Maternal, infant, and young child nutrition: a global perspective

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Overview of presentation

• General concepts – what is “international nutrition”?
  – Characteristics of lower income countries – demography, disease patterns, food supply
  – Public health approach to nutritional problems
Overview of presentation

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  – Characteristics of lower income countries – demography, disease patterns, food supply  
  – Public health approach to nutritional problems

• Global prevalence of malnutrition  
  – Dietary energy supply  
  – Childhood stunting and wasting  
  – Micronutrient deficiencies  
  – Overweight, obesity
Overview of presentation

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• Global prevalence of malnutrition 
  – Dietary energy supply 
  – Childhood stunting and wasting 
  – Micronutrient deficiencies 
  – Overweight, obesity 
• Intervention strategies to control undernutrition
## World Bank classification of countries by per capita income

<table>
<thead>
<tr>
<th>Level of income</th>
<th>2011 GNI per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income</td>
<td>$1,025</td>
</tr>
<tr>
<td>Lower middle income</td>
<td>$1,026 - $4,035</td>
</tr>
<tr>
<td>Upper middle income</td>
<td>$4,036 - $12,475</td>
</tr>
<tr>
<td>High income</td>
<td>$12,476</td>
</tr>
</tbody>
</table>
The demographic, health, food, and nutrition transitions from LIC to UIC

- Population growth rates
- Disease patterns
- Food supply and consumption patterns
- Nutritional status – under- and over-nutrition
~7,039,546,464*

*As of Sept 15, 2012

Long-term population increase, 400 B.C. to 2000 A.D.

Source: Nutrition Transition, eds Caballero, B and Popkin, BM, pg 72, 2002
Expected population growth

Urban and rural populations by development region (in millions)

Source: United Nations, Dept. of Economic and Social Affairs
(http://esa.un.org/unpd/wup/Fig_3.htm; accessed Dec 23, 2010)
TARGET
Reduce by two thirds, between 1990 and 2015, the under-five mortality rate.

Child deaths are falling, but not quickly enough to reach the target.

Under-five mortality rate per 1,000 live births, 1990 and 2008

<table>
<thead>
<tr>
<th>Region</th>
<th>1990</th>
<th>2008</th>
<th>2015 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>184</td>
<td>644</td>
<td>44</td>
</tr>
<tr>
<td>Southern Asia</td>
<td>121</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Oceania</td>
<td>125</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>CS, Asia</td>
<td>78</td>
<td>39</td>
<td></td>
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<tr>
<td>South-Eastern Asia</td>
<td>75</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Western Asia</td>
<td>66</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Northern Africa</td>
<td>80</td>
<td>30</td>
<td></td>
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<tr>
<td>Latin America &amp; the Caribbean</td>
<td>592</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Eastern Asia</td>
<td>43</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>CS, Europe</td>
<td>29</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Transition countries of South-Eastern Europe</td>
<td>14</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Developed regions:</td>
<td>122</td>
<td>77</td>
<td>111</td>
</tr>
<tr>
<td>Developing regions</td>
<td>8</td>
<td>72</td>
<td>110</td>
</tr>
</tbody>
</table>
Infant mortality rate per 1,000 births

The global burden of disease: Under-5 mortality by region and cause of death

Figure 6: Child mortality rates by cause and region, 2004

WHO Global Burden of Disease Project, 2008
Major causes of death among children under five worldwide, 2008

**FIGURE 9** Revitalizing efforts against pneumonia and diarrhoea, while bolstering nutrition, could save millions of children

Causes of deaths among children under age five, 2008 (percent)

- Neonatal: 41%
- Diarrhoea: 14%
- Pneumonia: 14%
- Malaria: 8%
- Injuries: 3%
- Measles: 1%
- HIV/AIDS: 2%
- Other: 10%

Globally, more than one third of child deaths are attributed to undernutrition.

