JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

International Nutrition

Current & Emerging Issues in Nutrition, Health & Survival

Keith P. West, Jr. DrPH, MPH

International Nutrition: Major Nutritional Problems

- General food insecurity
- Protein-energy malnutrition (PEM)
- Micronutrient deficiencies
  - Vitamin A deficiency & disorders
  - Iron deficiency anemia
  - Zinc deficiency
  - Iodine deficiency & disorders
  - Other micronutrient deficits
- Infection and infectious morbidity
- Overweight & obesity

Chronic diseases of imbalance and overabundance

International Nutrition: Responses to Nutritional Stress

Household Responses :

- Breast feeding/Complementary feeding
- Home-based fortification
- Improving household food security (quantity, quality distribution)
- Improving household hygiene
- Food and non-food budgeting

Community Responses :

- Growth monitoring & promotion
- Supplementary feeding
- Cooperatives
- Nutrition education activities

National and International Responses :

- Nutritional surveillance and program monitoring
- Food

Food aid

National food & nutrition policies

Multilateral and bilateral assistance programs

International Nutrition: Other Issues Covered

- Obesity and the Nutrition Transition
- Nutrition and Reproductive Health
- HIV and Micronutrient Nutrition
- Epidemiology of Famine
- Nutritional Problems Emerging from Student Papers (aka consultant reports!)

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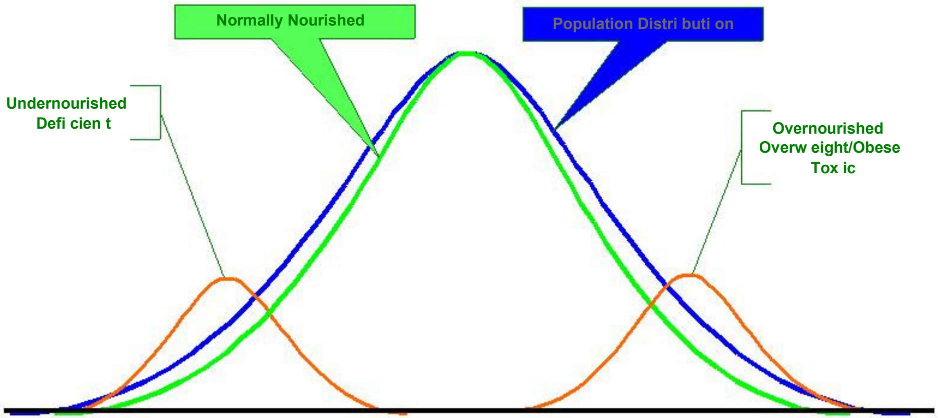
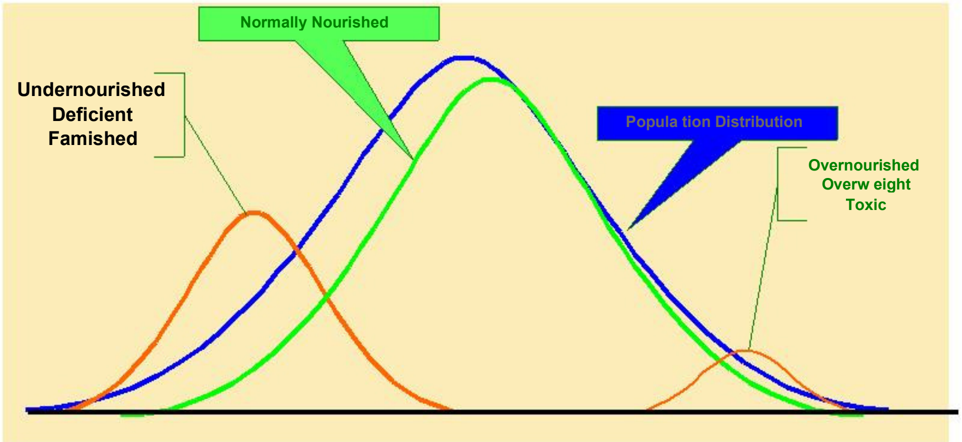
Population Distributions of Nutritional Status



For more information see: West et al. Nutrition. Intl Public Health. Aspen:Gaithersberg, 2001

Population Distributions of Nutritional Status
Mostly Undernourished (PEM, Micronutrient Deficiencies)



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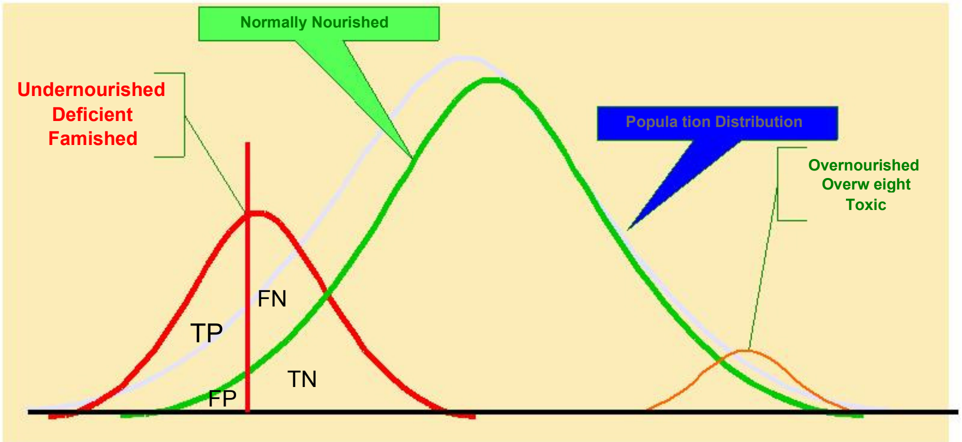


Low weight for height.. Normal weight for height
Low circulating retinol .Normal circulating retinol levels

Low hemoglobin

Low urinary iodine

Normal hemoglobin

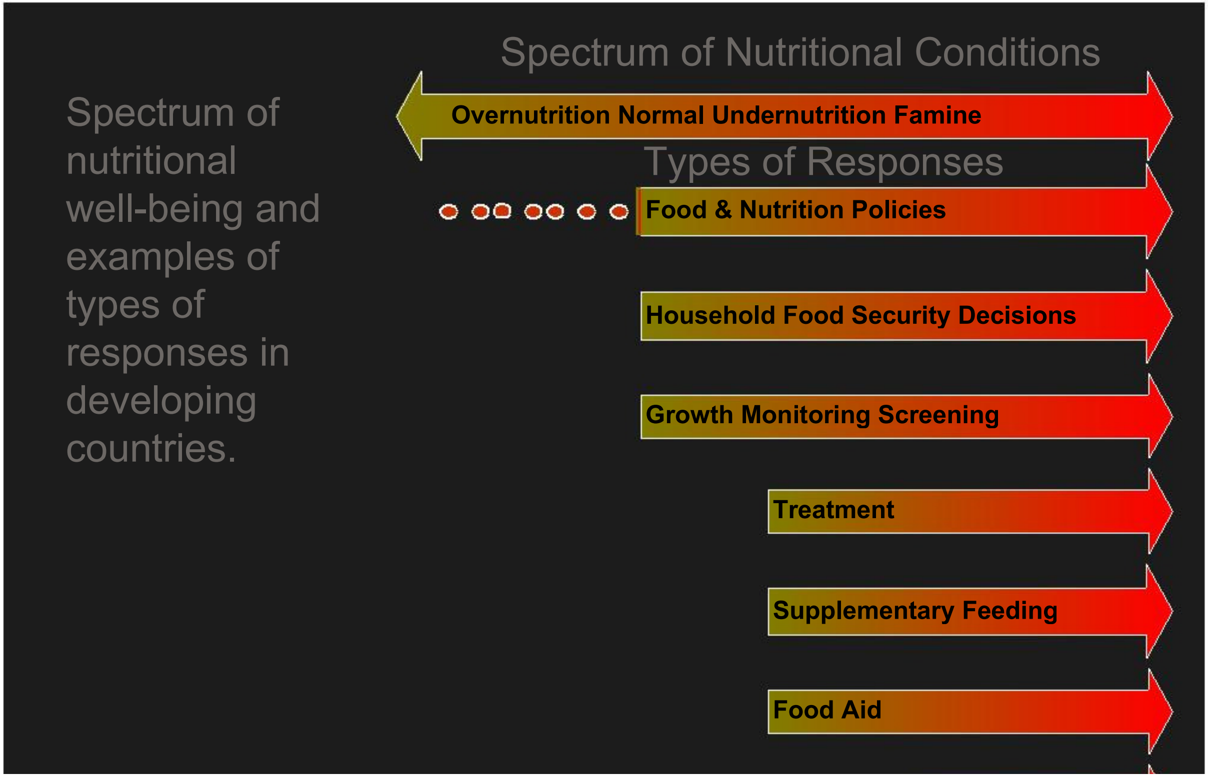
Normal iodine status

For more information see: West et al. Nutrition. Intl Public Health. Aspen:Gaithersberg, 2001

Burden of Undernutrition

- ~20% of world popn . inadequate food
- Growth failure . ~1/3 of children
- ~40% of women . under weight and/or anemic
- >1 billion suffer nutritional deficiencies

ACC/SCN of the UN 2000


Spectrum of nutritional well-being and examples of types of responses in developing countries.
Spectrum of Nutritional Conditions
Overnutrition Normal Undernutrition Famine
Types of Responses
Food & Nutrition Policies
Household Food Security Decisions
Growth Monitoring Screening
Treatment
Supplementary Feeding
Food Aid


Disaster Relief

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World Declaration on the Survival, Protection and Development of Children

Plan of Action for Implementing the World Declaration on the Survival, Protection and Development of Children in the 1990s

UNICEF


1990

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World Summit for Children 1990: Nutrition Goals

Reduce severe & moderate malnutrition < 5 yrs by half of 1990 levels;

Reduce rate of low birth weight (≤ 2.5 kg) to < 10 %;

Reduce iron deficiency anemia in women by 1/3 of 1990 levels;

Virtually eliminate iodine deficiency disorders;

Virtually eliminate vitamin A deficiency and consequences, including blindness;

Empower women to exclusively breast-feed for four to six months (now 6 months) and to continue breastfeeding, with complementary food, well into the second year;

Institutionalize growth promotion and monitoring in all countries by the end of the 1990s;

Disseminate knowledge and support services to

Disseminate knowledge and support services to increase food production to ensure household food security.

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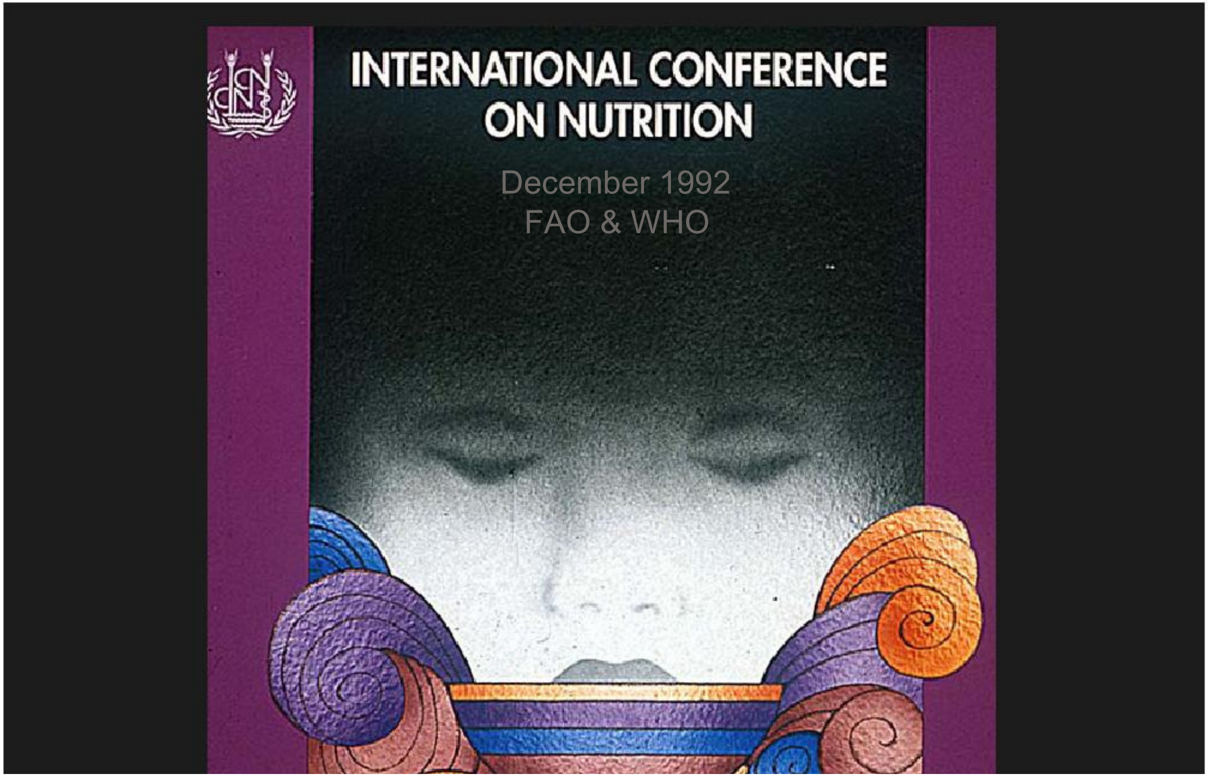

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By the year 2000 . . . eliminate:

famine and related deaths

starvation

man-made disaster-induced deficiencies

iodine deficiency

vitamin A deficiency

ICN, Rome 1992

World Food Summit of 1996
FAO

Monitoring adequacy of food supplies

Gender equality for education, training in food industry

Increased expert guidance to countries on human nutrition

Improved opportunities for nutrition education

Attention to food quality and safety

Ensure fair food trade practices

Establish linkages between nutrition and development

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www.developmentgoals.org

Goal 1: Eradicate Extreme Poverty and Hunger

Target 1: Halve, between 1990 and 2015, the proportion of people whose income is less than $1 (0.80 Euros) a day

Target 2: Halve, between 1990 and 2015, the proportion of people who suffer from hunger www.developmentgoals.org

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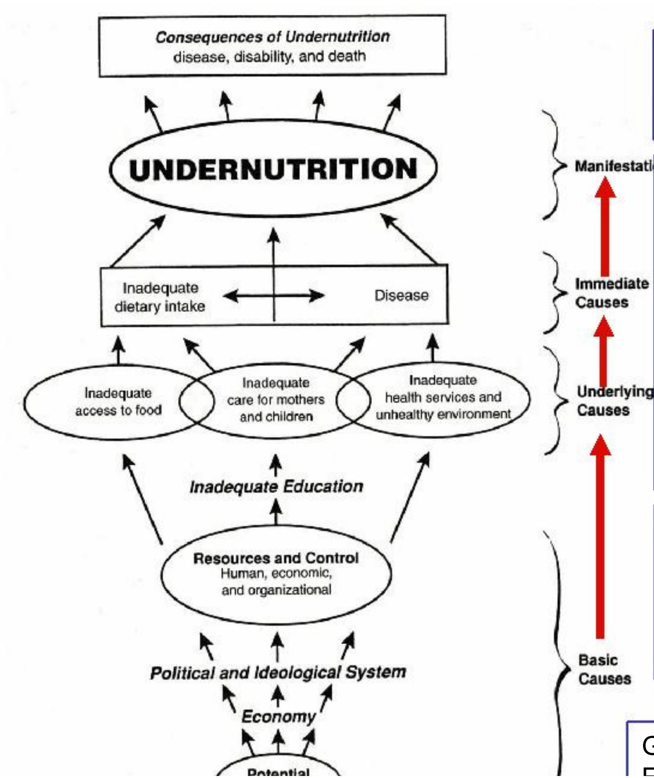

Clinical treatment protocols
(eg, severe PEM, keratomalacia)
Supplementary feeding

Nutrition surveillance & surveys
Direct nutrient provision
Supplementation
Food fortification
Feeding programs
Nutrition education
Food subsidies
Horticulture (gardens)
Pisciculture (fish farms)
Animal husbandry

Education
Equal opportunity
Health care system
Market access
Food aid

Good governance

UNICEF Conceptual Model of the Causation of Undernutrition, Modified To Include Its Consequences

Economic & development plans
Grains & livestock production
Trade policies
Human rights **(including food & nutrition)**

Undernutrition

Wasting

Stunting

Underweight

Micronutrient Deficiencies

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Severe Wasting w/ edema

Three-year old Indonesian boy with measles, marasmic-kwashiorkor and keratomalacia (right eye).

The synergy between malnutrition and infection can be devastating, threatening a child's sight and life.

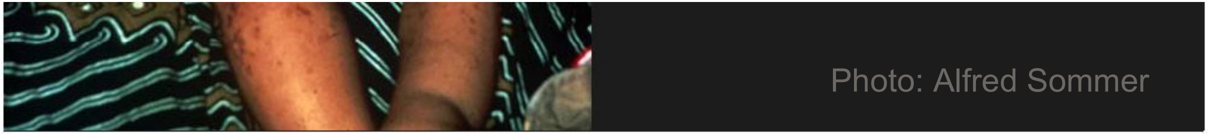
Photo: Alfred Sommer

Mild-to moderate stages of undernutrition are clinically less evident, less acute but much more frequent, associated with increased risks of poor health, developmental delay and mortality.

Most preschool child deaths occur among those who are mildly-to-moderately

undernourished.

Photo: Keith West

Underweight in Under Fives

Excess infection

Excess mortality

Decreased activity

Delayed development

Poor school performance

ACC/SCN, 1991

Micronutrient Malnutrition:
Hidden Hunger

- ~2 billion people affected
- VA, iron, iodine, and zinc deficiencies
- Effects: poor growth, increased morbidity, intellectual impairment, increased mortality
- Preventable: supplements, fortification, diet change

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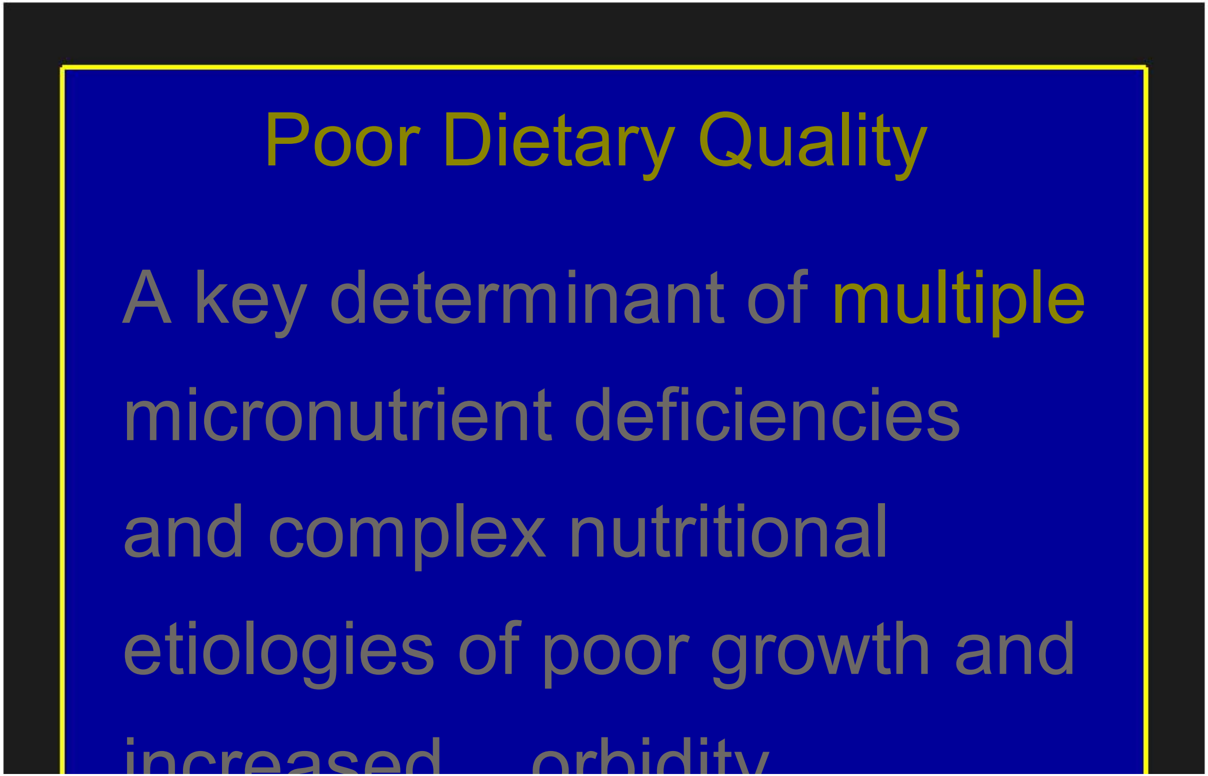
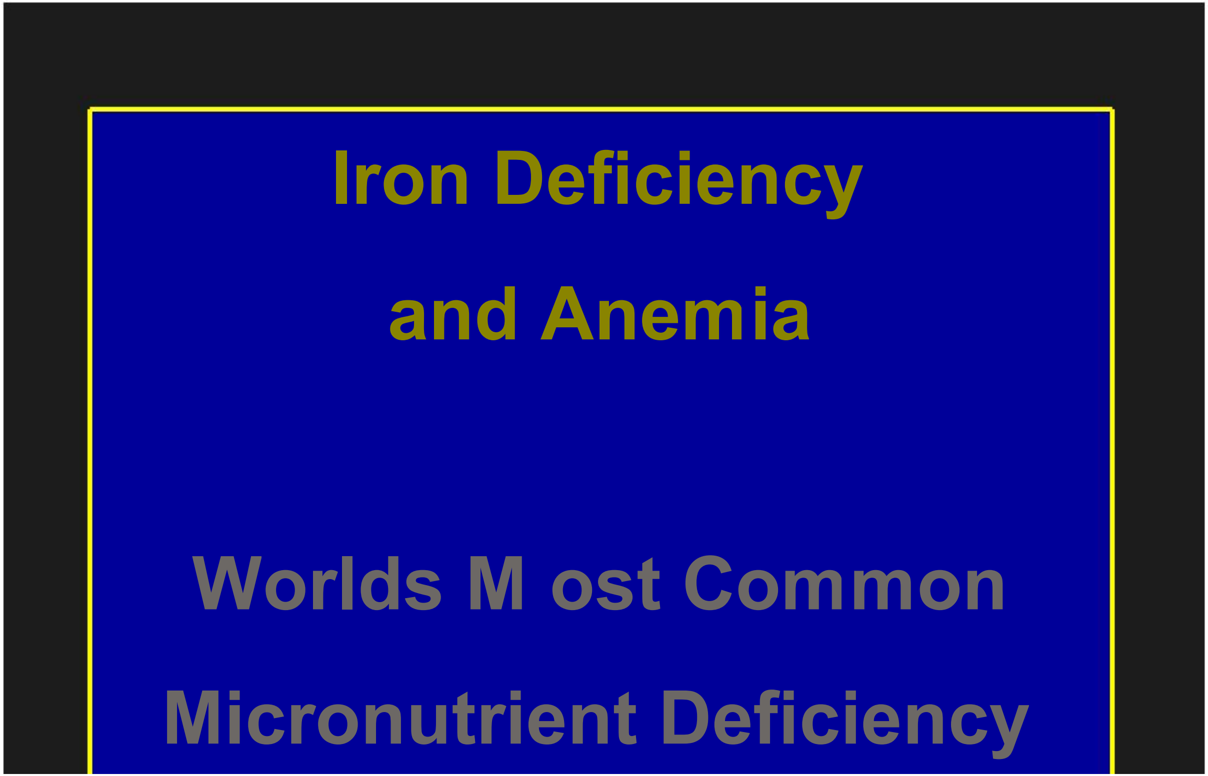


Vitamin A Deficiency

4-5 million...	children with xerophthalmia
125-130 million..	deficient children
1-2.5 million	child deaths/year
~7 million	deficient women
~6 million	night blind pregnant women

KP West J Nutr 2002


Iron Deficiency
and Anemia
Worlds M ost Common
Micronutrient Deficiency

Iron Deficiency/Anemia: A Major Global Problem

~ 2 billion anemic

Severe anemia . high mortality

Mild to moderate anemia

- Impairs child development
- Decreases work capacity
- Pregnancy complications

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Anemia: Many Causes

Iron deficiency

Other nutritional deficiencies

Hookworm

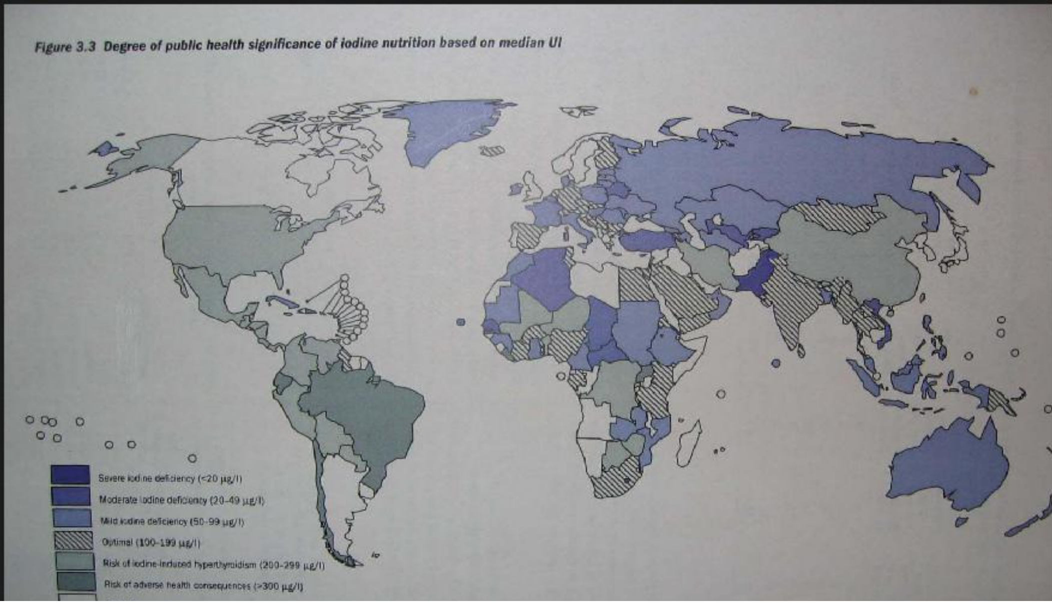
Malaria

Chronic infection (HIV)

Anemia: Many Solutions

- Iron supplementation
- Supplement with other nutrients
- Deworm/hygiene
- Malaria prophylaxis
- Prevent chronic infections

Iodine Deficiency Disorders WHO 2004



54 countries with IDD as public health problem based on urinary iodine concentration

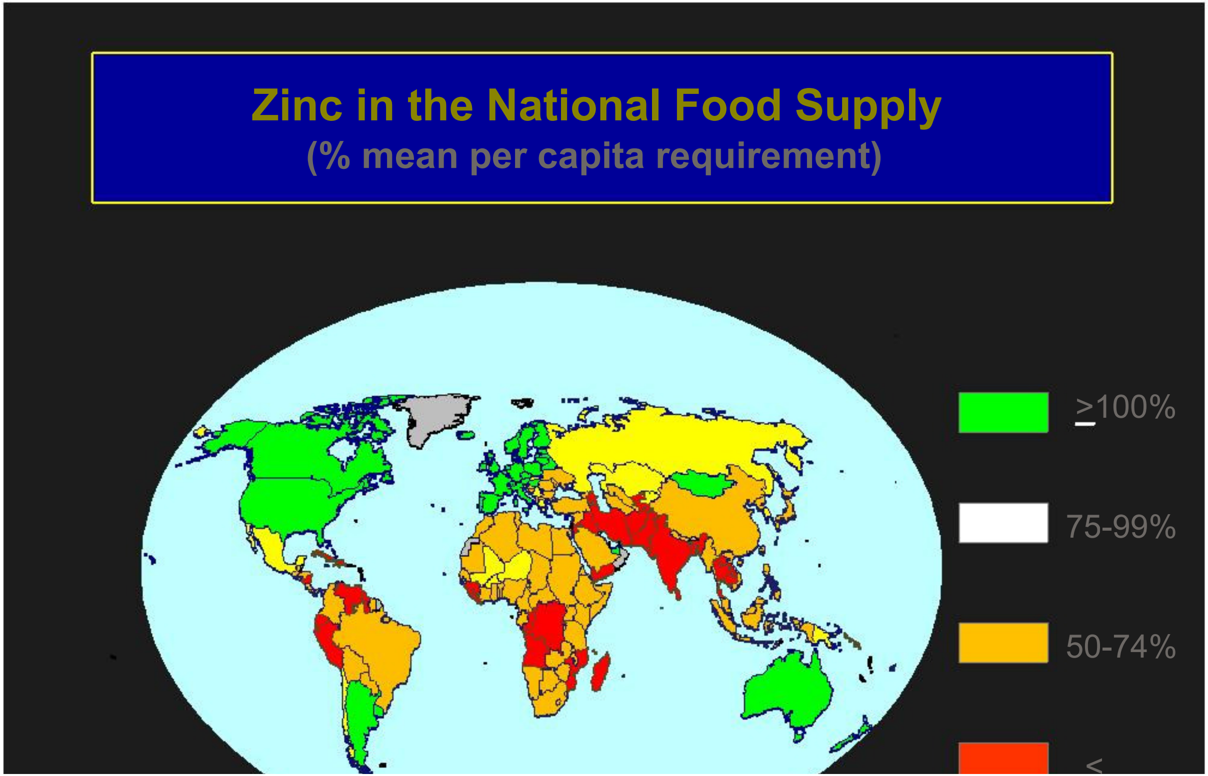
Effects of Iodine Deficiency on Neural Function

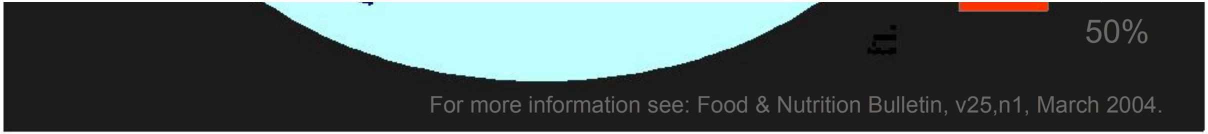
- Intelligence
- Learning capacity
- School performance
- Cognition
- Other outcomes

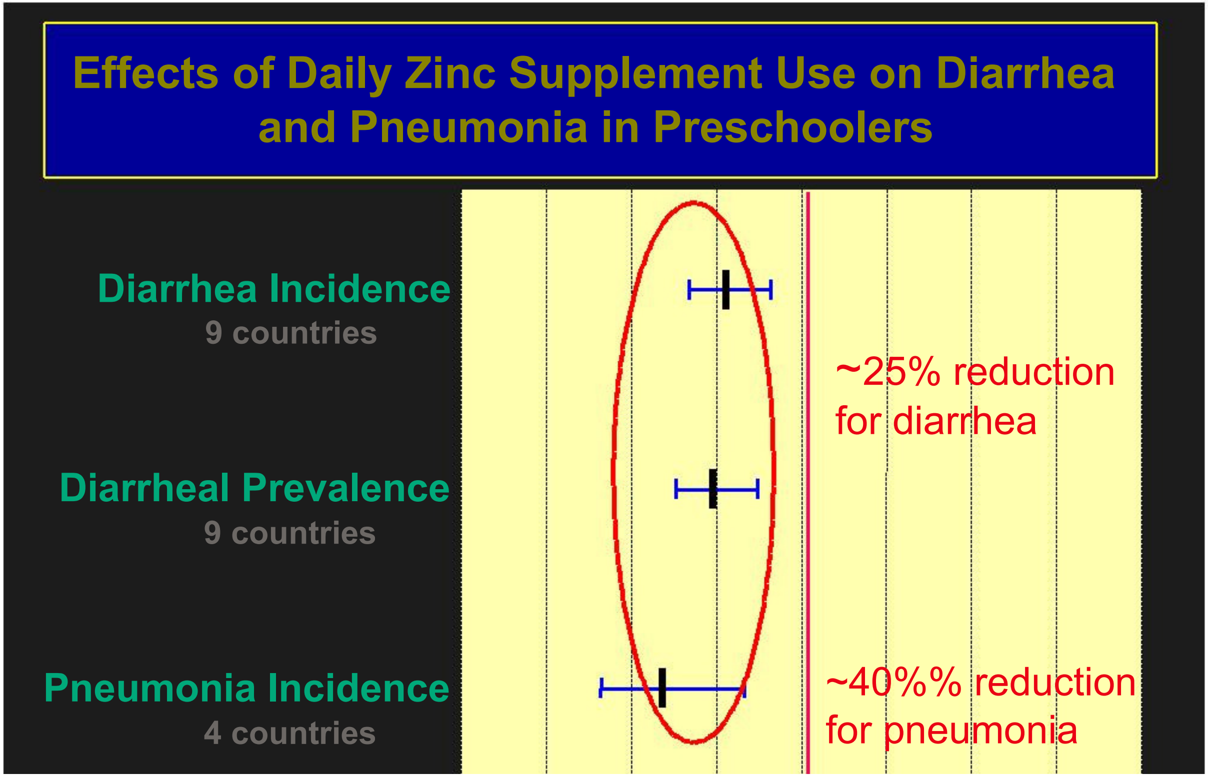
Zinc Deficiency

Vast problem, hard to assess
Low meat, high grain diets
Increases risk of
- Diarrhea
- Respiratory infection
- Severe malaria
- Death

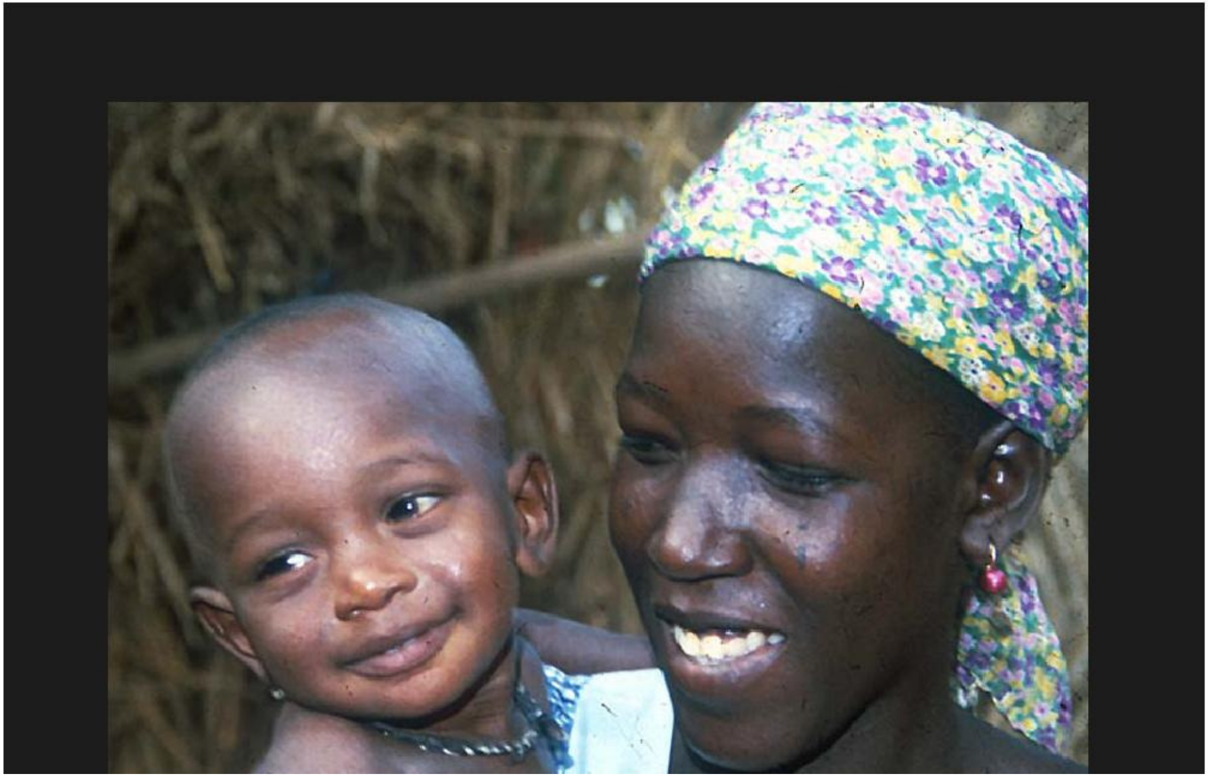
(likely)


Zinc in the National Food Supply
(% mean per capita requirement)
≥100%
75-99%
50-74%
<


50%
For more information see: Food & Nutrition Bulletin, v25,n1, March 2004.


Effects of Daily Zinc Supplement Use on Diarrhea and Pneumonia in Preschoolers
Diarrhea Incidence
9 countries
Diarrheal Prevalence
9 countries
Pneumonia Incidence
4 countries
~25% reduction for diarrhea
~40%% reduction for pneumonia

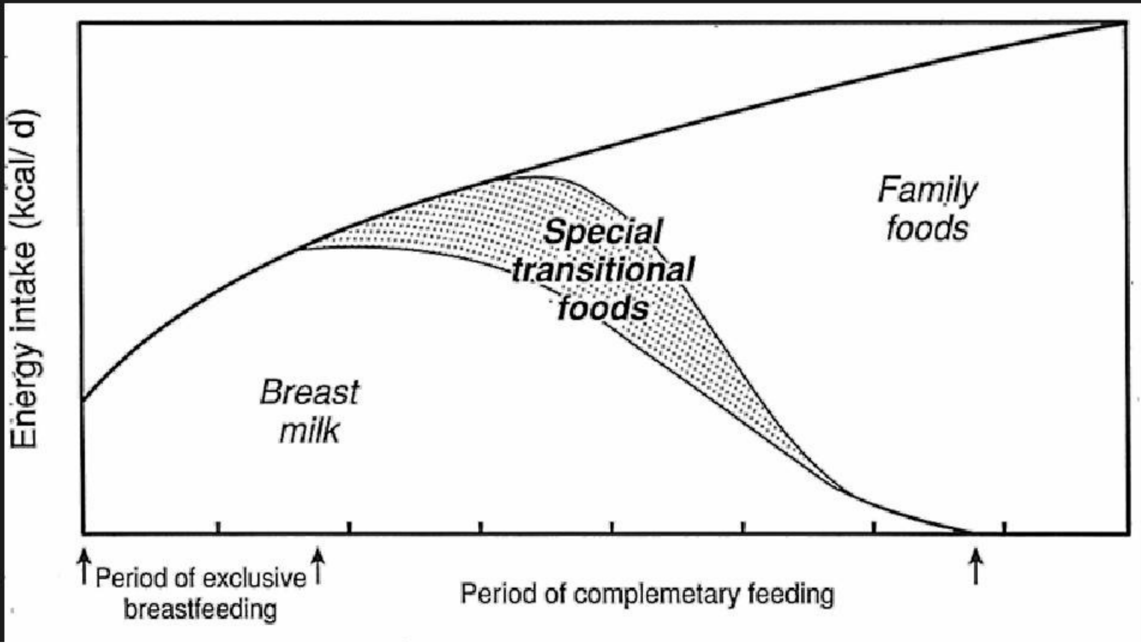

For more information see: Zinc Investigators Collaborative Group J Pediatrics 1999;135:689
0 0.25 0.5 0.75 1 1.25 1.5 1.75 2
Odds Ratio and 95% CI

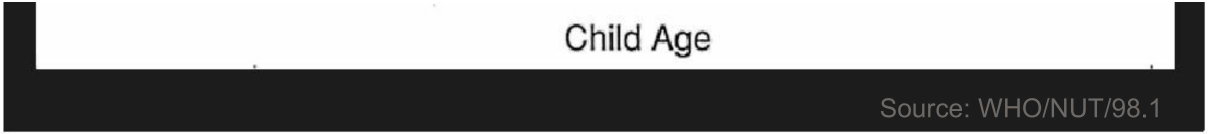


Household and Mother: 1st Line of Response

Photo: Keith West

Breast and Complementary Feeding




Child Age
Source: WHO/NUT/98.1

Breast feeding

Today, 23 March 2004, UNICEF and WHO launched the Global Strategy for Infant and Young Child Feeding:

Goal: Exclusive breast feeding in the first half-year of life and continued breast feeding coupled with appropriate foods thereafter to reduce the number of children < 5 dying from malnutrition

www.who.int/mediacentre/releases/2004

Household Food Security

Adequate access to food needed for a healthy and active life for all household members (in terms of quality, quantity, safety, cultural acceptance, and future expectations).

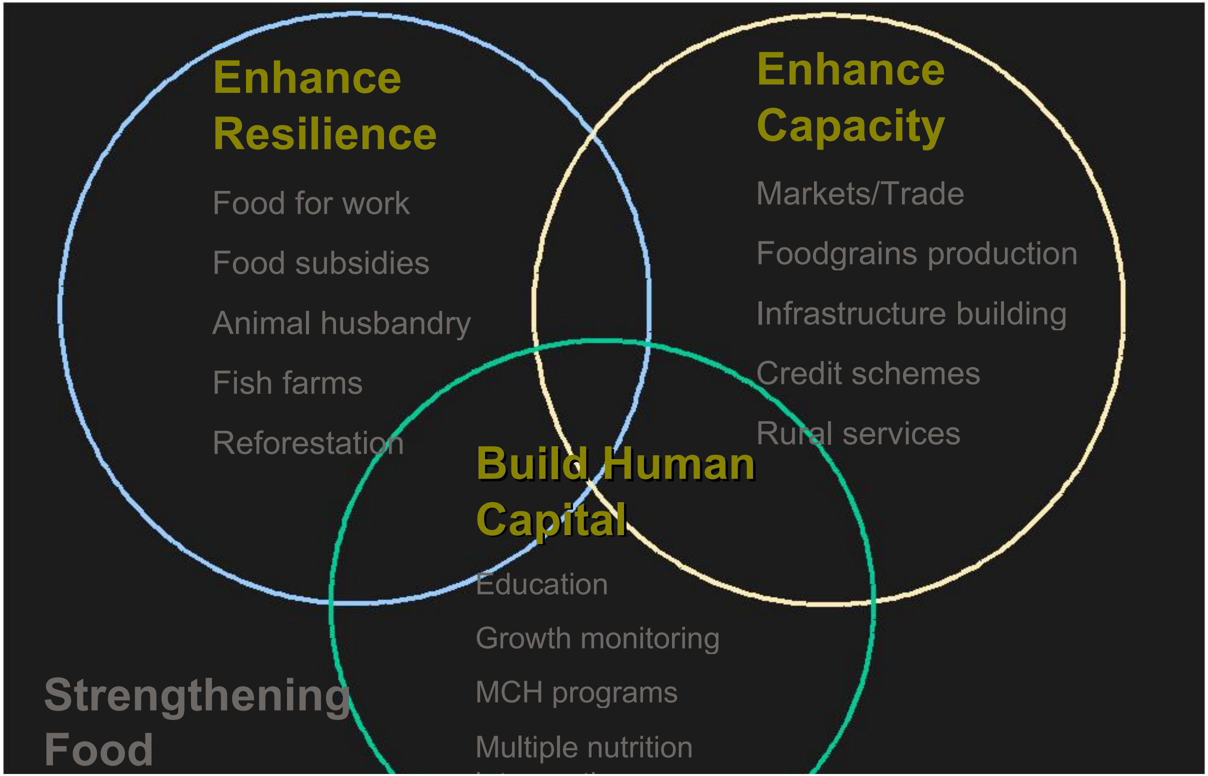
ACC/SCN, 1991

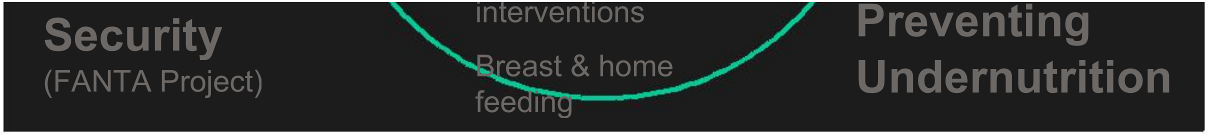
Although malnutrition has multiple causes, reality simply is not conducive to developing effective nutrition plans which simultaneously deal with all such causes.

