.

Nutritional deficits in fetuses and in children under 2 years of age may produce growth and development deficits in infants and young children that can never be overcome. About half of all deaths in children under five years worldwide are associated with nutritional deficits.

Underweight and micronutrient deficiencies in children make those children more susceptible to illness, cause illnesses to last longer, and can lead to deaths from diarrhea, pneumonia, and malaria that might have been preventable.
**Percent of Children Ever Breastfed**

Source: http://www.cdc.gov/breastfeeding/data/docs/ 2007 data most current available Jan 2011

**Global Trends in Breastfeeding**


**Benefits to Baby & Mom**

- Breastfed children have 6X greater chance of survival in the early months than non-breastfed children
  - Reduces deaths from acute respiratory infection and diarrhea
- Especially important in developing countries with a high burden of disease and low access to clean water and sanitation
- Industrialized countries also at greater risk:
  - US had 25% increase in mortality among non-breastfed infants
    - UK found 6 months exclusive breastfeeding linked to 53% decrease in hospital admissions for diarrhea and 27% decrease in respiratory tract infections
- Contributes to maternal health:
  - Reduces risk of post-partum hemorrhage
  - Delays return to fertility
  - Reduces type 2 diabetes and breast, uterine and ovarian cancer

**Protein-Energy Undernutrition**

- Most widespread form of malnutrition
  - Prevalent in Africa, Central & South America, East
- Condition of infants and children
- Develops after children are weaned from the breast
- Micronutrient deficiencies linked to its development
- Puts children at risk for delayed growth
  - Insufficient height for age
- Wasting (often because of recent acute malnutrition)
  - Increased risk of abdominal fat, cardiovascular disease
- Impaired psychological development

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**TABLE 8-4 Key Nutritional Needs, Sources, and Selected Functions**

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<tr>
<th>Key Nutritional Needs</th>
<th>Sources</th>
<th>Selected Functions</th>
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<tbody>
<tr>
<td>Protein</td>
<td>Milk, eggs, chicken, and beans</td>
<td>Promote growth of children and immune functions</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Liver, green leafy vegetables, orange and red fruits and vegetables</td>
<td>Promote immune function and prevention of scurvy and osteoporosis</td>
</tr>
<tr>
<td>Iron</td>
<td>Selected seafood and plants grown in soil containing soil</td>
<td>Growth and neurological development</td>
</tr>
<tr>
<td>Zinc</td>
<td>Fish, meat, poultry, grains, vegetables, and legumes</td>
<td>Promote growth, immune function, and cognitive development</td>
</tr>
</tbody>
</table>

Marasmus

- Type of malnutrition resulting from chronic protein-energy undernutrition
- Characterized by wasting of muscle and other body tissue
- Physical term for starvation

Kwashiorkor

- Type of malnutrition that occurs primarily in young children who have an infectious disease
- Diets supply marginal amounts of energy and very little protein (mostly carbs)
- Common symptoms include poor growth, edema, apathy, weakness, and susceptibility to infections
- Diarrhea & anemia compound problem

Nutrition Programs

- Plumpy’nut
- High Energy Biscuits
- Baby scales

Vitamin A

- Vitamin A needed for
  - Vision (night, day, colour)
  - Epithelial cell integrity (against infections)
  - Immune response
  - Haemopoiesis
  - Skeletal growth
  - Fertility (male and female)
  - Embryogenesis

Vitamin A Deficiency

- More than one million children die as a result of VAD annually
- VAD prevalent among poor who depend mainly on rice as daily energy source (400 million)
  - Rice does not contain β-carotene (provitamin A)
- Most severely affects children and pregnant women
  - Compromises immune systems of 40% of children <5
  - Predisposes infants and children to diarrheal disease
  - Usually co-existing with PEU
  - 250,000 to 500,000 children to go blind every year

Vitamin A Deficiency Map

**Vitamin A Supplementation**

- Shown are the percentage of children receiving at least one dose of vitamin A supplementation and the percentage of children receiving two doses (fully protected).

**Iodine**

- Primary function in the body is as a substrate for synthesis of the thyroid hormones.
- Crucial for normal growth and development.
- Iodine deficiency results when iodide intake < 20 µg/day.
- Nearly 1.6 billion people, including 500 million children, live in areas at risk for Iodine Deficiency Disorders.
- Leading cause of intellectual impairment, most preventable cause of mental retardation.