Energy from the dominant starch staples, 1990-1992

Source: Reproduced with permission from the Geographical Association (20)
Relationship between GNP per capita and the proportion of energy from each food source, 1990

Source: FAO Food Balance Sheets.
Demographic transition

Trends in worldwide population and health

Trad
- High fertility
- High IMR
- Young, rural population

Mod
- Low fertility
- Low IMR
- Aging, urban population
Trends in worldwide population and health

Demographic transition

High fertility
High IMR
Young, rural population

Low fertility
Low IMR
Aging, urban population

Health transition

Infectious diseases

Non-communicable diseases (CVD, cancer)
Trends in worldwide population and health

Demographic transition → Health transition → Dietary transition

**Trad**
- High fertility
- High IMR
- Young, rural population

**Mod**
- Low fertility
- Low IMR
- Aging, urban population

**Infectious diseases**
- Starchy staples
- Low fat
- Few ASFs

**Non-communicable diseases (CVD, cancer)**
- Refined cereals, sugars
- High fat
- ASFs
Trends in worldwide population and health

Demographic transition → Health transition → Dietary transition → Nutrition transition

Trad
- High fertility
- High IMR
- Young, rural population

Mod
- Low fertility
- Low IMR
- Aging, urban population

Health transition
- Infectious diseases
- Non-communicable diseases (CVD, cancer)

Dietary transition
- Starchy staples
- Low fat
- Few ASFs
- Refined cereals, sugars
- High fat
- ASFs

Nutrition transition
- Under-nutrition/famine
- Physical labor
- Over-nutrition
- Sedentary labor (TV)
- Obesity
FAO annual publication on global food security
*Defined as % of population for whom food availability is less than amount needed to satisfy energy requirements*
Prevalence of nutritional stunting (HAZ <-2 SD) among pre-school children (Dec 2010)

Data derived from WHO or most recent Demographic Health Surveys
Trends in young child height-for-age and weight-for-age, by region

Relationship between height-for-age and child mortality

Results are percentages of international median, as estimated from graph.
Data from Pelletier DL, J Nutr 1994
Mean weight-for-age, by age and birth weight

Risk of LBW by maternal pre-pregnancy BMI

Evidence for the inter-generational cycle of malnutrition
Relative importance of established factors with direct causal impacts on intrauterine growth restriction (IUGR) in rural developing countries

Source: Kramer, 1987

~45% of attributable risk due to maternal undernutrition
Effect of maternal iron supplementation during pregnancy on infant birth weight*


↓% LBW
(17% vs 4%, p<0.003)
Mean length-for-age Z-scores, by age and region

Data from: Shrimpton et al. Pediatrics 107: e75; 2001
Relationships between nutrition and infection

- Decreased dietary intake
- Malabsorption
- Increased catabolism
- Nutrient sequestration
- Impaired immune function
- Decreased barrier protection

Infection

Malnutrition
Relationship between breast feeding intensity and risk of morbidity and mortality, infants <6 mo

Source: Lancet 2008, Nutrition Series
Major MN deficiencies of public health importance in lower income countries

- Vitamin A
- Zinc
- Iron
- Iodine
- Others?
Global prevalence of vitamin A deficiency

Available at:
http://www.who.int/nutrition/publications/micronutrients/vitamin_a_deficiency/9789241598019/en/index.html
23% reduction in all-cause mortality; RR 0.77 (CI 0.71-0.94)
Distribution of plasma zinc concentration: children <5 and women 15-49 yr, 3 countries
Effect of preventive zinc supplementation on the incidence of diarrhea and ALRI

Preventive zinc supplementation reduces diarrhea incidence by ~20%

Preventive zinc supplementation reduces ALRI incidence by ~15%
Prevalence of anemia in pre-school children

Prevalence of iodine deficiency based on median urinary iodine concentration

De Benoist et al, Food Nutr Bull 2008
Dietary diversification / modification

- Exclusive breast feeding (first 6 mo)
- Appropriate complementary feeding
- Use of animal source foods
- Agricultural interventions
- Food processing
- Dietary diversification / modification
Intervention strategies to control MN deficiencies

Supplementation
- Preventive – daily, weekly, intermittent
- Therapeutic – diarrhea, PEM

Food fortification
- Mass (cereal)
- Targeted (infant foods, therapeutic foods)

Public health
- Infection control (e.g., hygiene & sanitation, bednets and malaria prevention; deworming)
Screening for acute malnutrition
Dietary counseling and child feeding
Mali-MMAM Study
Projected prevalence of overweight (BMI >25 kg/M²) among women ≥30 yr, 2005 and 2015

Figure from: WHO. Preventing chronic diseases: a vital investment, 2005
% Population under- and over-weight, 1993

Fig. 18. Percentage of population underweight and overweight, selected countries, around 1993

Underweight
(Body Mass Index <18.5)

Overweight
(Body Mass Index >25)

Russia
United Kingdom
Sweden
Colombia
Brazil
Costa Rica
Morocco
Togo
China
Haiti
Senegal
Ethiopia
India

Source: WHO
Global prevalence & trends in overweight and obesity, pre-school children