ACC/SCN, 1991


Examples of Community Responses:
Growth Monitoring and Promotion &
Supplementary Feeding


Photo: Keith West


Enhance Resilience
Food for work
Food subsidies
Animal husbandry
Fish farms
Reforestation
Enhance Capacity
Markets/Trade
Foodgrains production
Infrastructure building
Credit schemes
Rural services
Build Human Capital
Education
Growth monitoring
MCH programs
Multiple nutrition
Strengthening Food


Security
(FANTA Project)
interventions
Breast & home
feeding
Preventing
Undernutrition

National & International Responses

Food Aid

Nutritional Surveillance and Program Monitoring

Equitable trade policies

Conflict resolution

Economic Development policies

Classic Chain of Causation

Food Shortage

Starvation

Famine

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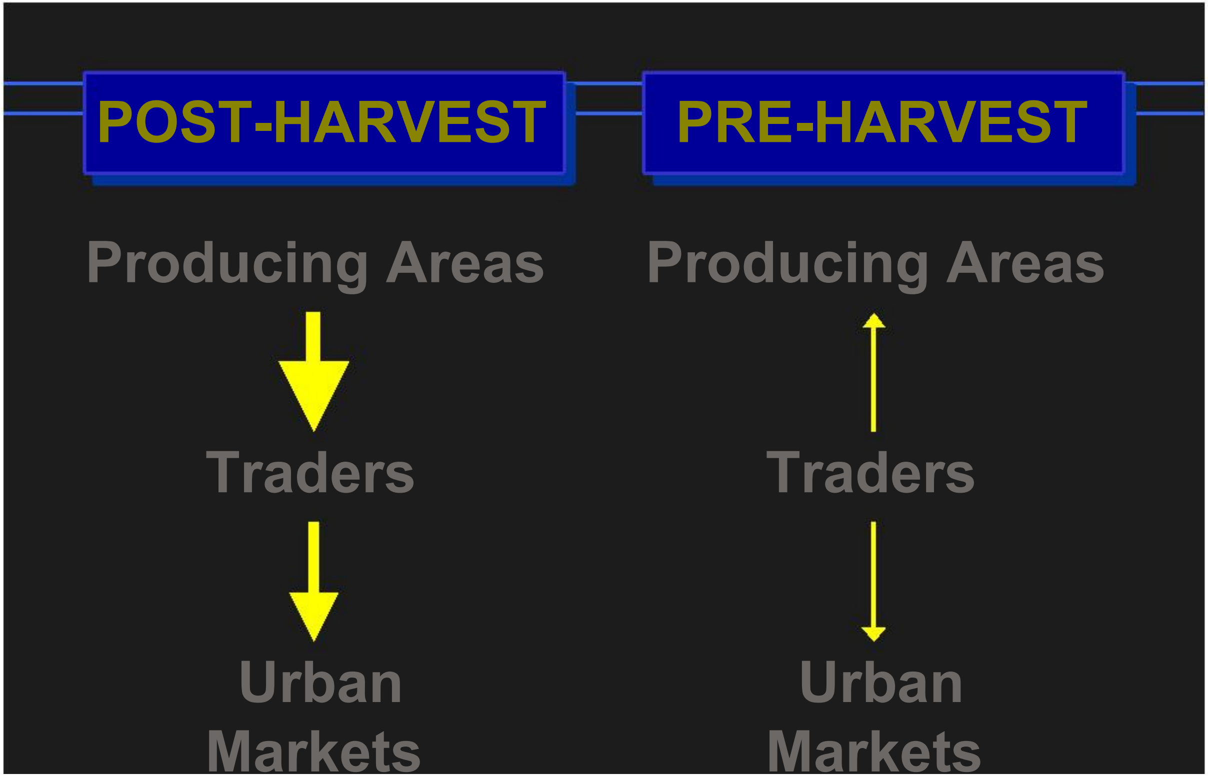


The Nutrition Transition

- An Emerging Global Epidemic of Obesity-

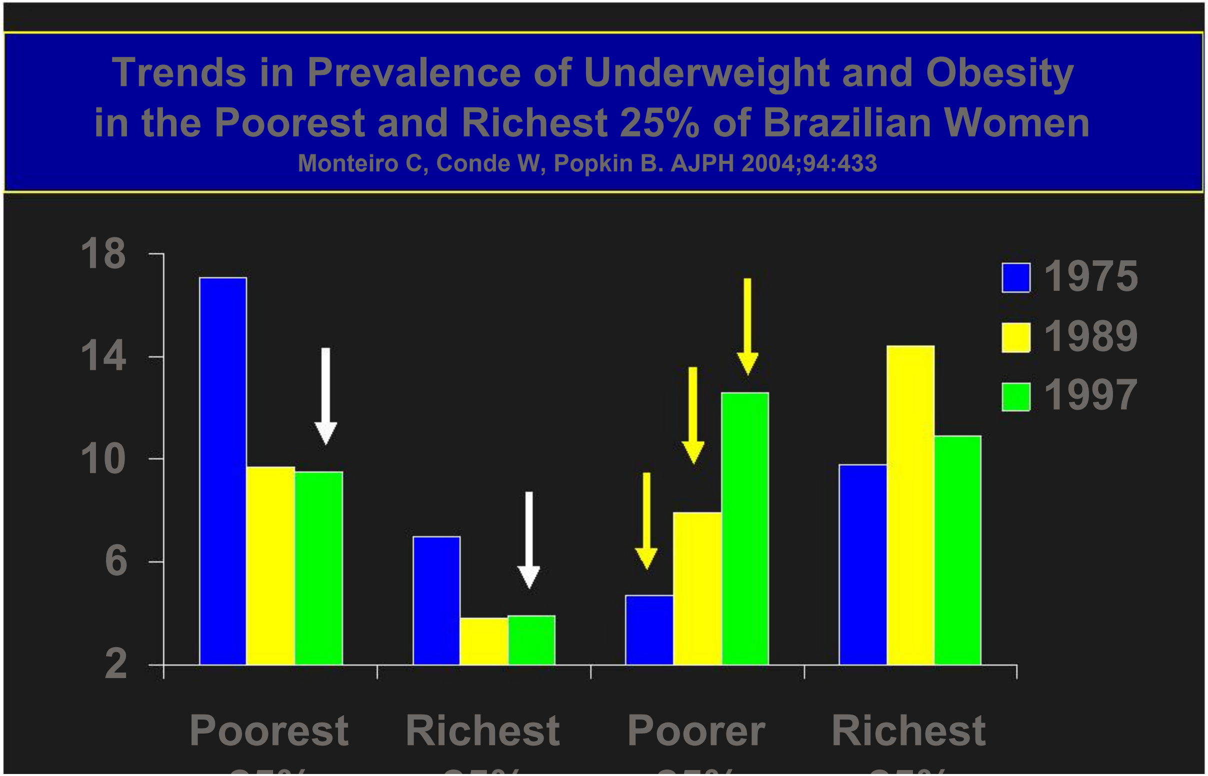
Prevalence (%) in Women 15-49 Years of Age

Region	Obese	Over Wt
USA	21	21
N Africa	20	31
ME/NA	17	29
CIS	15	27
LAC	14	29
SSA	4	12
S	0.1	2

S Asia	0.1	2

Obesity: BMI > 30 kg/m^2; Overweight BMI > 25 kg/m^2

Martorell R. Nutrition Transition
ed Caballero & Popkin, 2002


Trends in Prevalence of Underweight and Obesity
in the Poorest and Richest 25% of Brazilian Women
Monteiro C, Conde W, Popkin B. AJPH 2004;94:433
18
14
10
6
2
1975
1989
1997
Poorest
Richest
Poorer
Richest


25%
25%
25%
25%
Underweight
Obesity

Prevalence Ratios for Underweight and Obesity Among Brazilian Women, 1975-97

	Poorest 25%	Richest 25%
Underweight 1997:1975	0.5	0.4
Obesity 1997:1975	2.7	1.1

1997:1975

Monteiro, et al AJPH 2004


Welcome to
International Nutrition
Very Important Website
http:// www.who.int/nut/
publications.htm

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Protein-Energy Malnutrition (PEM) and Undernutrition Causes, Consequences, Interactions and Global Trends

Keith P. West, Jr., Dr.P.H.
International Nutrition

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PEM: Invariably reflects combined deficiencies in

- Protein : deficit in amino acids needed for cell structure, function
- Energy: calories (or joules) derived from macronutrients: protein, carbohydrate and fat
- Micronutrients : vitamin A, B-complex, iron, zinc

complex, iron, zinc,
calcium, others

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Undernutrition through Life Stages

Child and Maternal Health Problems

Nutritional Deficiencies

Infant or Child

Infection (diarrhea, ARI)
Poor growth
Impaired mental, motor and behavioral development
Death

Mother

Obstetric morbidity

PEM

Micronutrient Defic:

Vitamin A, zinc, iron, iodine, folate, others

Behavioral Causes:

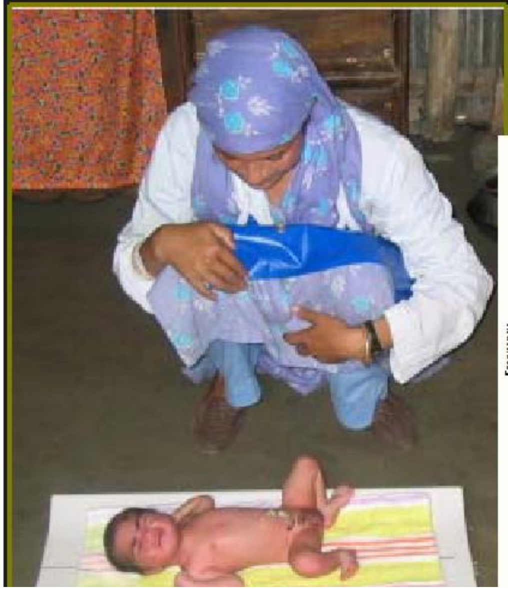
Related to breast feeding, complementary

Infection/sepsis
Anemia
Death

Photo: K West

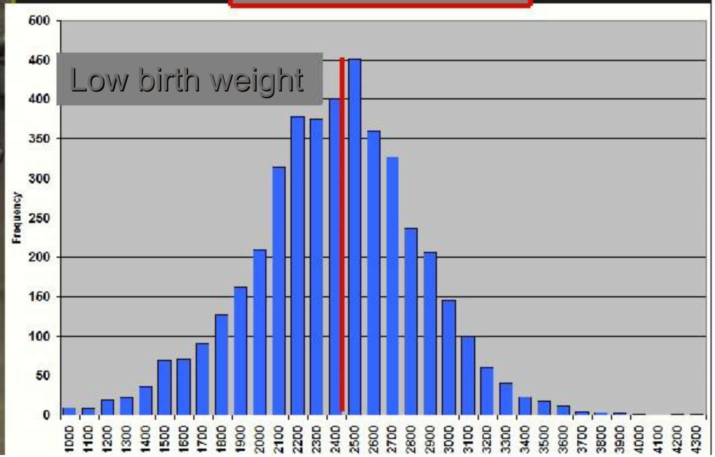
feeding,
HH
low SES,
diet,
poor educatoin

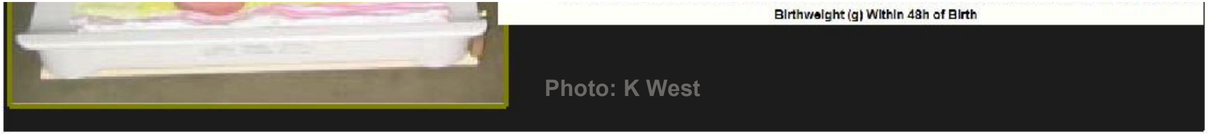
IUGR: Due to Maternal Malnourishment, Disease, Noxious Exposures



N=4615 Newborns
in NW Bangladesh

Mean= 2442 grams




Birthweight (g) Within 48h of Birth
Photo: K West

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Postnatal nutrition also can also dramatically affect early child growth

From mild growth deficit detectable by anthropometry or biochemical indices

To severe wasting malnutrition (eg, Marasmus)

Shown: 1-year old twins in Chittagong, Bangladesh

Bangladesh
Left: Male
Right: Female

Photo: K West

Severe Childhood PEM

Kwashiorkor: disease when child is displaced from breast (Cicely Williams, 1935, Gold Coast, W Africa)

Marasmus: Extreme wasting

Marasmic-Kwashiorkor

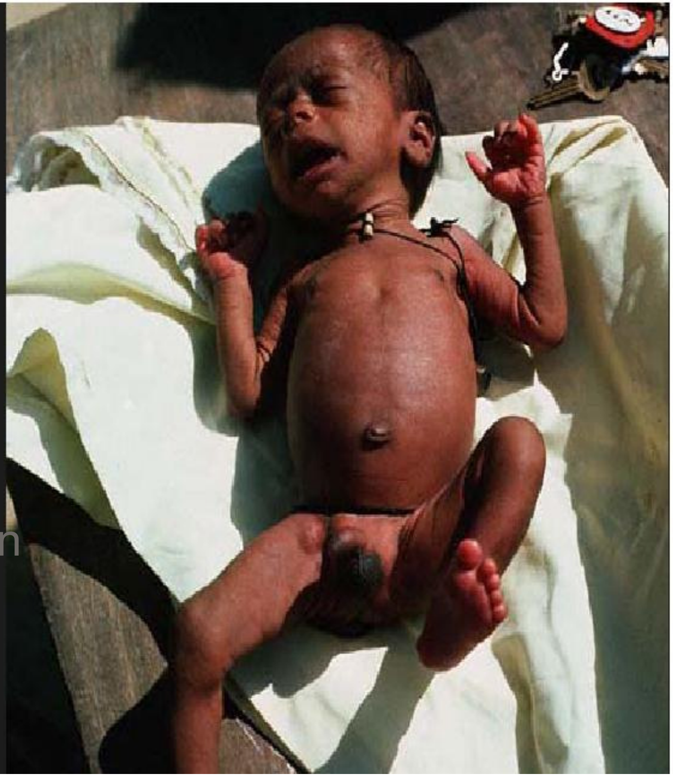
Kwashiorkor Marasmus

Different manifestations of similar nutritional deficits of energy, protein,

micronutrients;
unique causal roles for aflatoxins & oxidative stress
in Kwashiorkor.

Marasmus

- Severely wasted (emaciated) & stunted
- Very low WAZ
- Balanced starvation
- Old Man face, wrinkled appearance, sparse hair
- No edema, fatty liver, skin changes
- Too little breast milk or complementary foods



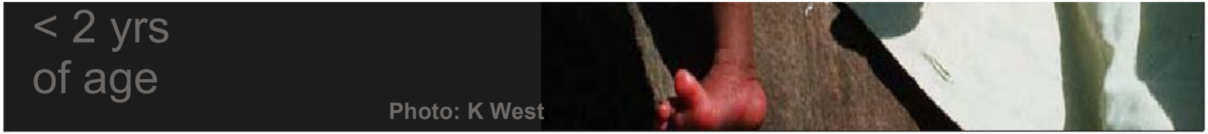

< 2 yrs
of age
Photo: K West

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Photo: K West
Dilute and unhygienic formula
or bottle feeding

Kwashiorkor

Edema

Mental changes

Hair changes

Fatty liver

Dermatosis (skin lesions)

Infection

Mod low WAZ, wasting

High case fatality

Low prevalence

1st to 3rd yrs of life

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Three-year old Indonesian boy with measles, marasmic-kwashiorkor and keratomalacia (right eye).

The synergy between undernutrition and infection can be devastating, threatening a child's sight and life.

Photo: Alfred Sommer

Causes of Severe Childhood PEM

- Chronic, severely low energy and protein intake
  - Exclusive breast feeding for too long
  - Dilution of formula
  - Unclean/non-nutritious, complementary foods of low energy and micronutrient density
- Infection (eg, measles, diarrhea, others)
- Xenobiotics

(aflatoxins)

Treatment of Severe PEM

- Nutritious feeds:
  - Breast milk;
  - Liquid feeds of skimmed milk, oil, sugar; soft
  - Cereal gruels with milk, oil, sugar soft
  - Soft ripe fruit, cooked vegetables
- Establish a daily, graduated intake of -
  - ~3-4 g protein per kg (actual) body wt

~200 kcal of energy per kg body wt

V Reddy, Protein Energy Malnutrition. Diseases of Children in the Subtropics & Tropics, 4th ed Ed P Stanfield et al, London:Hodder & Stoughton, 1991

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Treatment of Severe PEM (2)

- More frequent small feeds better than large meals
- Micronutrient supplements:
  - To treat clinical conditions (eg, anemia, xerophthalmia
  - To prevent further deficiencies
- Water for thirst
- Treat infections and illnesses; eg,
  - Diarrhea: ORS & zinc
  - Antibiotics, as indicated
- Prevent

Prevent
hypothermia

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1-year After Treatment of Severe Malnutrition, Bangladesh

(Khanum et al, Am J Clin Nutr 1998;67:940-5)

Diarrhea	67%
Pneumonia	58%
Mortality	2.3%
Mean WHZ	adequate
Mean HAZ	very low

Returning to same high-risk home setting

Mortality One Year Following Treatment for Severe Wasting Malnutrition

Tanzania	8%
Tanzania	41%
Zaire	19%
Niger	18%
Philippines	12%
Nigeria	15%
South	38%

Africa


Children can remain wasted
and underweight throughout
preschool years


Photos: K West

Undernutrition can be milder, "hidden", reflecting chronic low intake of calories, protein & micronutrients, affecting survival & quality of life Photo: K West

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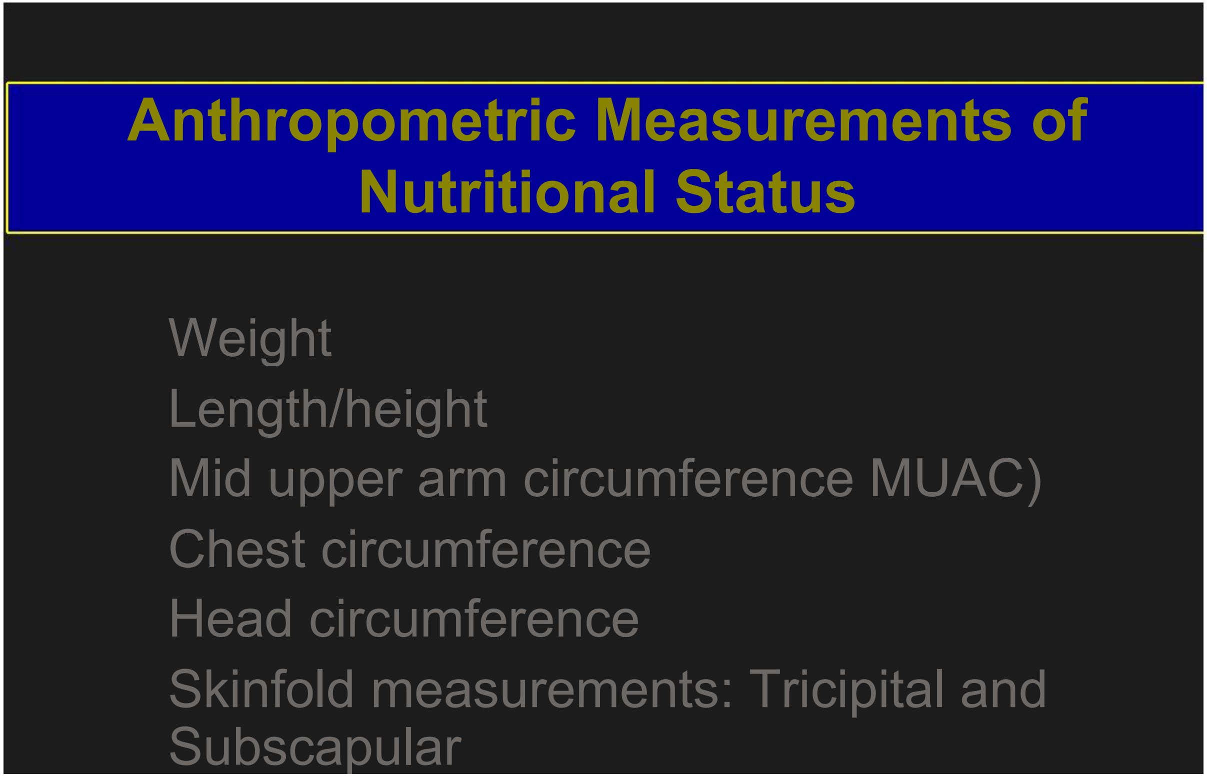

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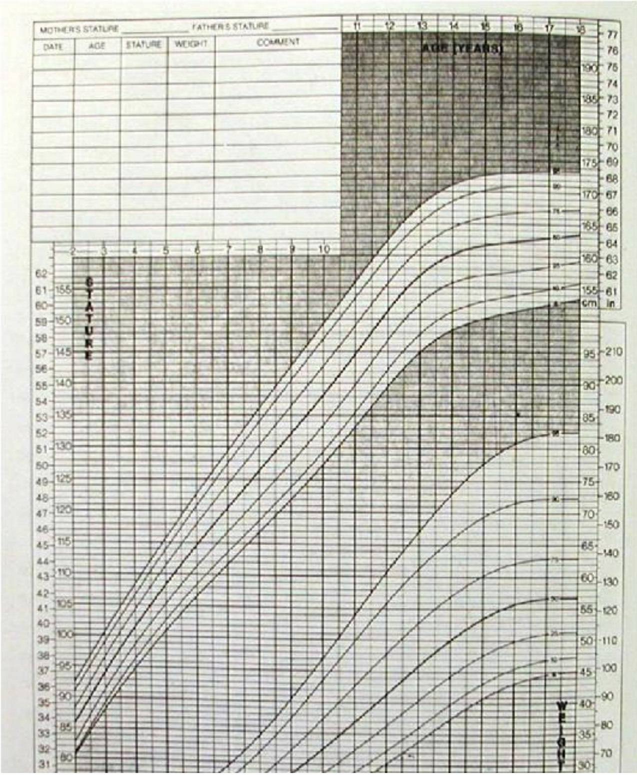
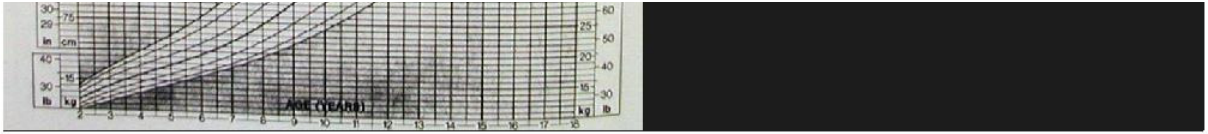


NCHS growth curves depicting percentiles of stature and weight for age of American girls, 2 to 18 years of age .

National Center for Health Statistics

For more information see:
Hamill et al AJCN 1979;32:607


in
cm
lb
kg
AGE (YEARS)
kg
lb

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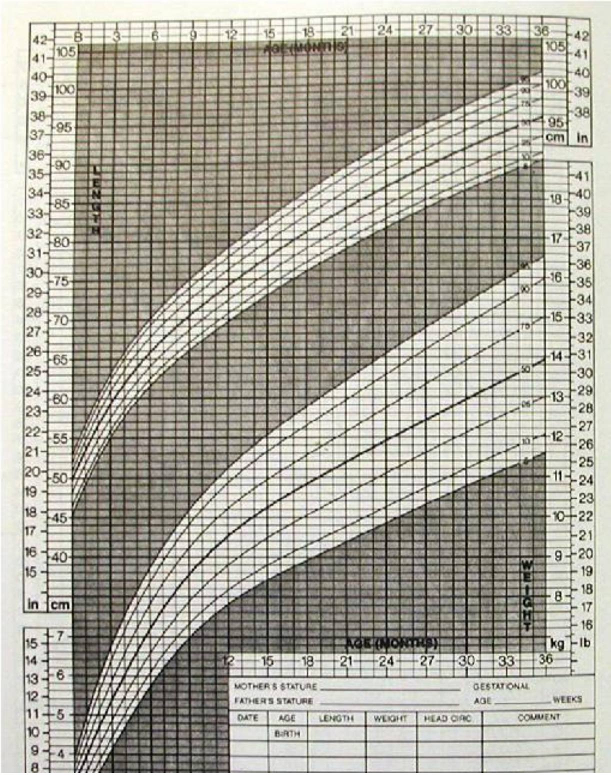

NCHS growth curves depicting percentiles of length and weight for age of American girls, birth to 36 months .

National Center for Health Statistics

For more information see:
Hamill et al AJCN 1979;32:607


7
6
5
4
3
2
lb
kg
B
3
6
9

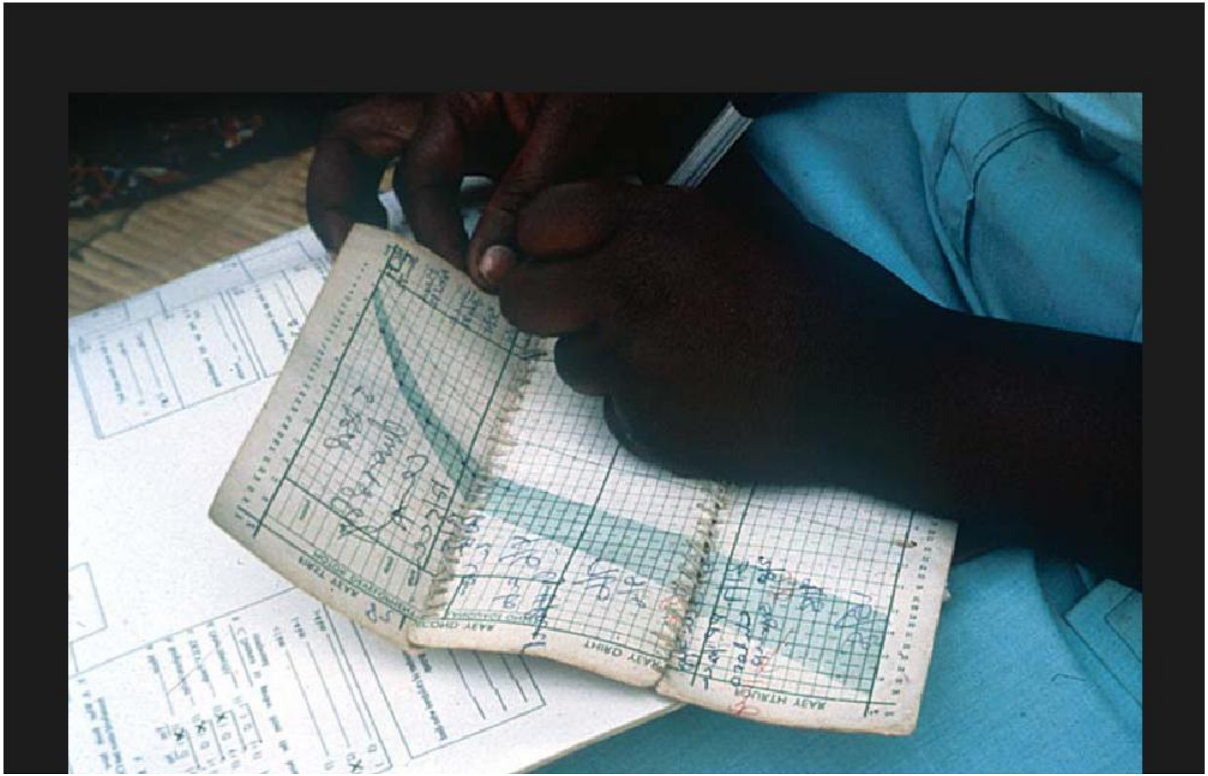

Photo: Keith West

Anthropometric classification of PEM

Underweight : Weight for age < -2SD of the *median* age-sex specific weight of the NCHS/WHO reference

Stunting: Height for age < -2SD of the median age-sex specific height of the NCHS/WHO reference

Wasting: Weight for height <-2SD of the median weight at a given

median weight at a given
height of the
NCHS/WHO reference

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Anthropometric Cutoffs for Assessing Undernutrition in

Indicator	Basis	Moderate or Severe	Moderate or worse	Mild or worse
Wt for Age	% med SND	<60% <-3 Z	<75% <-2 Z	<90% < -1 Z
Ht for Age	% med SND	<85% <-3 Z	<90% <-2 Z	<95% < -1 Z
Wt for Ht	% med SND	<70% <-3 Z	<80% <-2 Z	<90% < -1 Z

MUAC (cm)	Absolute (1-5 yrs)	<11.5	<12.5	<13.5

General Classification of Child Undernutrition by Anthropometry

(Waterlow Classification)

Ht-for-Age / Wt-for-Ht	Normal (> - 2 SD HAZ)	Stunted (< - 2 SD HAZ)
Normal (> - 2 SD WHZ)	Normal	Stunted
Wasted (< - 2 SD WHZ)	Wasted	Stunted & Wasted

JC Waterlow BWHO 1977;55:489

Classification of Nutritional Status of Children by Anthropometry

(Waterlow Classification)

Ht-for-Age / Wt-for-Ht	Normal (> - 2 SD HAZ)	Stunted (< - 2 SD HAZ)
Normal (> - 2 SD WHZ)	Normal	Stunted
Wasted (< - 2 SD WHZ)	Wasted	Stunted & Wasted

Underweight
(Low wt for age)


JC Waterlow BWHO 1977;55:489

Alternative Classification of Wasting Status of Children

Ht-for-Age / MUAC (cm)	Normal (> - 2 SD HZ)	Stunted (< - 2 SD WHZ)
Normal ($\geq$ 12.5)	Normal	Stunted
Wasted (< 12.5)	Wasted	Stunted & Wasted


MUAC=mid-upper arm circumference

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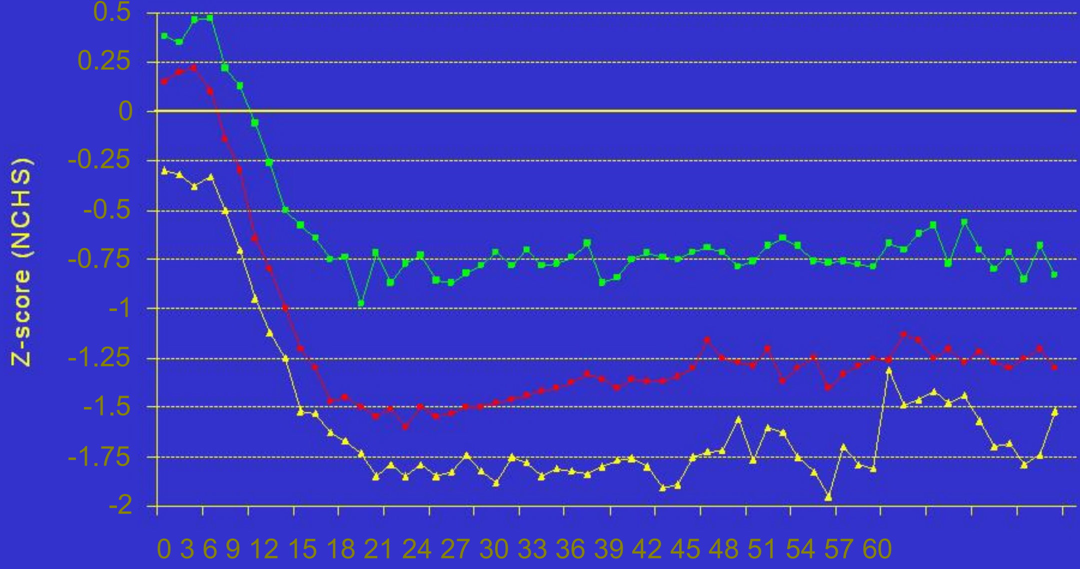
Means Weight for Age by Region




Age
(months)
Africa
Asia
Latin America and Caribbean
Source: DHS/IFPRI

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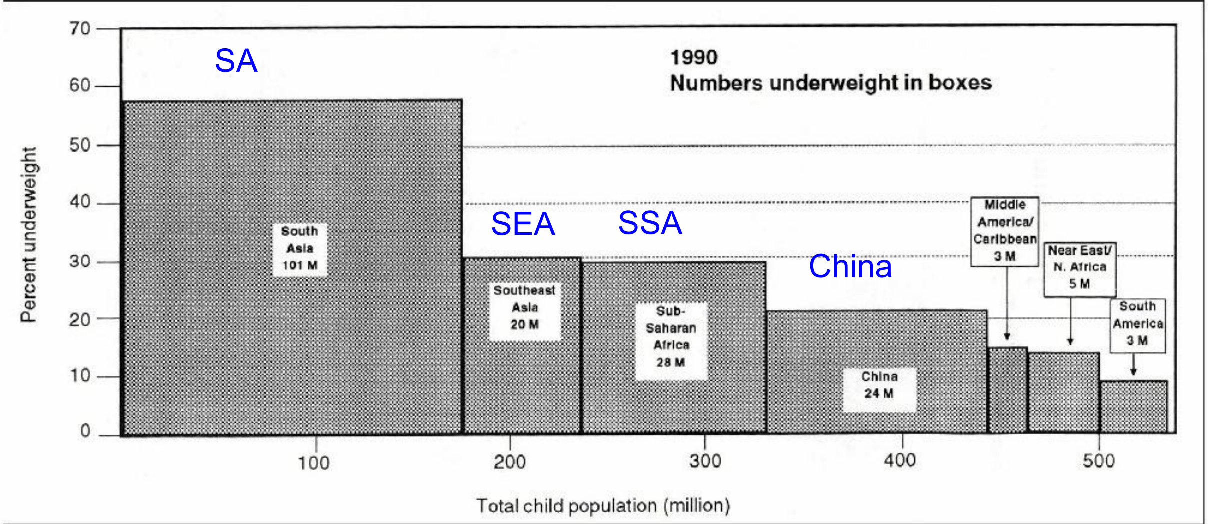
Prevalence and Numbers of Underweight Children by Region, 1990



ACC/SCN Report, 1992

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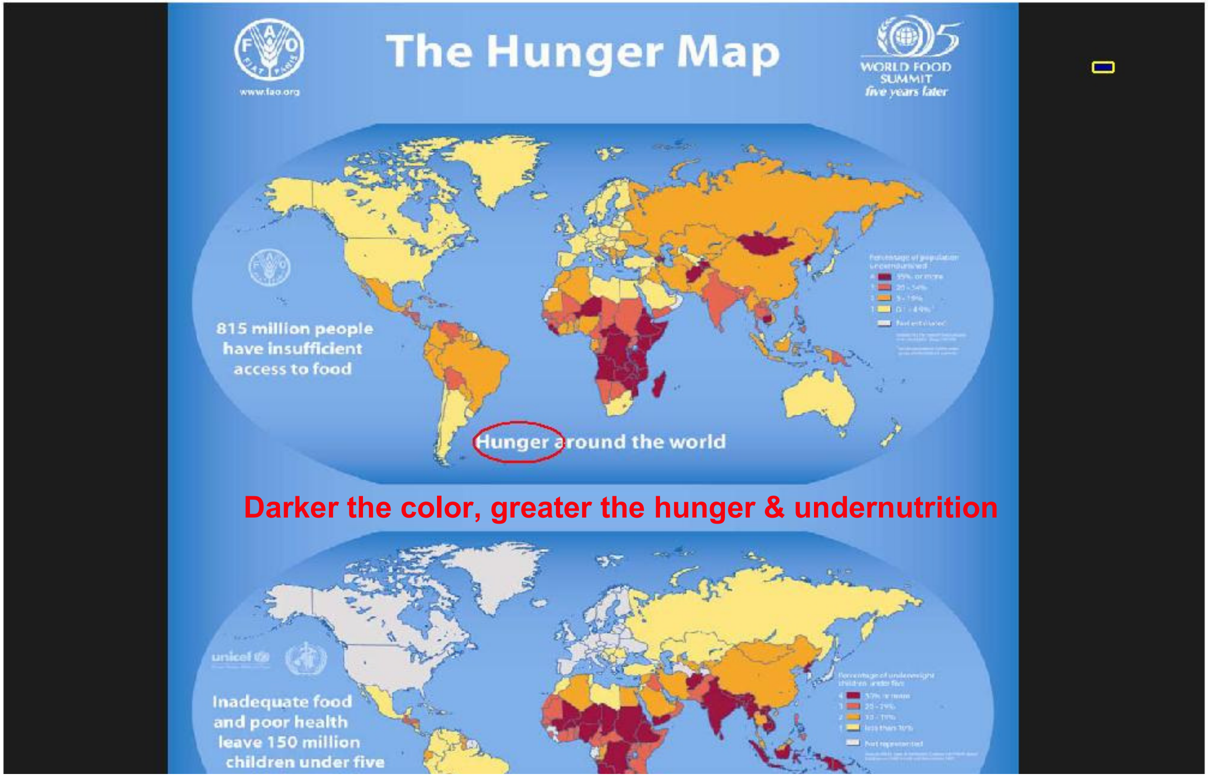


with low weight
for their age.
Underweight children
around the world

FAO Estimation of Undernourishment

Attempts to capture number & % of in each country whose food access is deemed to be inadequate; reflecting joint roles of food supplies & household incomes in affecting food security.

Calculated from 3 statistics:

- Daily per capita dietary energy supply
- CV (spread) in energy intake within a country, based on representative HH food intake surveys
- Minimum daily per capita energy requirement , based on age-sex body weight and activity level weighted by age-sex population fractions for

sex population fractions for
typical person

LC Smith, IFPRI, May 1998

The South-Asian Enigma

- Why are rates of malnutrition higher in South Asia than Sub-Saharan Africa.
  - Poverty
  - Agricultural performance is not the issue
  - Vegetarian diet
  - Government neglect
  - Higher mortality rates in SS Africa
- Womens status (gender discrimination)
- Poor child feeding and care practices

Low birth weight (reflecting
status e.g.
poor maternal weight gain and anemia)

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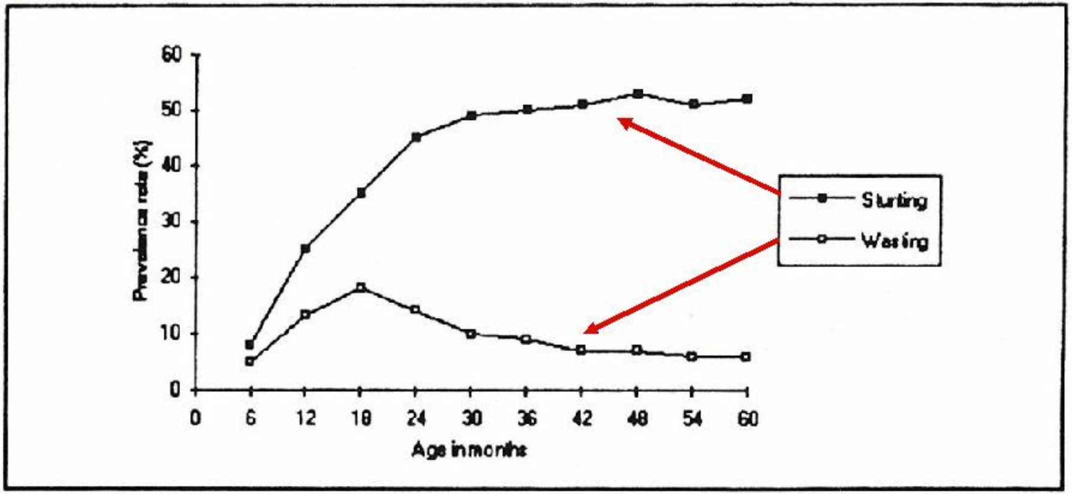
Figure II-1: A typical pattern of prevalence rates of wasted and stunted children in a developing country



Note: The figure was created on basis of a review of Demographic Health Survey data of many different countries.

DHS/MACRO

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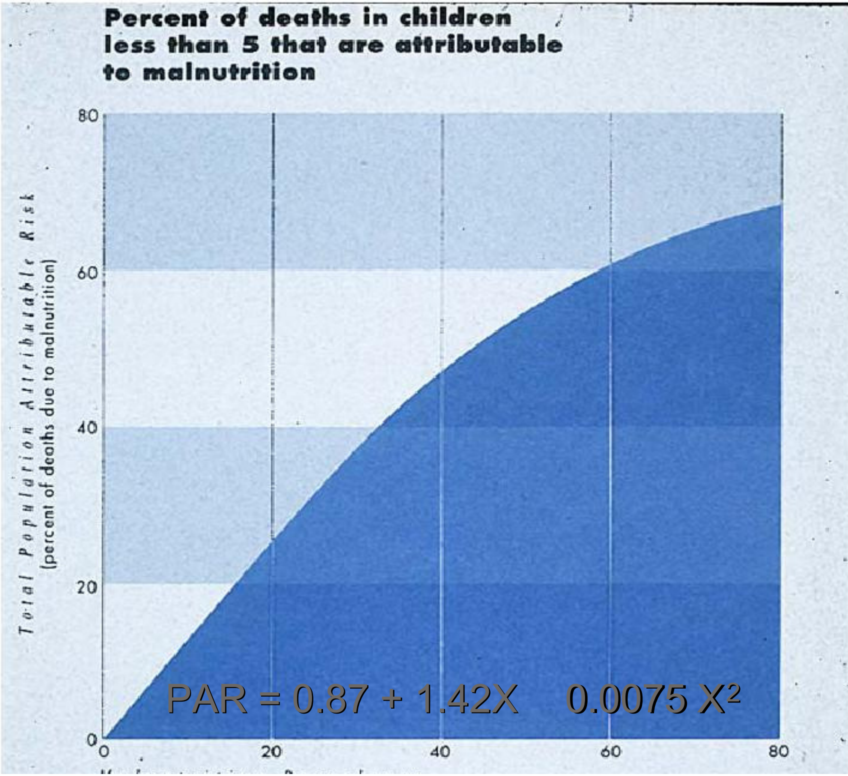

As the percent of children who are malnourished increases in a population, so too does the proportion of child deaths attributable to undernutrition.

Malnutrition Prevalence
(percent of children less than 80% of median weight-for-age)

Formula: Total Population Attributable Risk (PAR) = $0.87 + 1.42X - 0.0075X^2$
where X is Malnutrition Prevalence (percent under 80% of median weight-for-age)
Source: Pelletier, D. et al. *Bulletin of the World Health Organization*, 1995; 73 (in press)

BASICS Project
USAID

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Undernutrition is chronic in many parts of the world, affecting one generation after another, throughout the "Life Cycle". The longer-term consequences of mild-to-moderate undernutrition in early life are only beginning to be understood (eg, the early origins hypothesis of chronic disease risk;)


Photo: Keith West

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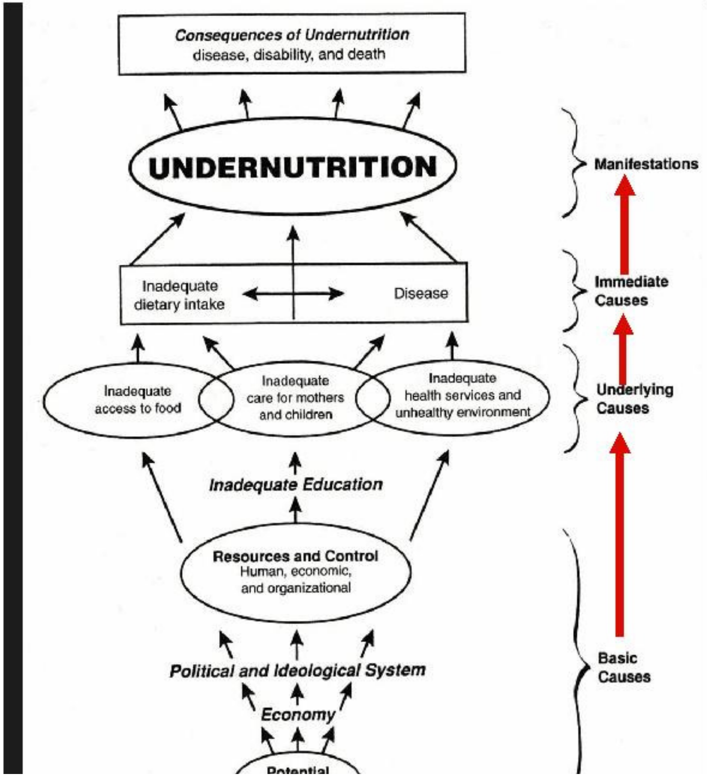
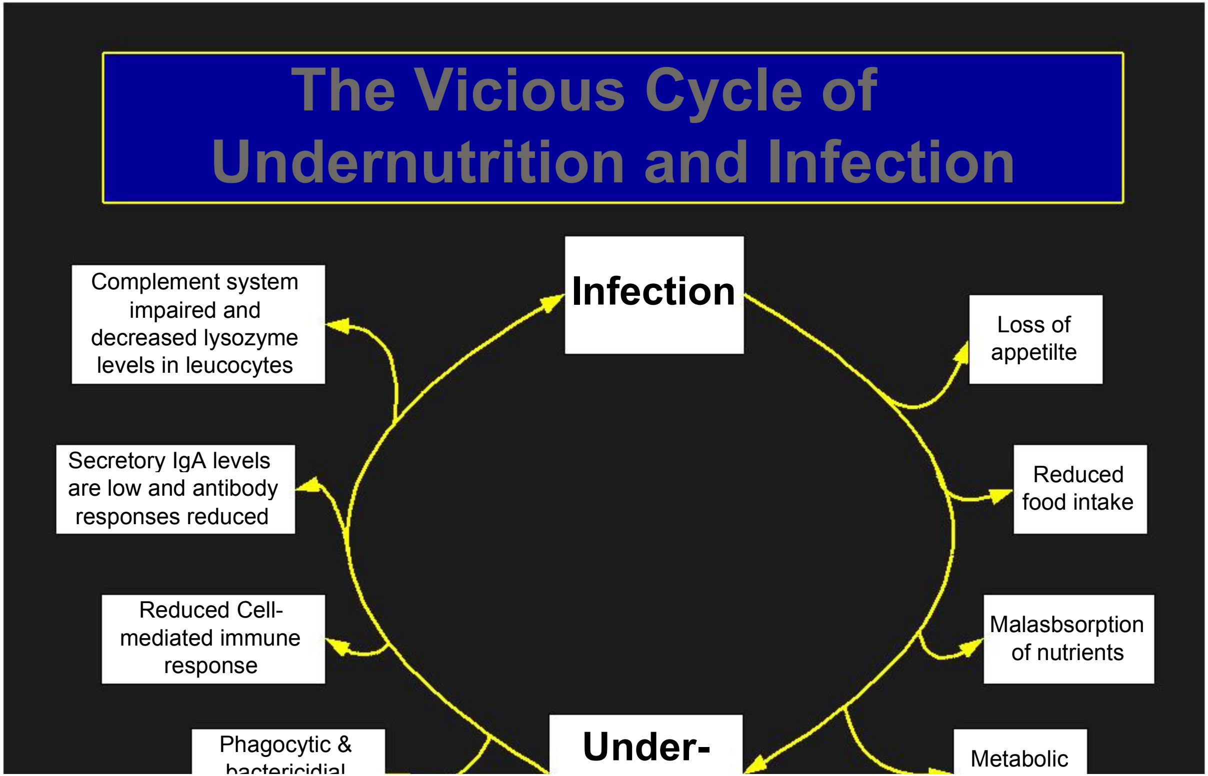


UNICEF conceptual model of causation of CHRONIC undernutrition

UNICEF Conceptual Model of the Causation of Undernutrition,
Modified To Include Its Consequences

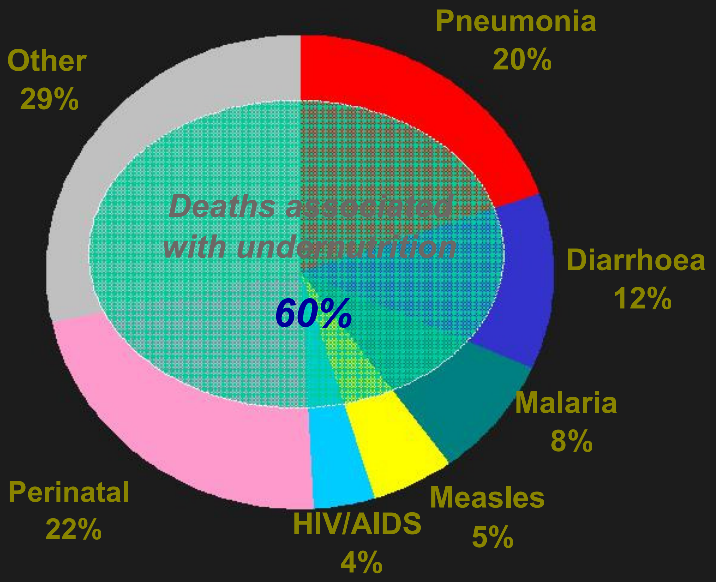
Health Consequences of Undernutrition and PEM


The Vicious Cycle of Undernutrition and Infection
Infection
Complement system impaired and decreased lysozyme levels in leucocytes
Secretory IgA levels are low and antibody responses reduced
Reduced Cell-mediated immune response
Phagocytic &
Under-
Loss of appetilte
Reduced food intake
Malasbsorption of nutrients
Metabolic


activites reduced
nutrition
losses

FOOD AND NUTRITION TECHNICAL ASSISTANCE

Major Causes of Death among Children



For more information see:
EIP/WHO.Caulfield LE, Black RE.
Year 2000

Malnutrition and Incidence and Duration of Diarrhea in African Children (Tomkins A Lancet 1981)

Nutritional status	n	Attack rate per child in 3 mo	% Time with Diarrhea
Wt/age			
>75%	220	1.2	8.5
<75%	123	1.5	11.3*
Ht/age			
>90%	245	1.4	7.9
<90%	98	1.4	10.8*
Wt/Ht			

>80%	302	1.3	7.6
<80%	41	1.9*	13.6*

Malnutrition and Diarrheal Morbidity in Children < 24 mo in Bangladesh

(Black et al AJCN 1984)

Nutritional status	**Duration** mean days	**Incidence** episodes/child
Wt/length		
=90%	6.8	16.9
80-89%	8.5	16.2
<80%	10.6*	16.4

*$p<0.05$

Effect of Morbidity on Weight Change

(Walker AJCN 1992)

		g/day ill		
Country	Age	Diarrhea	Fever	Apathy
Uganda	6-36	-5.4	-4.0	-
Bangladesh	6-48	-5.0	-	-
Bangladesh	6-32	-4.4	-10.3	-
Jamaica	9-48	-8.4	-16.8	-15.0

Effect of Morbidity on Weight Change
(Walker AJCN 1992)

		g/day ill		
Country	Age	Diarrhea	Fever	Apathy
Guatemala	12-36	-3.5	-	-2.3
Gambia				
Rural	6-36	-25.8	-20.0	-
Urban	0-24	-3.7	-	-
Sudan	3-12	-32.1	-29.5	-

Relative Risk of Preschool Child Death by Weight for Age

Cause	<-3 Z	-2 to -3 Z	-1 to -2 Z	≥ -1 Z
Diarrhea	12.5	5.4	2.3	1.0
ALRI	8.1	4.0	2.0	1.0
Malaria	9.5	4.5	2.1	1.0
Measles	5.2	3.0	1.7	1.0
All causes	8.7	4.2	2.1	1.0


S Fishman et al, CQHR, Vol1, WHO 2004

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Mortality of Tanzanian Children 6-60 Mo of Age within ~ 2 Years after Hospitalization for Pneumonia

Status Indicator	Adj HR for Mortality	95% CI
Ht for Age < - 2 Z (Stunted)	2.0	1.2-3.3
Wt for Ht < - 2 Z (Wasted)	2.9	1.8-4.6
Wt for Age < -2 Z (Underweight)	1.6	0.8-3.0
MUAC	1.9	1.1

MUAC <25 %ile	1.9	1.1 - 3.1

Villamor et al Int J Epidemiol 2005;34:61-68

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HIV Infection and Mortality by Level of Wasting Status in Tanzanian Children 6-60 Mo of Age

Wasting (<-2 WHZ)	HR for Mortality HIV+/HIV-	95% CI
No	1.6	0.5-4.6
Yes	5.2	2.5-10.6

Adjusted for age, ht for age, Hb concentration, severity of pneumonia at baseline, water supply

of pneumonia at baseline, water supply,
vitamin A receipt

Villamor et al Int J Epidemiol 2005;34:61-68

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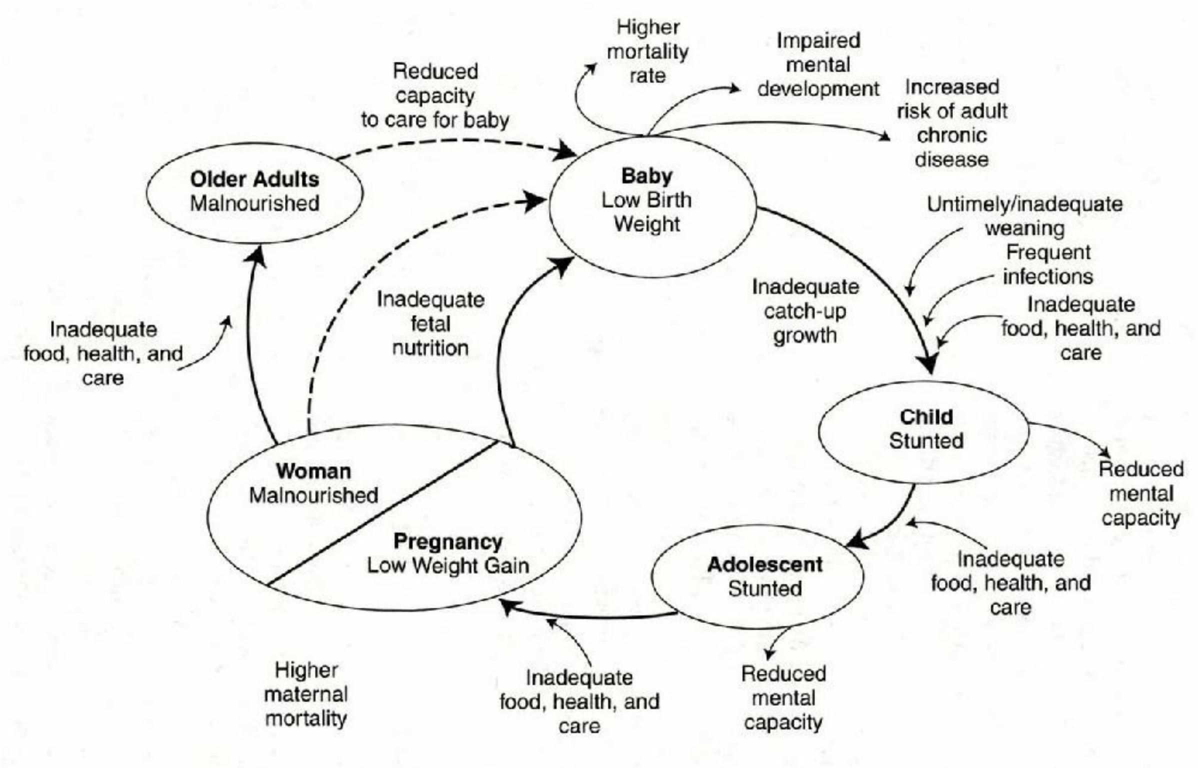

Conceptual Model of the Effects of Undernutrition throughout the Life Cycle

ACC/SCN, 4th Report on the World Nutrition Situation, 2000

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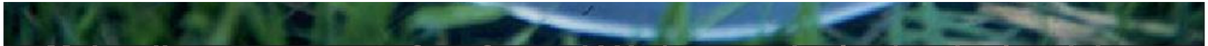
Photos: Keith West

Vitamin A Deficiency and Child Health, Survival and Vision

Keith P. West, Jr, Dr.P.H.
Center for Human Nutrition
Bloomberg School of Public Health
Johns Hopkins University



Major dietary sources of preformed VA;1 ug retinol = 1 retinol activity equivalent (RAE), previously retinol equivalent (RE)

Photo: V. Sheffield

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Photo: V. Sheffield

Functions of Vitamin A

Regulates cellular differentiation:

- Embryonic
- Epithelial (eg, conjunctival, tracts)
- Immune stem cells
- Hematopoietic
- Osteoid (osteoblasts, - clasts)