**Iodine Deficiency**

- Goiter and endemic cretinism common in developing world.
  - Prevalence of cretinism from 3-15% in severely affected rural populations.
  - Squinting of eyes, deafness, and primitive brain reflexes.
- Mild deficiency may reduce IQ by 10-15%.
  - Supplements given to school-age children can improve performance on tests of intellectual functioning.
  - Mild deficiency has increased rates of stillbirths, perinatal mortality, and infant mortality.

**Salt Iodization**

- Iodizing table salt is one of best and least expensive methods of preventing IDD.
- 5¢ a year and a teaspoon of iodine for a lifetime.
- Over 70% of US households use iodized salt.
- Trick is to provide universal salt iodization.

**Cretinism**

- Caused by severe iodine deficiency.
- Severe physical & mental retardation.
  - A man and 3 females (age range 17-20 years old) with myxedematous cretinism.
  - Republic of the Congo in Africa, a region with severe iodine deficiency.
Salt Iodization Map

Iron Deficiency

- Most common micronutrient disorder in world
- Leads to severe anemia, diminished learning capacity, increased susceptibility to infections & risk of death in pregnancy/childbirth
  - Causes profound fatigue
  - Usually leads to shortage of vitamins B6, B12, and folate

Iron Supplementation

- Iron supplements to pregnant women, and to young children
- Fortification of wheat or maize flour
- Sprinkles

Flour Fortification Status 2010

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Zinc Deficiency

- 20% of world's population affected
  - Range from 4 to 73% in some regions
- 800,000 deaths annually
- Associated with malaria (18%), lower respiratory tract infections (16%) and diarrhea (10%)
- Characterized by impaired immune function
  - Severe cases: short stature, hypogonadism, skin disorders, cognitive dysfunction, anorexia

Zinc Map

- Zinc deficient soil
  - Very important to people with limited protein in diet
- Zinc fertilizer may be effective intervention
- Human risk of zinc deficiency
**Intestinal Nematodes**

- More than 500,000 species
- Some are free living
- Complete digestive system
- Egg, larvae (molts), adults
- Male & female adults
- Long-lived

**Ascaris lumbricoides**

- Large intestinal roundworm- up to 35 cm
- Estimated **1.4 billion infected** worldwide
- 4 million in United States (immigrants)
- ♀ produce 200,000 eggs daily- survive in soil more than 1 year
- Geophagia

**Roundworm**

- Asymptomatic with small numbers
- Fever, spicy foods might make worms exit body abruptly via nose, mouth, rectum
- Malabsorption of fat, protein, carbohydrates, and vitamins
- Results in growth retardation

**Collection of roundworms from small village in India**

**Malnutrition and Infection**

- **Two causal pathways:**
  1. infection leads to malnutrition
  2. malnutrition increases susceptibility to infections

  Difficult to resolve, pathways may occur concurrently

**Impact on Children**

- Malnutrition continues to be a worldwide crisis
- Major killer of children <5
- Not only a health crisis, but continues cycle of poverty
- “Steals child’s natural curiosity, dulls intellect, and leads to lifetime learning disabilities”
Interesting Stats

- Who is responsible for farming in Africa? Asia?
- 70% of the world’s hungry are _______ & _______.
- 1 out of 3 households, the _____ are the sole breadwinners.
- Food aid is far more likely to reach the mouths of needy children when distributed by?
- What is the most extreme form of poverty?

Practice Questions

- Identify 6 classes of nutrients. What is different about the new food pyramid?
- How do nutrition requirements change as we age?
- Define malnutrition. What is the nutrition transition?
- Name 3 diseases that are linked to overnutrition.
- What region has the most hunger? What are 3 key factors underlying child nutrition?
- What are the benefits of breastfeeding to baby, mom?
- Match key nutrients to their dietary source.
- Describe 3 nutrient deficiencies & what is being done to solve the problem.
- How does infection increase malnutrition (roundworm example)?

In Summary...

- Nutritional status is a major determinant of health status
- Important bearing on the health of pregnant women and of pregnancy outcomes
- Major determinant of birthweight of children, how children grow, and extent to which their cognitive functions develop properly
- Linked to the strength of one’s immune system and ability to stay healthy
- There are known cost-effective interventions to address key nutritional concerns
- Focus on breastfeeding, appropriate complementary foods, selective supplementation, fortification
- Focus on growth monitoring, behavior change, and community-based approaches