Prevalence & trends in overweight and obesity, pre-school children, by UN region

Conclusions

• Most of the world’s population resides in LICs, where the major nutrition problems are still related to undernutrition (LBW, poor IYCF practices, stunting, wasting, and MN deficiencies), with greatest risk among women and young children (first 1000 d)
  – Effective, public health interventions are available to ameliorate these problems, but they are not being implemented at scale

• With increased income and changing food supply and life styles, overweight and obesity are beginning to emerge as public health problems, even in LICs
Thanks!
Poverty → Income, Food, Education, Environment, Health services → Malnutrition
Malnutrition → Educational inefficiency, Physical capacity, Susceptibility to infection → Poverty
Malnutrition

Poverty
GNP vs. % underweight
(<-2SD W/A)
• MDG #1: Reduce extreme poverty and hunger (measured as proportion of people with insufficient food, percent children underweight)

• MDG #4: Reduce child mortality
Despite some progress, one in four children in the developing world are still underweight.

**Proportion of children under age five who are underweight, 1990 and 2008 (Percentage)**

- **Southern Asia**: 51% in 1990, 46% in 2008
- **Sub-Saharan Africa**: 31% in 1990, 27% in 2008
- **South-Eastern Asia**: 37% in 1990, 34% in 2008
- **Western Asia**: 25% in 1990, 14% in 2008
- **Eastern Asia**: 17% in 1990, 11% in 2008
- **Northern Africa**: 11% in 1990, 7% in 2008
- **Latin America & the Caribbean**: 11% in 1990, 6% in 2008
- **Developing regions**: 31% in 1990, 26% in 2008

**TARGET**

Halve, between 1990 and 2015, the proportion of people who suffer from hunger.

Hunger may have spiked in 2009, one of the many dire consequences of the global food and financial crises.
Assistance from DAC member countries (2001) in USD billions

Assistance from DAC member countries (2001) as % GNI

Child deaths and births

Changes in the total fertility rate (average number of births per woman) compared with changes in under-five mortality rates. For each region, the points on the graph show the situation in 1960, 1970, 1980 and 1990.
Prevalence of Child Malnutrition

Percent of children underweight
- less than 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- more than 50
- no data
- national borders

Children are defined as underweight if their weight for age z-scores are more than two standard deviations (2.5D) below the median of the NCHS/CDC/WHO International Reference Population.

Data Summary

<table>
<thead>
<tr>
<th></th>
<th>Countries</th>
<th>Data units</th>
<th>Avg. units/country</th>
<th>% of world Population</th>
<th>% of non-OECD Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>National data only</td>
<td>41</td>
<td>41</td>
<td>1.0</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Subnational data</td>
<td>74</td>
<td>640</td>
<td>8.6</td>
<td>65</td>
<td>78</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>681</td>
<td>5.9</td>
<td>81</td>
<td>96</td>
</tr>
</tbody>
</table>

Sources: UNICEF, Demographic and Health Surveys (DHS), National Human Development Reports (nHDR), African Nutrition Database Initiative (ANDI). Data for 98% of countries are from 1995 or later. All data are from 1990 or later.
"I just got damn well fed up with being formal all the time."
Main causes of death in low-income countries
In South-East Asia and Africa
Estimates for 1998

- Infectious diseases: 45%
- Noncommunicable conditions: 35%
- Injuries: 11%
- Perinatal: 6%
- Maternal: 2%
- Nutritional: 1%

Source: WHO 1998
Leading infectious killers

Millions of deaths, worldwide, all ages, 1998

Deaths in millions

- Acute respiratory infections (including pneumonia and influenza)
- AIDS
- Diarrhoeal diseases
- TB
- Malaria
- Measles

- Over age five
- Under age five

* HIV-positive people who died with TB have been included among AIDS deaths.