Participates in rod cell visual cycle

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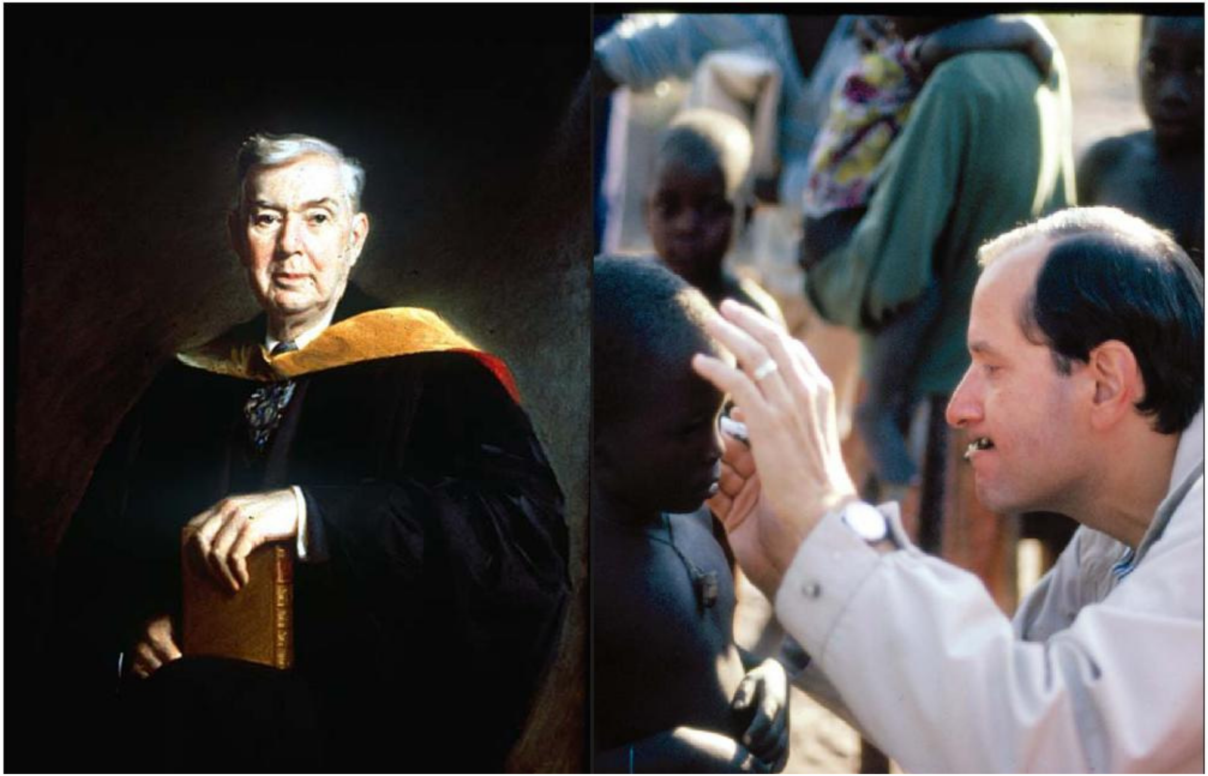
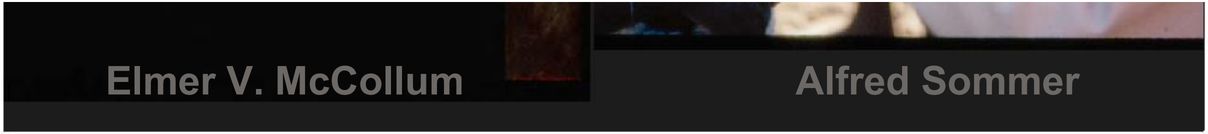
Vitamin A

Adequacy		Deficiency
Bone growth	→	Growth retardation
Reproduction	→	Dysfunction (M&F)
Embryogenesis	→	Teratogenesis
Rod vision	→	Night blindness
Cell differentiation	→	Epithelial metaplasia
		Impaired

immunity $\longrightarrow$ impaired
innate acquired defenses
&




Elmer V. McCollum
Alfred Sommer

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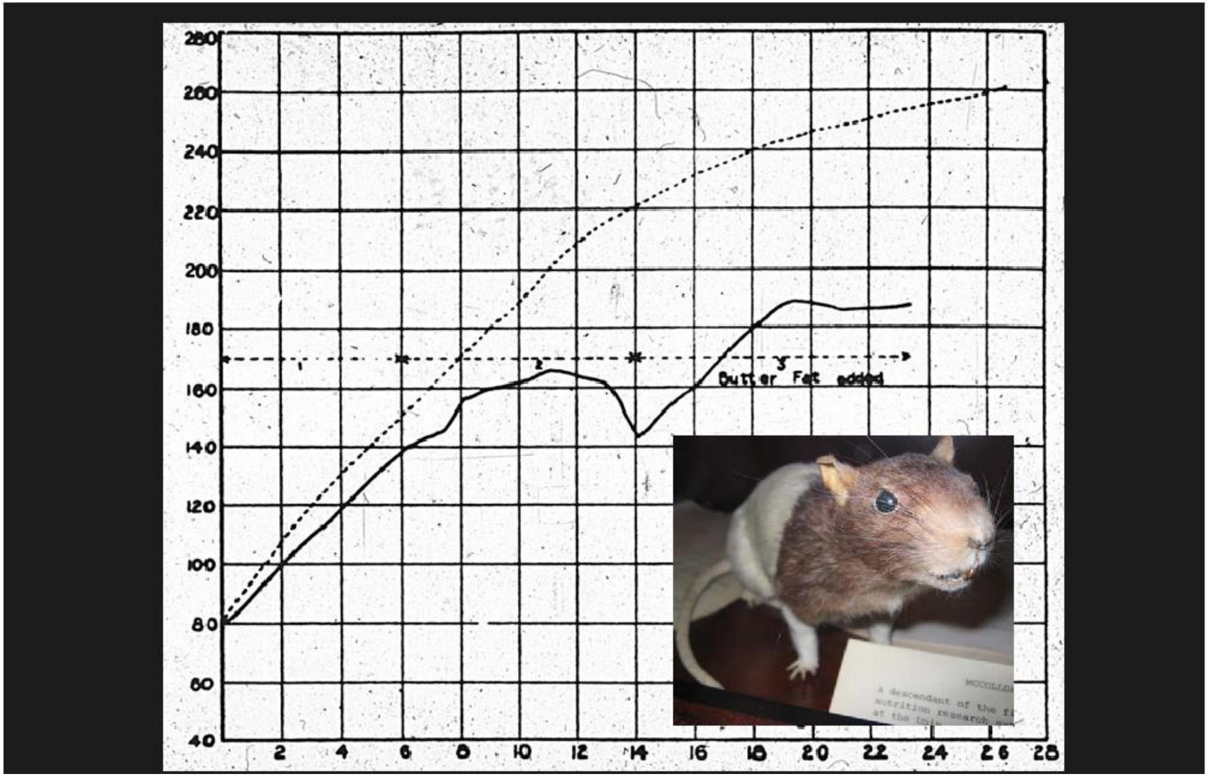
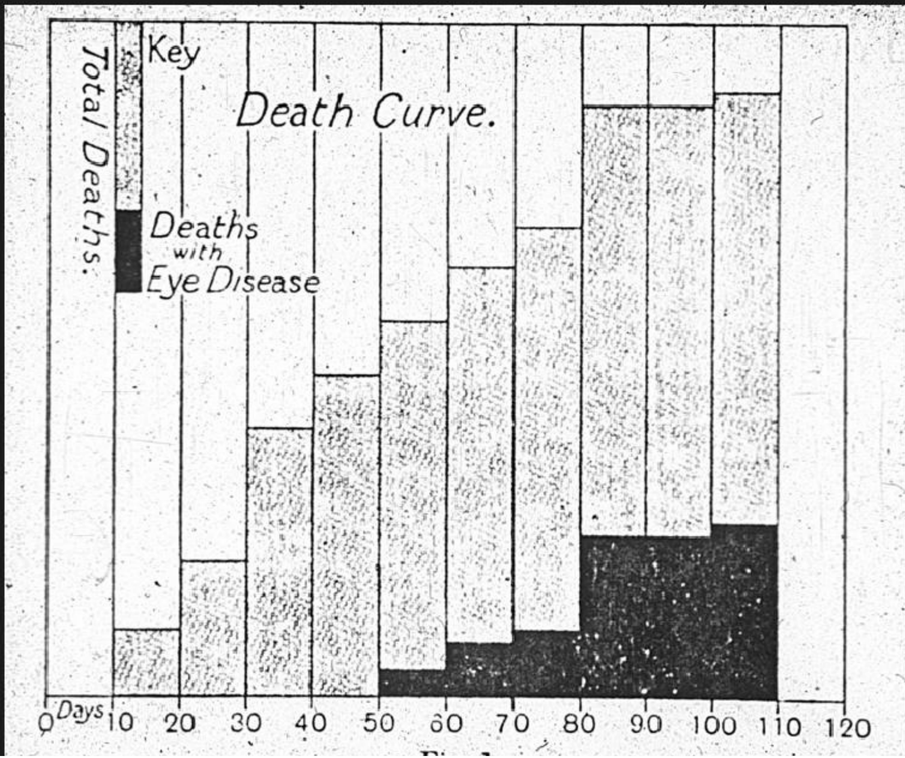


A 1913 McCollum experiment showing normal rate growth and
Growth of rat while becoming VA-depleted, followed by adding
A small amount of butter fat to the diet


Death Curve.
Key
Total Deaths.
Deaths with Eye Disease
Days
0
10
20
30
40
50
60
70
80
90
100
110
120

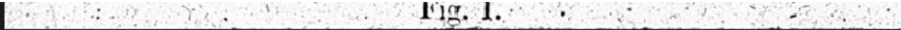


Fig. 1.

Early mortality and xerophthalmia histogram of rats during progressive vitamin A depletion (Stephenson, 1920)

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VITAMIN A DEFICIENCY DISORDERS

→ Health Consequences of VAD

Xerophthalmia: Mild to severe

Corneal blindness and disability

Anemia

Stunted growth

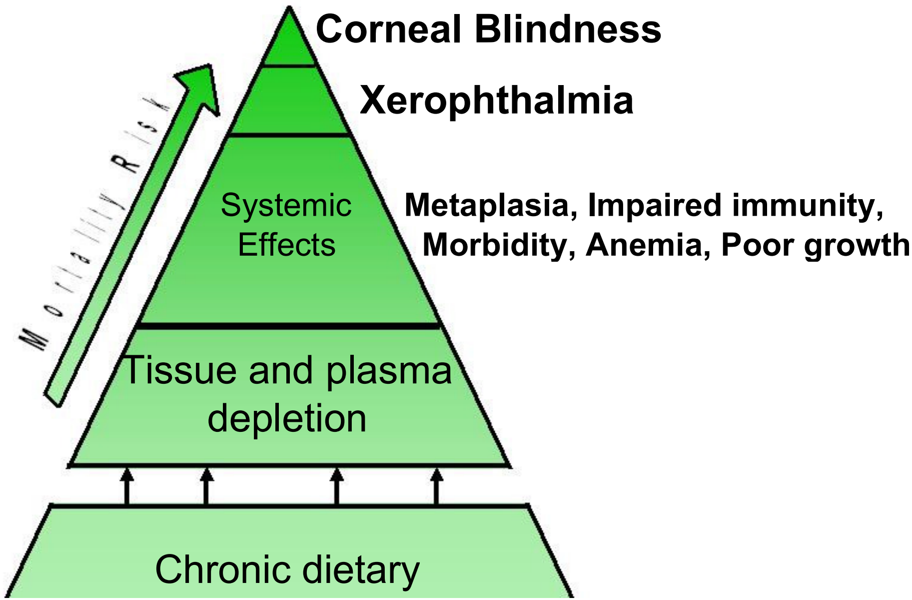
Impaired immunity

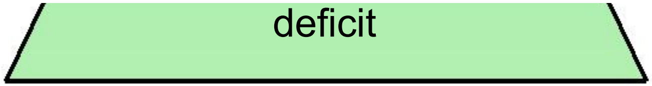
Increased severity of infection (eg,measles, diarrhea, or malaria)

Mortality


Mortality

VADD Reflect a Gradient of Health Consequences





Adapted from: KP West Jr J Nutr 2002;132:2857S

WHO Xerophthalmia Classification (1982)

XN	Nightblindness
X1A	Conjunctival xerosis
X1B	Bitots spots
X2	Corneal xerosis
X3	Corneal ulceration
	Keratomalacia
XS	Corneal scarring

XF	Xerophthalmic fundus


KAKULANGAN SA BITAMINA A
Vitamin A Deficiency


Hindi nakakakita sa gabi
Nightblindness
19
Courtesy of Helen Keller International

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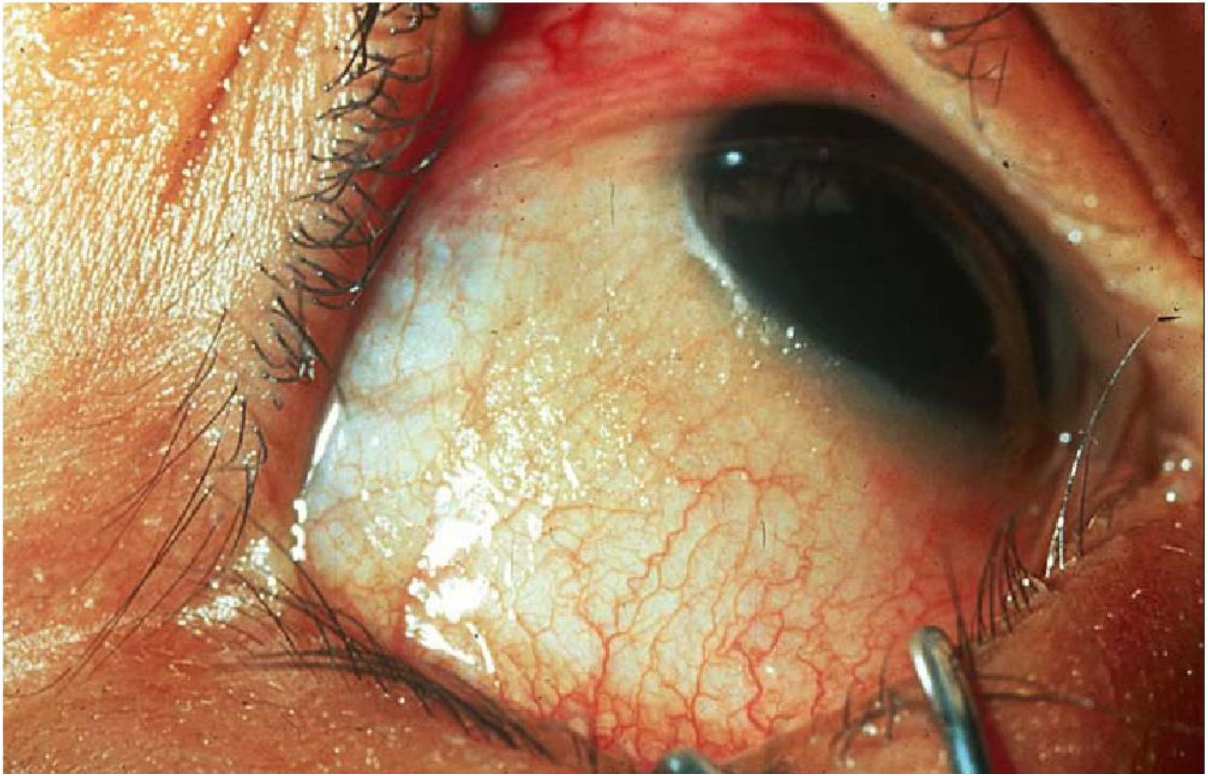
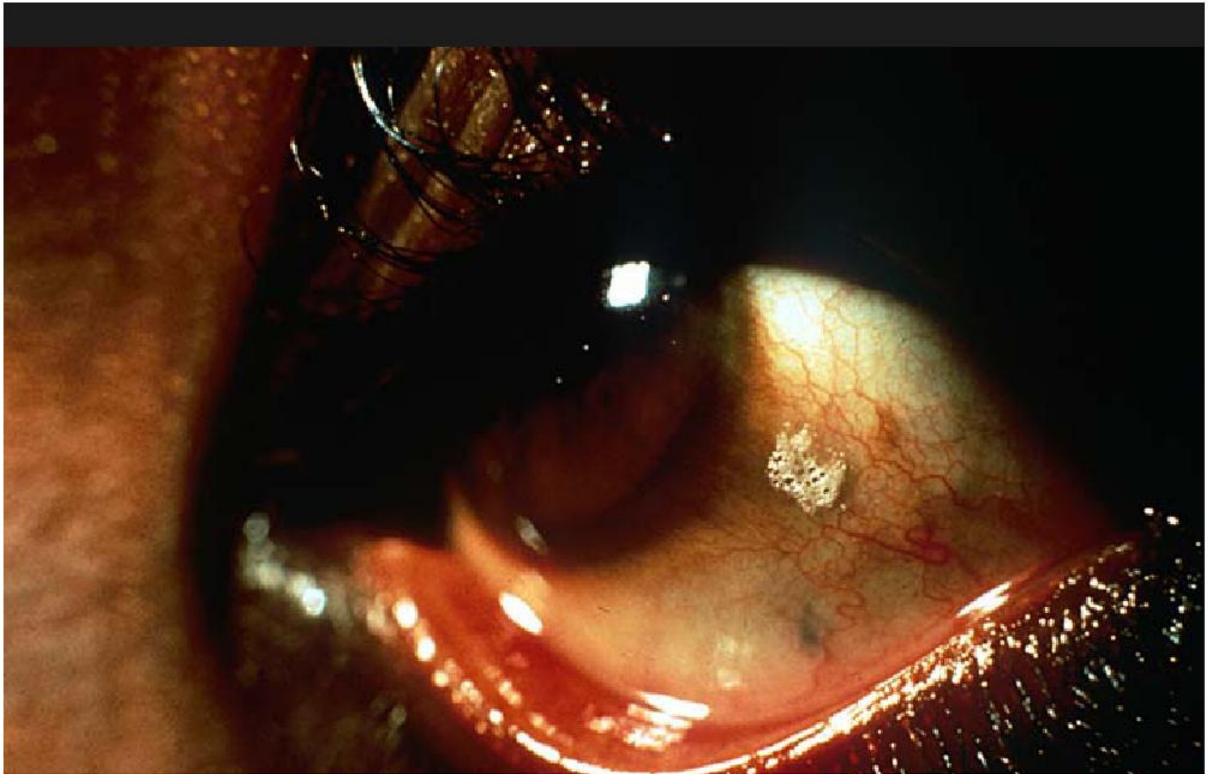
Examine eyes for conjunctival xerosis with handlight shown from side



Conjunctival xerosis (X1A) Photo: A Sommer



Bitots spot (X1B) Photo: A Sommer

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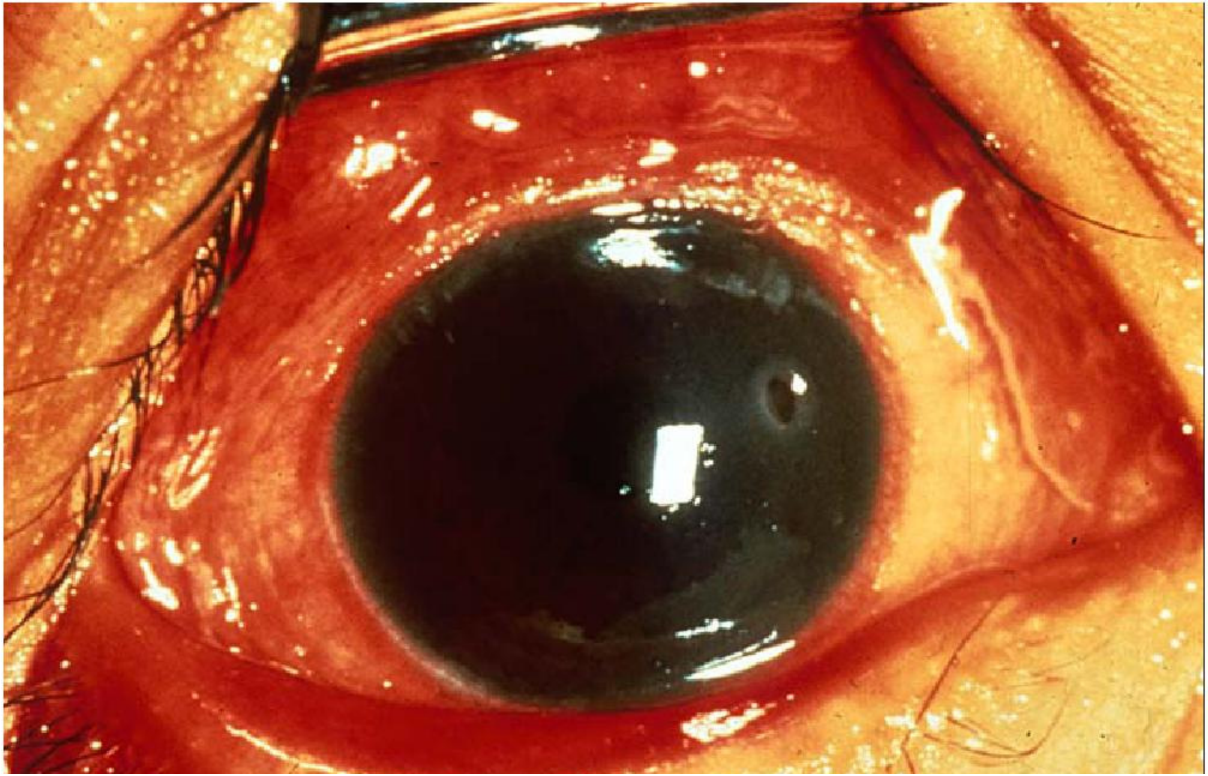
Bitots spot (X1B) Photo:

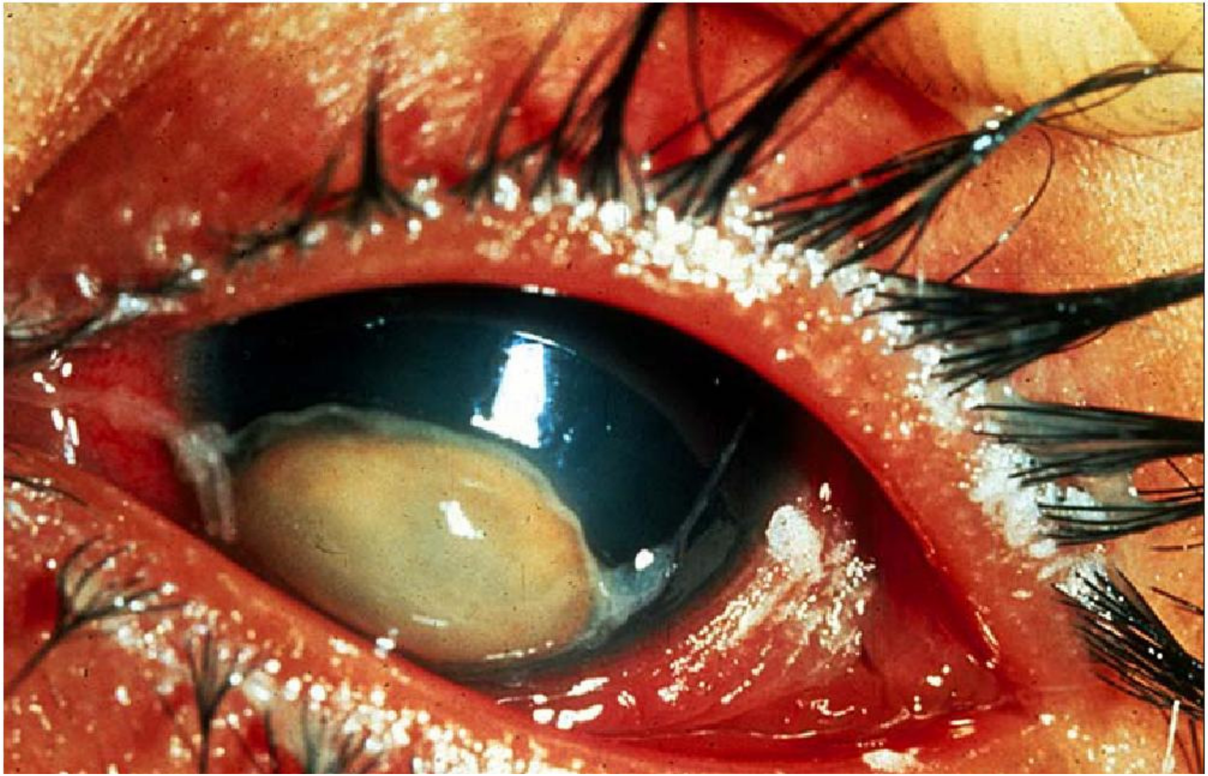

Night blindness or Bitots spots may occur in wasted or non-wasted children; typical prevalence of 1 to 5%


Photos: K West

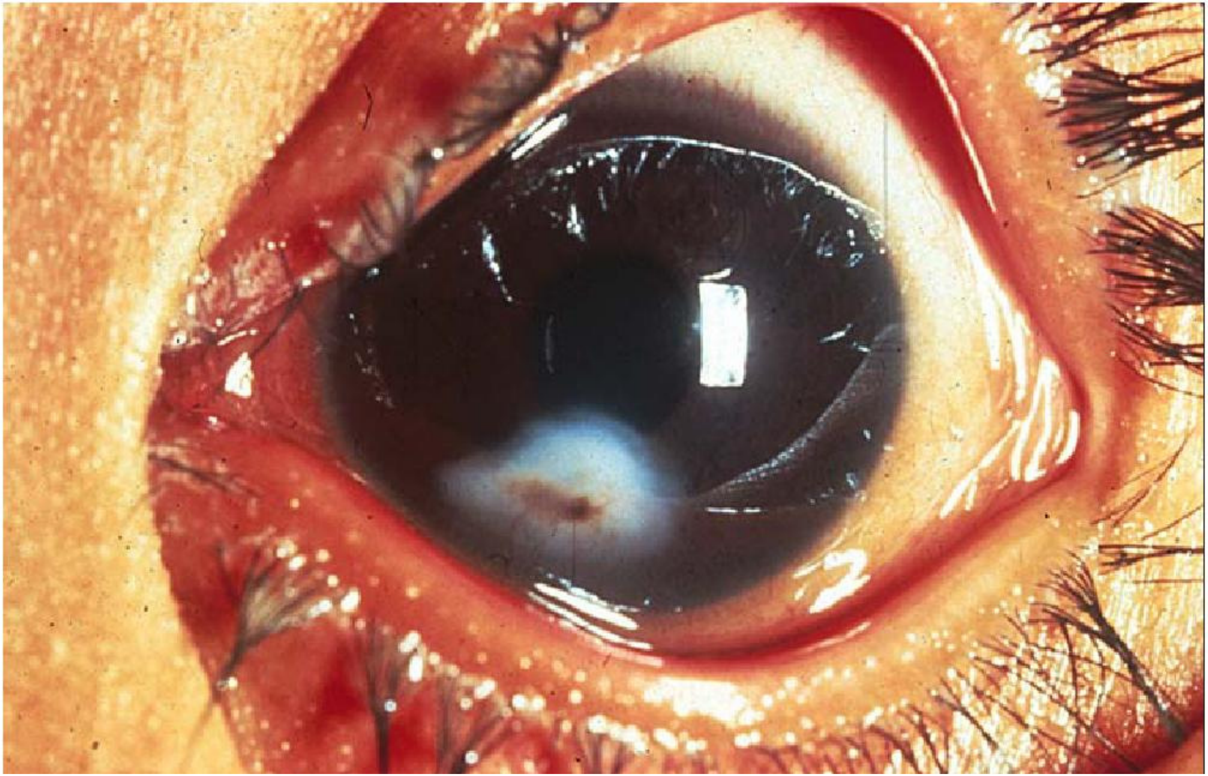
Corneal xerosis (X2) Photo: A Sommer



Corneal ulcer (X3A) Photo: A Sommer



Corneal necrosis - Keratomalacia (X3B) Photo: A Sommer



Corneal scar: Adherent leukoma (XS) Photo: A Sommer

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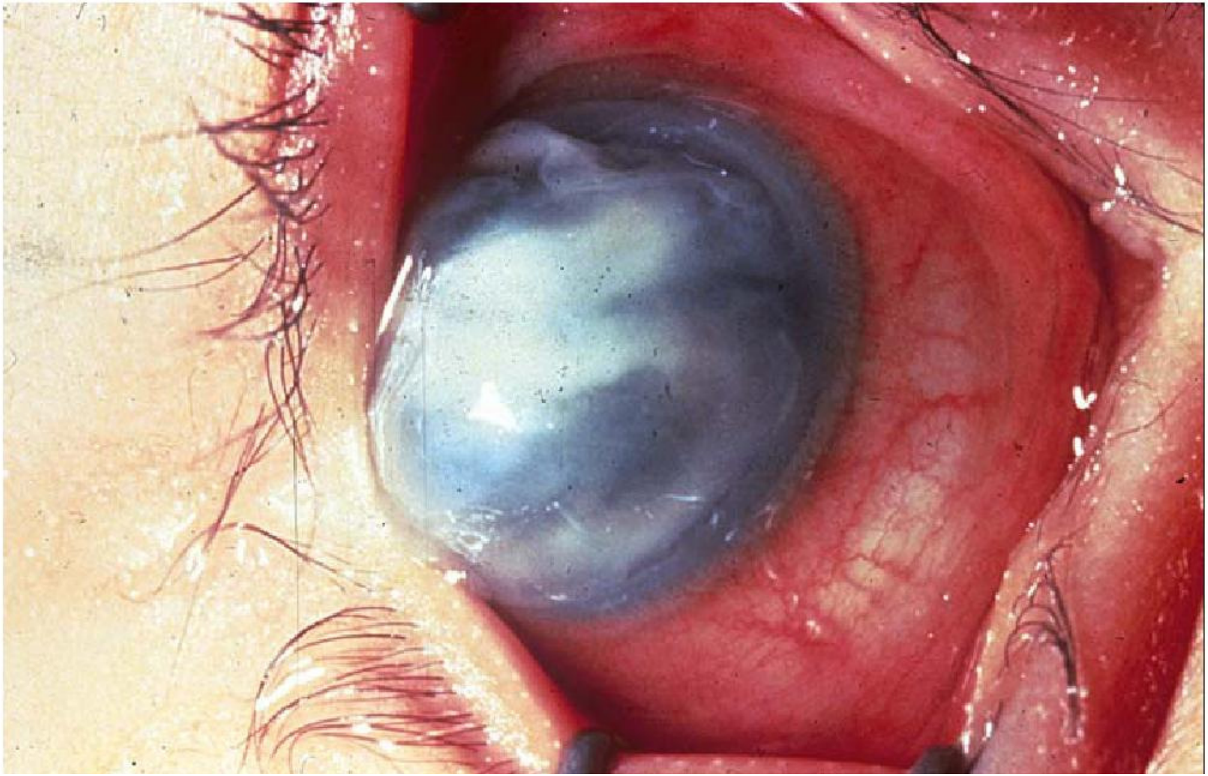

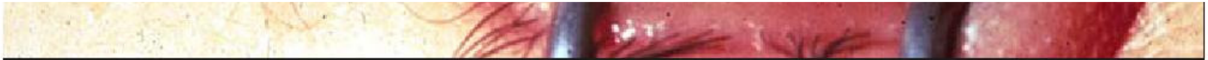

Corneal necrosis keratomalacia (X3B) Photo: Alfred Sommer

Keratomalacia

Nutritional blindness
Corneal necrosis
Associated with
- Severe wasting
- Severe illness
  (eg, measles)
- Chronic, severe
  vitamin A
  deficiency

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IVACG/WHO Vitamin A Treatment Schedule

Xerophthalmia	Oral Dose
Day 1	200,000 IU
Day 2	200,000 IU
Day 14	200,000 IU

High Risk Conditions

Severe PEM
Severe diarrhea
Severe ALRI

} single 200,000 IU

Severe ... 200,000

Severe Measles	200,000 IU on days 1 & 2	D Ross J Nutr 2002

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Initial Response to Vitamin A

Nightblindness:	1 day
Conjunctival Xerosis/ Bitots Spots:	1-3 days
Corneal Ulcers Keratomalacia:	2

Keratomalacia: 2 - 4 days

Sommer, 1982

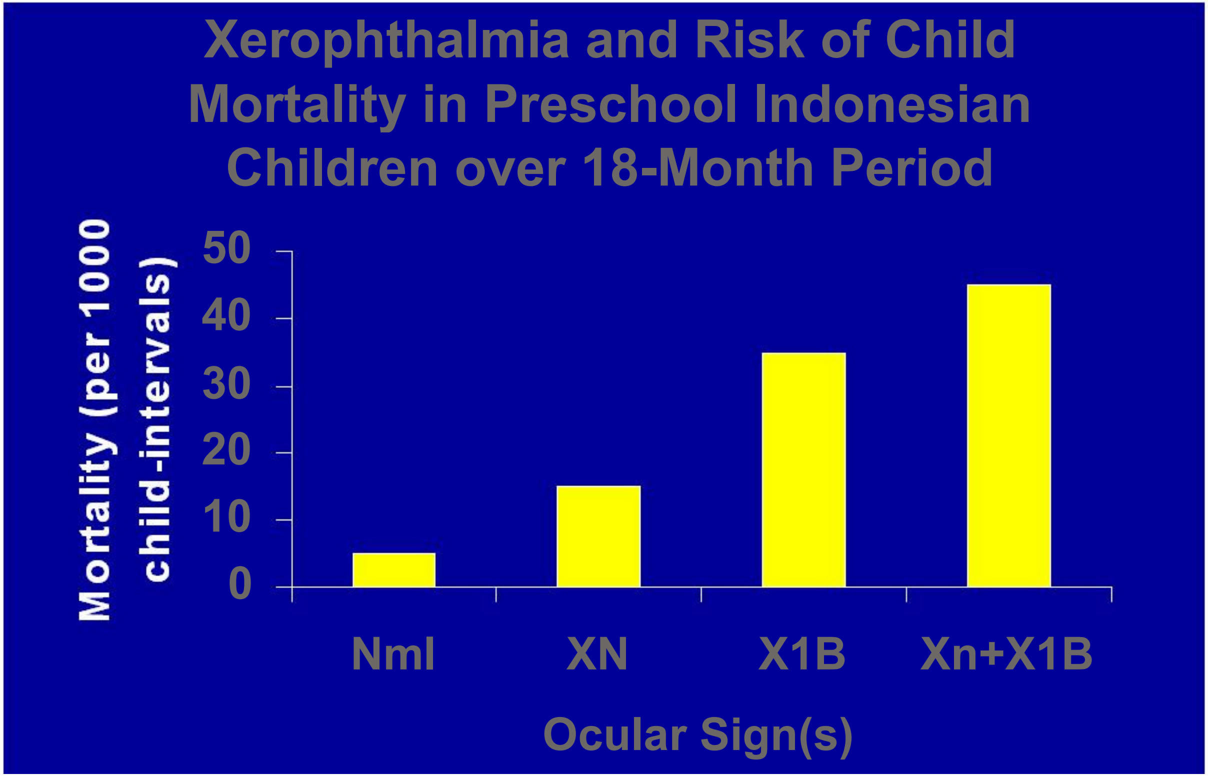
Bilateral corneal scars (XS):

Photo: A. Sommer


Four-year old
Indonesian child
with leukoma (RE) and


staphyloma
(LE)
Photo: K West, Jr.

VADD in Preschool Children: Morbidity and Mortality


Xerophthalmia and Risk of Child Mortality in Preschool Indonesian Children over 18-Month Period
Mortality (per 1000 child-intervals)
50
40
30
20
10
0
Nml
XN
X1B
Xn+X1B
Ocular Sign(s)

Sommer et al, Lancet 1983

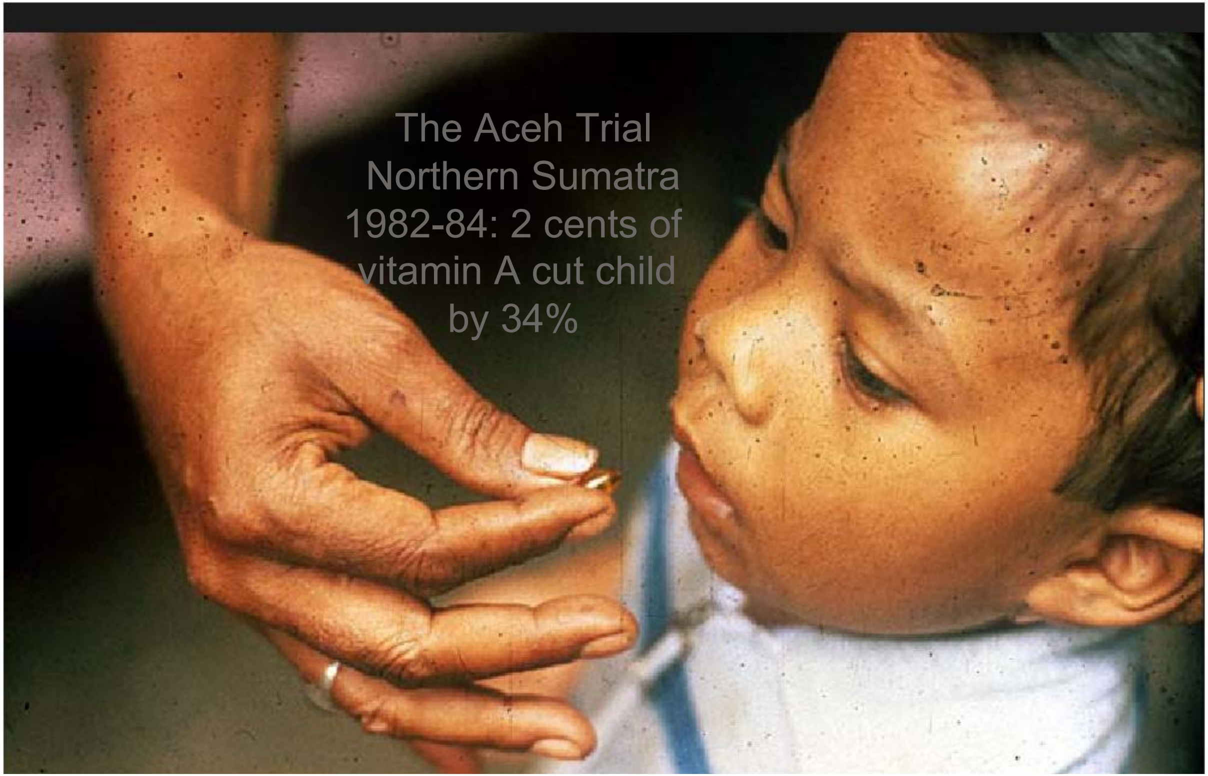

The Aceh Trial
Northern Sumatra
1982-84: 2 cents of
vitamin A cut child
by 34%

Photo: K West, Jr.

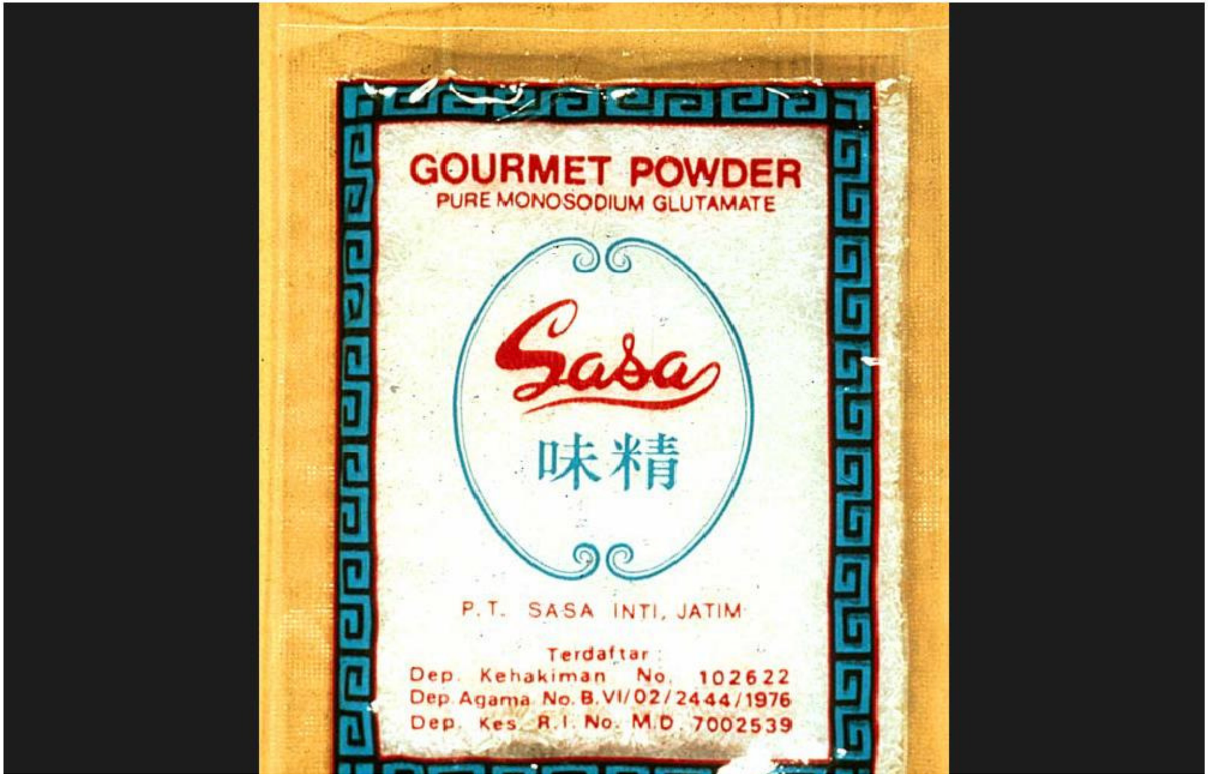
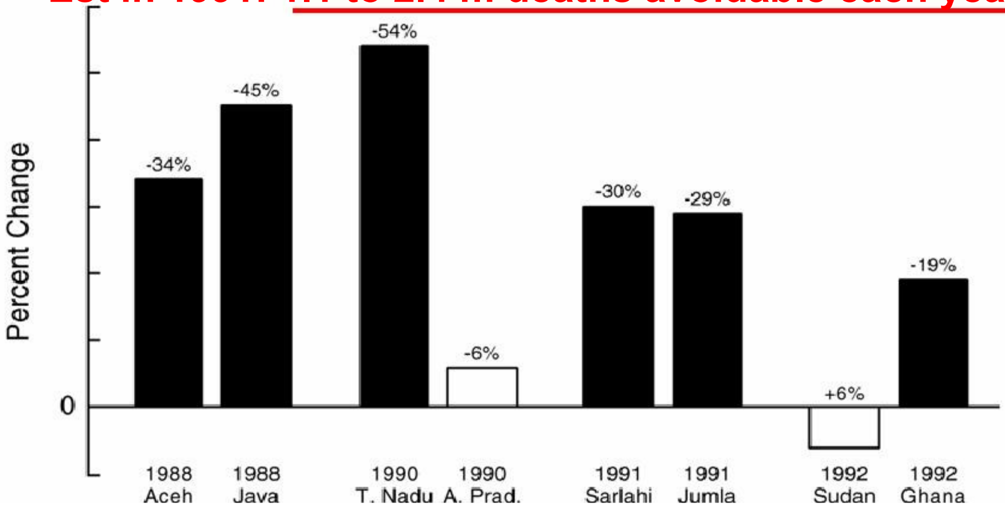

GOURMET POWDER
PURE MONOSODIUM GLUTAMATE
Sasa
味精
P.T. SASA INTI, JATIM
Terdaftar :
Dep. Kehakiman No. 102622
Dep. Agama No. B.VI/02/2444/1976
Dep. Kes. R.I. No. M.D. 7002539

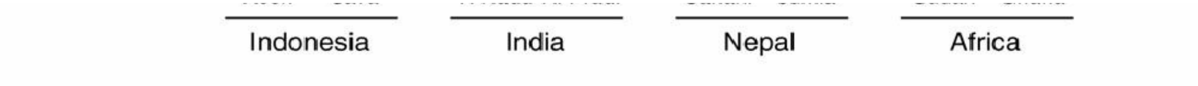

Photo: K West, Jr.

Eight Major Trials Over a Decade Revealed: 25-35% Reduction in Preschool Child Mortality

Over 165,000 children participated in these 8 trials

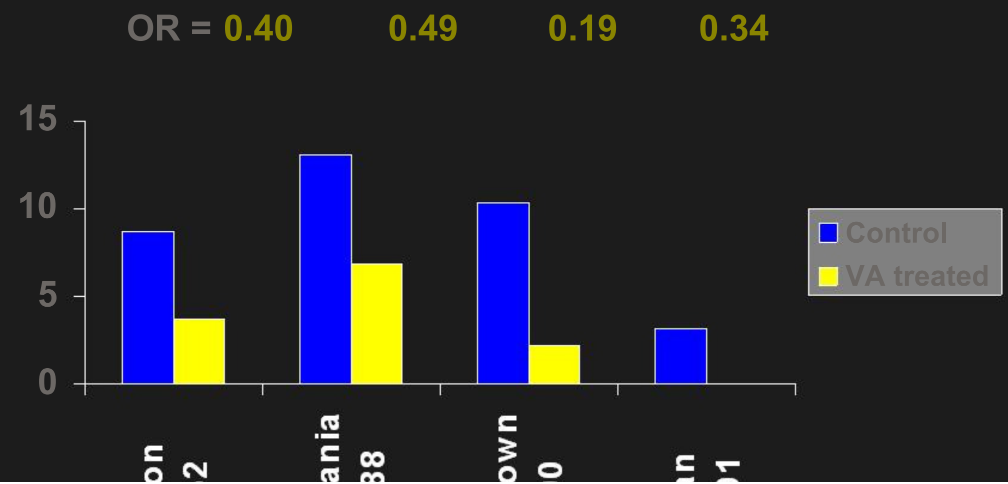
Est in 1991: 1.1 to 2.4 m deaths avoidable each year



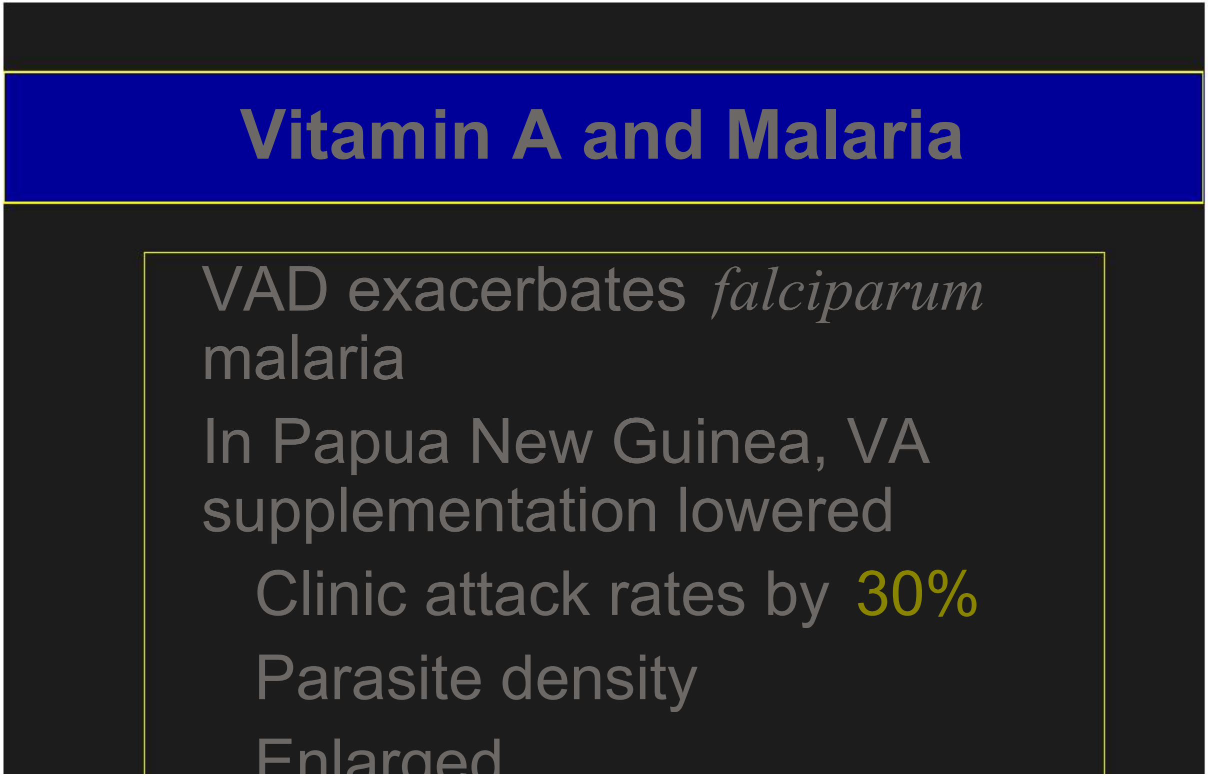


Adapted from Sommer & West, 1996

VA deficiency Increases Measles Fatality; VA Treatment Reduced CFR by 50% to 80%




Lond
193
Tanz
198
Capet
199
Durba
199


Vitamin A and Malaria
VAD exacerbates falciparum malaria
In Papua New Guinea, VA supplementation lowered
Clinic attack rates by 30%
Parasite density
Enlarged

Enlarged spleen rates

Shankar et al, Lancet 1999;354:203

Vitamin A and Severity of Morbidity Ghana VAST Trials

	RR (VA/Control)	95% CI
Clinic attendances	0.88	(0.81-0.95)
Hospital admissions	0.62	(0.42-0.93)
Mortality	0.81	(0.68-0.98)

P Arthur et al, Lancet 1992; Ghana Vast Team, Lancet 1993

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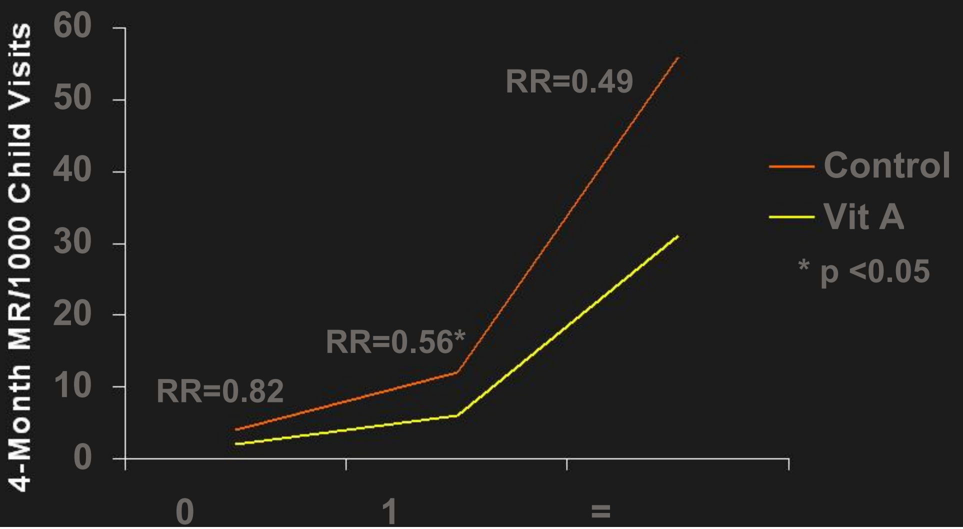
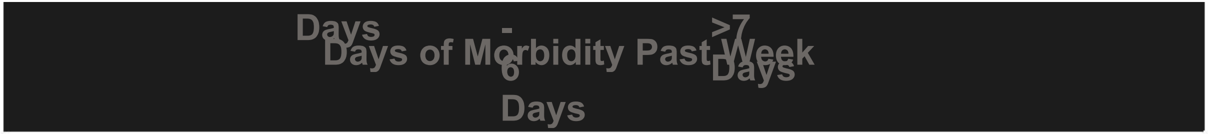
Fever-related Mortality = >6 Months of Age, Sarlahi, Nepal (NNIPS-1)




Days
-
6
Days
>7
Days
Days of Morbidity Past Week

Effect of Vitamin A on Diarrhea
Serrinha, Bahia, Brazil

Stools/ Day	Control n=620	Vit A n=620	RR	p
=3	51.7	47.8	0.92	0.07
=4	25.9	23.2	0.90	0.05
=5	12.3	9.9	0.80	0.005
=6	5.6	4.3	0.77	0.006

Barreto et al, Lancet 1994

Can infant health and survival be improved by direct supplementation with VA any time during the first 6 months of life.