Source: WHO 1998

http://www.who.int/infectious-disease-report/pages/graph2.html
Confidence in survival

Under-five mortality rates (per 1000 live births) related to levels of contraception in 108 countries of the developing world.
Major causes of death among children under five, worldwide, 2000

Source: http://www.who.int/child-adolescent-health/OVERVIEW/CHILD_HEALTH/piechart1.jpg
FIGURE 8 The 10 countries with the most under-five deaths

Number of under-five deaths, by country, 2009 (thousands)

- India: 1,726
- Nigeria: 794
- Dem. Rep. of the Congo: 558
- Pakistan: 460
- China: 347
- Ethiopia: 315
- Afghanistan: 237
- United Rep. of Tanzania: 188
- Uganda: 184
- Bangladesh: 171
- Other countries: 3,107
Major causes of death among children under five, worldwide, 2004

Deaths among children under five

Noncommunicable diseases (postneonatal) 4%
Injuries (postneonatal) 4%
Other infectious and parasitic diseases 9%
HIV/AIDS 2%
Measles 4%
Malaria 7%
Diarrhoeal diseases (postneonatal) 16%
Acute respiratory infections (postneonatal) 17%

Neonatal deaths

Other 9%
Congenital anomalies 7%
Neonatal tetanus 3%
Diarrhoeal diseases 3%
Neonatal infections 25%
Birth asphyxia and birth trauma 23%
Prematurity and low birth weight 31%

35% of under-five deaths are due to the presence of undernutrition


Source: http://www.who.int/child-adolescent-health/OVERVIEW/CHILD_HEALTH/piechart1.jpg
Shifts in the distribution of occupation, 1972-1995

Relationship between the proportion of energy from each food source and GNP per capita in 1990

with the proportion of the population residing in urban areas placed at 25%

with the proportion of the population residing in urban areas placed at 75%

Goal 1: Eradicate extreme poverty & hunger

### Target
Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day

**Asia leads the decline in global poverty**

<table>
<thead>
<tr>
<th>Region</th>
<th>Proportion of people living on less than $1 a day, 1990 and 2002 (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>44.6</td>
</tr>
<tr>
<td>Southern Asia</td>
<td>39.1</td>
</tr>
<tr>
<td>Eastern Asia</td>
<td>33.0</td>
</tr>
<tr>
<td>South-Eastern Asia and Oceania</td>
<td>7.3</td>
</tr>
<tr>
<td>Latin America &amp; the Caribbean</td>
<td>11.3</td>
</tr>
<tr>
<td>Northern Africa and Western Asia</td>
<td>2.4</td>
</tr>
<tr>
<td>Transition countries of South-Eastern Europe</td>
<td>0.4</td>
</tr>
<tr>
<td>Developing regions</td>
<td>19.4</td>
</tr>
</tbody>
</table>

- **1990**
- **2002**
- **2015 target**
More people go hungry, even though worst-hit regions show improvement and rates of hunger decline


- Sub-Saharan Africa
- Southern Asia
- CIS, Asia*
- Eastern Asia
- South-Eastern Asia
- Oceania
- Latin America & the Caribbean
- Western Asia
- Northern Africa
- CIS, Europe*

Chronic hunger - measured by the proportion of people lacking the food needed to meet their daily needs - has declined in the developing world. But progress overall is not fast enough to reduce the number of people going hungry, which increased between 1995-1997 and 2001-2003. An estimated 824 million people in the developing world were affected by chronic hunger in 2003.

The worst-affected regions - sub-Saharan Africa and Southern Asia - have made progress in recent years. But their advances have not kept pace with those of the early 1990s, and the number of people going hungry is increasing. Of particular concern is Eastern Asia: in the early 1990s, the number of hungry people declined, but again it is on the rise.
Goal 4
Reduce child mortality

More children are surviving their first years of life, though sub-Saharan Africa trails far behind.

Under-five mortality rate per 1,000 live births, 1990 and 2004

<table>
<thead>
<tr>
<th>Region</th>
<th>1990</th>
<th>2004</th>
<th>2015 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>168</td>
<td>106</td>
<td>50</td>
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<tr>
<td>Southern Asia</td>
<td>126</td>
<td>87</td>
<td>40</td>
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<tr>
<td>Oceania</td>
<td>90</td>
<td>87</td>
<td>40</td>
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<tr>
<td>CIS, Asia</td>
<td>83</td>
<td>83</td>
<td>40</td>
</tr>
<tr>
<td>Western Asia</td>
<td>76</td>
<td>69</td>
<td>35</td>
</tr>
<tr>
<td>South-Eastern Asia</td>
<td>78</td>
<td>78</td>
<td>35</td>
</tr>
<tr>
<td>Northern Africa</td>
<td>58</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Latin America &amp; the Caribbean</td>
<td>54</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>Eastern Asia</td>
<td>48</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>CIS, Europe</td>
<td>26</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Developing regions</td>
<td>87</td>
<td>57</td>
<td>10</td>
</tr>
</tbody>
</table>
Children in rural areas are nearly twice as likely to be underweight as those in urban areas.

In some regions, the prevalence of underweight children is dramatically higher among the poor.