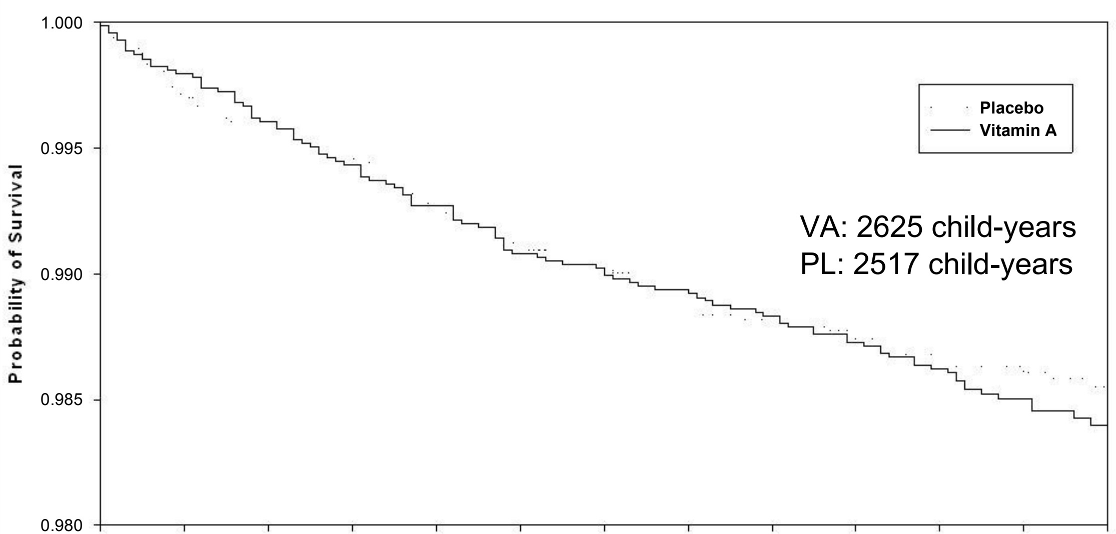
Bangladeshi infant < 6 months of age receiving

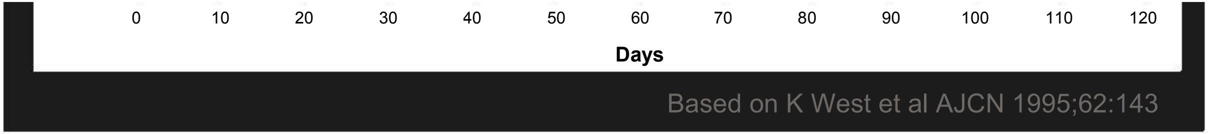
Bangladeshi infant < 6 months of age receiving 50,000 IU vitamin A by expressing 3-4 drops of oil from capsule into mouth

Photo: K West, Jr.

Vitamin A in the First Six Months of Life and Mortality

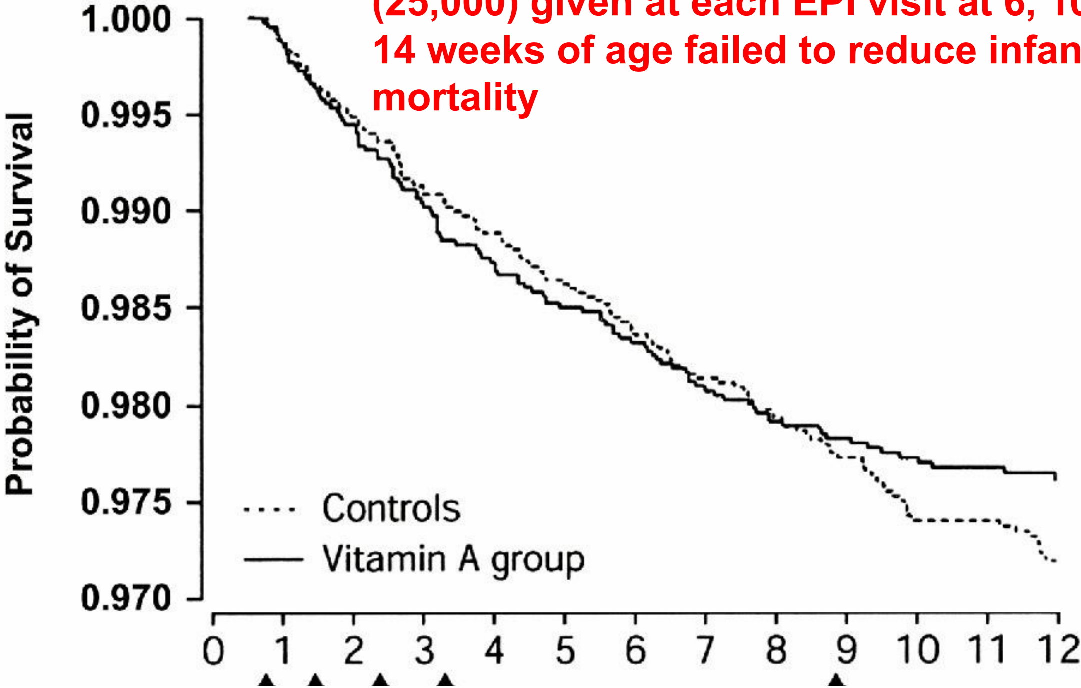
In Nepal: 50,000 and 100,000 IU given to infants < 6 months of age, recruited during six 4-monthly home visits over a 2-year period. Vitamin A failed to reduce mortality (NNIPS-1)

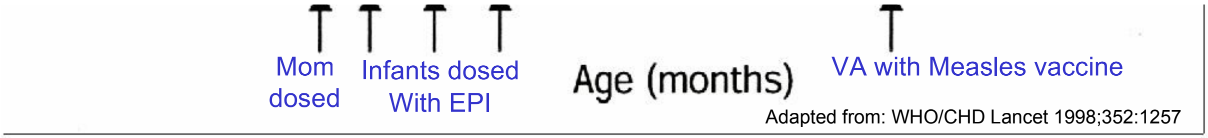



0 10 20 30 40 50 60 70 80 90 100 110 120
Days
Based on K West et al AJCN 1995;62:143

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

In Ghana, Peru and India: Vitamin A (25,000) given at each EPI visit at 6, 10 & 14 weeks of age failed to reduce infant mortality




Mom
dosed
Infants dosed
With EPI
Age (months)
VA with Measles vaccine
Adapted from: WHO/CHD Lancet 1998;352:1257

Biologically Plausible Mechanisms

Immunopotentiation

- Cell mediated (T-cell)
- Humoral (Antibody-mediated)

Innate Immune mechanisms

- Neutrophils, Macrophages, NK cells
- Epithelial cell differentiation

Epidemiology of VA Deficiency
Guide to Prevention

Xerophthalmia

→ Location

→ Age, Sex

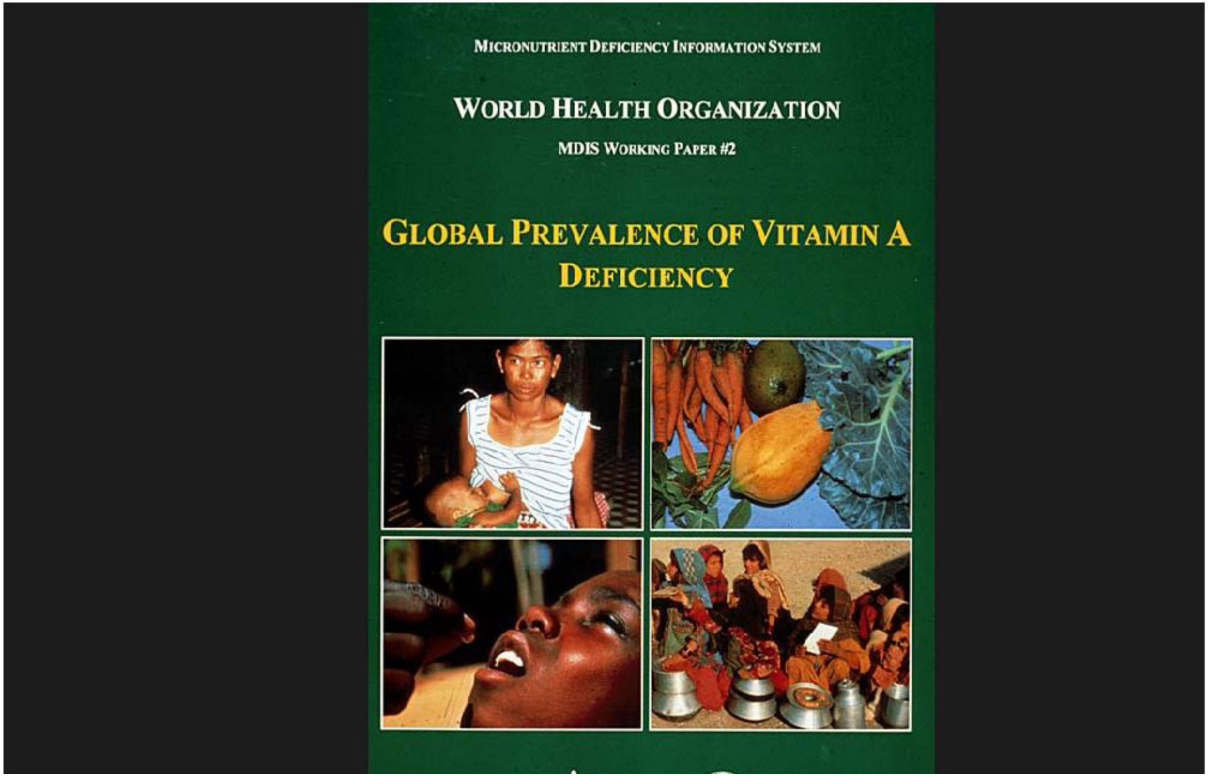
→ Season

Risk Factors

→ Diet

→ Morbidity

→ SES, Care


MICRONUTRIENT DEFICIENCY INFORMATION SYSTEM
WORLD HEALTH ORGANIZATION
MDIS WORKING PAPER #2
GLOBAL PREVALENCE OF VITAMIN A DEFICIENCY

World Health Organization United Nations Children's Fund

Magnitude of Preschool Problem in Developing (Low Income) Countries

Xerophthamia: 4.4 million (0.9%)

VA deficient (< 20 ug/dl): 127 million (25%)

K West J Nutr 2002;132:2857S

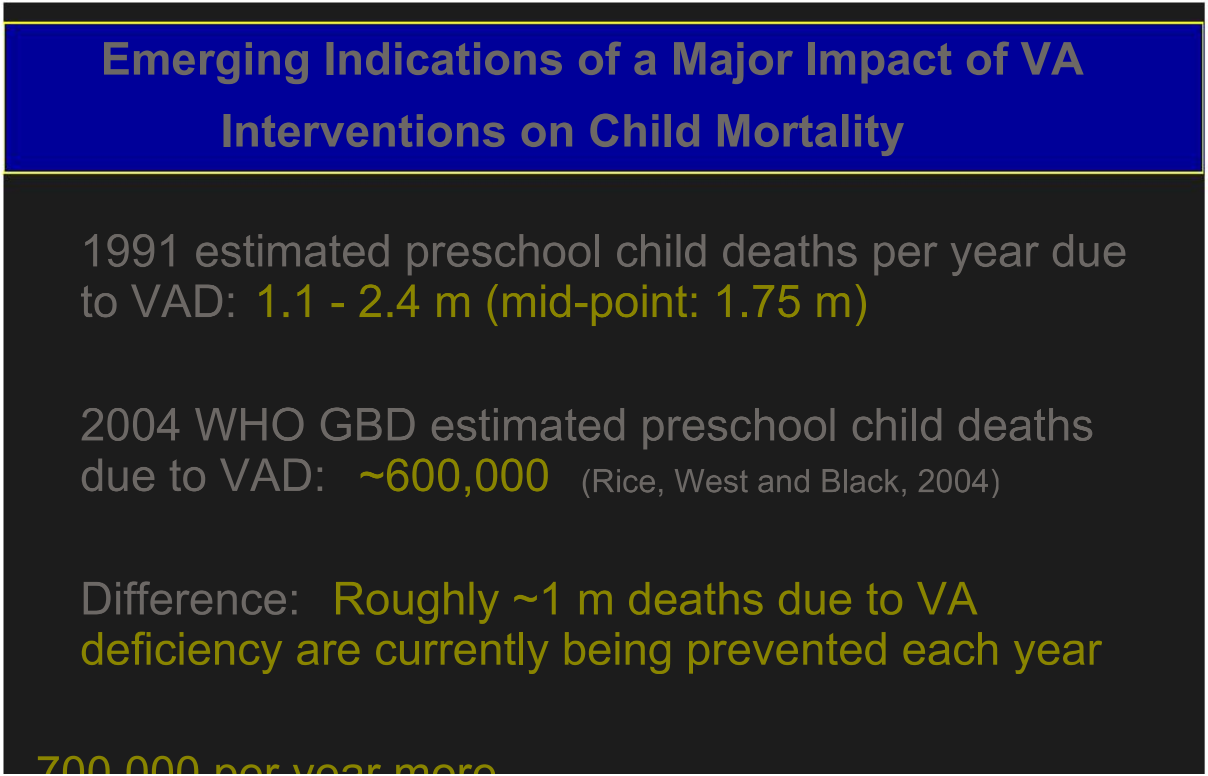
versus in 1980s/early 1990s

2.8 to 13 million with xerophthalmia

118 to 190 million with vitamin A deficiency

Humphrey, West & Sommer BWHO 1992;70:225
WHO MDIS: Geneva 1995

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw



700,000 per year more
to go!

Village and Household Pairwise Odds Ratio for Xerophthalmia

	Village	Household
Malawi	1.2	4.4
Zambia	1.7	7.4
Indonesia	1.7	9.7
Nepal	2.2	7.7

Katz et al, Internat J Epidemiol 1992

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Lessons from CLUSTERING.

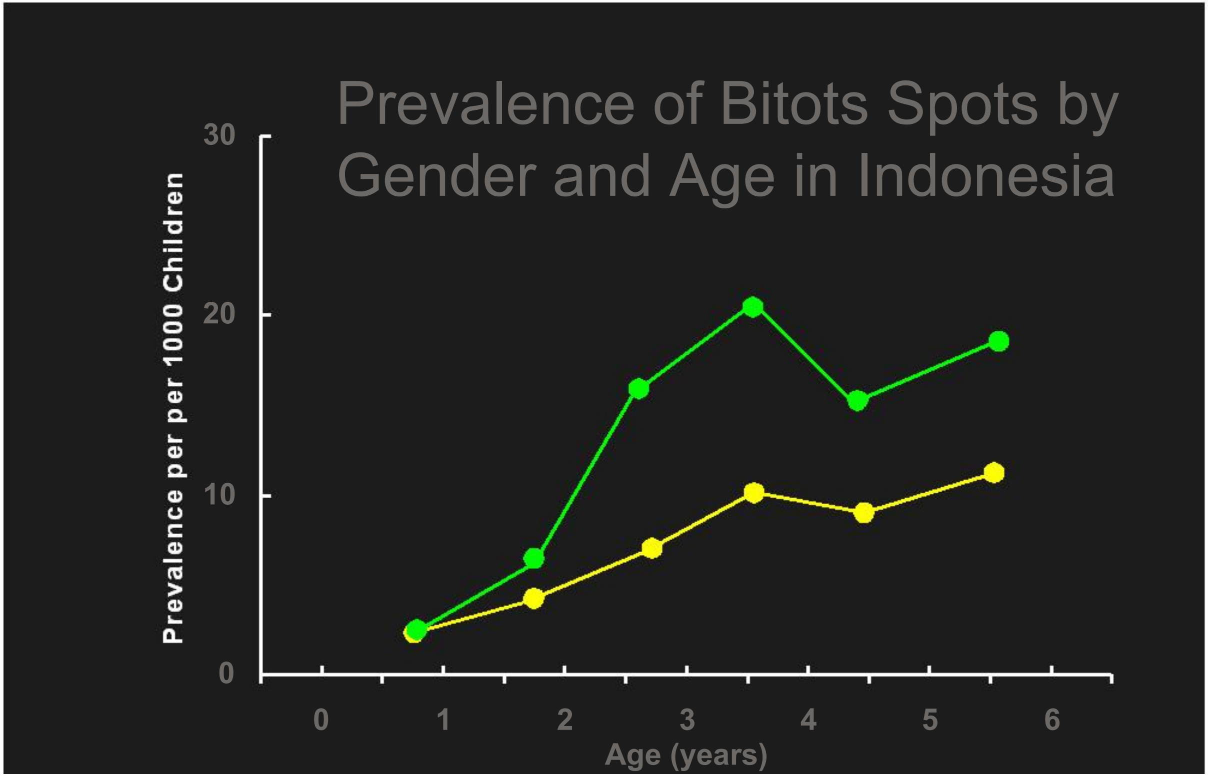
Treat child with xerophthalmia

Dose siblings of a case with VA

Counsel mother about family diet

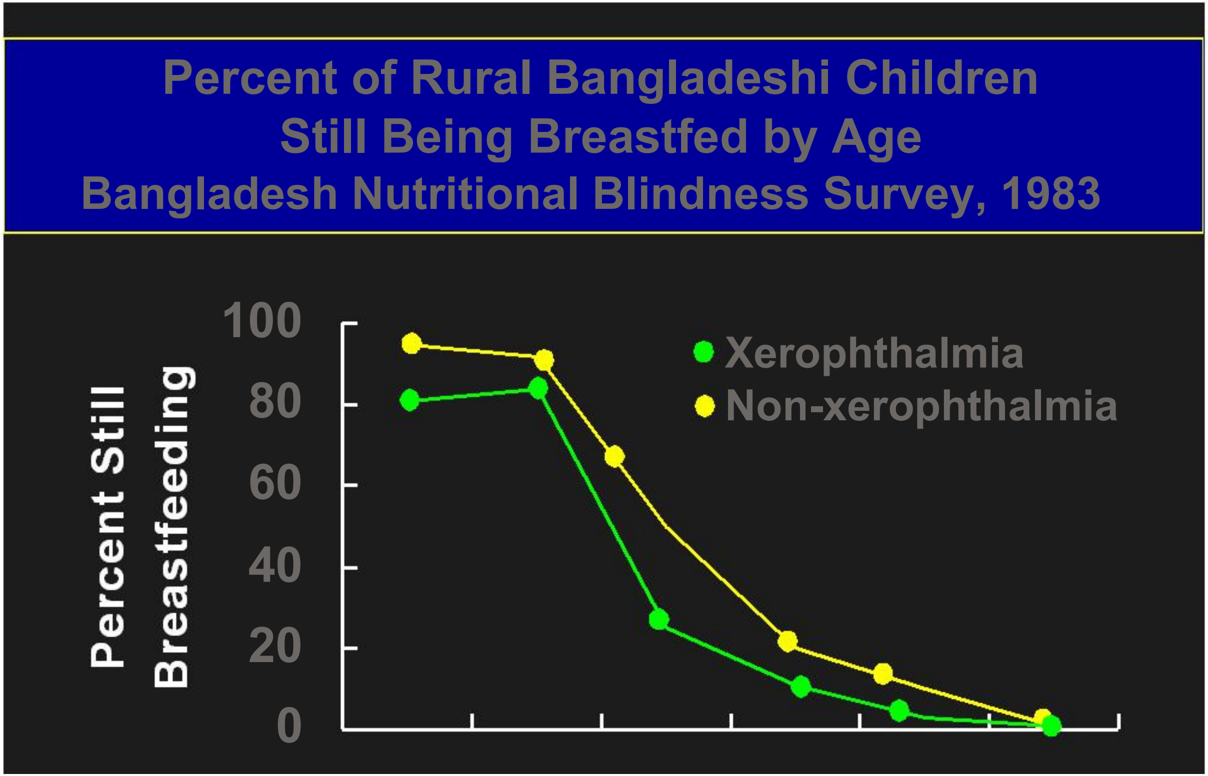
Target cases village for program

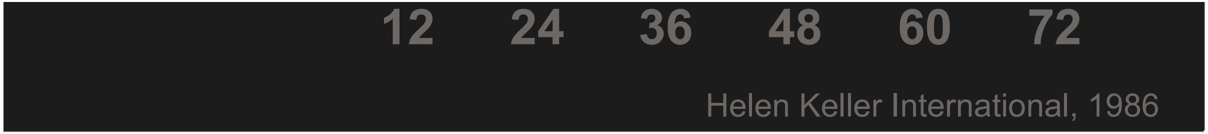
IVACG Policy Statement, 1996


Prevalence of Bitots Spots by Gender and Age in Indonesia
Prevalence per per 1000 Children
30
20
10
0
0
1
2
3
4
5
6
Age (years)

Sommer, 1982


Photo: K West, Jr.


Percent of Rural Bangladeshi Children
Still Being Breastfed by Age
Bangladesh Nutritional Blindness Survey, 1983
Percent Still Breastfeeding
100
80
60
40
20
0
Xerophthalmia
Non-xerophthalmia


12 24 36 48 60 72
Helen Keller International, 1986


Dietary Protection From Xerophthalmia
Summary of Epidemiologic Studies
Age (years)
Food
<1 1 2 3 4 5
Breastmilk
Yellow Fruit
Dark Green Leaves
Eggs/Dairy

Liver

KP West, 2001

Risk of Xerophthalmia in Nepalese Children by Type of Food Usually Eaten in 1st 2 Years of Life

	Odds Ratio	Risk Decrease	r with Sib Diet
Meat w/liver	0.09	91%	0.38
Egg	0.11	89%	0.53
Fish w/liver	0.41	59%	0.39
Mango	0.28	62%	0.54

Gittelsohn et al Eur J Clin Nutr 1997;51:484

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Vitamin A deficiency appears to be a major health problem among women of reproductive age in many developing countries, suggesting that it is a chronic; that is, it persists throughout the life cycle.


Photo: Keith West

In developing countries

Increased evidence of VA deficiency among pregnant women ; suggests that VAD persists throughout life cycle.

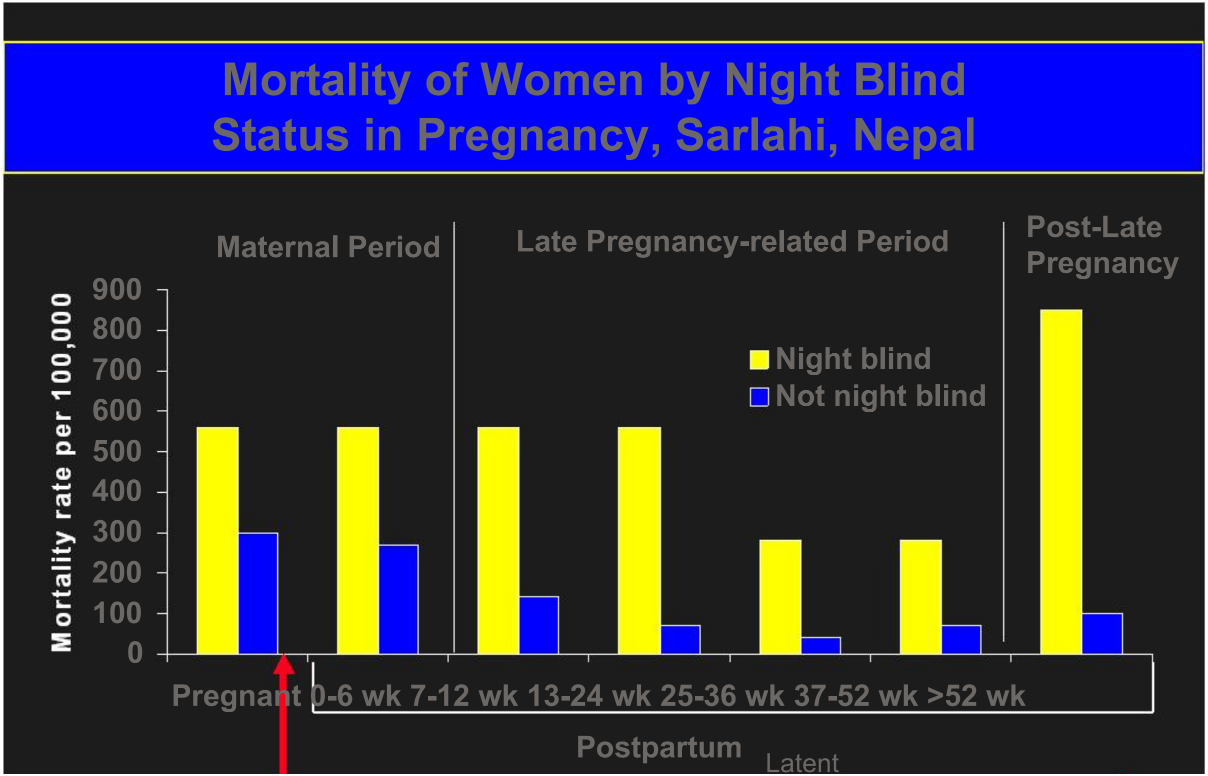
Low VA status: ~ 20 m
VA deficient: ~ 7 m
Night blind: ~ 6 m

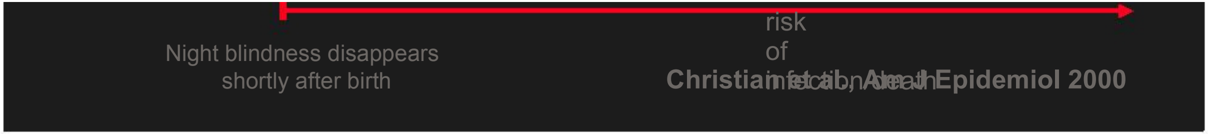
K West J Nutr 2002

Photo: Keith West

Night blind, pregnant
Nepalese woman

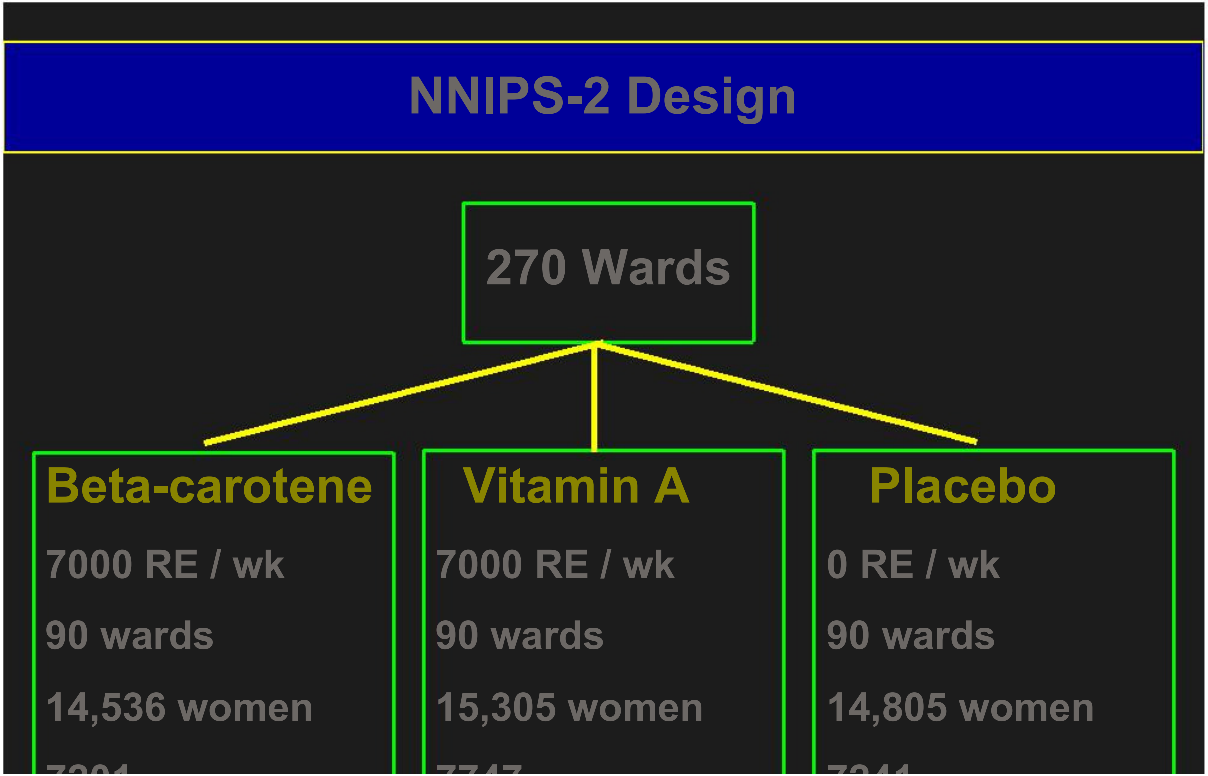
Photo: P Christian


Mortality of Women by Night Blind Status in Pregnancy, Sarlahi, Nepal
Maternal Period
Late Pregnancy-related Period
Post-Late Pregnancy
Mortality rate per 100,000
900
800
700
600
500
400
300
200
100
0
Night blind
Not night blind
Pregnant 0-6 wk 7-12 wk 13-24 wk 25-36 wk 37-52 wk >52 wk
Postpartum
Latent

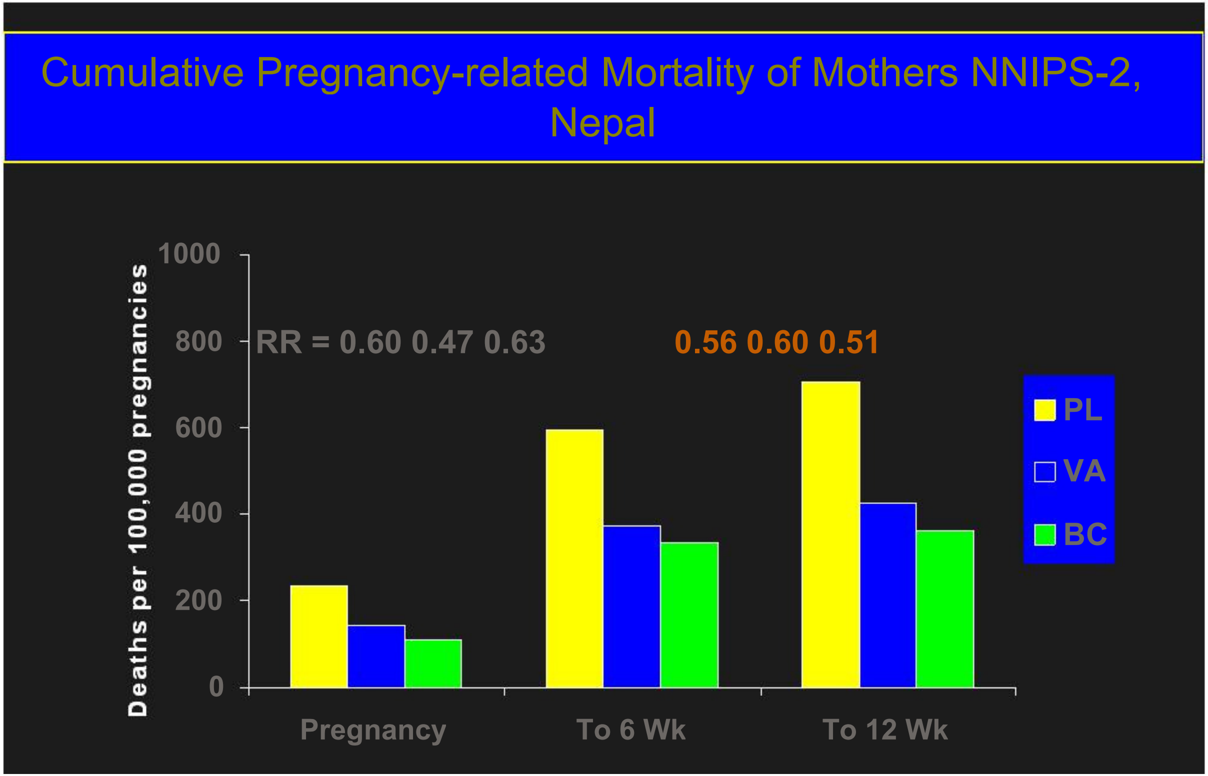

Night blindness disappears
shortly after birth
risk
of
Christian et al., Am J Epidemiol 2000


Can intervening with VA improve maternal health and survival.

Photo: Keith West


NNIPS-2 Design
270 Wards
Beta-carotene
7000 RE / wk
90 wards
14,536 women
Vitamin A
7000 RE / wk
90 wards
15,305 women
Placebo
0 RE / wk
90 wards
14,805 women


7201
pregnancies
7747
pregnancies
7241
pregnancies


Cumulative Pregnancy-related Mortality of Mothers NNIPS-2, Nepal
Deaths per 100,000 pregnancies
1000
800
600
400
200
0
RR = 0.60 0.47 0.63
0.56 0.60 0.51
PL
VA
BC
Pregnancy
To 6 Wk
To 12 Wk

RR = Relative Risk; **RR excludes 1.0** West et al, BMJ, 1999

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VADD: Women of Reproductive Age

- Maternal XN/ with disability
- Other xerophthalmic eye signs
- Infection: Diarrhea, sepsis/fever
- Anemia
- Reproductive morbidity (.)
- Maternal mortality

Infant risk:
Mortality

JiVitA Bangladesh

A new 8-year research project in Bangladesh to confirm the impact of maternal vitamin A or beta-carotene supplementation on maternal mortality (n=68,000);

Jivita: Bengali word Meaning alive

Supported by USAID & Gates

Additional Maternal VA Trials

Ghana : Maternal mortality; underway

Tanzania : No survival benefit for infants born to HIV+ mothers; possible increased risk of MCT of HIV (W Fawzi et al)

Zimbabwe : postpartum dosing on infant mortality, HIV transmission, other outcomes, unaffected by VA

(J Humphrey et al)

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Improving VA Intake: Complementary Approaches

- Supplementation
- Food fortification
- Dietary diversification
- Novel approaches: genetic modification, plant breeding


Fortification
Diet
Supplements
Deficient
Population

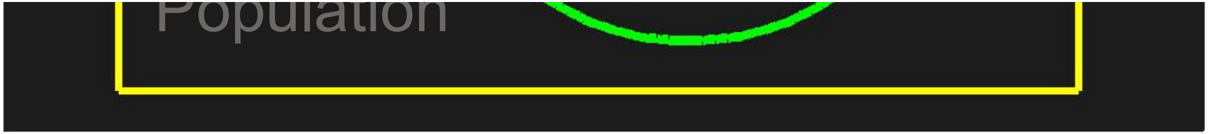
Population

Photo: K West, Jr.

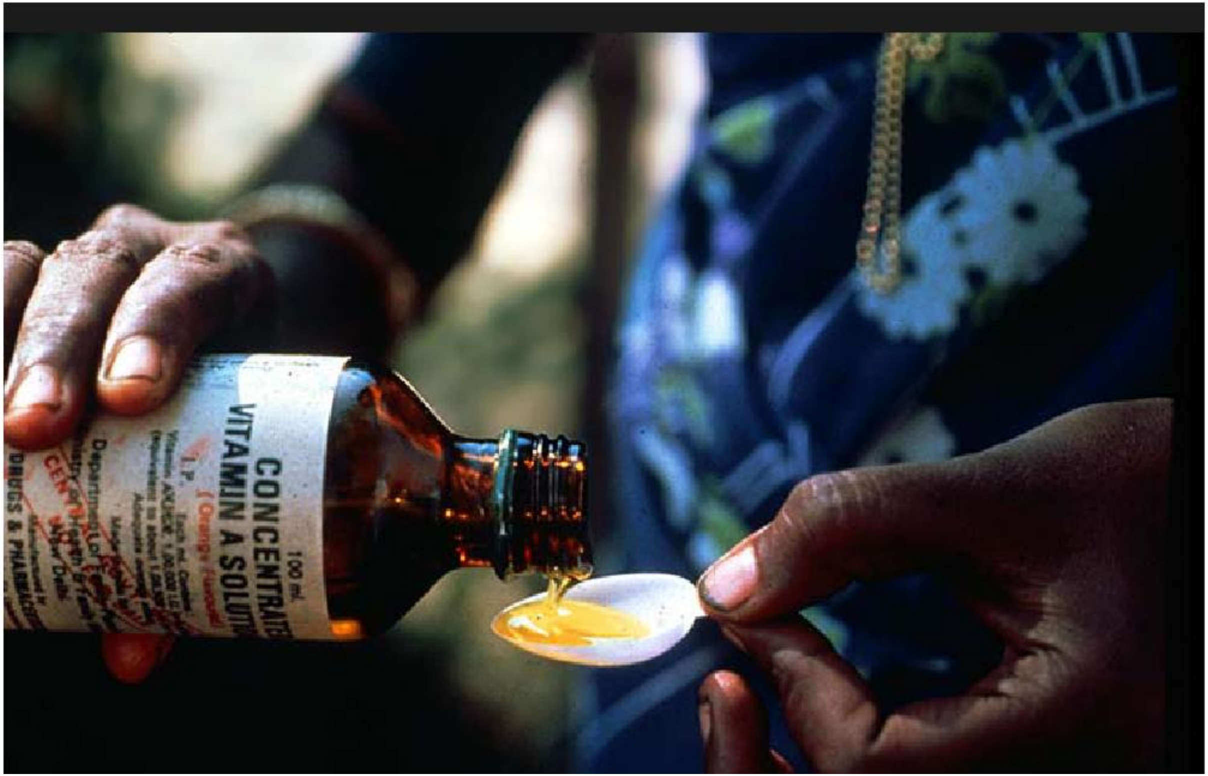
100 ml.
CONCENTRATE
VITAMIN A SOLUTI
DRUGS & PHARMACE


Photo: K West, Jr.

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Vitamin A Supplementation

- Centerpiece for prevention
- Proven, low-cost, sustainable, rapid
- Highly effective
- Low risk (in both extent and severity)
- ~600 m capsules distributed by UNICEF

each year

Target Groups and Vitamin A Prophylaxis Guidelines

Group	Dosage (IU)	Frequency
Children		
< 6 mo	50,000	6, 10, 14 wk
6-12mo	100,000	Every 4-6 mo
=12 mo	200,000	Every 4-6 mo
Mothers	400,000	=6-8 wks postpartum

postpartum

(IVACG, J Nutr 2002)

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VA Supplementation

Medical: Therapeutic

Saturated: All health contacts with target groups

Universal: Stand-alone, NIDS, semi-

annual campaign

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Vitamin A Coverage Increases with Campaigns

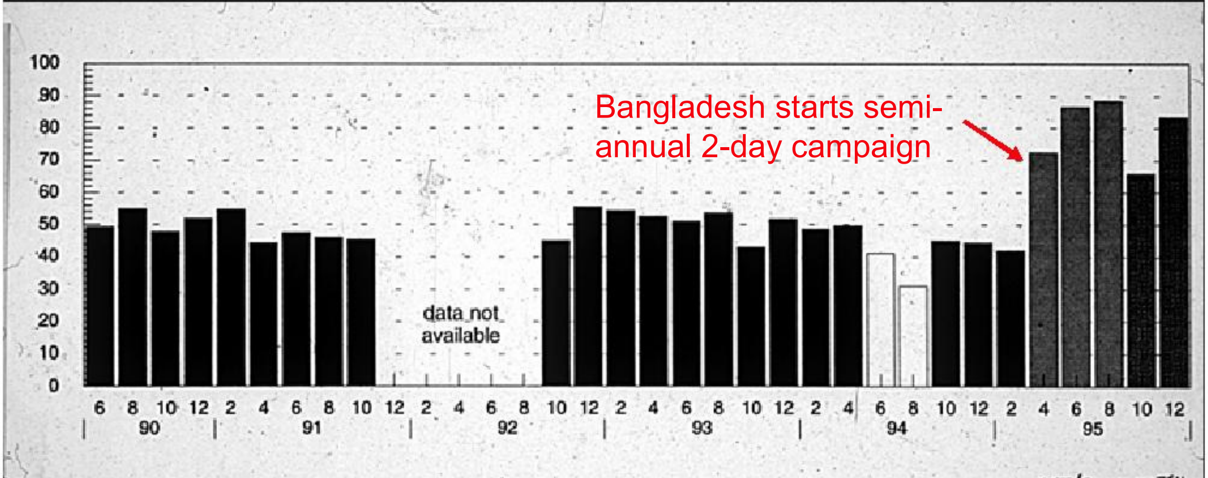


Figure 3. Percentage of children 6-59 months, who received a vitamin A capsule, in rural areas, in the last six months, June 1990 - December 1995 HKI/BANGLADESH


Helen Keller International, 1996

Large Dose Vitamin A

.2 per 200,000 IU dose in oil

encapsulate

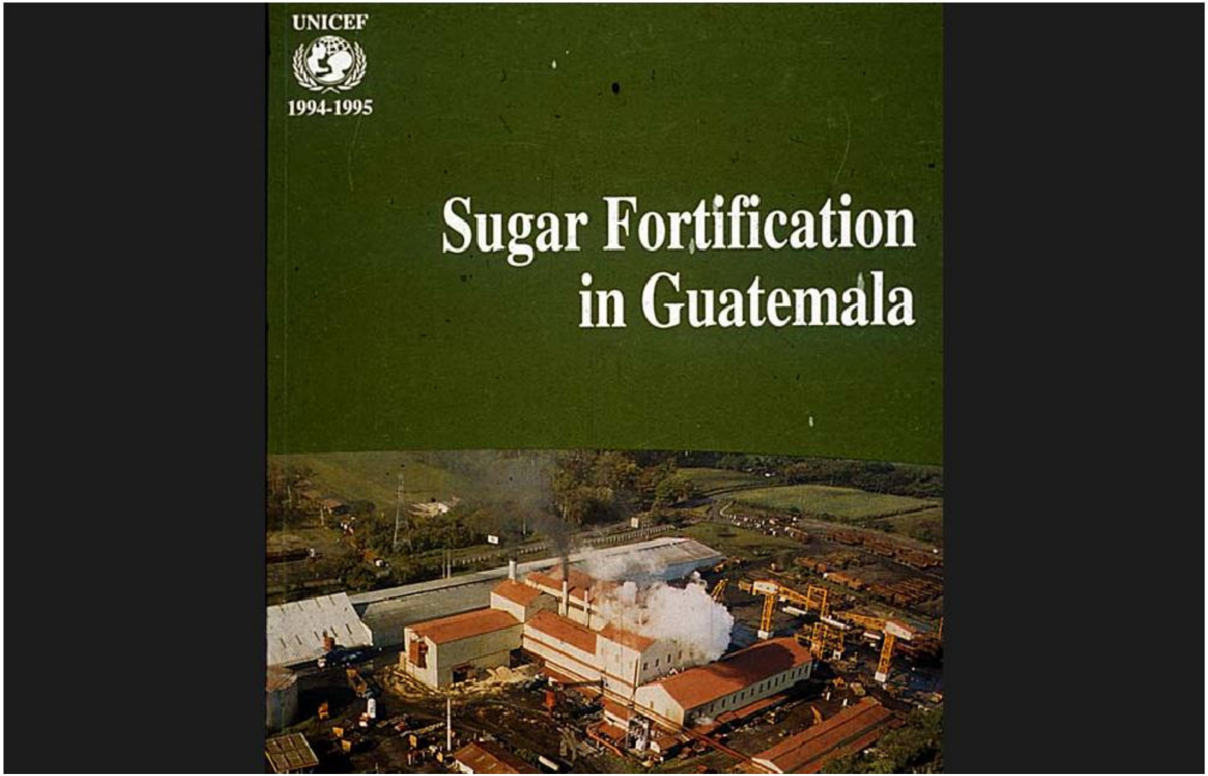
2 per 200,000 IU capsule

delivery system

20 per

delivered dose

K. West, ACC/SCN State of Art Paper No. 2, 1987


UNICEF
1994-1995
Sugar Fortification
in Guatemala


FORTIFIED
NET WT. 250 grams
STAR
MARGARINE
DOH

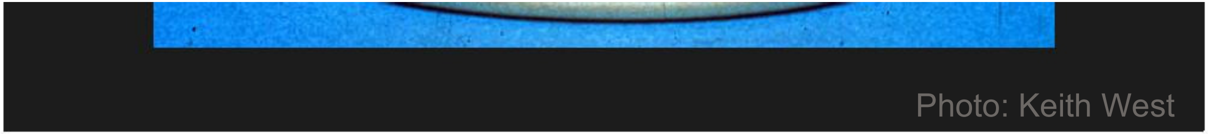


Photo: Keith West

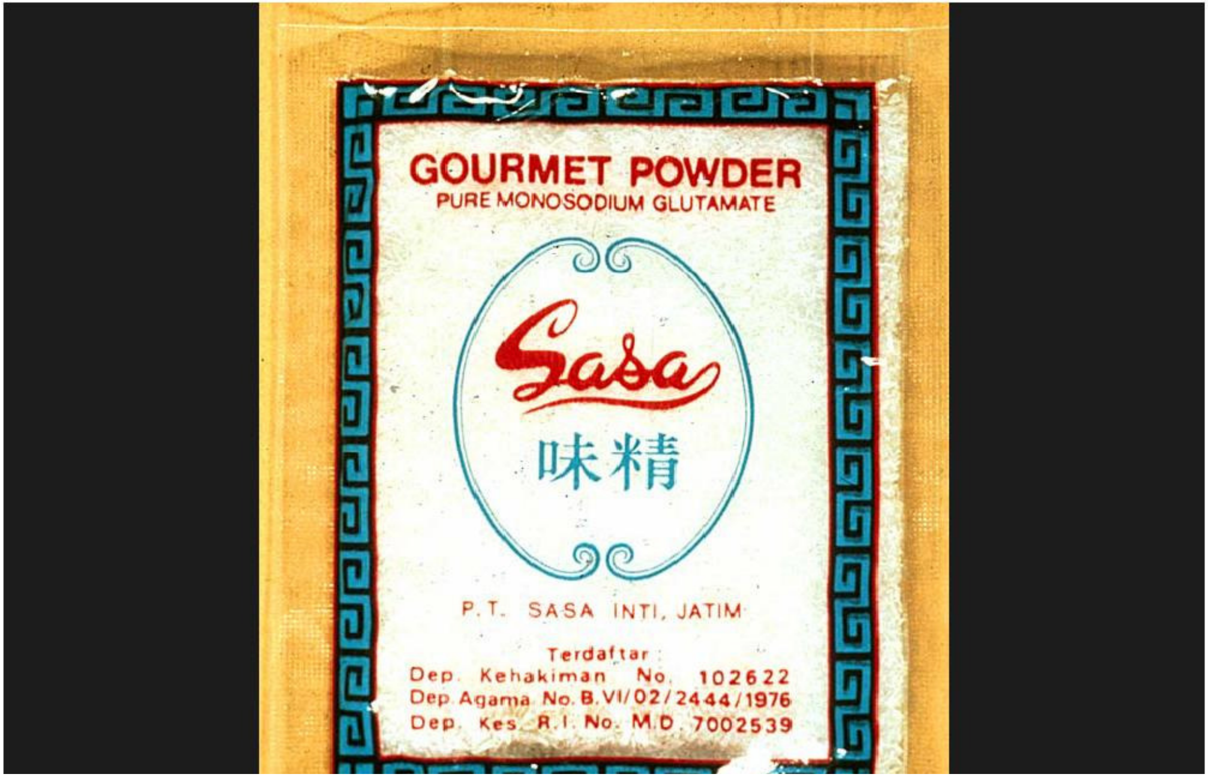
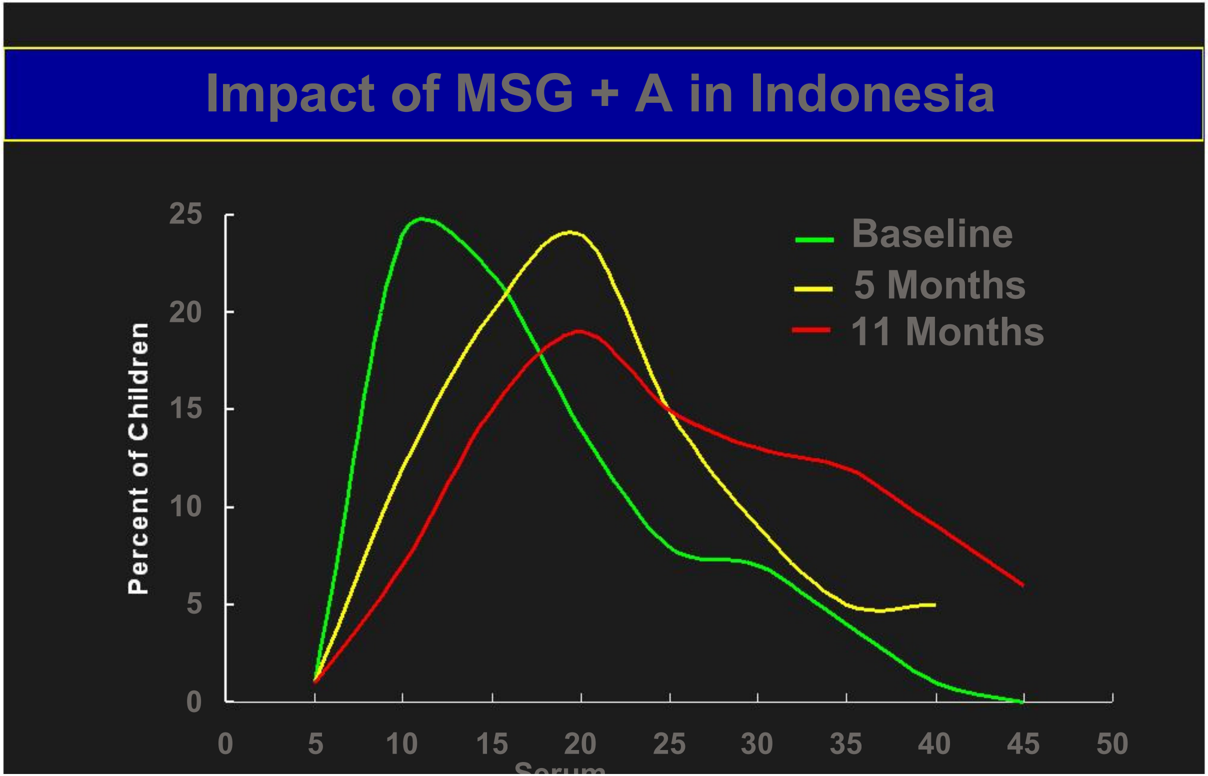

GOURMET POWDER
PURE MONOSODIUM GLUTAMATE
Sasa
味精
P.T. SASA INTI, JATIM
Terdaftar :
Dep. Kehakiman No. 102622
Dep. Agama No. B.VI/02/2444/1976
Dep. Kes. R.I. No. M.D. 7002539

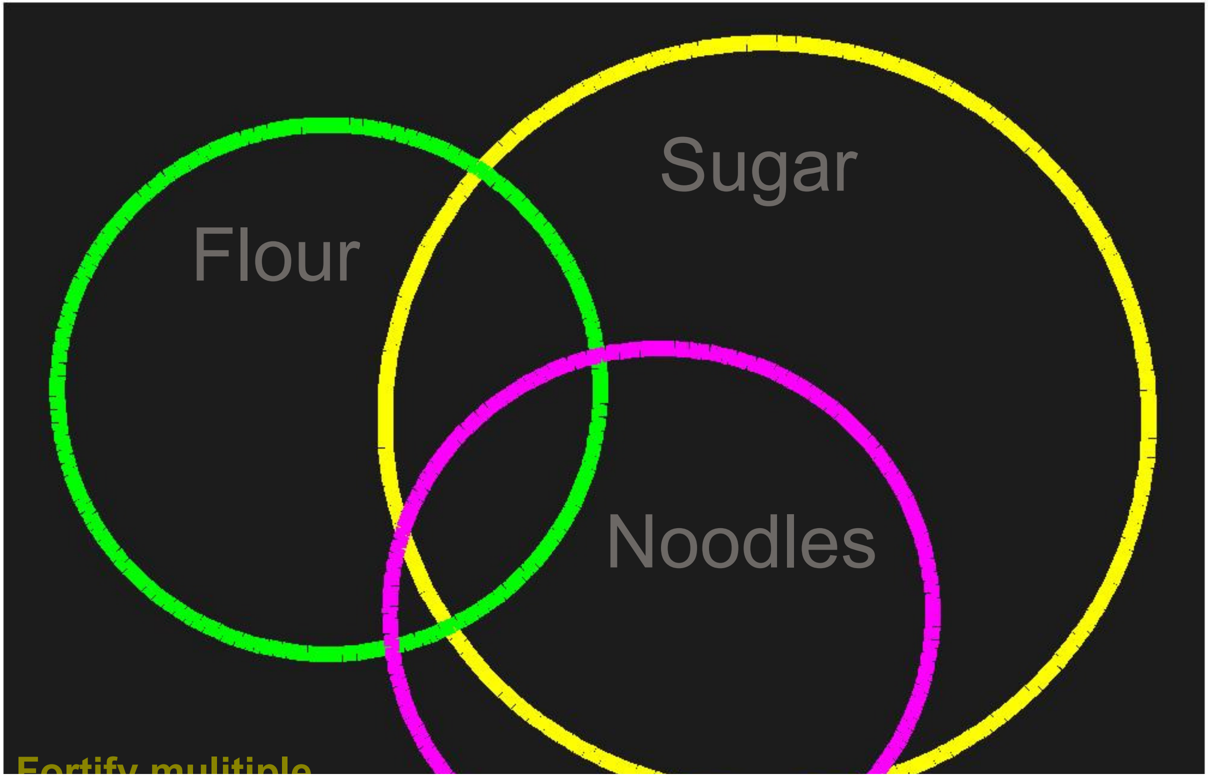

Photo: Keith West

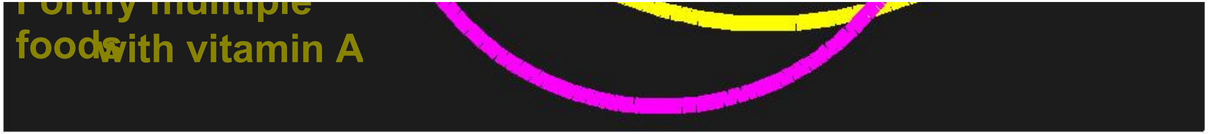


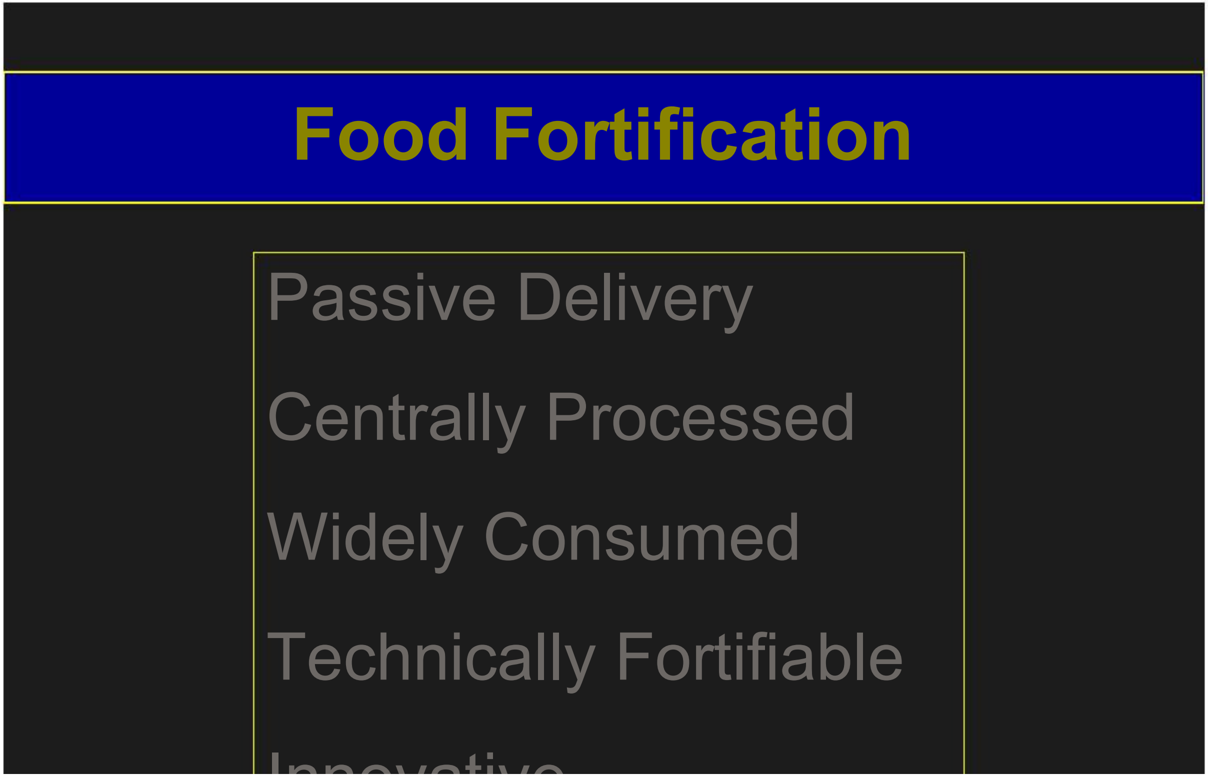
Impact of MSG + A in Indonesia
Baseline
5 Months
11 Months
Percent of Children
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50

Serum Retinol (µg/dL)

Based on Muhilal et al, Am J Clin Nutr 1988;48:1265


Sugar
Flour
Noodles


foods with vitamin A


Food Fortification
Passive Delivery
Centrally Processed
Widely Consumed
Technically Fortifiable
Innovative

Innovative
Financing


Photo: K West, Jr.

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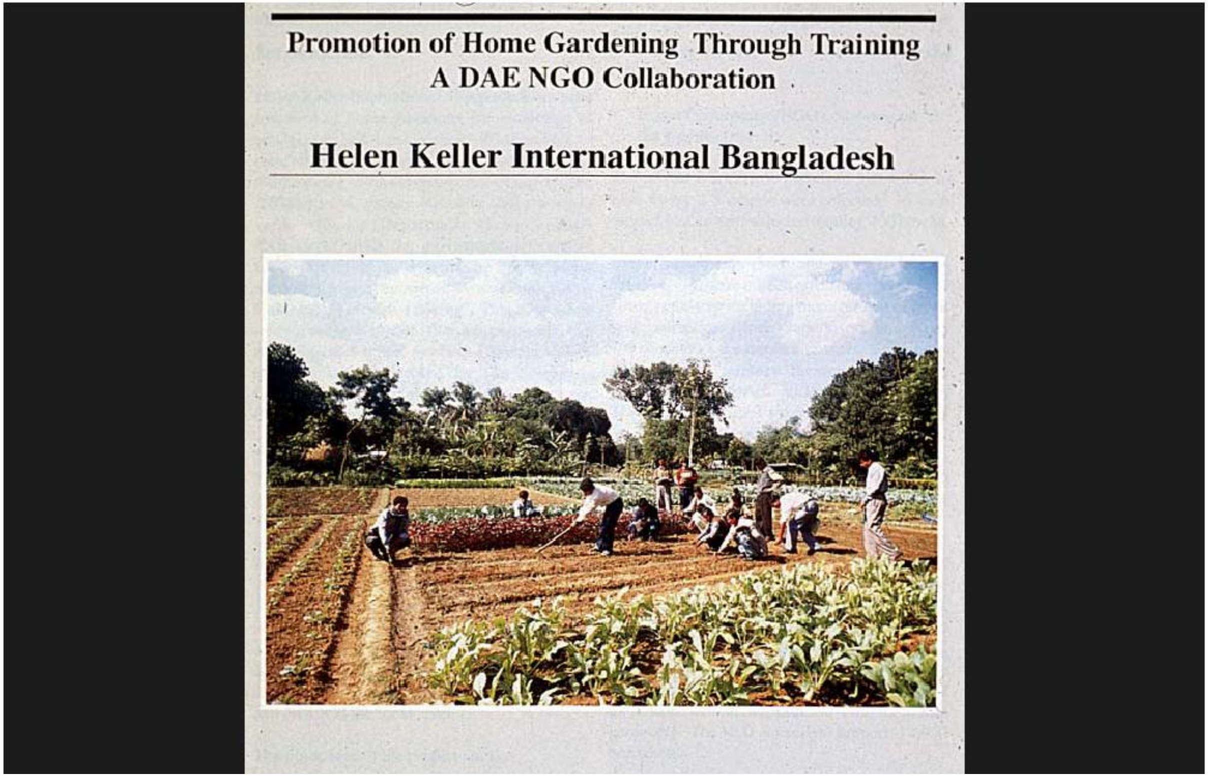
Magplano ng pagkain nang maaga. 8

Plan meals ahead of time.

Helen Keller International


Promotion of Home Gardening Through Training
A DAE NGO Collaboration
Helen Keller International Bangladesh

Monitoring of Activities in Block Nurseries and Household Gardens

Round 1


max. 500 g
0
20
50
100
150
200
250
300
350

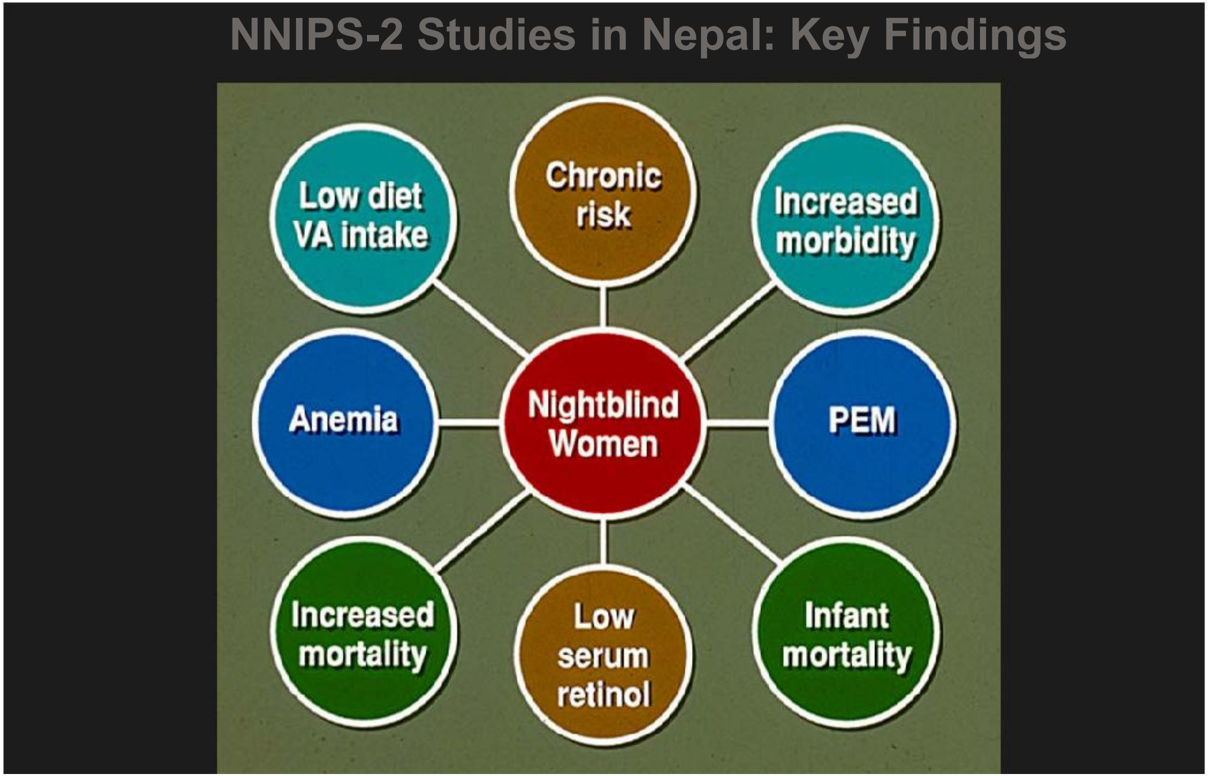

400
450
500
SOEHNLE
Photo: K West, Jr

Vitamin A and Child Mortality Prevention
Evidence-based Global Advocacy

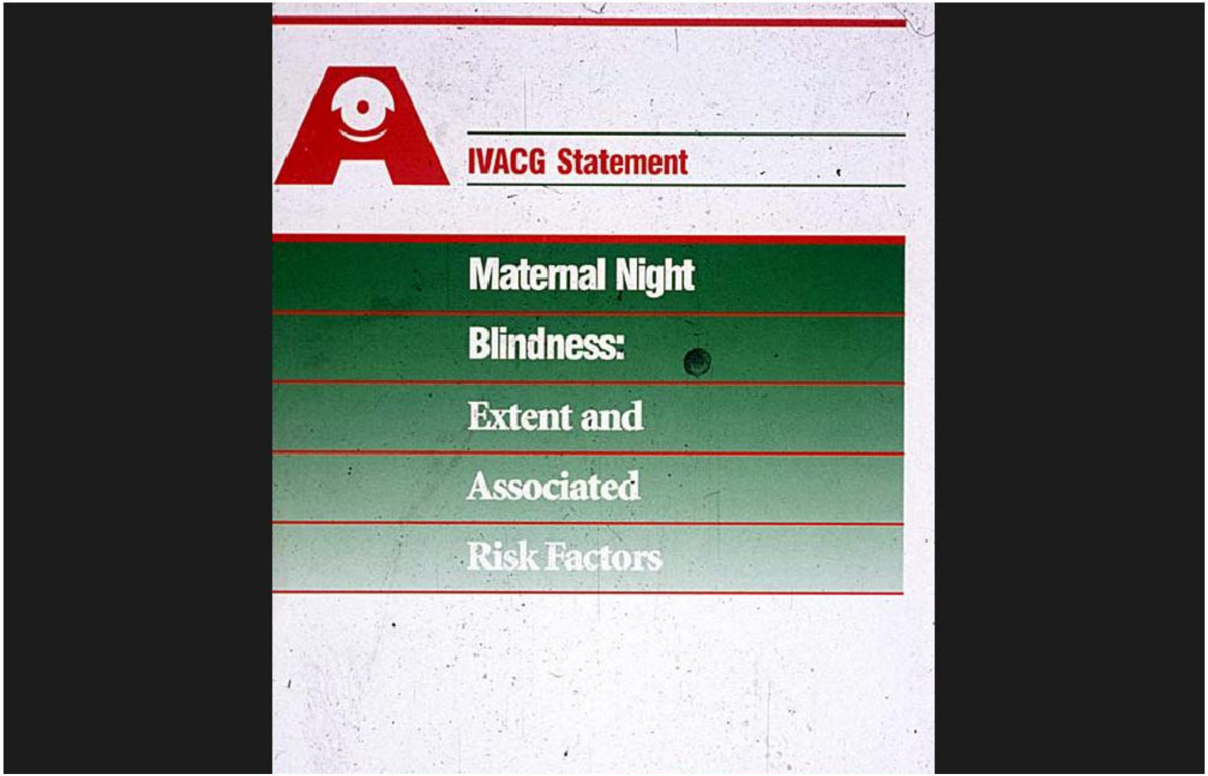
UN-ACC/SCN Statement (1986)
WHO/UNICEF Statement (1987)
IVACG Statement (1989)
World Summit for Children (1990)
Lusaka Convention (1990)
Ending Hidden Hunger (1991)
Internatl Conference on Nutrition (1992)
Bellagio Brief (1992)
25th Session of UN-ACC/SCN (1993)
UNICEF/WHO Mid-Decade

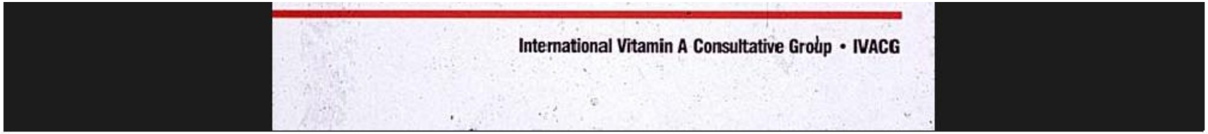
Goals (1994)

2002 UNGA Special Session to follow-up of World Summit and Millenium Dev. Summit


NNIPS-2 Studies in Nepal: Key Findings
Low diet VA intake
Chronic risk
Increased morbidity
Anemia
Nightblind Women
PEM
Increased mortality
Low serum retinol
Infant mortality

For more information see: P Christian et al: Int J Epidemiol 1998; Eur J Clin Nutr 1998; Am J Clin Nutr 1998; Soc Sci Med 1998; Am J Epidemiol 2000; Katz et al, 1995


IVACG Statement
Maternal Night
Blindness:
Extent and
Associated
Risk Factors


International Vitamin A Consultative Group • IVACG

Impact of Maternal Vitamin A or Beta-carotene Supplementation on Pregnancy-related Mortality (Through 12 Weeks Post-partum)

	PL (7241)	VA or BC (14948)
No. deaths	51	59
MR/100,000	704	395
RR	1.00	0.56
(95% CL)	-	(0.37,0.85)

44% reduction ($p < 0.005$)

West et al, BMJ 1999

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Iodine
Iodine Deficiency
Iodine Deficiency Disorders (IDD)

Most preventable cause of mental retardation in the world

Keith P. West, Jr., DrPH

Center for Human Nutrition

Iodine

- Required to produce thyroid hormones that control cell metabolism, neuromuscular tissue growth and development, especially the fetal-perinatal brain
- Present in minute amounts (15-20 mg) in the body

>90% of iodine stored in the thyroid

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Hormones

Endocrine: produced & circulated to distant sites of action vs-

Paracrine: act on neighboring cells

Autocrine: act on same cells that produce

Iodine needed for thyroid hormones

- Thyroxine (T_4)
- Triiodothyronine (T_3)

Iodides attached to the amino acid tyrosine

Thyroid hormones regulate numerous functions: eg

- Biochemical reactions (eg, protein synthesis, enzyme activities)
- Influence early organ development (eg, brain

(eg, brain
through 2-3 yrs
of age)

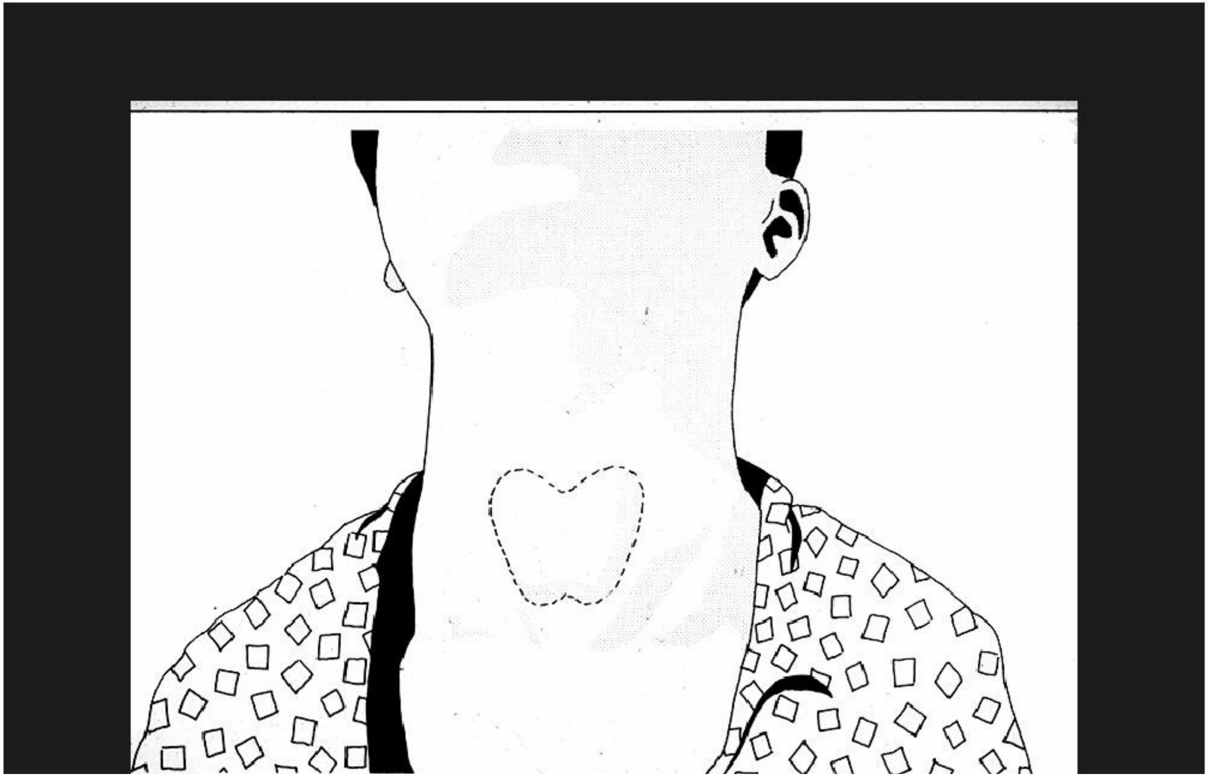
Functions of Thyroid Hormones

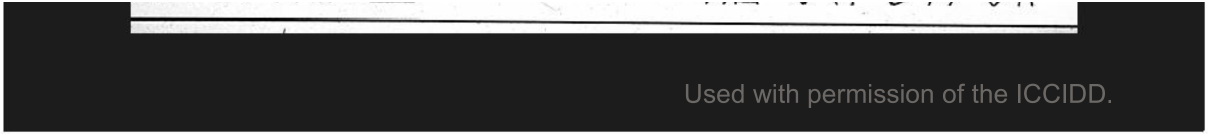
By influencing gene transcription, thyroid hormones regulate oxygen and energy utilization, evident through

- Cellular metabolism (oxygen & energy utilization, ATP production)
  - Basal metabolic rate
  - Protein

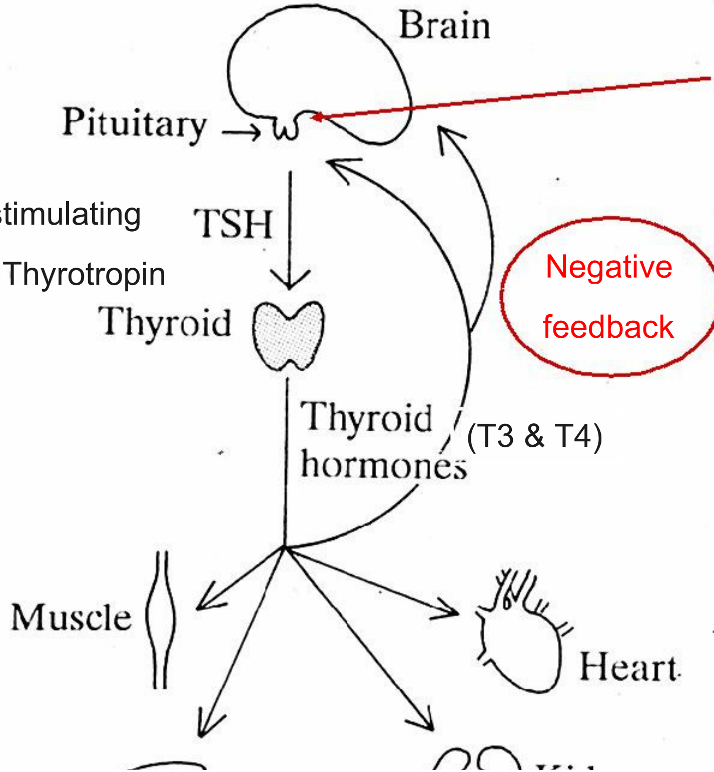
synthesis

Thermogenesis





Thyroid-stimulating Hormone / Thyrotropin

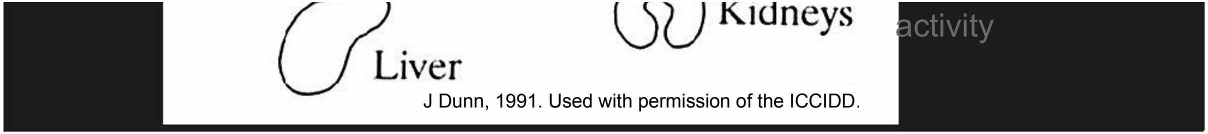


(T3 & T4)

Negative feedback

Thyrotropin-releasing hormone (TRH) produced by the hypothalamus controls TSH production in the anterior pituitary

Low T3 & T4 levels Up-regulate; high levels down-regulate the thyroid; increase in energy need increases



J Dunn, 1991. Used with permission of the ICCIDD.

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1 Follicular cells of Thyroid trap iodide ions in blood

2 Follicular cells make & secrete thyroglobulin (TG) with tyrosine amino acids

3 Iodide anions are oxidized w/ peroxidase to iodine & pass into colloid

4 Iodine attaches to TG tyrosine AAs. Binding

T1 = monoiodotyrosine

T2 = diiodotyrosine

5 Two T2s couple to make T4 = thyroxine (80% of total); or one T1 and one T2 couple to make T3= triiodothyronine (20% of total, but 4x stronger).

6 TG re-enters the follicular cell, merges w/ lysozyme and is digested. T3 & T4 are cleaved & released.

7 Lipid soluble T3 & T4 diffuse through plasma membrane into blood

8 T3 & T4 transported by thyroxine-binding globulin (TBG)

Iodine Deficiency Disorders (IDD)

Fetal Iodine Deficiency

Abortion
Stillbirth
Congenital defects
Mental retardation
Paraplegia
Deaf-mutism
Dwarfism
Psychomotor defects

Neonatal ID

Neonatal goiter
Hypothyroidism
(too little thyroid hormone)
Infant mortality

Cretinism	B Hetzel Lancet 1983;2:1126;
Infant mortality	R Semba, 2002

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Materno-Fetal Iodine Deficiency:
Neurological Damage

Default		CNS Site *
Intellectual deficit	.	Cerebral cortex
Deafness	.	Cochlea
Motor rigidity	.	Basal ganglia

* Probable 2nd trimester insult R. DeLong, 1994

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Cretinism

- Severe mental retardation
- Severe growth deficit
- Paraplegia (lower limb paralysis)
- Rigidity
- Deaf-mutism
- Facial disturbances
- The type and severity of brain, neural and musculoskeletal defects arise

Figure 5: Cretin in China J Dunn, 1991

arise
from
timing
severity
and duration of deficiency.

Photo used with permission of the ICCIDD.

Effects of Iodized Oil in Pregnancy on Infant Mortality in Papua New Guinea

	No. Births	Deaths n	%	Cretins n	%
Untreated	503	97	19.3	26	5.2
Treated	478	66	13.8	7	1.5
RR			0.71		0.29

Pharoah et al, Lancet 1971;1:308

Effects of Infant Iodine Supplementation on Mortality in Indonesia

RCT, 617 Indonesian infants, ~6 weeks of age

100 mg iodized oil vs placebo

Motivation: Earlier studies lowered infant mortality when pregnant mothers iodine status

was
corrected Cobra et al. J Nutr 1997;127:574

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Iodine Supplementation Reduced Early Infant Mortality in Indonesia

Follow-up	RR	(95% CI)	% Reduction
1 mo	0.20	(0.04-0.91)	80%
2 mo	0.30	(0.10-0.90)	70%

4 mo	0.52	(0.21 - 1.28)	48%

Cobra et al. J Nutr 1997;127:574

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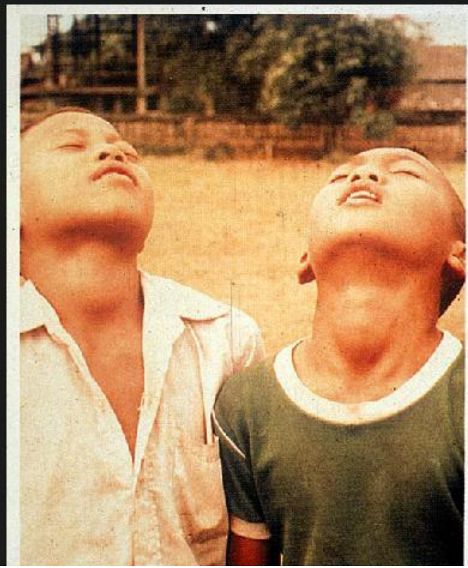
Iodine Deficiency Disorders (IDD)

Child/Adolescent

Goiter

Hypothyroidism

Impaired mental and physical development



B Hetzel Lancet

1983;2:1126;
R Semba, 2002

Photo used with permission of the ICCIDD.

Figure 1: Goiters in children (courtesy of Romsai Suwanik and Thailand Ministry of Health)

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Iodine Deficiency Disorders (IDD)

Adult

- Goiter
- Hypothyroidism
- Impaired mental function
- Iodine-induced hyperthyroidism (too much thyroid hormone)

B Hetzel Lancet 1983;2:1126

Photo: Keith West

Main Causes of Hypothyroidism

- Iodine deficiency
- Thyroiditis (inflammation) - autoimmune (Hashimotos Disease)
- Surgical causes

Symptoms of Hypothyroidism

http://www.endocrineweb.com

- Fatigue ;Weakness
- Weight gain or increased difficulty losing weight
- Coarse, dry hair
- Hair loss
- Dry, rough pale skin
- Cold intolerance
- Muscle cramps/aches
- Constipation
- Depression
- Irritability
- Memory loss

Abnormal menstrual cycles
Decreased libido

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IDD Globally (WHO, 1994)

	Total	
	Millions Affected	% All Regions
At-risk	1,572	29
Goitrous	655	12

Cretinism	11	2

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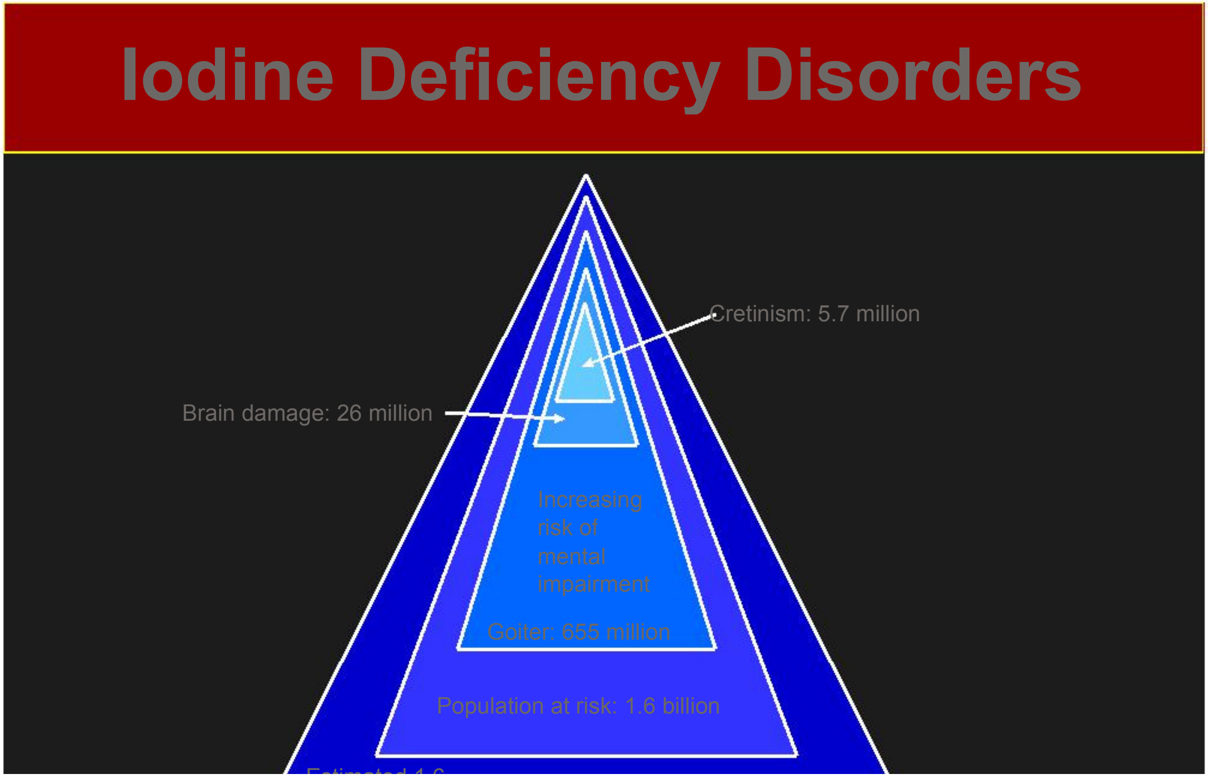


Adapted from a British Geological Survey diagram.

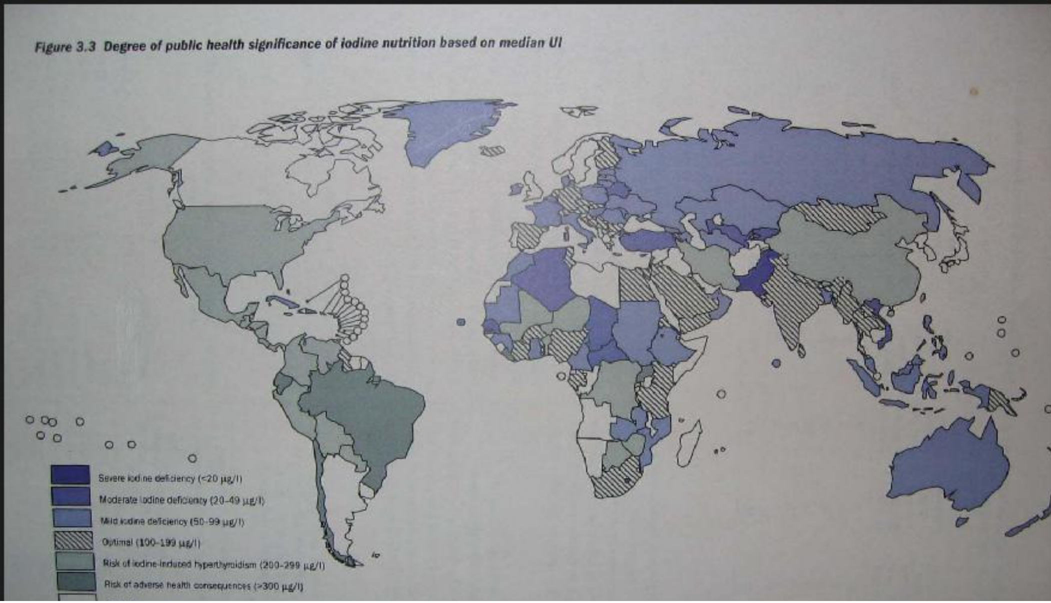
Iodine Deficiency: Global & Regional WHO 2004

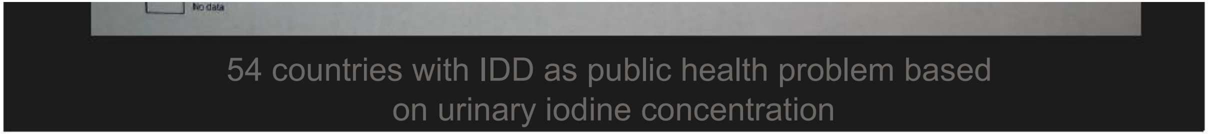
UN Region	% Countries	Low I Intake (millions)	% of popn	Goiter (millions)	% of popn
Africa	42	324	43	202	27
Asia	50	1,239	36	505	15
Europe	53	331	53	102	16
LAC	11	47	10	22	5
N Am	0	28	10	-	-
Oceania	75	19	65	4	13

Global	42	1,989	35	893	16

West et al, Intl Pub Hlth Nutr, 2005

Iodine Deficiency Disorders
WHO 2004




No data
54 countries with IDD as public health problem based
on urinary iodine concentration

Europe is iodine deficient

Vitti et al., Lancet 2003

Sufficient (UI = 100 g/L)

Austria, Bosnia, Bulgaria, Croatia, Cyprus, Czech Rep., Finland, Macedonia, Netherlands, Poland, Portugal, Slovak Rep., Serbia, Switzerland, UK, *Iceland, *Luxembourg, *Norway,

Deficient (UI < 100 g/L)

Belgium, Denmark, France, Germany, Greece, Hungary, Italy, Ireland, Montenegro, Romania, Slovenia, Spain, Turkey, #Albania

*Sweden

* Likely sufficient; # Likely deficient

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Iodine Status Assessment

- Goiter classification
- Urinary iodine concentration
- TSH (thyroid stimulating hormone) concentration
- Other common clinical measures:
  - Ultrasonoagraphy of thyroid volume
  - Serum concentrations: thyroxine,

TBG, many
other analytes

Goiter

This Ecuadorian boy is exhibiting signs of a goiter, an enlargement of the thyroid gland, due

to an iodine
deficiency.

Photo courtesy of CDC PHIL:
http://phil.cdc.gov/

Simplified Goiter Classification

Grade	Thyroid Size
0	Not palpable / not visible
1	Palpable in normal position
2	Visible in normal position

Poor response indicator to Universal Iodization of Salt (USI)

WHO, 1994

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Epidemiological Criteria for Assessing Severity of IDD Based on Median Urinary Iodine Levels (WHO, 1994)

Median Value (g/l)	Severity of IDD
< 20	Severe IDD
20-49	Moderate IDD
50-99	Mild IDD
100	No

≥ 100	No deficiency

Sensitive indicators of iodine intake, not thyroid function

IDD: As a Public Health Problem (WHO, 1994)

Indicator	Mod/Severe Cut-off (% of population)
Goiter grade > 0	20%
Median urinary iodine	< 50 g/L
TSH > 5 mU/L blood (best in newborns)	20%
Thyroid volume	20%

> 97%ile

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Best IDD Indicators by Target Group (WHO, 1994)

Goiter grade >0	School children
Cretinism	Children/adults
Median UI (g/L)	School children
TSH >5 mU/L blood	Neonates
Thyroid volume >97% ile	School children

Thyroglobulin (DBS)	Children

Iodine Interventions

Universal Iodization of Salt
Iodization of other Vehicles
Iodized Oil Supplementation

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RDA for Iodine

Infants 0-6 mo:	100 ug
7-12 mo	120 ug
Children 1-8 yr:	90 ug
Adolescents:	120-150 ug
Pregnant/lactating women:	200 ug

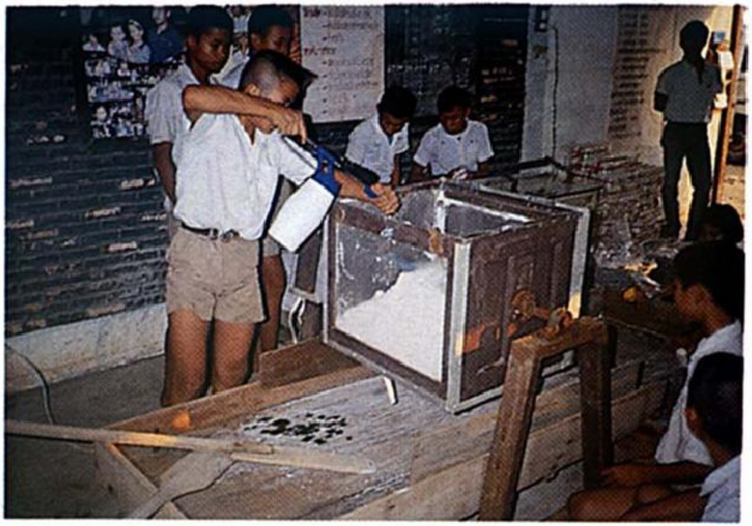
Dietary Reference Intakes, Institute of Medicine, National Research Council, Wash DC, 2001

Iodization of Salt

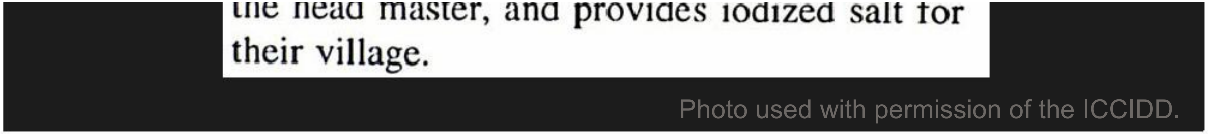
At a level that assures

150 ug/day is safe for all populations

WHO, UNICEF, FAO, ICCIDD, IAEA



(Chapter 8) - Simple iodization in a village school, using hand spraying of iodate solution. The entire operation is carried out by schoolchildren under the supervision of


the head master, and provides iodized salt for
their village.
Photo used with permission of the ICCIDD.

Different levels of sophistication for producing salt

Photos used with permission of the ICCIDD.

(Chapter 11) - A salt packaging machine

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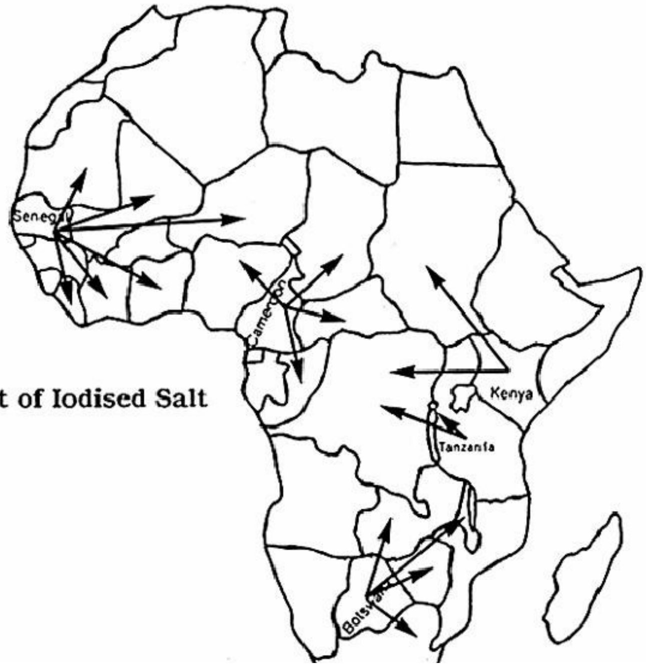
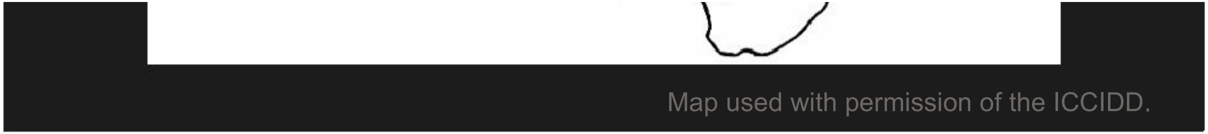
FIGURE 8



Africa - Transport of Iodised Salt

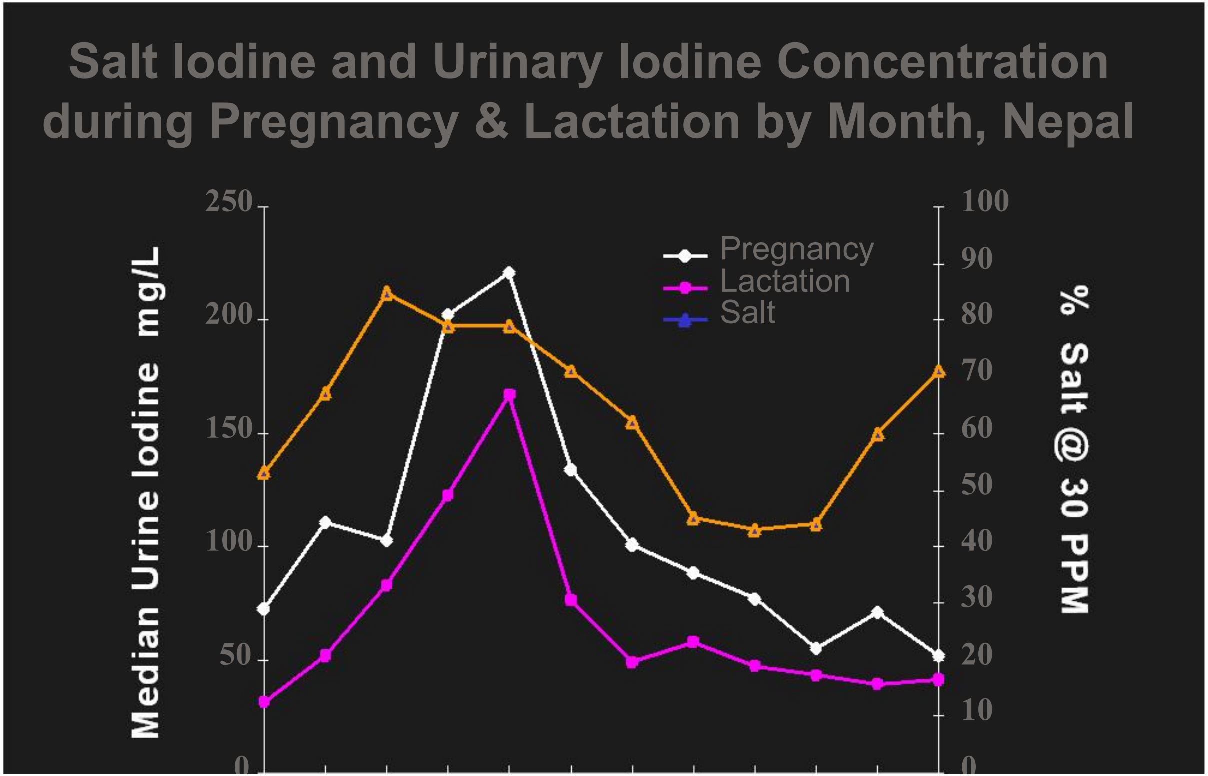


Map used with permission of the ICCIDD.