**Proportion of under-five children who are underweight, by household wealth, around 2008 (Percentage)**

- **Southern Asia**: Around 1990 - 1.3, Around 2008 - 4.8
- **South-Eastern Asia**: 1.7
- **Sub-Saharan Africa**: 2.4
- **Northern Africa**: 1.7
- **Latin America & the Caribbean**: 2.0
- **Western Asia**: 2.1
- **Eastern Asia**: 2.1
- **Developing regions**: 1.9
- **CIS, Asia**: 1.9

Rural children disadvantaged.
## Annual natural increase in population, more and less developed countries

<table>
<thead>
<tr>
<th>Population mid-1998 (millions)</th>
<th>World</th>
<th>More developed</th>
<th>Less developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population mid-1998 (millions)</td>
<td>5,926</td>
<td>1,178</td>
<td>4,748</td>
</tr>
<tr>
<td>Births per 1,000 population</td>
<td>23</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Deaths per 1,000 population</td>
<td>9</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Natural increase annual, %</td>
<td>1.4</td>
<td>0.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Doubling time in years</td>
<td>49</td>
<td>548</td>
<td>40</td>
</tr>
</tbody>
</table>
Population of the world, 1950 and 2025

http://www.povertymap.net/pub/mipwa/sections/w-global/demo-pop/anamorphose-pop-world.htm
Child mortality rate per 1,000 births, 2003

Under-five and infant mortality rates, by WHO Region, 2003

http://www.who.int/healthinfo/statistics/02.whostat2005graph_under5infantmortality.jpg
Mortality risk by weight-for-height Z-score*

Dietary energy supply, 2001-2003
Figure 1: Population growth rate by country
Data from UN, 2011.
Population distributions by age, sex, and level of national development 2000 and 2050

Source: The Sex and Age Distribution of the World Populations: 1998 Revision, Volume II: Sex and Age (United Nations publication)
The global burden of disease

Six causes of death account for 73% of child mortality:
- Diarrhea (17%)
- Pneumonia (17%)
- Prematurity & LBW (11%)
- Neonatal infections (9%)
- Birth trauma/asphyxia (8%)
- Malaria (7%)

WHO Global Burden of Disease Project, 2008
Operational definition of “international nutrition”

Those aspects of both nutrition science and related social and behavioral sciences that are of particular relevance to the nutritional well-being of human populations of economically less-developed countries.
Population distributions by age, sex, and level of national development, 2000

Source: The Sex and Age Distribution of the World Populations: 1998 Revision, Volume II: Sex and Age (United Nations publication)
Intergenerational cycle of growth failure
Copenhagen Consensus -- conclusions

<table>
<thead>
<tr>
<th></th>
<th>Top ten investments to solve major global challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Micronutrient supplements for children (vitamin A and zinc)</td>
</tr>
<tr>
<td>2</td>
<td>The Doha development agenda</td>
</tr>
<tr>
<td>3</td>
<td>Micronutrient fortification (iron and salt iodization)</td>
</tr>
<tr>
<td>4</td>
<td>Expanded immunization coverage for children</td>
</tr>
<tr>
<td>5</td>
<td>Biofortification</td>
</tr>
<tr>
<td>6</td>
<td>Deworming and other nutrition programs at school</td>
</tr>
<tr>
<td>7</td>
<td>Lowering the price of schooling</td>
</tr>
<tr>
<td>8</td>
<td>Increase and improve girls’ schooling</td>
</tr>
<tr>
<td>9</td>
<td>Community-based nutrition promotion</td>
</tr>
<tr>
<td>10</td>
<td>Provide support for women’s reproductive role</td>
</tr>
</tbody>
</table>
Prevalence of overweight (BMI >25 kg/M^2) among women ≥30 yr, 2005

Figure from: WHO. Preventing chronic diseases: a vital investment, 2005
Indicators of socio-economic development*

- **Economic**
  - GNI *per capita*, %GNP for education, %GNP for health
- **Demographic**
  - Population growth rate, % urban, fertility rate
  - IMR, U5MR, MMR
- **Food supply**
  - Per capita energy availability
- **Education**
  - % enrollment, % reaching grade 5, literacy (% >15)
- **Health**
  - Access to safe water
  - Physician/population, hospital bed/population
  - Reproductive health, women 15-49 (contraceptive prev, HIV prev)

*See UNDP world development reports.*
Theoretical model of the demographic transition
Number of stunted and underweight children, by year and region