Prevalence of Goiter Before/After Salt Iodization Programs

	Columbia Year	%	Guatemala Year	%
Before	1945	82	1952	39
After	1952	37	1962	15
	1965	3	1965	5

Scrimshaw, 1994


Salt Iodine and Urinary Iodine Concentration during Pregnancy & Lactation by Month, Nepal
Median Urine Iodine mg/L
% Salt @ 30 PPM
Pregnancy
Lactation
Salt
250
200
150
100
50
0
100
90
80
70
60
50
40
30
20
10
0


JFM
AM
J
JA
SO
N
D
Month
K Schulze et al EJCN 2003

Iodizing Irrigation water in Xinjiang, China

- Area of severe iodine deficiency
- Potassium iodate added to irrigation water in 3 villages; control areas supplied by different irrigation system
- Maternal urinary iodine increased from <10 to 55 ug/L
- iodinated water could reduce infant mortality by

mortality by
approximately half

DeLong et al, Lancet, 1997; Semba, 2001

Effect of Iodination of Water Supply in Sarawak, Malaysia

	Before Iodination	9 Mo After Iodination
Goitre (%)	61	30
Serum T_4 (nmol/L)	80	109
Urinary iodine (g/L)	20	178
Serum TSH (U/L)	12	< 4

Maberly, et al, 1981

Iodized Oil Supplementation

Target Group: Women during pregnancy and 1st year post-partum; Children

When/Where:

IDD moderate-severe

Cretinism/neonatal

Cretinism/neonatal
hypothyroidism
No universal salt iodization for 1-2 yr

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Effect of Iodized Oil in Tanzanian School Children

	Before	After 1 Yr
Urine iodine (ug/g Cr.)	2.6	39.0
% children with TSH >5 mU/L	61.0	2.0

Source: TFNC, Tanzania

Iodized salt

- Universally and regularly consumed
- Costs ~$0.04/yr/person
- Simple technology

Iodized oil

- Effective in high risk groups
- Administered every 6 to 12

months

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Animals will probably

Receive widely (universally)

distributed iodized salt;

but not iodized oil

Goitrogens

eg, Thiocyanate found in cassava

Insufficient soaking or cooking

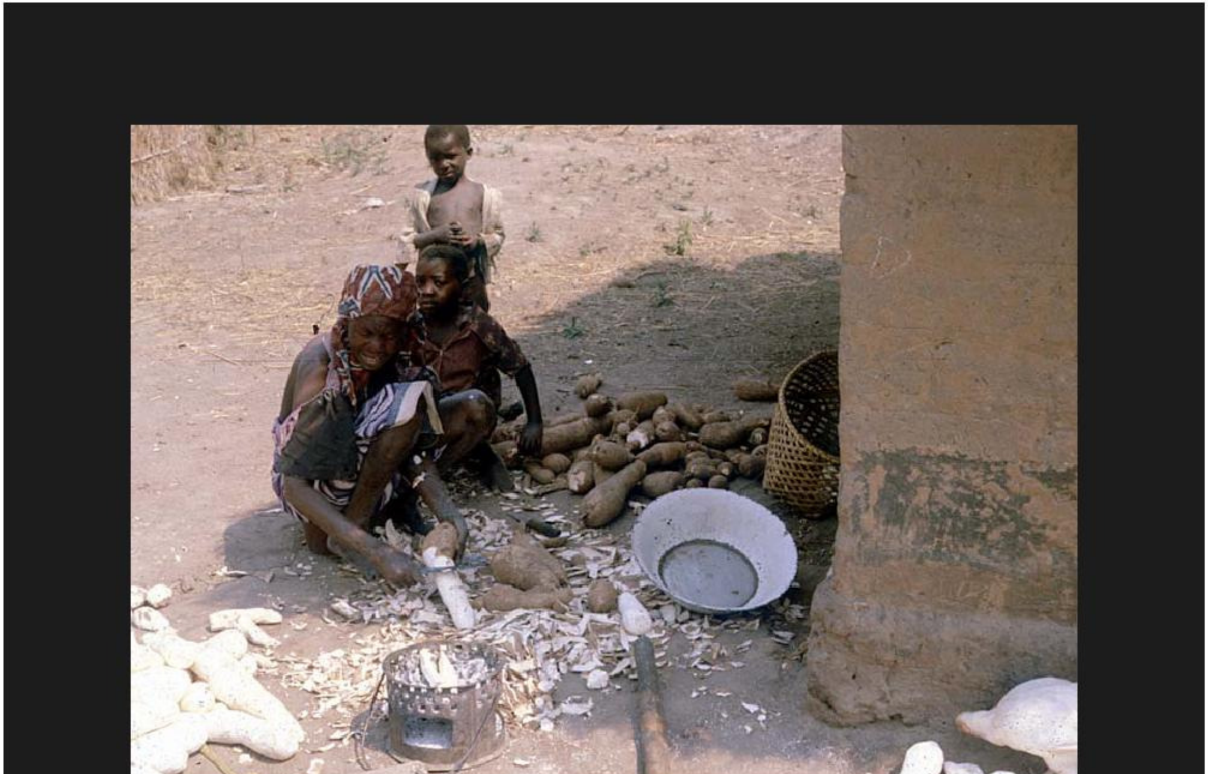
SCN decreases I uptake by thyroid

Suppresses circulating T_4

Problem where I intake is

Problem where I intake is
marginal


Photo: Keith West



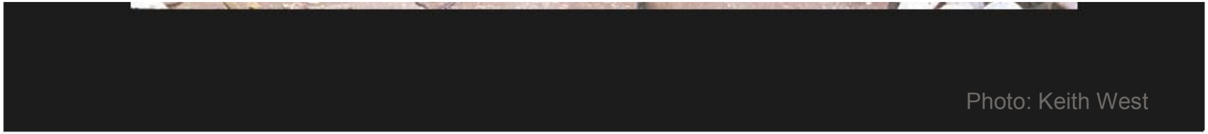


Photo: Keith West

Successful advocacy

Every year China loses 60-70 million IQ points due to IDD

Newton's IQ was 190

China is losing 368,000 Newtons every year

PRC Ministry of Health Endemic Disease Control Office, 1997

Virtual Elimination of IDD

1985	ICCIDD founded
1990	World Summit for Children
1991	Conference on Ending Hidden Hunger (Montreal)
1992	ICN, Rome
1994	UN

Policy Statement on USI

Committee on Health

Web resources

Thyroid Manager

www.thyroidmanager.org/

ICCIDD International Council for the Control of Iodine Deficiency Disorders

www.people.virginia.edu/~jtd/iccidd/

PAMM Program Against Micronutrient Malnutrition

www.sph.emory.edu/PAMM/iodine.htm

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Iron Deficiency and Anemia
Causes, Consequences, and Solutions

Parul Christian
International Nutrition
2005

Outline

- Anemia, ID, IDA Global burden
- Iron requirements
- Etiology of IDA
- Functional and health consequences of ID and anemia
- Iron-infection interaction
- Strategies for combating iron deficiency and

anemia

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Biologic Importance of Iron

Iron is essential for almost all living organisms

- Participates in oxidative and reductive processes as part of redox enzymes and thus plays an essential role in oxidative energy production
- Involved in oxygen transport as part of the heme molecule

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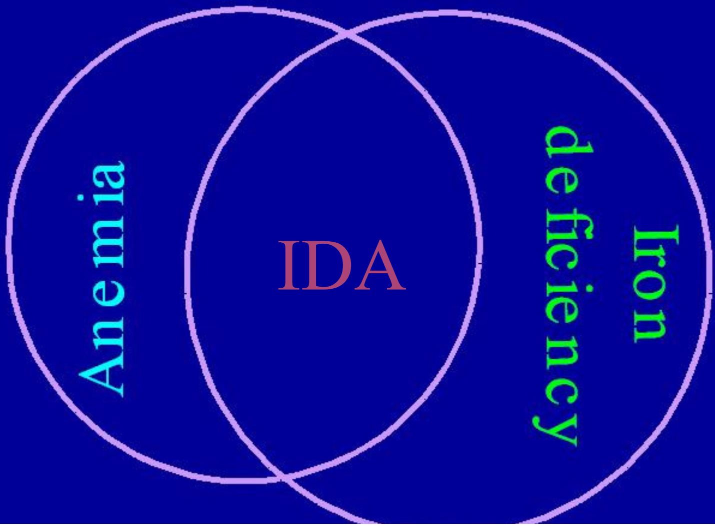
Iron deficiency

Importance

Iron deficiency is the most prevalent nutritional deficiency in the world, and probably the most important micronutrient deficiency in the US. Globally, it is estimated to affect 1.25 billion people

Iron deficiency vs. anemia



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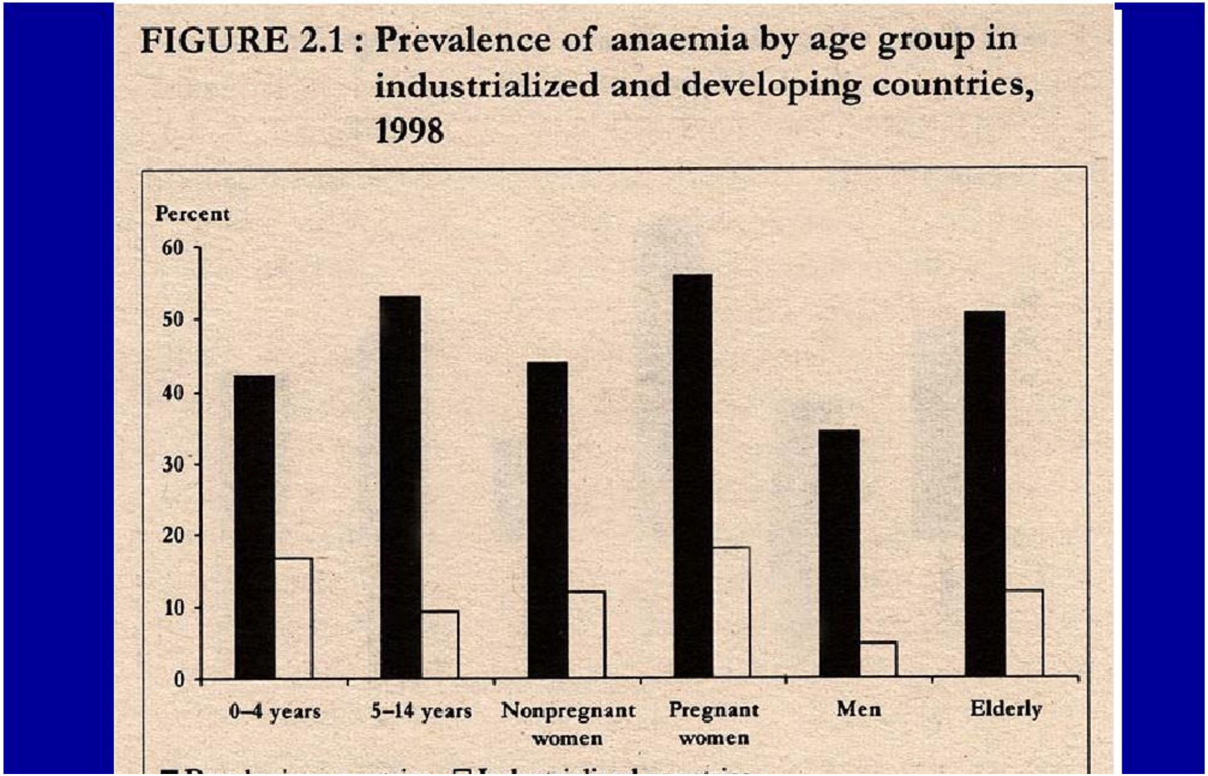
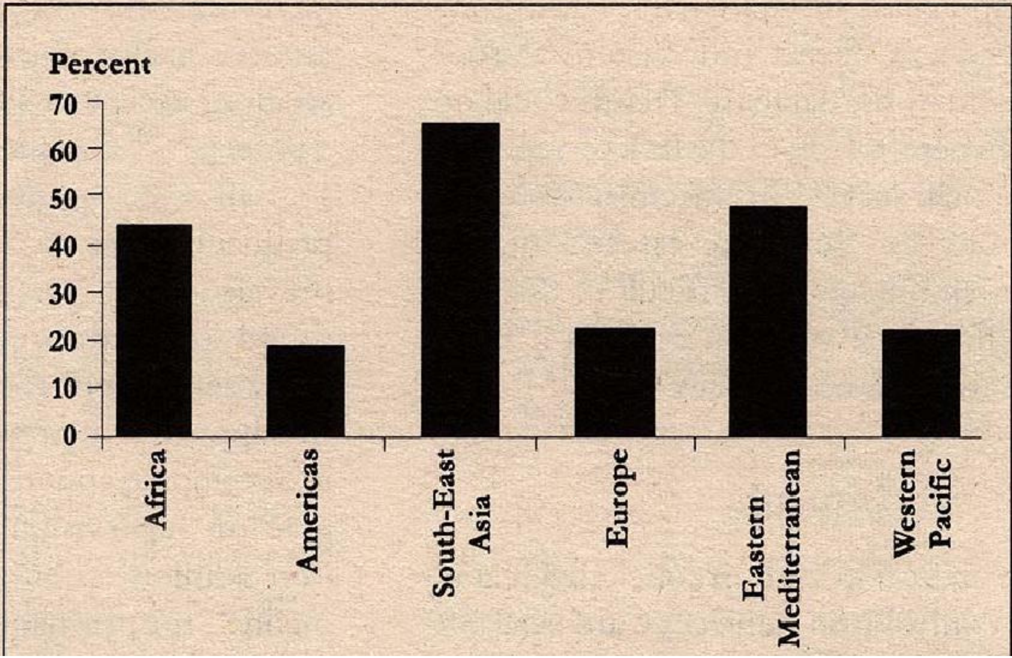
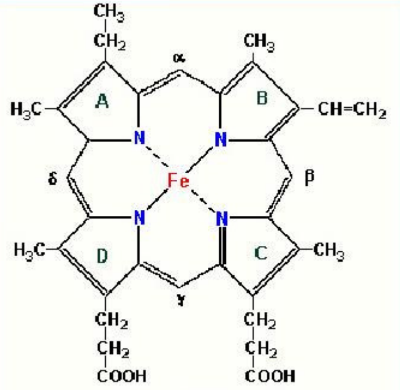



Developing countries
Industrialized countries
ACC/SCN 4 th Report on World Nutrition Situation, Jan 2000

FIGURE 2.2 : Prevalence of anaemia in children 0–5 years old by WHO region, 1998




ACC/SCN 4 th Report on World Nutrition Situation, Jan 2000



Heme Molecule

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Iron compounds

(approx. values for a 55 kg woman)

Functional Compounds	Hemoglobin	1700 mg
	Myoglobin	222 mg
	Heme enzymes	50 mg
	Non-heme enzymes	55 mg
	Transferrin	3 mg
Storage Complexes	Ferritin	200 mg
	Hemosiderin	70 mg

Total		2300 mg

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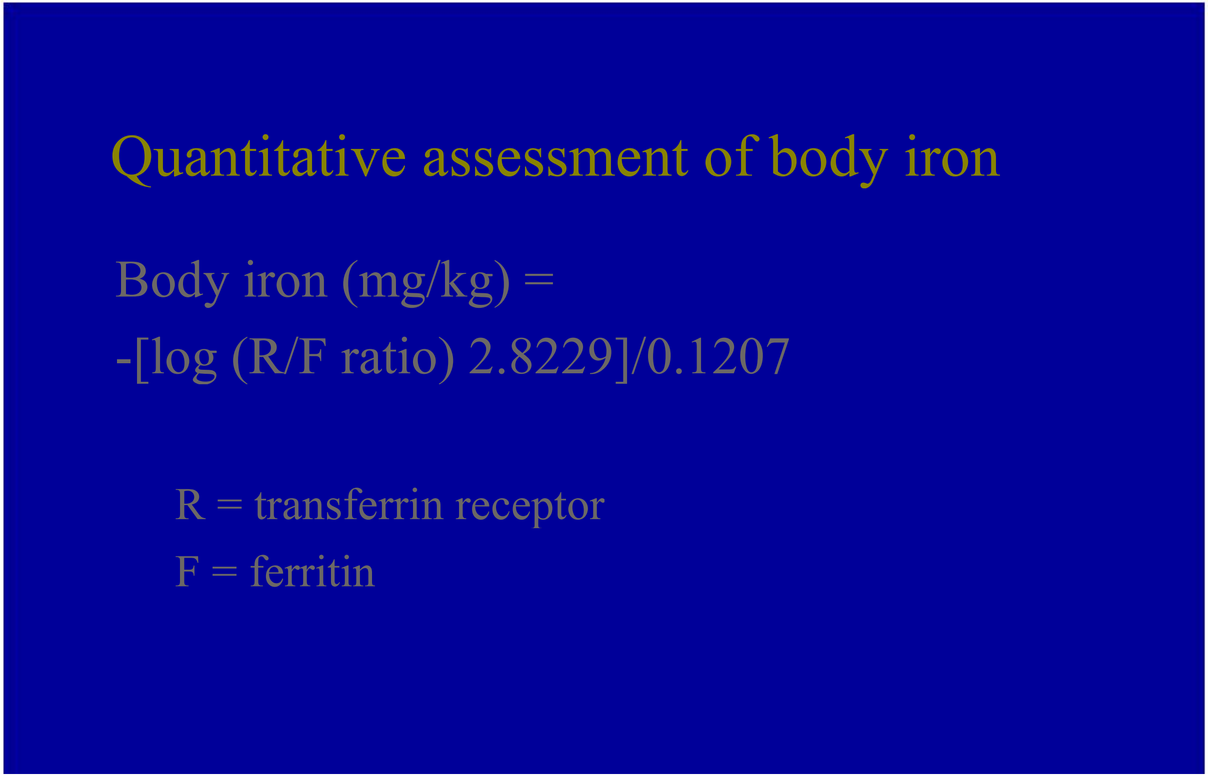
Comparison of screening and definitive measurements of iron status

Screening	Advantages	Limitations
1. Hemoglobin	Inexpensive, Universally available	Low sensitivity, Low specificity
2. Transferrin saturation	Inexpensive, Well established	Wide diurnal variation, Low specificity
3. Mean corpuscular Hb	Well available, established	Late indicator, low specificity
4. Zinc protoporphyrin	Portable assay, Inexpensive	Automation difficult, Affected by lead exposure
Definitive		
1. Serum ferritin	Quantitative (stores), well standardized	Affected by inflammation, liver disease
2. STfr	Quantitative (tissue deficiency) unaffected by inflammation	Affected by recombinant human erythropoietin
3. Bone-marrow iron	Well established, high	Affected by EPO treatment,

	specificity	invasive, expensive, error-prone

Cook JD; Best Pract Res Clin Haematol 2005


Quantitative assessment of body iron
Body iron (mg/kg) =
-[log (R/F ratio) 2.8229]/0.1207
R = transferrin receptor
F = ferritin

Cook JD; Blood 2003

Defining anemia at sea level

Age or Sex group	Hb below g/dL	Hematocrit below %
Children 6mo-5 y	11.0	33
Children 5-11 y	11.5	34
Children 12-13 y	12.0	36
Non-pregnant women	12.0	36
Pregnant women	11.0	33
Men	13.0	39

Men	13.0	39

Stoltzfus & Dreyfuss; INACG/UNICEF/WHO 1998

Dietary Iron

- Two types of iron
  - Heme iron (animal sources)
  - Non-heme iron (plant sources)
- Absorption of heme iron is 20-30%
- Absorption of non-heme iron varies between 1-10% and is much more affected by iron status and intraluminal factors

Non-heme Iron Absorption

Enhancers : ascorbic acid, meat

Inhibitors : phytates, phosphates, tanins, oxalates, soy protein

Other nutrients: zinc, calcium

Iron requirements for growth

Group	Age (y)	Wt gain (kg)	Mg iron/kg body wt	Mean iron for growth (mg/d)
Children	0.25-1	4.2	37	0.65
	1-2	2.4	37	0.24
	2-6	7.9	40	0.22
	6-12	20.2	41	0.38
Boys	12-16	26.2	46	0.66
Girls	12	15.2	43	0.36

Girls	- 16	15.2	43	0.36

Iron Losses
Men and Post-menopausal Women

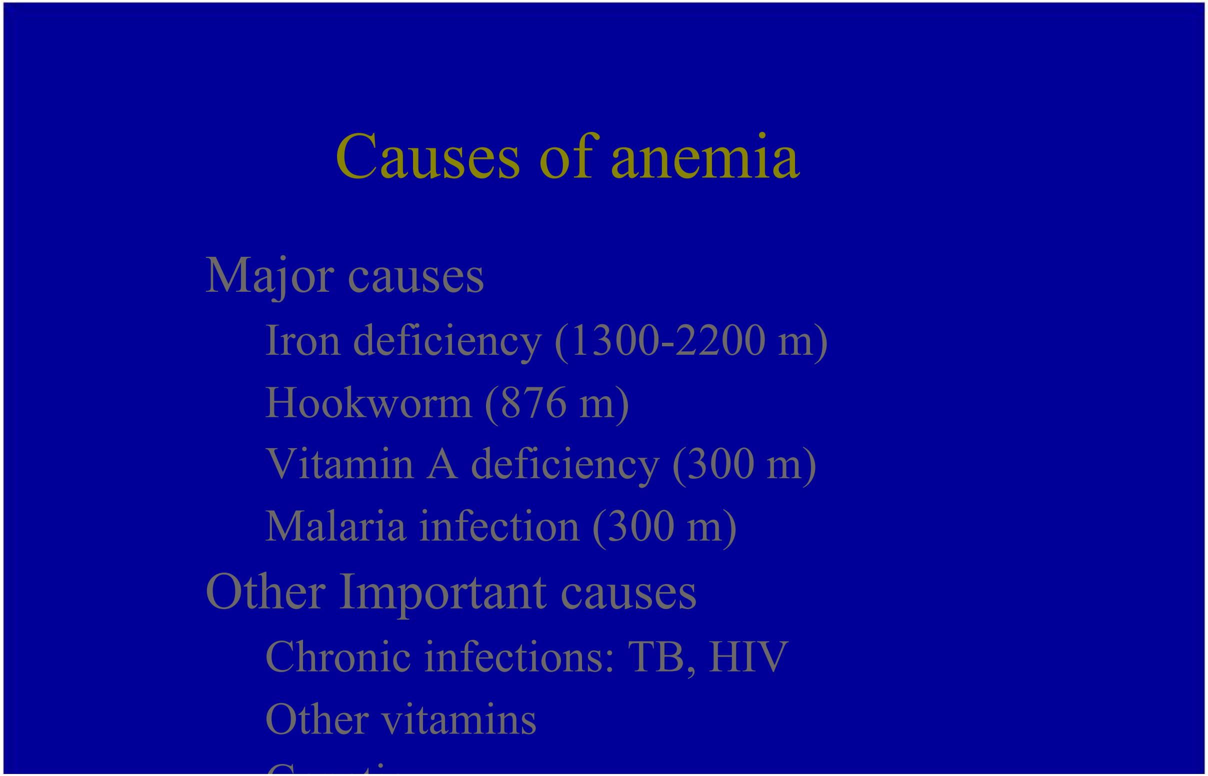
Area of loss	Amount (mg/d)
Feces	0.2-0.5
Urine	0.2-0.3
Sweat, hair, nails	0.2-0.5
Total	0.8-1.0

Iron Losses

(Menstruating women - 55 kg)

Additional loss of 0.5 mg/d of Fe occurs due to menstruation; range is high

	Basal Fe loss	Menstrual Fe loss	Total Fe loss
	g/kg/d		
No contraceptive	14	8	22
Oral contraceptive	14	4	18
IUD	14	16	30


Causes of anemia
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

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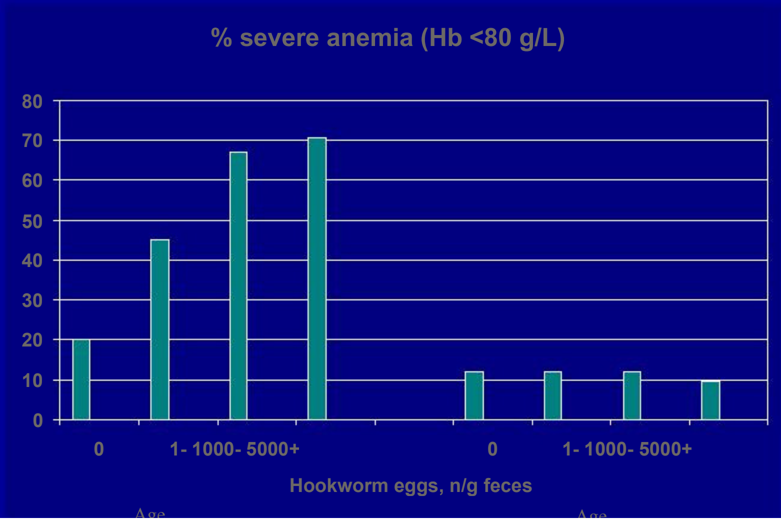
Hookworm and Malaria in the Etiology of Iron Deficiency and Anemia



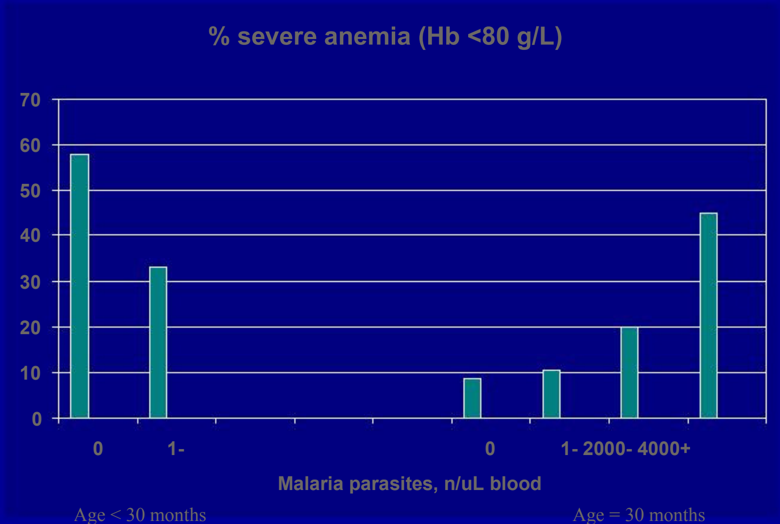
Proportion of Zanzibari children with severe anemia (hemoglobin <80 g/L) by malaria parasite density or hookworm fecal egg counts and age group. Chi-square tests for trends of association: malaria parasite density in age <30 months, P<0.00001, age = 30 months, P>0.20. Hookworm fecal egg counts in age <30 months, P = 0.002, age =30, P = 0.005.

Age
<
30
months

Age
=
30
months

Adapted from: Stoltzfus et al, J Nutr 2000

Hookworm and Malaria in the Etiology of Iron Deficiency and Anemia



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Adapted from: Stoltzfus et al, J Nutr 2000

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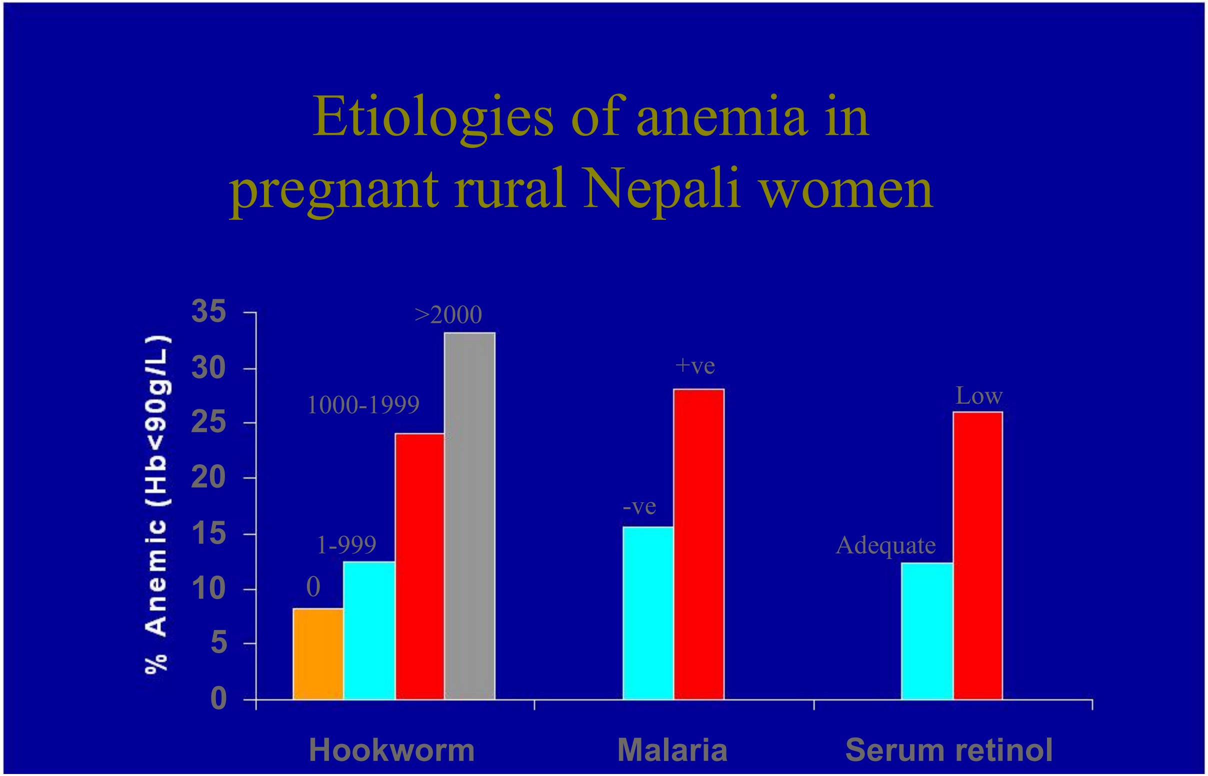

Dreyfuss et al, J Nutr 2000

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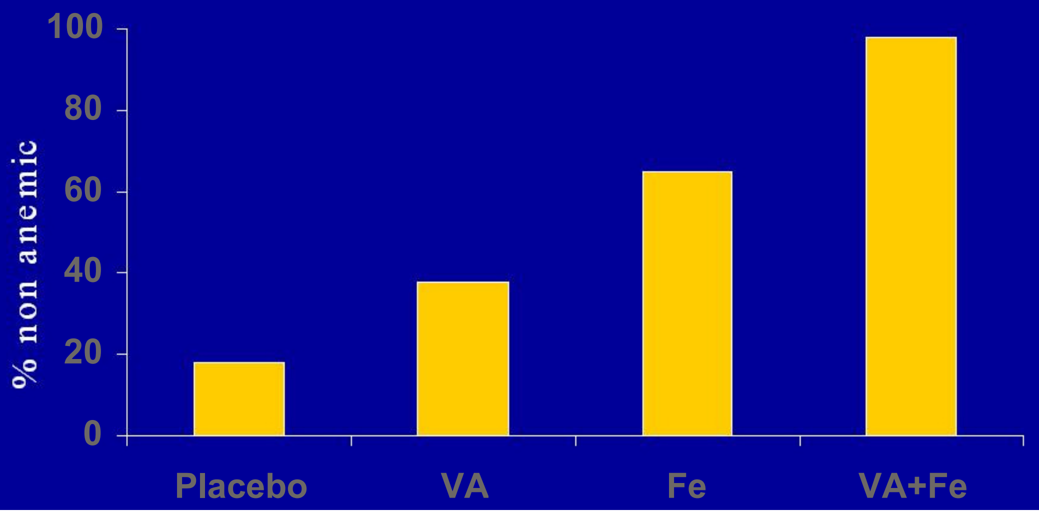
Deficiency of vitamins may cause anemia

RBC production (erythropoeisis)	VA, FA, B12, B6, riboflavin
Protect mature RBC free radical oxidation	VC, VE
Fe mobilization Fe absorption	VA, VC, riboflavin

Fishman, Christian and West et al, PHN 2000

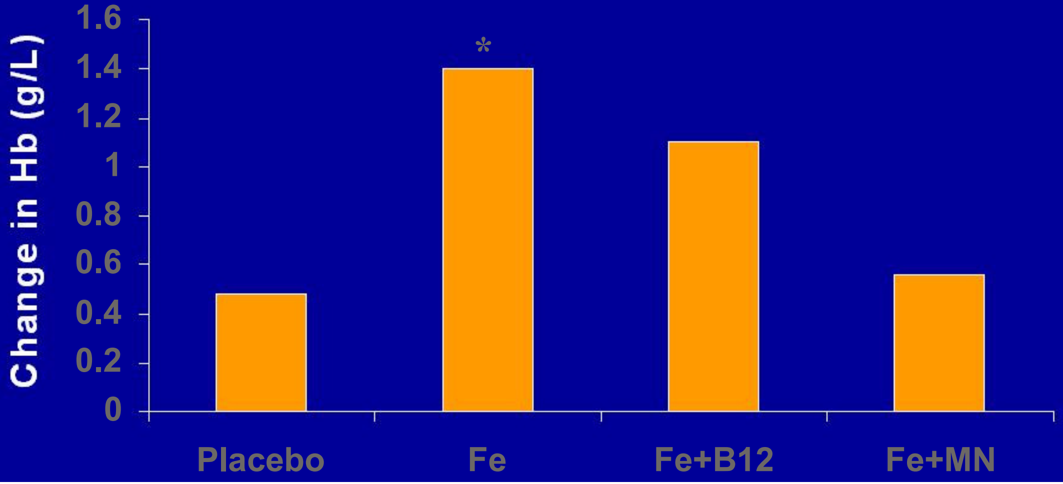
Vitamin A and iron interaction in Indonesian pregnant women



Suharno et al, AJCN 1993

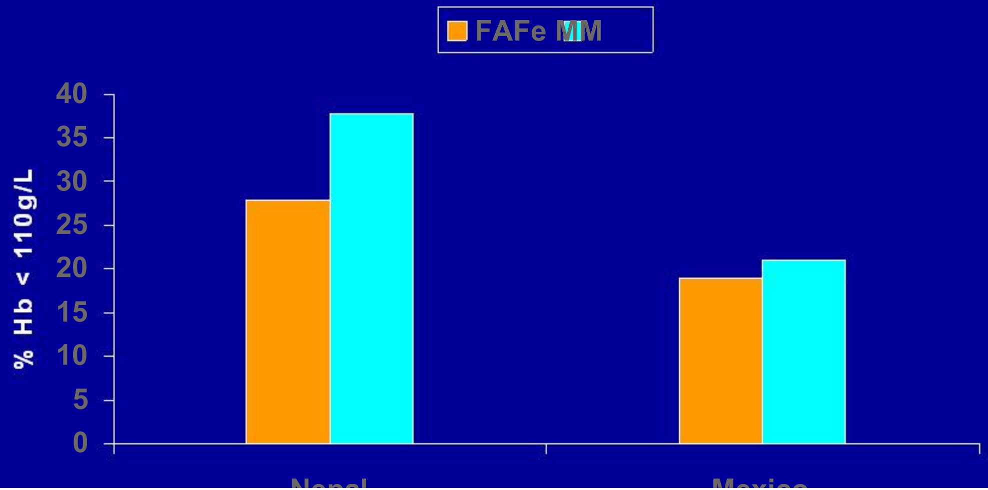
Iron and micronutrients supplementation in anemic Mexican children - RCT

(Lopez et al, J Nutr 2001)



B2, B12, A, B6, E, folic acid, zinc, copper

Impact of antenatal multiple micronutrient supplementation on anemia in the third trimester



Nepal Mexico

Christian et al, J Nutr 2003; Ramakrishnan et al, J Nutr 2004

Consequences of Iron Deficiency and Anemia

- Decreased work capacity
- Prematurity and LBW
- Perinatal mortality
- Maternal mortality
- Child mortality
- Impaired neurocognitive function in children

Iron and work capacity

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Iron deficiency and anemia and work capacity

Laboratory studies

- IDA causally associated with 10-50% reduction in VO_2 max
- No clear association between IDA and endurance capacity
- ID may impair energetic efficiency

Field studies

- Provide further causal evidence
- ID and IDA may affect productivity
- Institutional and technological factors may constrain ability or motivation of subjects

What does this mean.

- Productivity losses due to iron deficiency
- Losses to GNP estimated from 6 countries range from 0.85% to 1.27%
- South Asia, where ID is high, loses $ 5 billion annually

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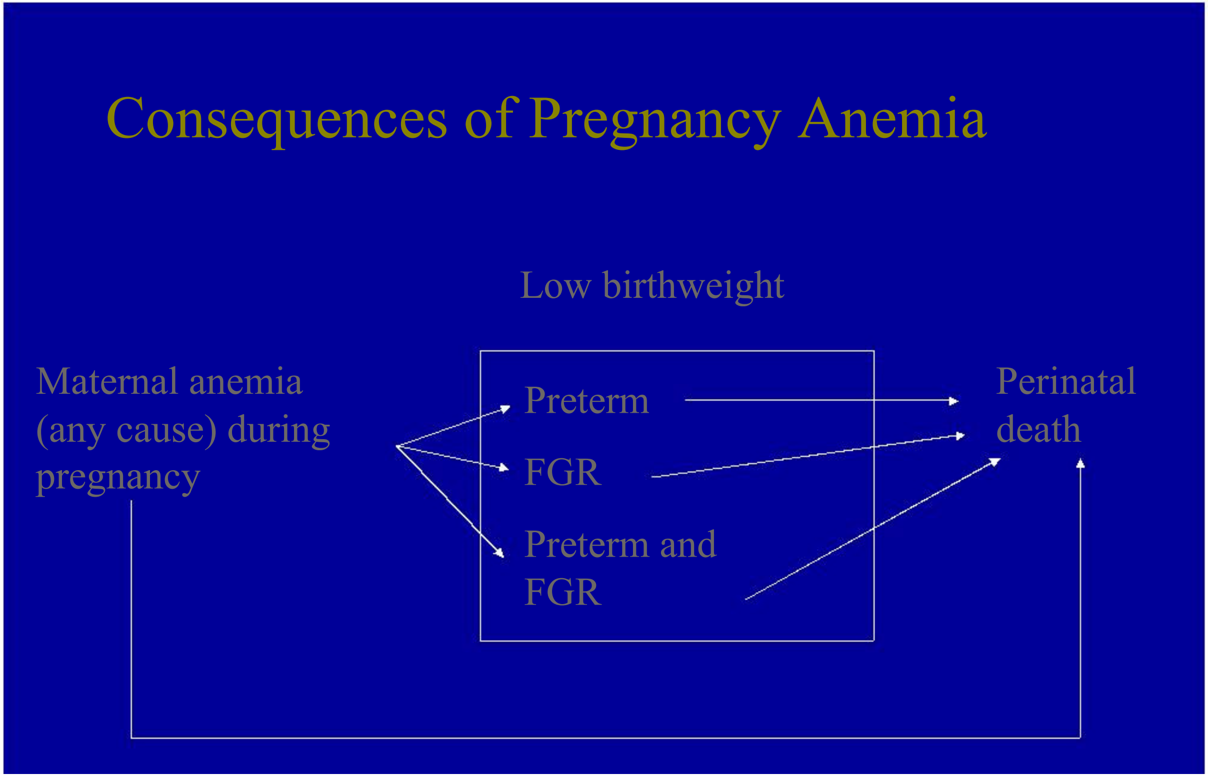
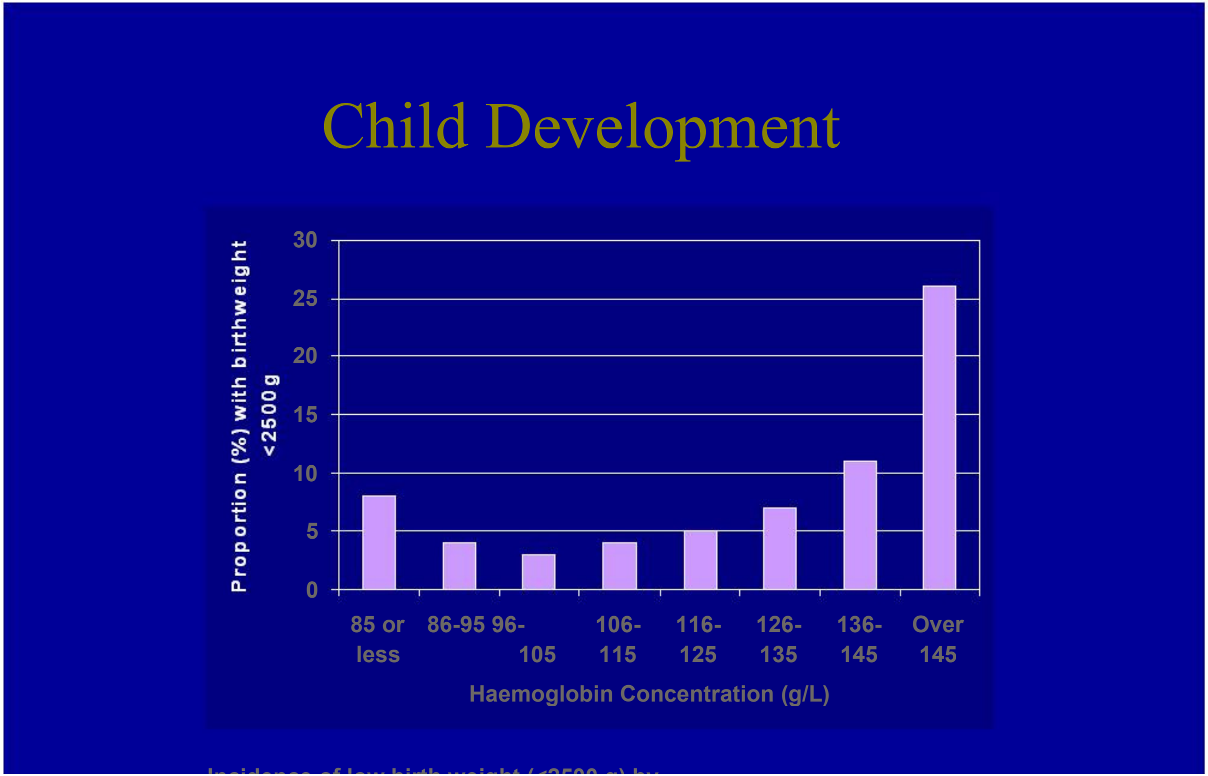


Adapted from Rasmussen, J Nutr 2001

Fetal/Placental development

- Maternal hematocrit determines O_2 tension in amniotic fluid (Nigeria)
- Maternal anemia/iron status influences placental size, morphology
- ID may be associated with increases in maternal ACTH and cortisol


Child Development
Proportion (%) with birthweight <2500 g
30
25
20
15
10
5
0
85 or less
86-95
96-105
106-115
116-125
126-135
136-145
Over 145
Haemoglobin Concentration (g/L)

Incidence of low birth weight (<2500 g) by haemoglobin concentration (g/L).

Data for white women only.

Adapted from: Steer et al; BMJ 1995

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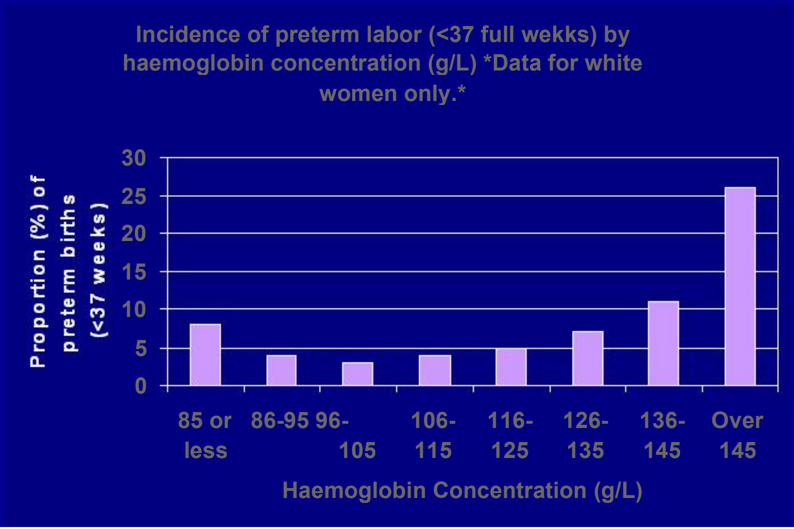
Child Development

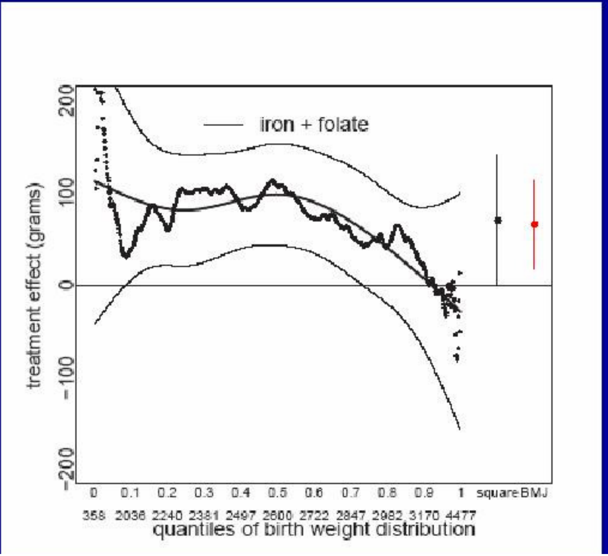


Adapted from: Steer et al; BMJ 1995

Antenatal iron and low birth weight

- All systematic reviews of RCTs have found evidence to be inconclusive (Rasmussen 2000)
  - Mainly because of poorly conducted studies, inadequate design, low sample size, biases
- Recent trials in Nepal and the US found that antenatal iron supplementation increased birth weight

Effect of antenatal iron supplementation on birth weight in rural Nepal



Iron folate improved birth weight by about 80g for weights below 2800 g

Christian et al; unpublished

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Anemia and maternal mortality

No clinical trials, but strong clinical impression

At 6.0g/dL evidence of circulatory decompensation becomes apparent. Women experience breathlessness and increased cardiac output at rest. At this stage, added stress of labor can result in maternal death. Without effective treatment, maternal death from anemic heart failure is likely with Hb concentration of 4.0g/dL. Even a blood loss of 100 ml can cause circulatory shock and death. (INACG

death. (INACG
Statement)

Child Mortality

Relationship through infectious disease incidence is unlikely

Relationship through anemia is possible, and probably severe anemia of any cause

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Nepal Trial

RCT, 2x2 factorial design

Placebo, Fe+FA, Zn, Fe+FA+Zn

Children ages 2-35 mo

Outcome: Infant/Child survival

Iron arms of the trial stopped because of a lack of any impact on infant/child survival

Tielsch et al; unpublished

Child Development

- Ironmay affect brain development through decreased brain iron which affects
  - Myelination
  - Neural transmission systems (both neuronal metabolism and dopaminergic functioning)
- Functions affected
  - Delays in maturation of visual, auditory, motor functions and other aspects of neurofunctional development (e.g. recognition memory)
  - Child-caregiver interaction
  - Child functional isolation through lack of exploratory movement

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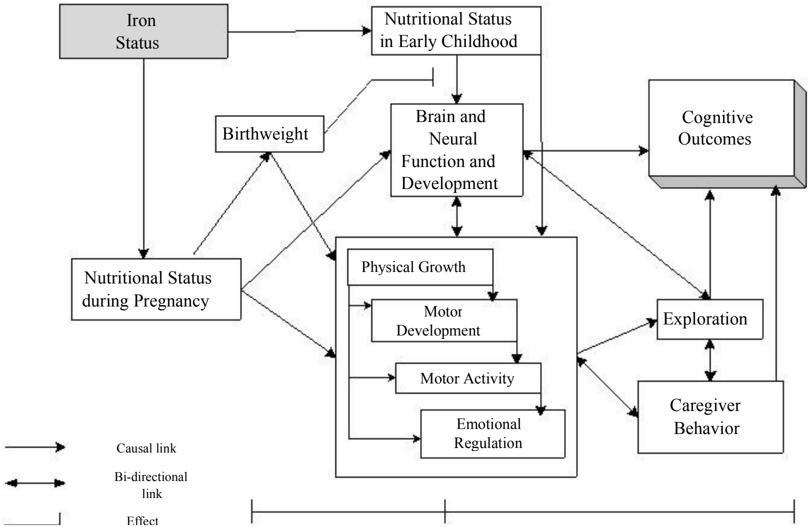
Iron status and neurocognitive development



Modified from Pollit E; EJCN 2000

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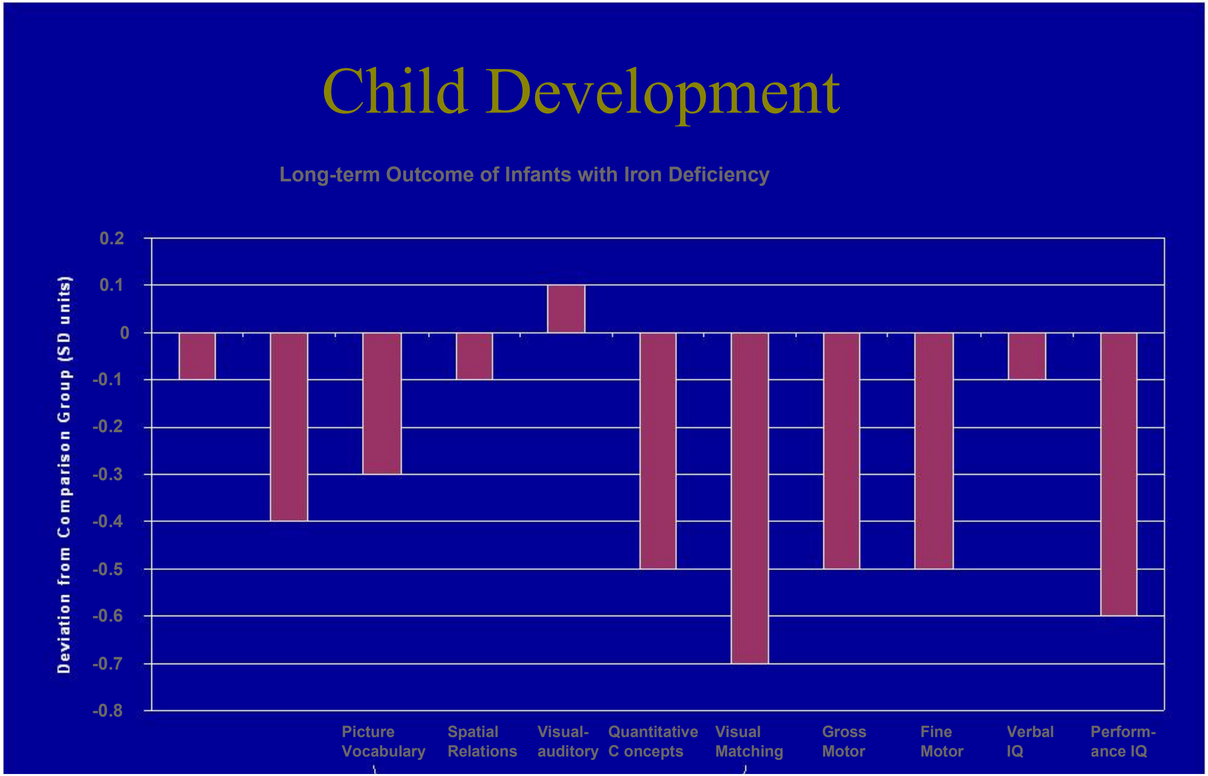

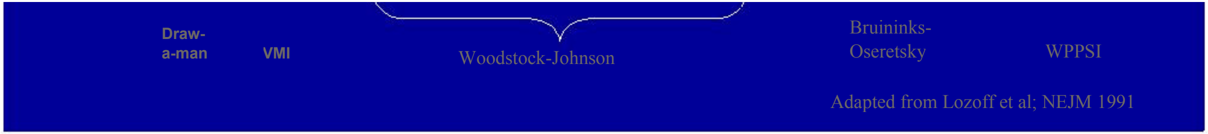
Draw-
a-man
VMI
Woodstock-Johnson
Bruininks-
Oseretsky
WPPSI
Adapted from Lozoff et al; NEJM 1991

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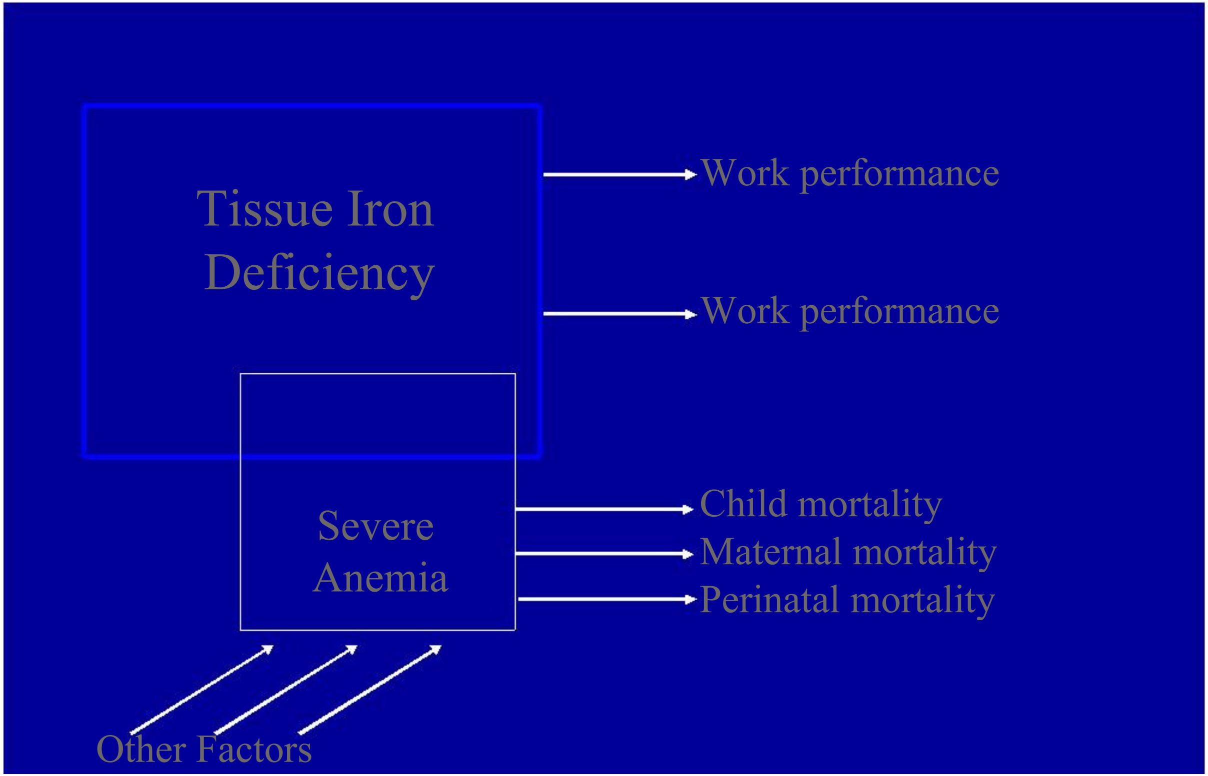
Language scores in four treatment groups with differences in scores showing effects of treatment

Treatment	Final language score*	Difference in score
Placebo (n=85)	13.1 (12.7 to 13.9)	
Mebendazole (n=85)	13.5 (12.6 to 14.4)	
Iron (n=94)	14.0 (13.2 to 14.8)	
Mb + iron (n=85)	14.2 (13.4 to 15.0)	
Effect of iron v no iron		0.8 (0.2 to 1.4)
Effect of Mb vs no Mb		0.3 (-0.3 to 0.9)


Stoltzfus et al; BMJ 2001

Child Development - Summary

- Evidence favors a true relationship, but not conclusive; data from RCTs are not consistent
- Issues of timing, reversibility and optimal intervention remain unresolved
- Predictive and construct validity of Bayleys scales is questionable


Tissue Iron Deficiency
Work performance
Work performance
Severe Anemia
Child mortality
Maternal mortality
Perinatal mortality
Other Factors

Adapted from: Stoltzfus RJ; J Nutr 2001

Iron Supplementation and Infectious Disease

3 Systematic reviews:

- Shankar et al (iron supplementation and malaria)
- Oppenheimer (all interventions, all ages, all outcomes)
- Gera and Sachdev (iron supplementation and incidence of infections in children)

INACG Consensus Statement-1999
(based on Shankar et al.)

Known benefits of iron supplementation are likely to outweigh the risk of adverse effects caused by malariaOral iron supplementation should continue to be recommended in malarious areas where IDA is prevalent.

Belmont meeting* conclusion (based on Oppenheimer)

Evidence not convincing for or against a relationship of public health significance

*
WHO/INACG
convened
meeting

Oppenheimer SJ; J Nutr 2001

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Iron supplementation in young children in Pemba, Zanzibar

- 2x2 factorial study of iron-folic acid and zinc in malaria endemic Pemba island
- The iron arms of the trial were discontinued due to evidence of increased hospitalization and mortality
- In a subsample, where children received treatment for malaria and other infections, iron reduced mortality in iron deficient children

children

Sazawal, Black, Unpublished

Infectious disease and iron supplementation - summary

IF an adverse relationship exists, it probably derives from risks of iron intervention, not protective effect of iron

THUS, question is NOT : Is it better for children to be iron deficient

BUT RATHER: How can we safely correct iron deficiency.

Pemba study suggests screening and treatment of malaria and other infections may be required

Prevention and treatment guidelines for iron supplementation (WHO/UNICEF/INACG)

Pregnant women:

- Prevention: 60 mg iron + 400 g folic acid daily for 6 mo in pregnancy
- Treatment of severe anemia: 120 mg iron + 400 g folic acid daily for 3 mo

Children 6-24 mo:

- Prevention: 12.5 mg iron + 50 g folic acid daily from 6-12 mo of age or from 2-24 mo of age if lbw
- Treatment of severe anemia: 25 mg iron + 100-400 g of folic acid daily for 3 mo

Children 2-5 yr : 20-30 mg iron

Where hookworm is endemic, give anthelminthics

Prevention Strategies

Supplementation of target populations little success in pregnancy

Dietary diversification/modification can it work.

Fortification Potential vehicles: cereals, flour, condiments, infant formula. Issues regarding the appropriate vehicle, type of fortificant, organoleptic properties, bioavailability, efficacy and

efficacy and
effectiveness

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Table 8.1 Different Options for Aims of Iron Supplementation Activities in Terms of Hemoglobin Concentration (Hb)

Aim	Whom to Supplement	Programmatic Implications	How to Evaluate Aim	Advantages	Disadvantages
Reach full Hb potential (prevent and treat)	All	Routine supplementation of all women		All who may benefit receive supplement	Low effectiveness
Prevent low Hb level	Those at risk for low Hb level	Routine or screening	% above low Hb level	Moderate effectiveness	Uncertainty of cut-off levels, difficulties in screening.
Treat low Hb level	Those below low Hb level	Screening low level	% above low Hb level	High effectiveness	Uncertainty of cut-off levels, difficulties in screening.

Adapted from: Ekstrom EC; In: Nutritional anemias (ed Ramakrishnan U). CRC Press 2001

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Difficulties in Iron Supplementation

	Thailand	India	Indonesia	Myanmar	Caribbean
Service Utilization	***	****	**	***	*
Tablet supply	***	***	**	**	**
Within-facility factors	**	**	*	*	*
Individual compliance	*	*	*	*	*

**** major constraint * minor constraint

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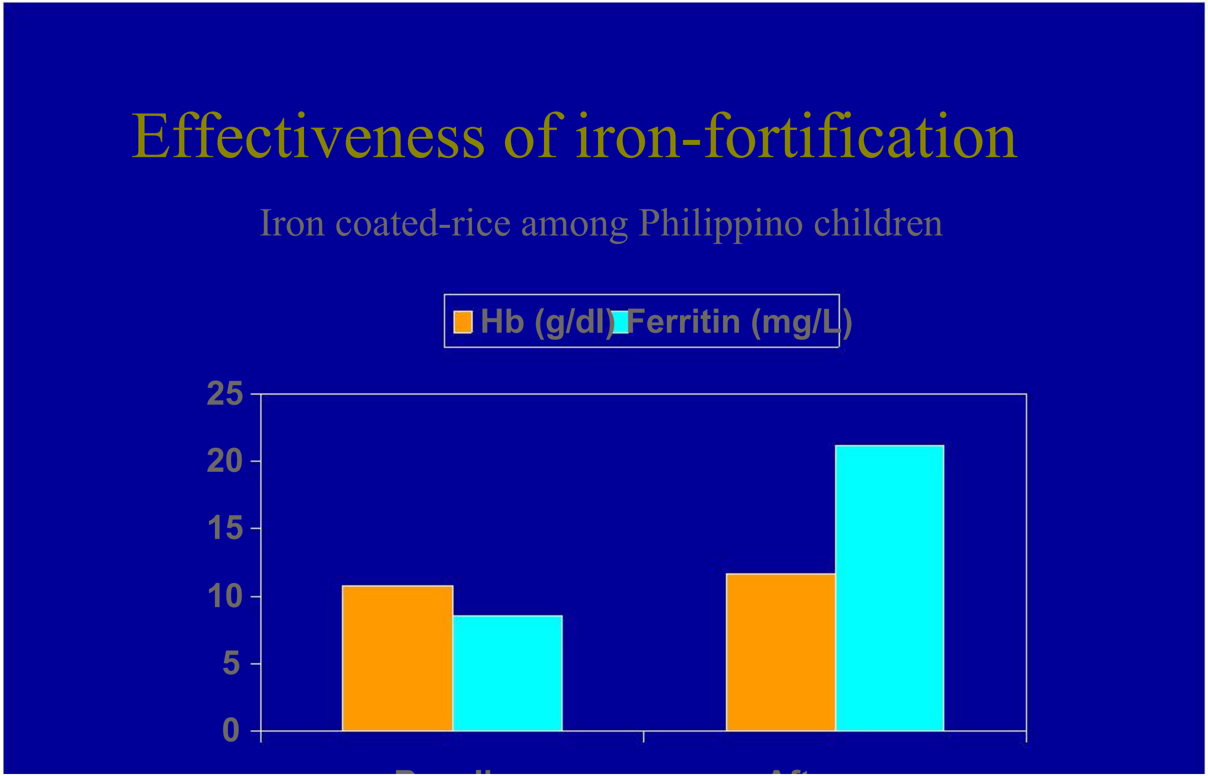
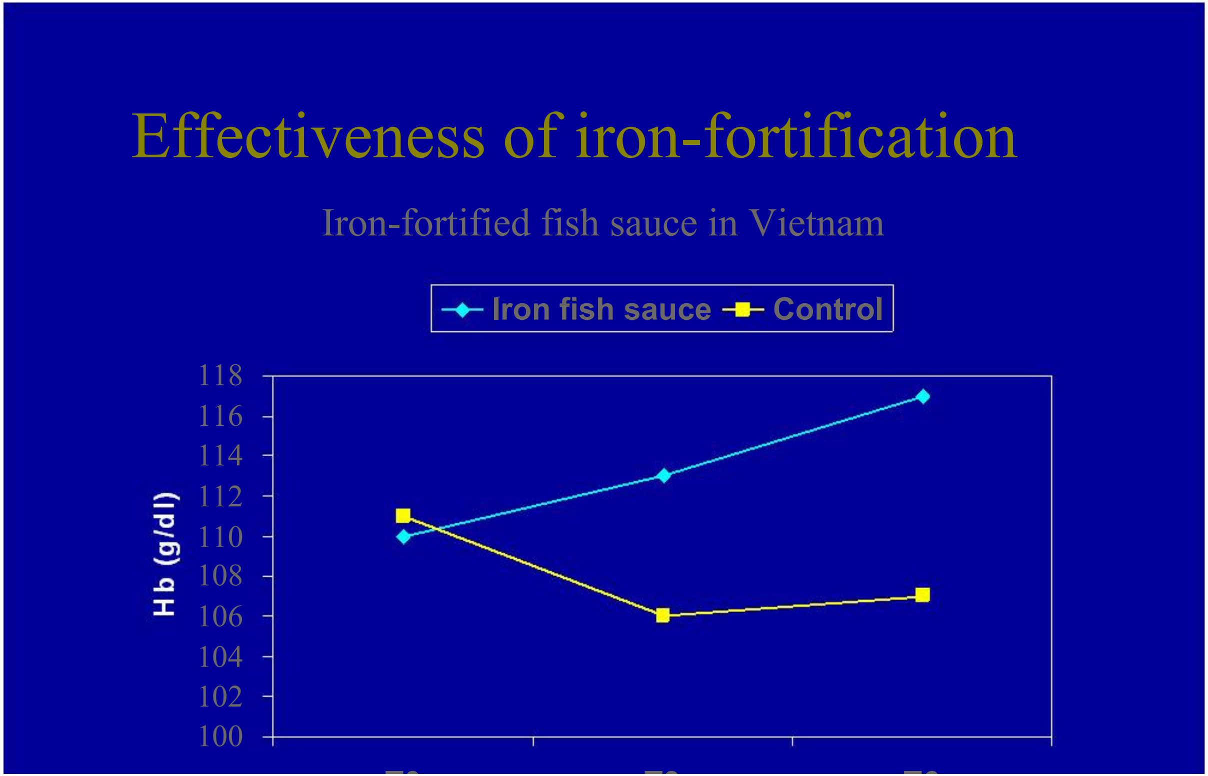


Baseline

After 6 mo

Mannar & Gallego, J Nutr 2002


Effectiveness of iron-fortification
Iron-fortified fish sauce in Vietnam
Iron fish sauce
Control
Hb (g/dl)
118
116
114
112
110
108
106
104
102
100

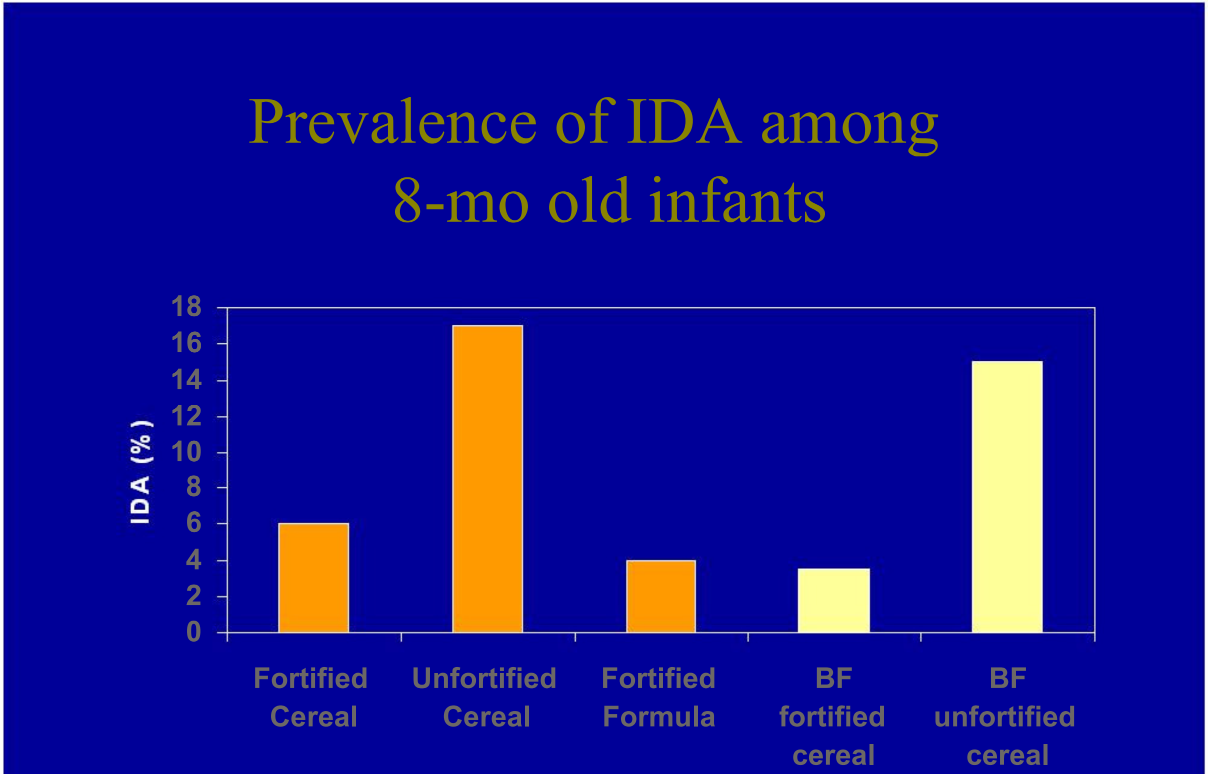
T0 T3 T6

Mannar & Gallego, J Nutr 2002

Special case - Infants

- Infants are born with high iron stores
- Human milk has low iron content but bioavailability is high
- First 2-3 mo of life: exclusively BF infant is in positive iron balance
- During 3-6 mo of life infants are in negative balance
- Foods with bioavailable iron, fortified foods or a low-dose iron supplement should be provided at 6 mo (IOM recommendation)

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw



Walter et al, Pediatrics 1993

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Home-fortification or Sprinkles

- Sprinkles are single-dose sachets containing micronutrients in a powdered form, which are easily sprinkled onto any foods prepared in the household
- Great for adding to complementary foods for young children
- Any homemade food can be fortified with the single-dose sachets, hence the term home fortification.
- Sprinkles Nutritional Anemia Formulation has been

been
tested in
infants

Effective control of anemia through combination of strategies

- Increased iron intake
  - Iron supplementation
  - Fortification of foods with iron (especially weaning foods)
- Control of parasitic infections (diagnosis and treatment, chemoprophylaxis, preventing transmission)
- Increased intake of other vitamins such as vitamin A, folic acid through
  - Supplementation, Fortification

Supplementation, Fortification,
Nutrition Education

Summary

- Causes of iron deficiency and anemia are multifactorial
- The strength of causal evidence that ID or anemia affects functional outcomes is variable
- Control of iron deficiency and anemia may require multiple strategies and is context specific

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

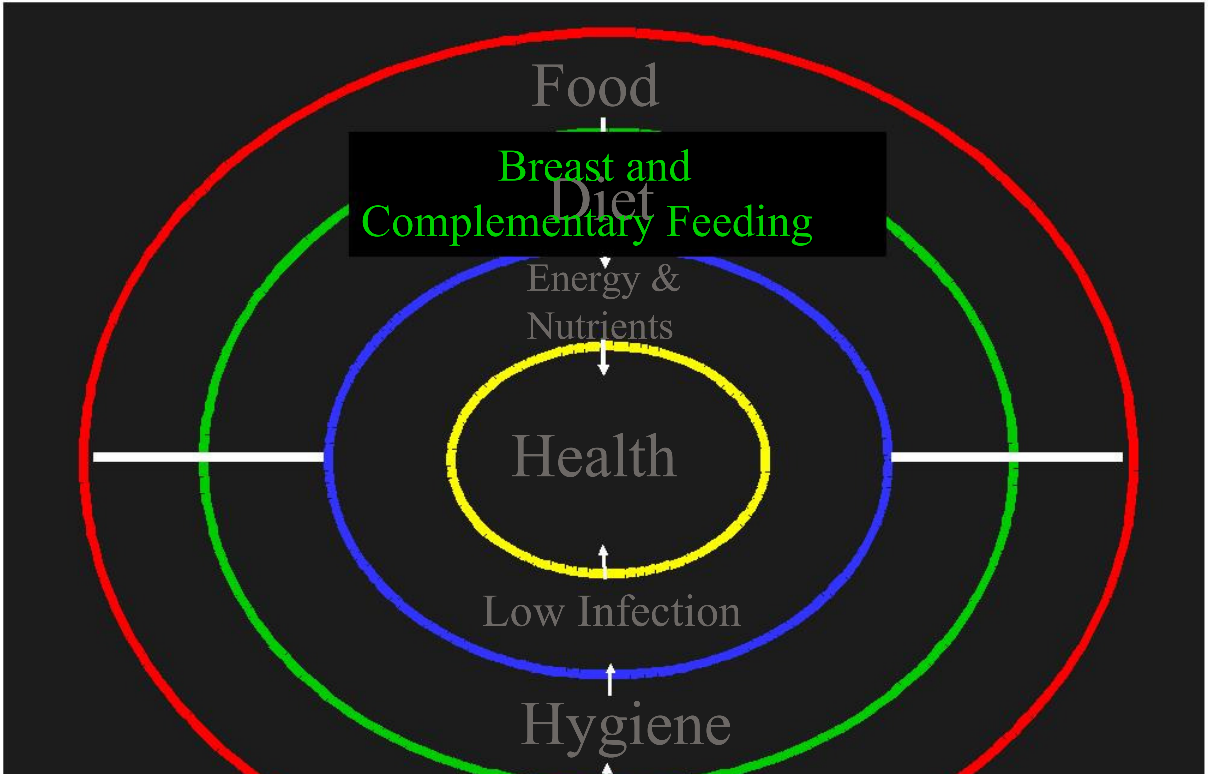
Breast and Complementary Feeding

Household Actions to Keep Children Healthy

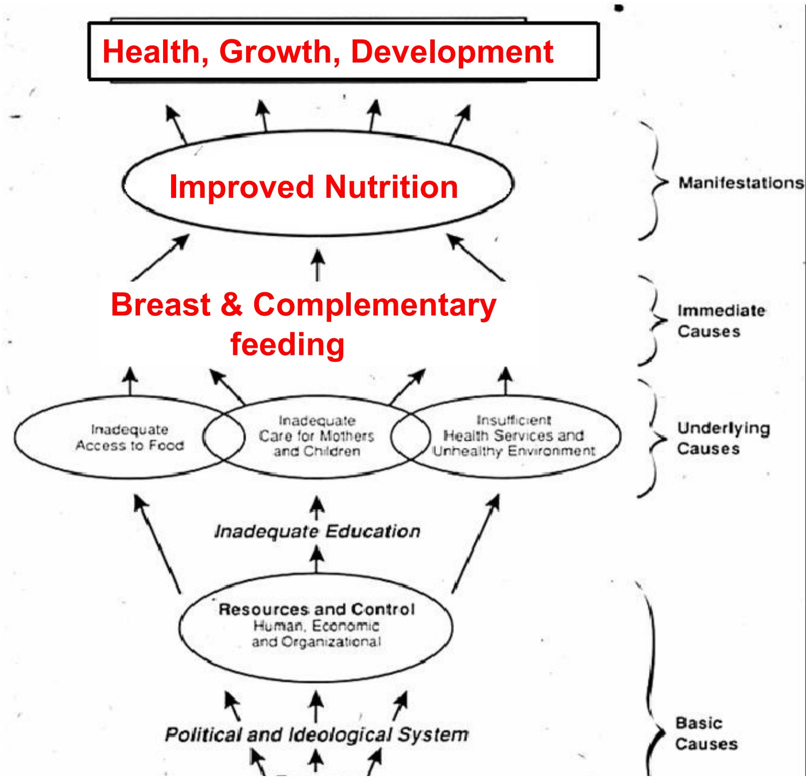
Keith P. West, Jr., Dr.P.H.
Professor

Breast feeding and complementary feeding practices represent the front line of maternal care, nurturing and interaction with infants and young children; adequacy of feeding determines many aspects of child growth, health and development. Breast feeding also can affect maternal health.

Photo: K. West

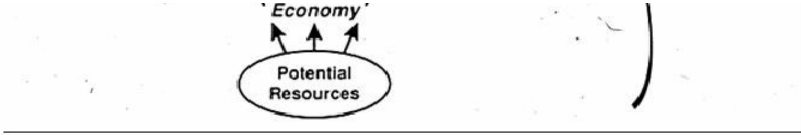

Food
Breast and
Complementary Feeding
Diet
Energy &
Nutrients
Health
Low Infection
Hygiene


Environment



Adapting the UNICEF model of causation;

Mothers, supported by family, play pivotal role in protecting children from undernutrition



Adapted from a UNICEF model.

Breast feeding

Breast milk supplies ideal mix, density and physiologic form of nutrients to promote adequate infant growth & development

Reduces exposure of infant to enteropathogens

Anti-bacterial & anti-viral

Reduces infant infections

Provides biologic & emotional bond between mother & infant

Healthy for mother: reduces risk of

risk of ovarian & breast cancer,

post-partum hemorrhage & anemia, increases birth spacing

WHO/UNICEF Recommendation: Exclusively breast feed for 1st 6 months

EBF can provide adequate
- Energy
- Nutrients
- Fluid
- Protection from infection
- Nutrition for growth

Feeding colostrum: important

Avg intake: 700-800 ml/day

Individual exceptions exist

Photo: K. West

WHO/UNICEF 2001

Selected Nutrient Concentrations (mean SD) in Mature Human Milk

Energy: 740 kcal per liter

Nutrient	Amount
Protein (g/L)	10.5 2.0
Fat (g/L)	39.0 4.0
Minerals	
Calcium (mg/L)	280 26
Copper (mg/L)	0.25 0.03
Iodine (g/L)	110 40
Iron (mg/L)	0.30 0.10

Zinc (mg/L)	1.2 0.2

K Brown, K Dewey & L Allen, 1998

Selected Nutrient Concentrations (mean SD) in Mature Human Milk

Nutrient	Amount
Vitamins	
Folate (g/L)	85 37
Niacin (mg/L)	1.50 0.20
Riboflavin (mg/L)	0.35 .025
Thiamin (mg/L)	0.21 0.03
Vitamin B $_6$ (g/L)	93 8
Vitamin $_{12}$ (g/L)	0.97

Vitamin B	$_{12}$ (g/L)	0.97

K Brown, K Dewey & L Allen, 1998

Selected Nutrient Concentrations (mean SD) in Mature Human Milk

Nutrient	Amount
Vitamins	
Vitamin C (mg/L)	40 10
Vitamin A (g RE/L)	500
Vitamin D (g/L)	0.55 0.10
Vitamin E (mg/L)	2.3 1.0
Vitamin	2.1

K (g/L)	0.1 K Brown, K Dewey & L Allen 1998

Definitions: Breast Feeding

Exclusive (or Full) Breast feeding (EBF): all fluid, energy and nutrients are from breast milk (except small amounts of medicinal supplements); minimal pathogen exposure

Almost EBF: refers to use of water or other non-nutritive liquids plus EBF

Partial BF: mixed feeding with breast milk plus non-human milk, some solids, other fluids as sources of energy and nutrients

E Piwoz et al, 1996

Definitions: Complementary Feeding

Period of complementary Feeding (CFg): when other foods or liquids are given along with breast milk (previously weaning period)

Complementary Foods (CFs): food or liquids other than breast milk given to young children during the period of complementary feeding

Transitional Foods (TF): nutrient dense CFs designed meet nutritional needs of child

Weaning: complete

feeding

cessation of

any breast

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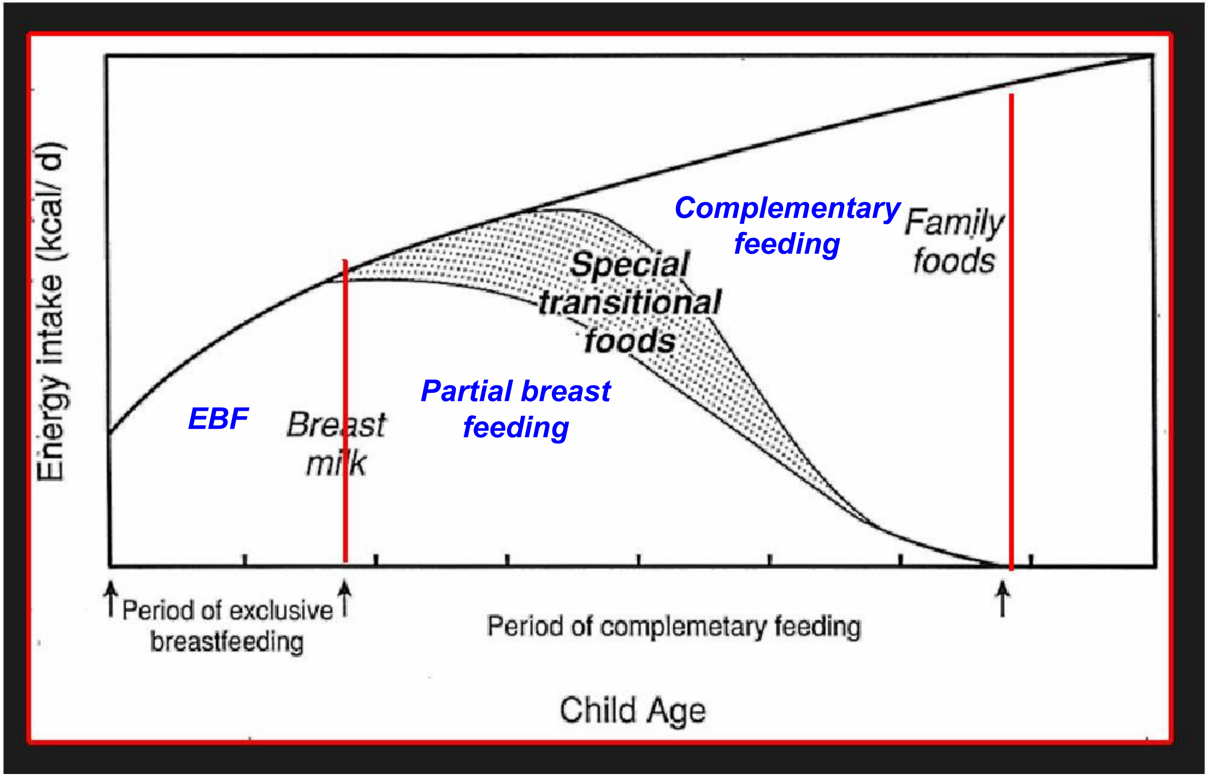
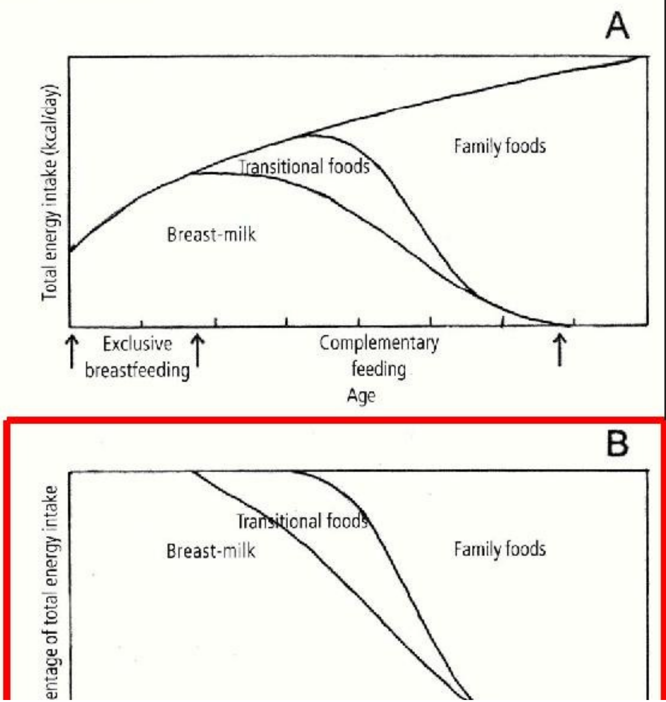


Adapted from: KH Brown, K Dewey & L Allen. Complementary
Feeding of
Young Children in Developing Countries. Geneva:WHO, 1998.
Redrawn in KP West Jr, 2000

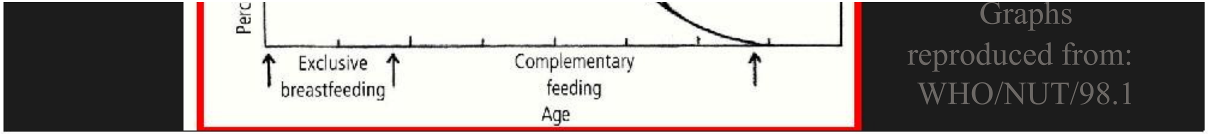
home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Total
Energy
Intake

Fig. 1. Contribution of different food sources to young children's energy intake in relation to age

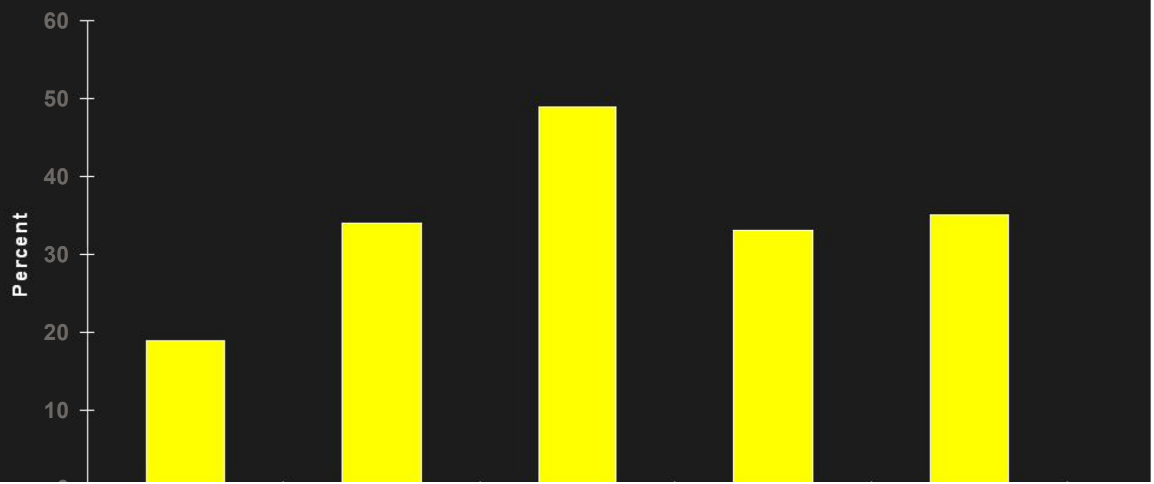


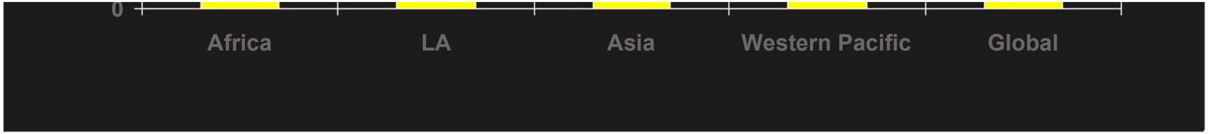
Percent
Total
Energy
Intake


Perc
Exclusive
breastfeeding
Complementary
feeding
Age
Graphs
reproduced from:
WHO/NUT/98.1

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

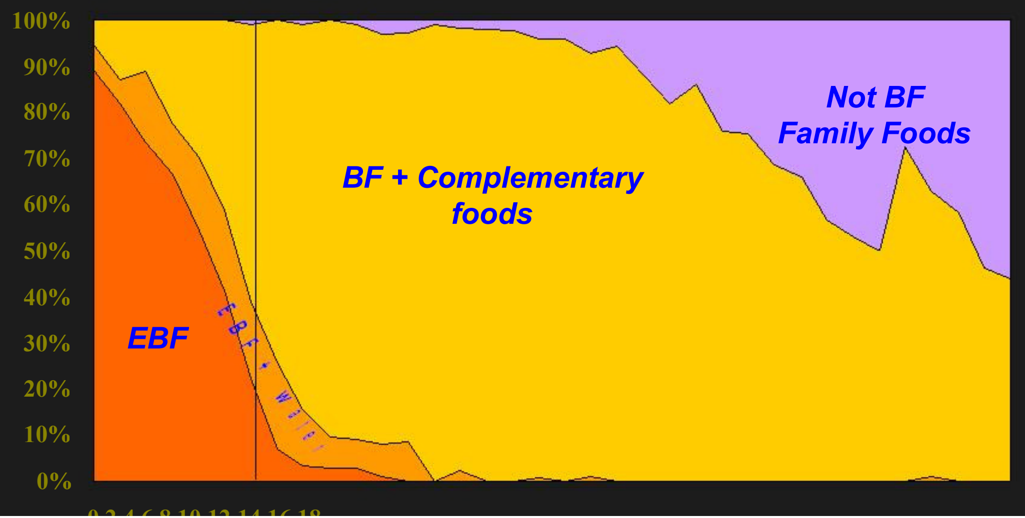
Exclusive Breastfeeding (EBF) <4 mo WHO, 1996: 20 to 50%

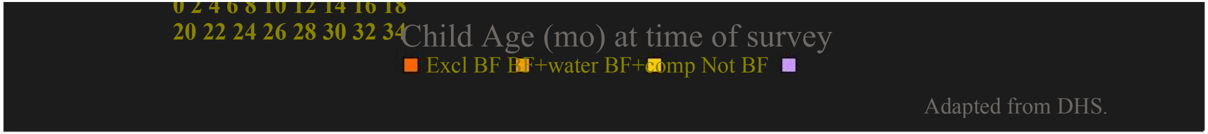



0
Africa
LA
Asia
Western Pacific
Global

Breastfeeding Status of Nepalese Children

Ages 0-35 months, 2001 DHS in Nepal

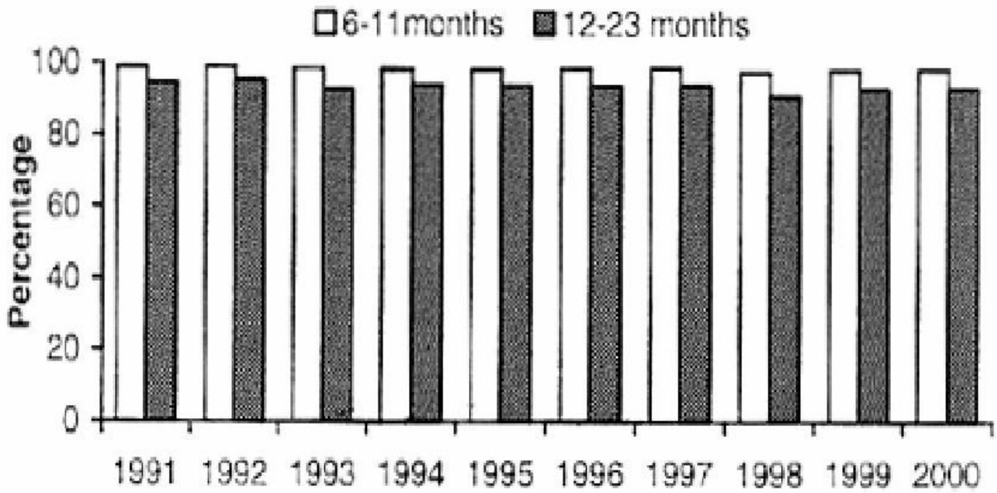



0 2 4 6 8 10 12 14 16 18
20 22 24 26 28 30 32 34
Child Age (mo) at time of survey
Excl BF BF+water BF+comp Not BF
Adapted from DHS.

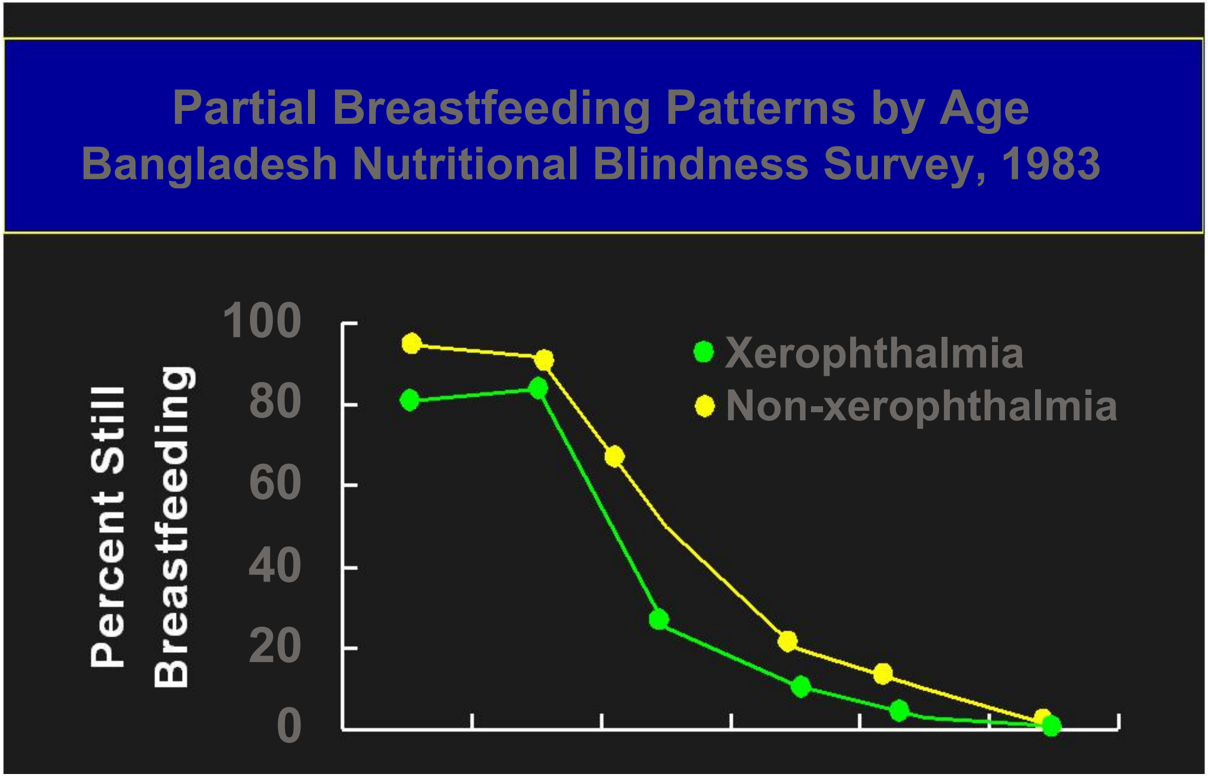
Breast feeding and complementary feeding: 0 to 4 mo

In most developing countries, most breast fed infants also receive liquids and other foods in addition to breast milk.

Percentage of Bangladeshi children 6 to 11 and 12 to 23 months of age reported to be breast fed, 1991-2000 (n=170,967): >90%



Helen Keller Worldwide, Bangladesh Nutrition Surveillance Project


Partial Breastfeeding Patterns by Age
Bangladesh Nutritional Blindness Survey, 1983
Percent Still Breastfeeding
100
80
60
40
20
0
Xerophthalmia
Non-xerophthalmia

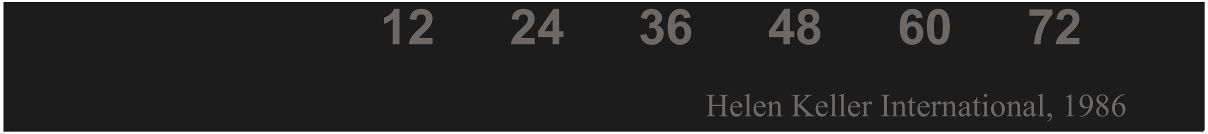

12 24 36 48 60 72
Helen Keller International, 1986

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Photo: K. West

Age of Introduction of Complementary Foods: Effects on Intake and Growth in Honduras

Infants of low-income, primaparous mothers EBF to 4 mo post partum

Randomized from 4 to 6 mo to

(1) EBF (n=50)

(2) CF plus ad lib BF (n=47)

(3) CF plus maintained BF frequency (n=44)

(n=44)

R Cohen et al Lancet 1994;343:288-93

Other Changes in Feeding Variables from 4 to 6 Months of Age in Honduran Infants by Randomized Group

R Cohen et al Lancet 1994;343:288-93

Group	BF Frequency (x per day)	BF Duration (min/day)	Energy (kJ/day)
EBF	-0.2	-28	
CF+AL BF	-2.4	-60	+210
CF+M BF	-0.5	-30	+260

Complementary feeding without counseling about breast feeding (ad lib) decreased BF frequency and duration. Increased energy intakes did not translate into improved infant growth.

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WHO Global Infant Feeding Recommendations, 2002

Start BF early (<1hr after birth)

Exclusive breast feeding for 6 months

Start complementary feeding at 6 months with continued breast feeding to =2 yrs

Provide appropriate complementary feeding:

- Timely
- Adequate
- Safe

Properly fed

WHO, Report of Global Consultation, 2002

Complementary Feeding

Timely : CFs introduced when need for energy and nutrients exceeds that provided by BF

Adequate : CFs should provide sufficient energy, protein, and micronutrients

Safe: CFs that they are hygienically stored and prepared and fed

Properly fed: CFs given in line with childs signals for appetite and satiety and that meal frequency and feeding method (active) are suitable for age

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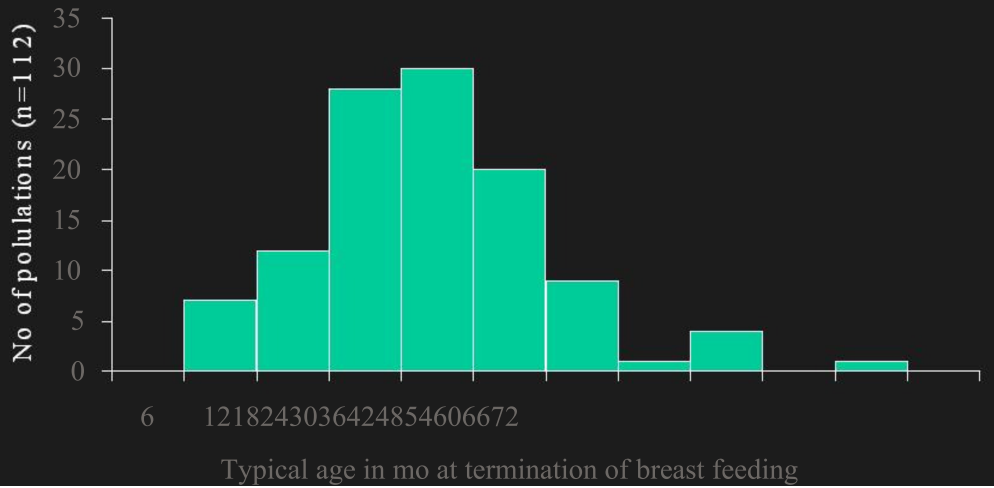
Distribution of Reported Ages at Weaning in Non-industrialized Societies



Sellen DW, J Nutr 2001

Complementary Foods Vary in Quality

rice

fish+vegetable+oil


Photos: R. Klem

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Social Concerns about Complementary Feeding

- Feeding mode is rooted in poverty
- Food insecurity (limits access)
- Maternal responsibility (vs other HH members)
- Food taboos and social norms govern types and timing of CF introduction
- No CFg advocacy, few CFg programs
- Part of larger

Part of larger
development problem

Piwoz et al FNB 2003

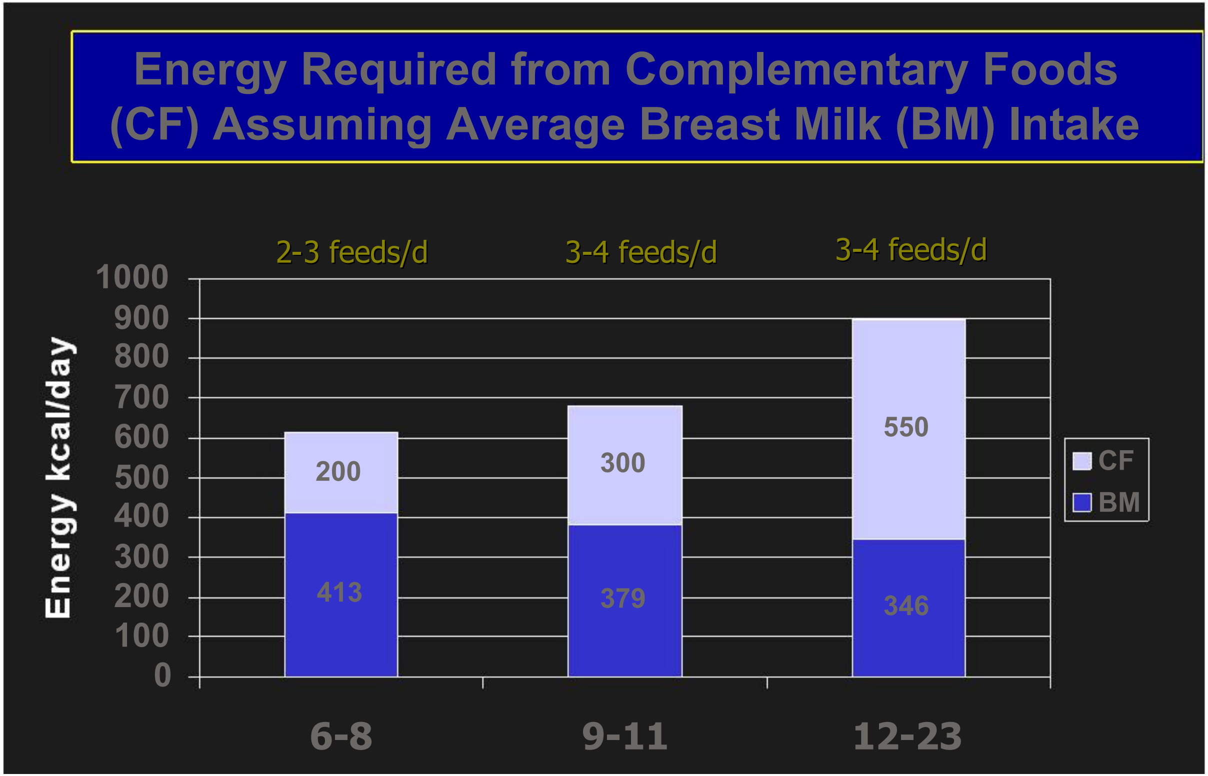
Nutritional Concerns about Complementary Feeding

- Density and total intake of energy
- Quality vs quantity
- Hygienic delivery
- Appropriate age at introduction
- Impact of CF intake on breast milk

intake

Piwoz et al FNB 2003

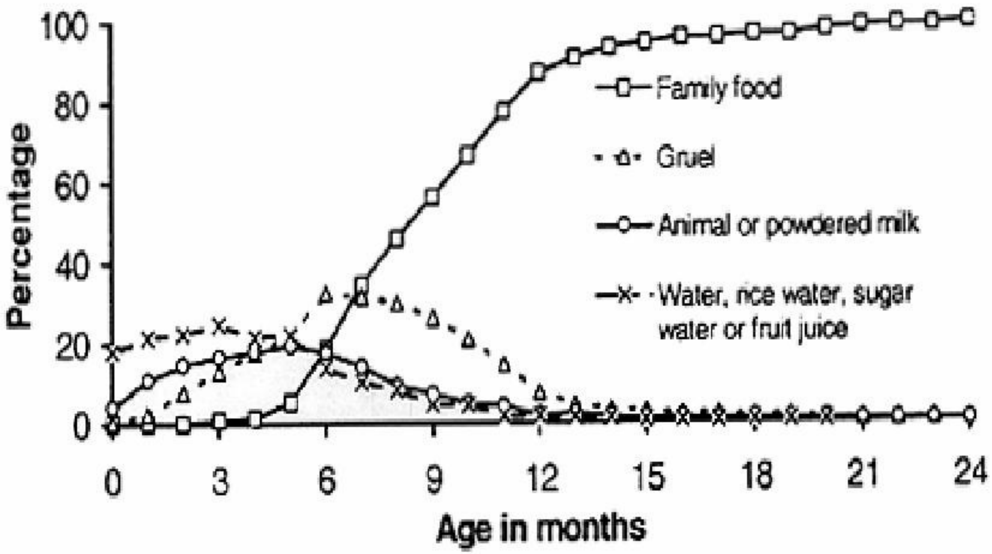
home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw




Age, months
Brown KH et al, FNB, 2002

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Main types of food given to infants and young children < 24 months of age in rural Bangladesh (n=26,557)



Helen Keller Worldwide, Bangladesh Nutrition Surveillance Project

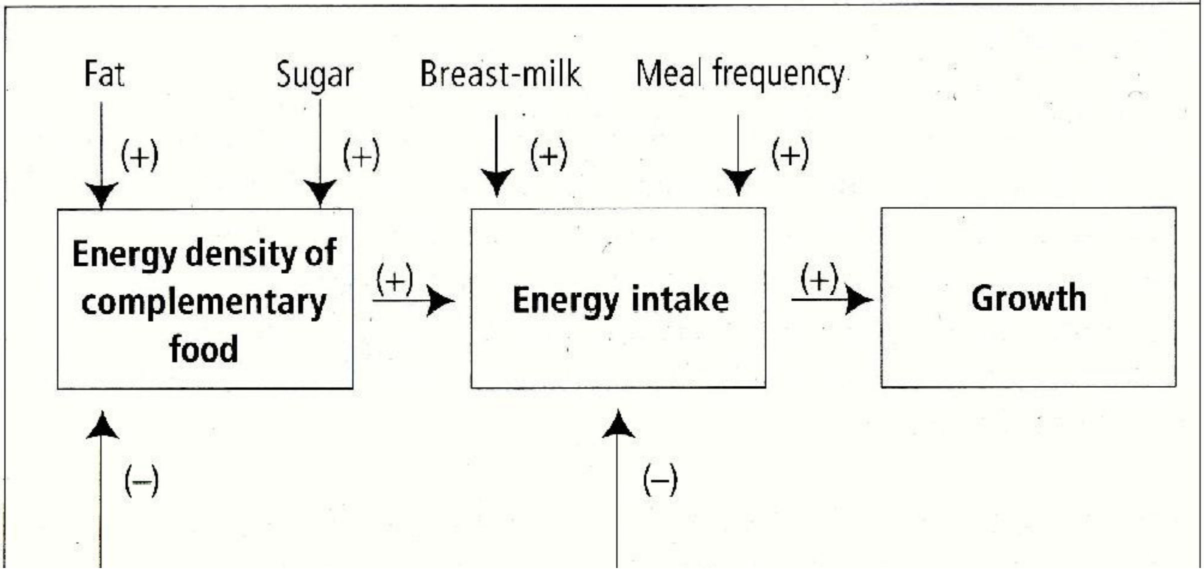
Correlation of Food Intake Patterns in Nepalese Children by Type of Food Usually Eaten in 1st 2 Years

	r with Sib Diet
Meat w/liver	0.38
Egg	0.53
Fish w/liver	0.39
Mango	0.54

Gittelsohn et al Eur J Clin Nutr 1997;51:484

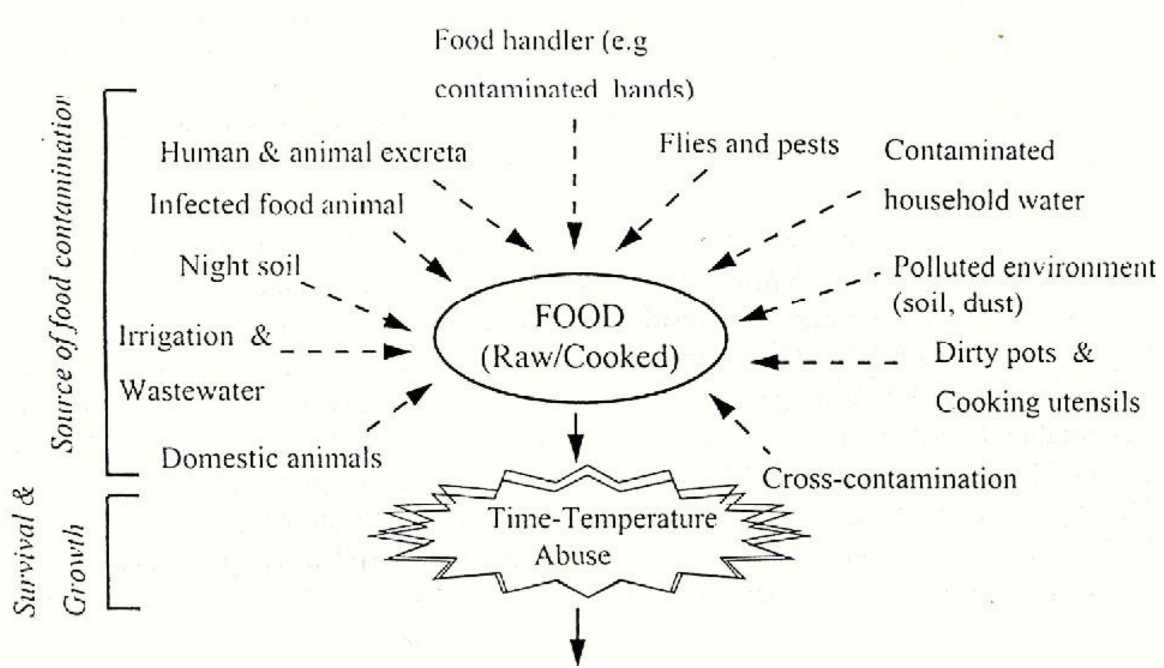
Fig. 13. Factors affecting the energy density of complementary foods and energy intake by the infant and young child.

The direction of influence is indicated as positive (+) or negative (–).



WHO/NUT/98.1

Figure 7. Sources of food contamination



Contaminated Food

WHO/NUT/98.1

Guiding principles for complementary feeding of the breast fed child

Dewey K, Lutter C. PAHO, Division of Health Promotion And Protection, Food and Nutrition Program, Washington DC, 2003;

http:/www.paho.org

1. Practice EBF from birth to 6 mo; introduce CF at 6 mo while continuing to breast feed

May, 2001, 54 th WHA global recommendation to BF exclusively up to 6 mo of age

Protects against gastrointestinal infections

Possible enhanced motor development

Prolongs lactational amenorrhea & accelerates maternal weight loss

No adverse effects of EBF on *population basis*

Nutritional needs met for most infants:

If not gaining weight or appears hungry, give CFs

2. Continue frequent, on-demand breast feeding until 2 years of age (or beyond)

Breast milk continues as vital source of energy (30-40%, on avg) and nutrients into 2nd yr of life

Key source of

- protein & essential fatty acids
- micronutrients:
  - 70% of vitamin A
  - 40% of calcium & riboflavin
- fluid and nutrients during infection

Associated with greater linear growth

Linked to lower risk of chronic diseases
& obesity

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

3. Practice responsive feeding

- Feed infants directly & assist older toddlers eat; be sensitive to hunger & satiety cues
- Feed patiently; encourage, but dont force
- If child refuses, experiment with different food combinations, tastes, textures
- Minimize distractions during meals
- Talk to child during feeding; maintain eye contact

Key: what, but also how, when, where

& by whom child is fed

4. Practice good hygiene & proper food handling

- Washing caregivers and childs hands before preparing, handling and eating food
- Store foods safely; serve shortly after prepared
- Use clean utensils to prepare & serve food
- Use clean bowls & cups when feeding child
- Avoid feeding bottles which are hard to clean

Note: Diarrhea and growth faltering peak in 2nd half of infancy, directly related

half of infancy, directly related
to CFg

5. Start at 6 mo with small amounts of food; increase quantity with age, maintaining frequent breast feeding

- Energy needs from CFs should complement energy intake from breast milk
  - Nutritional principle: adjust CF intake to meet energy requirements by age not obtained from breast milk
- If infant breast feeds more or less than average, adjust CF intake accordingly

In practice: this is achieved through responsive feeding

feeding

6. Increase food consistency & variety with age, adapting as you go

Can feed pureed, mashed & semi-solids @ 6 mo; lumpy foods before 10 mo

Can feed finger foods by 8 mo

By 12 mo, family foods can be eaten, keeping in mind need for nutrient-dense (transitional) foods

Avoid foods that can cause choking (eg, nuts, carrots, grapes, etc)

Key: Poor choices in CFs can depress intake

7. Increase meal frequency with age

On average, provide CFs

- 2-3 x per day by 6-8 mo
- 3-4 x per day by 9-11 mo, and
- by 12-24 mo add 1-2 snacks (soft fruit, bread w/ nut paste)

Nutritional principles:

- Number of feeds based on estimated gastric capacity of 30 g of food per kg per day & minimum CF energy density of 0.8 kcal per gram
- When amount eaten per feed or energy density are lower, increase meal frequency

Key: Be mindful not to displace breast feeds

The "Weanling's Dilemma"

Delayed introduction of complementary foods may lead to insufficient energy and nutrient intakes and poor growth

BUT

Premature introduction of CF can increase pathogen exposure, risk of infection and

mortality

Rowland et al Lancet 1978;i:136-8


Photo: K. West

8. Ensure nutrient density* and content of CFs are met through dietary variety

Meat/fish/poultry/eggs daily or often

Provide non-human milk in cooked gruels

Vegetarian diets generally can not meet nutrient needs at this age without supplements or fortification

Feed carotene-rich fruits and vegetables

Avoid giving drinks of low nutrient value (eg, tea, coffee, sugar-beverages)

Limit amount of juice to avoid displacing

more
nutritious foods

*Nutrient content/100 calories

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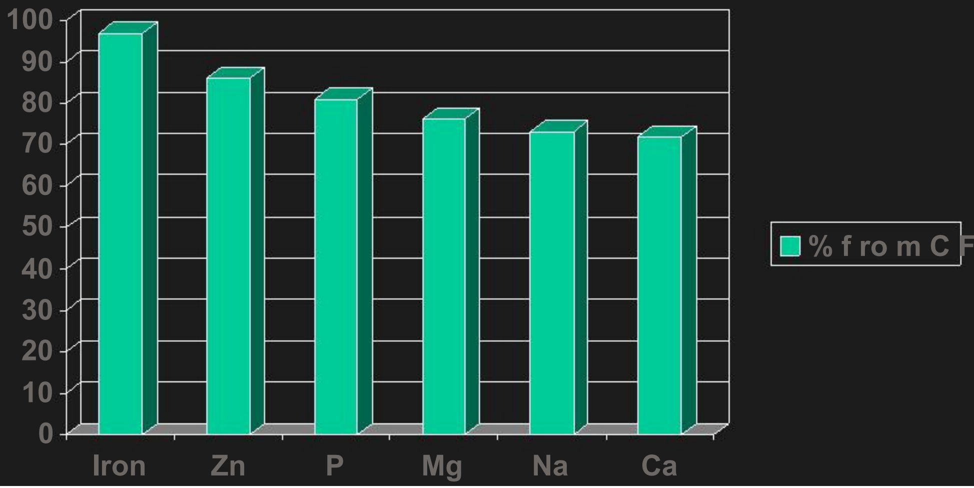
Percent of Recommended Nutrient Intake Required from CFs by 9-11 Mo of Age

(not provided by breast milk)



K Dewey Ped Clin N Amer 2001;48:87

9. Use fortified CF or micronutrient supplements for infants or mothers, as needed

- Animal source foods help keep nutrient density high, but are costly
- Difficult to achieve adequate iron, zinc or calcium density in usual CF mixtures
- Mothers in some undernourished populations may require added micronutrients, from supplements or fortified foods
- Sprinkles home-based fortification of CFs may be a future

partial solution

10. Feed a child more fluid & food during illness including breast milk & soft, varied, appetizing, favorite foods

After illness:

- give food more often than usual
- encourage child to eat more

Meet increased fluid requirement

Sick children prefer breast milk

Encourage food intake despite poor appetite

Catch-up growth after illness depends on extra food intake

International Code of Marketing of Breast Milk Substitutes (1)

- Resolution (34.22) passed by the 34th WHA on May 21, 1981
- Governments shall inform citizens of
  - Benefits of breast feeding (BF)
  - Importance of maternal preparation for BF
  - Negative effects of bottle-feeding
  - Health hazards of unnecessary or improper use of infant formula or breast milk

substitutes

International Code of Marketing of Breast Milk Substitutes (2)

Governments shall

- Restrict advertising, use of visual materials that promote use of BM substitutes
- Restrict direct & indirect access of manufacturers & distributors to pregnant women & families
- Prohibit free sample & gift distributions
- Review & approve educational materials on breast feeding and BM substitute use
- Assure no health facility promotes formula
- Comply with rigid code of conduct in approval &

use of BM substitutes,
when indicated

Baby Friendly Hospital Initiative As of 2002

16,000 hospitals certified

33 certified in USA: Barrier

Must comply with the Breast Milk Substitute Marketing Code

Innocenti Declaration on the Protection, Promotion & Support of Breast Feeding (1990)

- Appoint national breast feeding authority
- Assure each maternal service facility fully practices *Ten Steps to Successful Breast Feeding* (WHO/UNICEF)
- Give effect to principles and aim of all Articles of the Intl Code of Marketing Breast Milk Substitutes and later WHA resolutions
- Enact legislation to protect and enforce

breast
feeding
rights

Ten Steps to Successful Breast Feeding

1. Written, routinelly communicated breast feeding (BF) policy
2. Train all health care staff to implement policy
3. Inform all pregnant women about benefits and management of BF
4. Help mothers initiate BF w/in 1/2 hr of birth
5. Show mothers how to initiate and

maintain
BF

Piwoz et al, 2003

Ten Steps to Successful Breast Feeding

6. Give newborns no food or drink other than BM
7. Practice rooming-in 24 hrs a day
8. Encourage BF on demand
9. Give no artificial teats or pacifiers to BF infants
10. Foster BF support groups/ refer mothers to them on

discharge from hospital or clinic	Piwoz et al, 2003

WHO/UNAIDS/UNICEF Feeding Options for Infants of HIV-Infected Mothers

Exclusive breast feeding by mother for 1st 6 months of life, continuing to > 2 yrs

EBF with early cessation & rapid weaning to replacement milk

Breast milk expression with heat treatment, fed via cup

Wet nursing by an HIV

Wet-nursing by an HIV-
mother

Papathakis & Rolins, 2004

WHO/UNAIDS/UNICEF
Replacement Milks for Infants of HIV-Infected Mothers

- Commercial infant formula
- Fresh full cream milk, boiled, with added water, sugar and micronutrients
- Evaporated or powdered full cream milk with added water, sugar & micronutrients

Papathakis & Rolins, 2004

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

International Nutrition

Nutrition Surveillance and Program Monitoring

Philip Harvey MPH, PhD

MOST ***The USAID Micronutrient Program***

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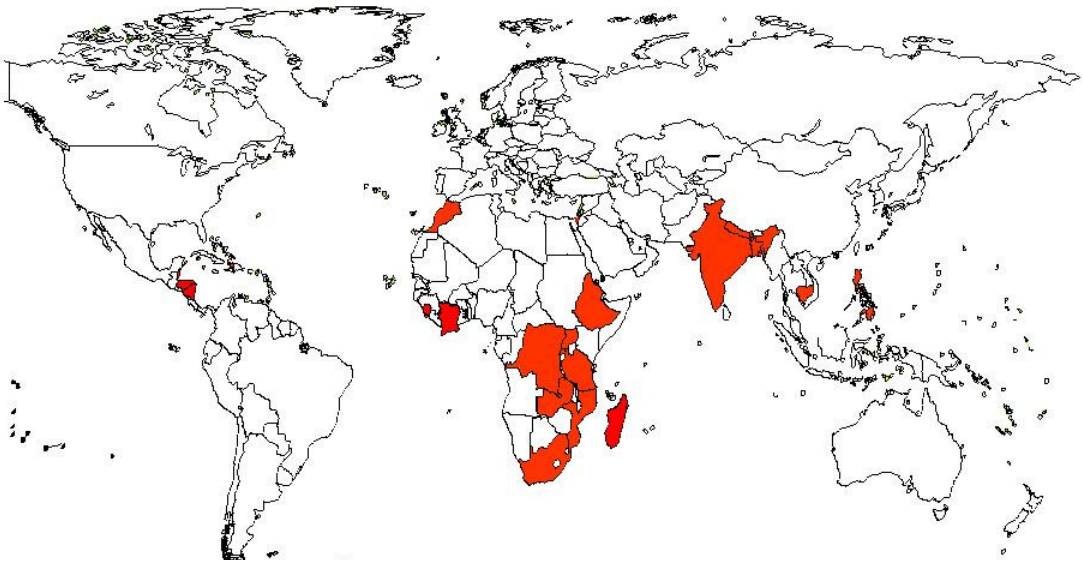
Countries in which MOST works or has worked



Countries in which MOST works

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Definitions

Surveillance: from French surveiller, to watch over with great attention

- term from infectious disease epidemiology
- adopted for nutrition at 1974 World Food Conference

Survey: collection of info at one point in time

Assessment: appraisal of available info

Evaluation: process of reaching a judgment

Monitoring: continuous observation, here describes activity more specific than surveillance

Nutrition Surveillance

Based upon regular collection of data about nutritional conditions & factors influencing them

Provide basis for decisions re: immediate action, policy, planning, management of programs

Surveillance & service cannot be separated

data MUST by collected and analyzed in a way that is useful for decision making

Concerned with data on populations, not

individuals

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Information and Indicators

Levels of information (classification from WHO 1976)

A: Ecology -- meteorology, land, water, vegetation

Demography

Infrastructure - transport, communications, services

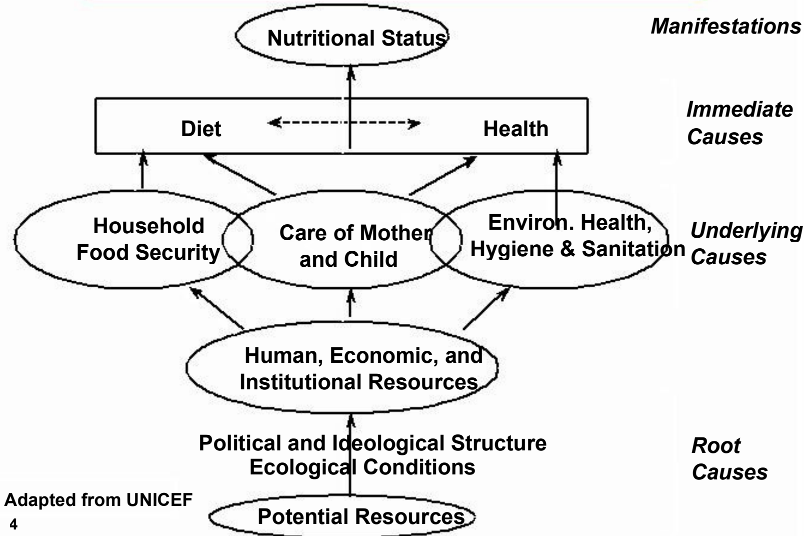
B: Resources & production -- ag. productn, livestock, food imports/exports/stocks, fuel

C: Income & consumption -- market data, income, food consumption

D: Health status -- nutritional status, disease patterns

Intervening effectively to improve nutrition requires understanding the causes of malnutrition (UNICEF Framework)

UNICEFs Conceptual Framework of Malnutrition



Cut-off points and trigger levels

Cut-off point -- a value that marks the boundary of acceptability (e.g. < -2SD W/A)

Trigger level -- percent of observations below a cut-off point required to initiate action (e.g. % children < 5 y with W/A < -2SD greater than 10%)

Need to use the most sensitive indicators (in terms of triggering action) that are feasible

Applications & system types

Surveillance used for

1. Early warning & intervention
2. Planning & advocacy
3. Program monitoring
4. Evaluation

Surveillance activities include

Nutrition surveillance systems

Special surveys (DHS, NNS)

Routinely reported data (HMIS, program M&E)

Sentinel

Sites

MOST *The USAID Micronutrient Program*

Application 1: Early warning & intervention

FEWS Net -- Famine Early Warning System Network, information system to identify problems in the food systems in 17 sub-Saharan countries <http://www.fews.net>

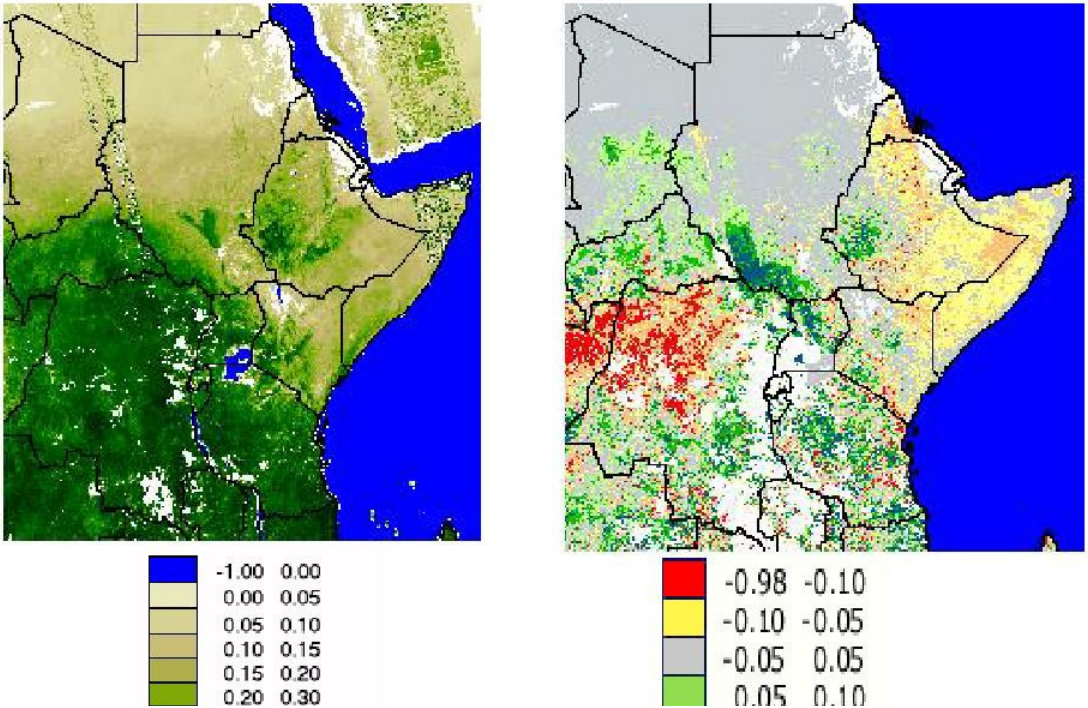
Data sources: USGS/EROS Data Center satellite data monitor agricultural conditions

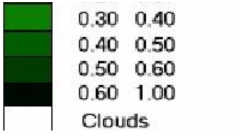
Normalized Difference Vegetation Index (NDVI)

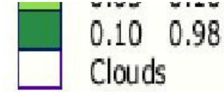
Water Requirements Satisfaction Index (WRSI)

Monthly bulletin distributed to decision makers

NDVI (Normalized Difference Vegetation Index)







Maps courtesy of FEWS NET, http://www.fews.net.

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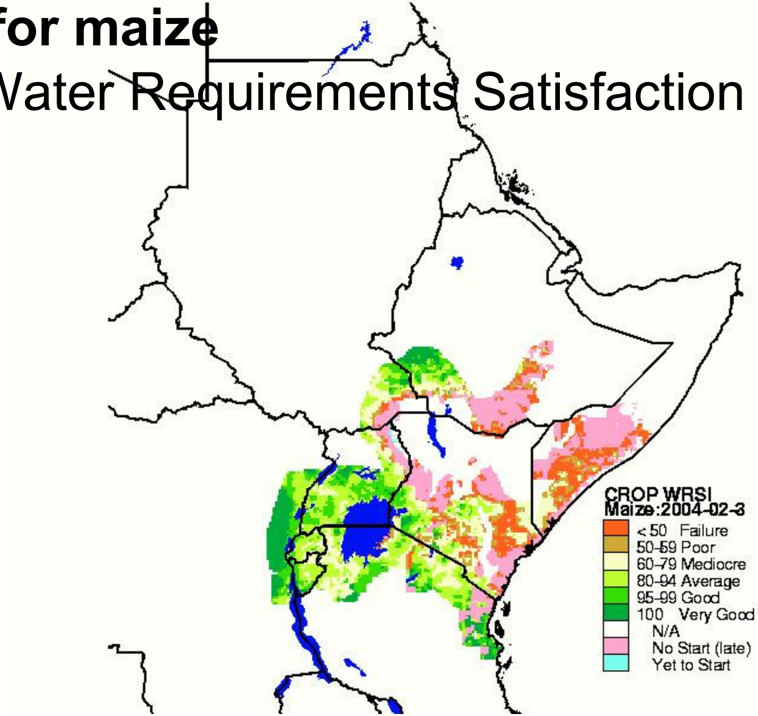
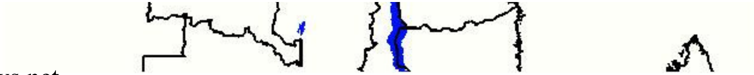
WRSI for maize

(Water Requirements Satisfaction Index)



Map courtesy of FEWS NET, http://www.fews.net.



Application 2: Planning & advocacy

Demographic and Health Surveys (DHS)

Multiple Indicator Cluster Survey (MICS)

National Nutrition Surveys (Philippines, Central American countries)

WHO/FAO Projections

DHS History (Source: Mukuria A, ORC/Macro)

1972 - 1984	World Fertility Survey (WFS)
1976 - 1984	Contraceptive Prevalence Surveys (CPS)
1984 - 1998	Demographic and Health Surveys (DHS)
1998 - Present	Demographic and Health Surveys

(MEASURE
DHS+)

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Measure/ *DHS*+ Nutrition Data

Household

- Iodized salt testing

Individual Mothers (given birth in past 6 y)

- Heights/Weights
- Anemia Testing
- Iron supplementation
- Night blindness
- Vitamin A supplementation

Individual Child (less than 6 y)

- Heights/Weights
- 24 hr. dietary recall (expanded)
- 7 day food frequency
- Frequency of solids or semi-solids in past 24 hrs.
- Vitamin A supplementation
- Hemoglobin (anemia) testing

Presentation of DHS data

The Seminar

The reports and the data

The Chartbooks -- telling a story with pictures

Immediate Influences
- Diarrhea and Cough with rapid breathing

Biological and Behavioral Influences
- Undernutrition of children (6-23 months) by measles vaccination status

Underlying social and economic influences:
- Mothers education
- Source of drinking water
- Type of toilet

Basic influences:
- Bv

region
urban-rural residence

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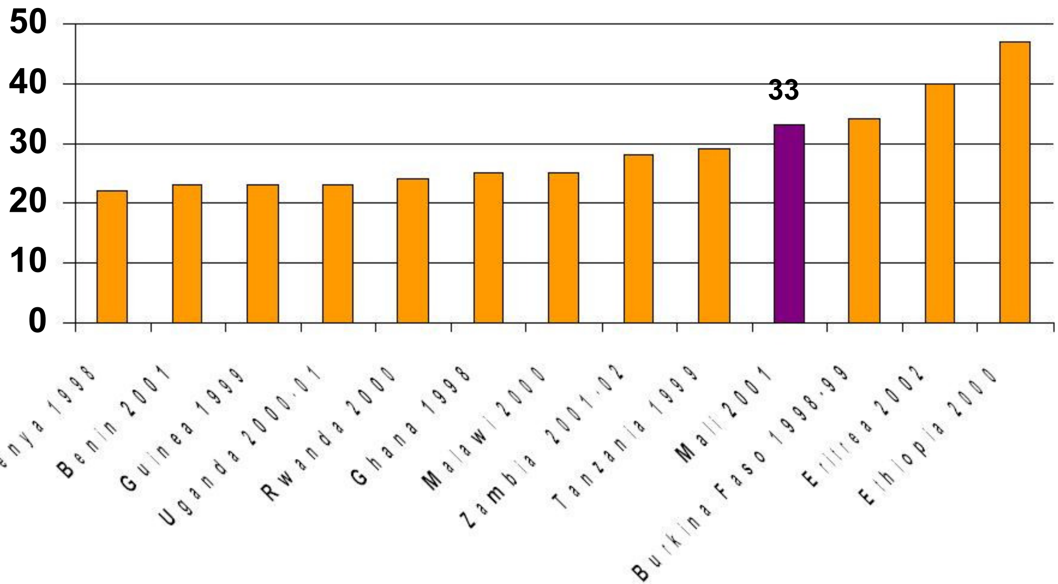
Prevalence of underweight in children under 5 years, Sub-Saharan Africa



(Source:
DHS/Measure+,
ORC/Macro)

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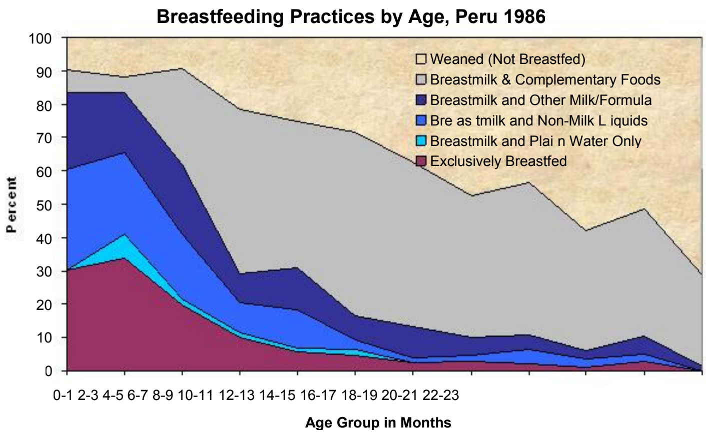

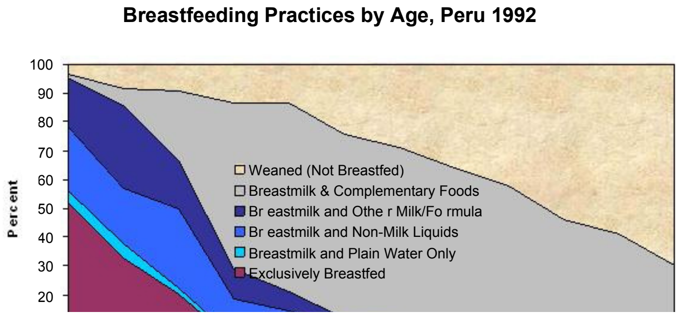

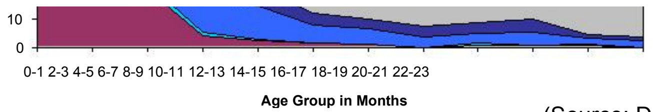

(Source: DHS/Measure+, ORC/Macro)

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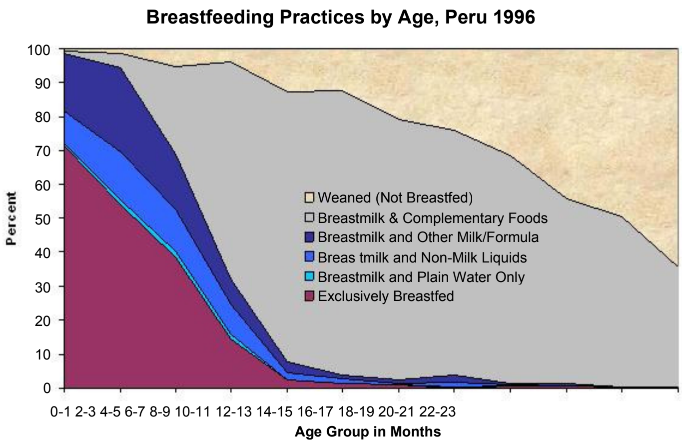

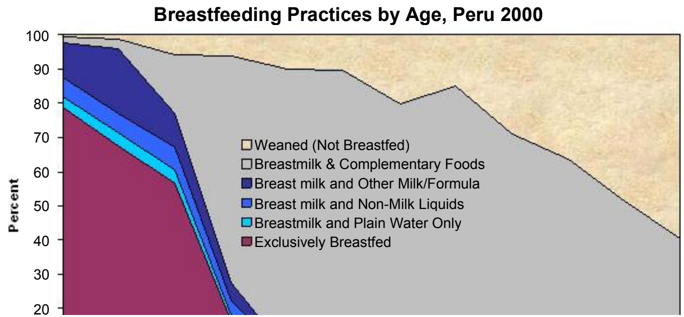

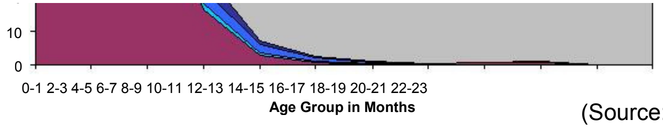

(Source: DHS/Measure+, ORC/Macro)

DHS contd:
24-h recall vs 7-d food frequency

7-day Food Frequency

How many days during the last 7 days including yesterday did (name) drink (eat) each of the following:

24-Hour Recall

In total, how many times during the last day or at night did (name) eat (drink) each of the following foods either separately or combined with other food.

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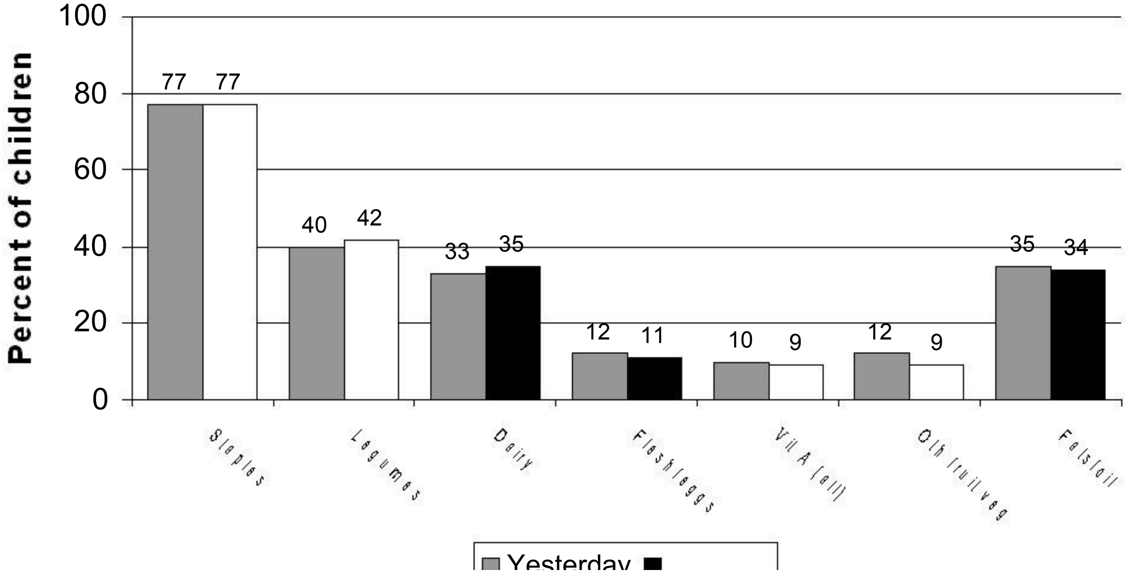
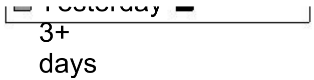
Ethiopia 2000: Comparing yesterday (Y/N) to 3 or more days in the last seven days





(Source: DHS/Measure+, ORC/Macro)

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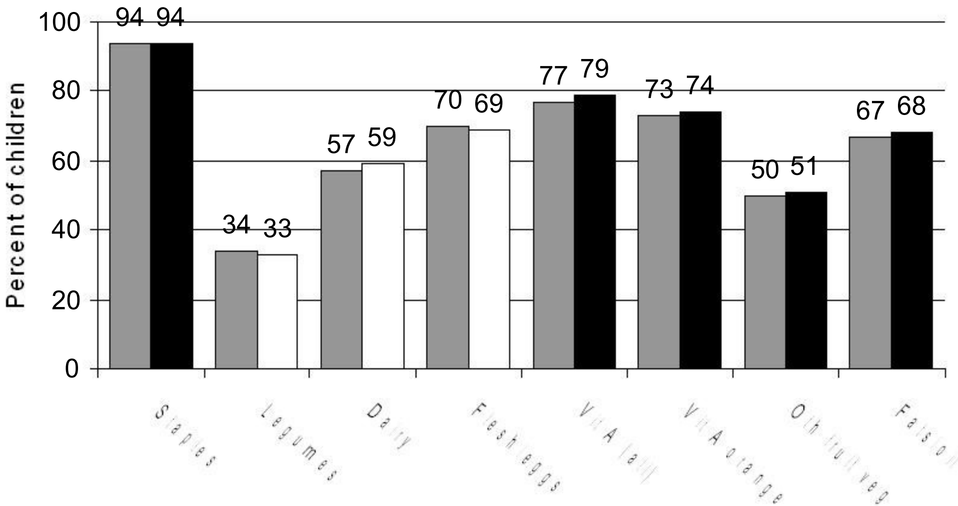
Peru 1996: Comparing yesterday (Y/N) to 3 or more days in the last seven days



Yesterday 3+ days

(Source: DHS/Measure+, ORC/Macro)

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UNICEFs Indicator Cluster Surveys

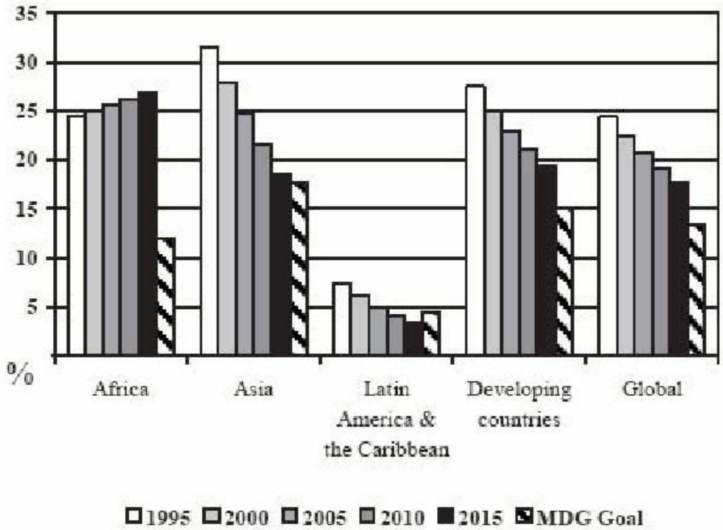
UNICEFs major tool for monitoring progress to goals (2 surveys to date MICS1, MICS2)

MICS2 used for end-of-decade assessment of World Summit for Children Goals, provided data on 63 of 75 indicators. web site has indicators, questionnaires, manuals etc.

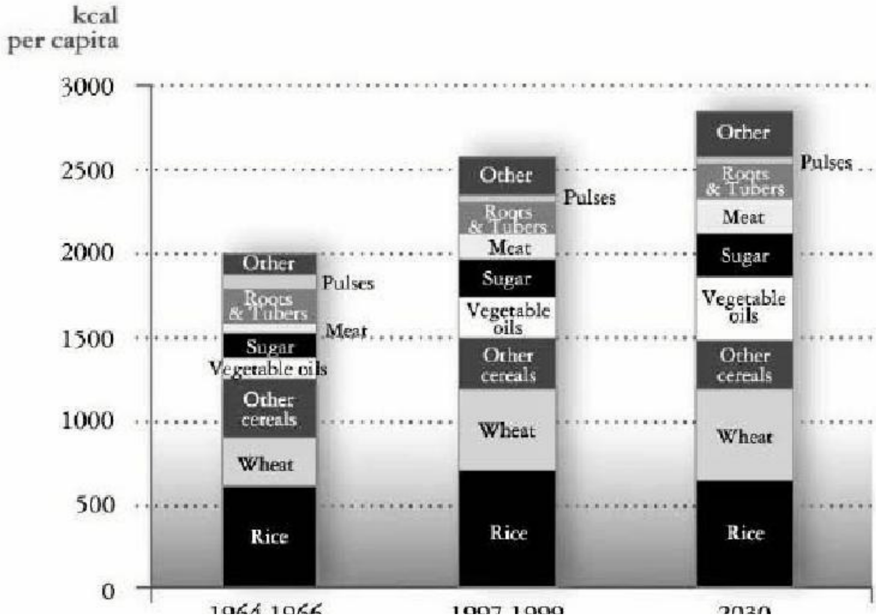
UNICEF and ORC/Macro collaborate in standardizing across surveys where possible

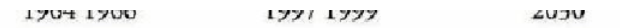
MICS3 will assess progress towards Millennium Development Goals

figure 1 Trends and projections of underweight rates in children <5 years compared to the MDG Goal in 2015[4]



Sources: WHO Global Database on Child Growth and Malnutrition 2003 (http://www.who.int/nutgrowthdb); de Onis M and Blössner M 2003; de Onis M, Blössner M, Borghi E et al. 2004 figure 19 Trends in diet composition and total per capita calorie consumption developing countries between 1964 and 1999, and projections for 2030





Source: WHO/FAO 2003
Reprinted with permission from WHO

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Application 3: Program monitoring

HKI Nutrition Surveillance Systems, Indonesia & Bangladesh (www.hkiasiapacific.org), Nicaragua (SIVIN)

Monitoring for management

USAID frameworks

Cluster surveys for supplementation

Sentinel Site Surveillance

Cost analyses

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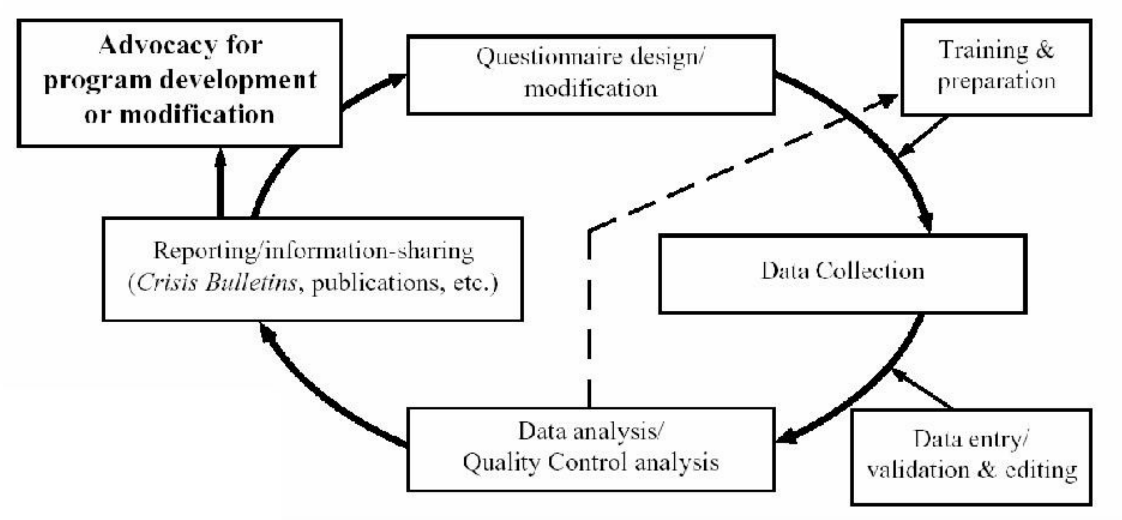
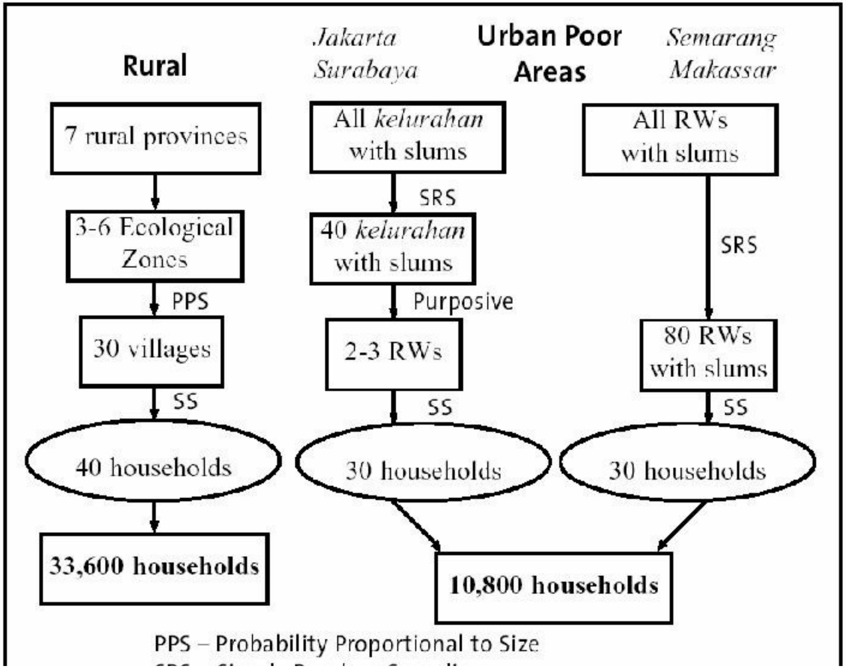
Nutrition Surveillance Process



Source: HKI Indonesia Crisis
Bulletin, January 2000

Sampling framework for HKI/GOI NSS



SRS – Simple Random Sampling
SS – Systematic Sampling

Source: HKI Indonesia Crisis Bulletin, January 2000

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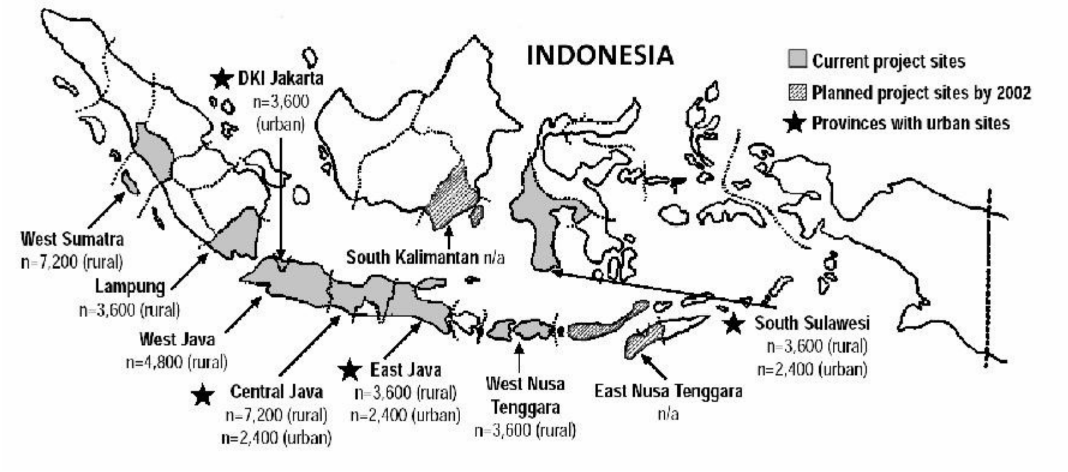
Map of the HKI/GOI NSS Project Sites



Source: HKI Indonesia Crisis
Bulletin, January 2000

Uses of Indonesia HKI/GOI NSS

- Monitoring
  - Impact of economic crisis (Crisis Bulletins)
  - Implementation of vitamin A supp program
  - Nutritional status and program information in specific provinces
- Targeting food aid (donors)
- Providing survey vehicle for collaborations on specific issues, e.g. malaria
- Further issues forthcoming (e.g. anemia)

- USAID funding for NSS

recently ceased

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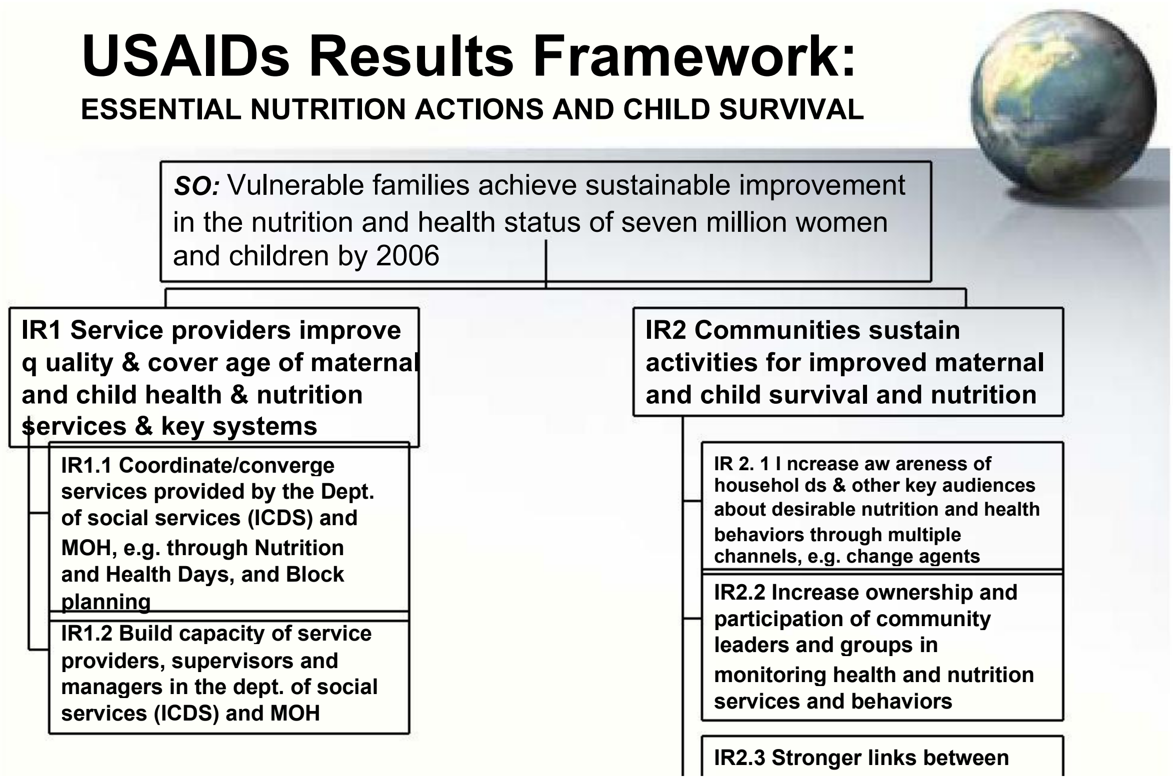

health systems communities and

Source: Adapt ed from CARE/India INHP II,

DAP II 2001- 2006

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Logical Framework

Nutrition Program Example

PURPOSE	PERFORMANCE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
Sustainable improvement in the nutrition and health status of women and children through improved services provision and community participation	1.Proportion of children 6-36 months in any grade of malnutrition 2. Coverage of essential nutrition actions: exclusive BF, appropriate CF, vitamin A, iron supplements /fortified foods, iodized salt use, coverage of sick and malnourished in special programs 3. Proportion of households at risk of HH food insecurity or vulnerable	1.Annual reports from MCH services, special surveys 2.Annual reports, special surveys 3.National / local tracking reports (surveillance) of high risk areas/ populations	- Stable political situation, sustained political commitment and financing - Sufficient numbers of competent health care personnel and supplies in the government sector - No natural disaster or disease epidemic

NOTE: A logic model would allow a program to select indicators that monitor all stages (inputs, process, outputs) of their activities e.g. funds and staff available (inputs), training sessions completed (process), number of skilled workers or villages with trained volunteers (outputs).

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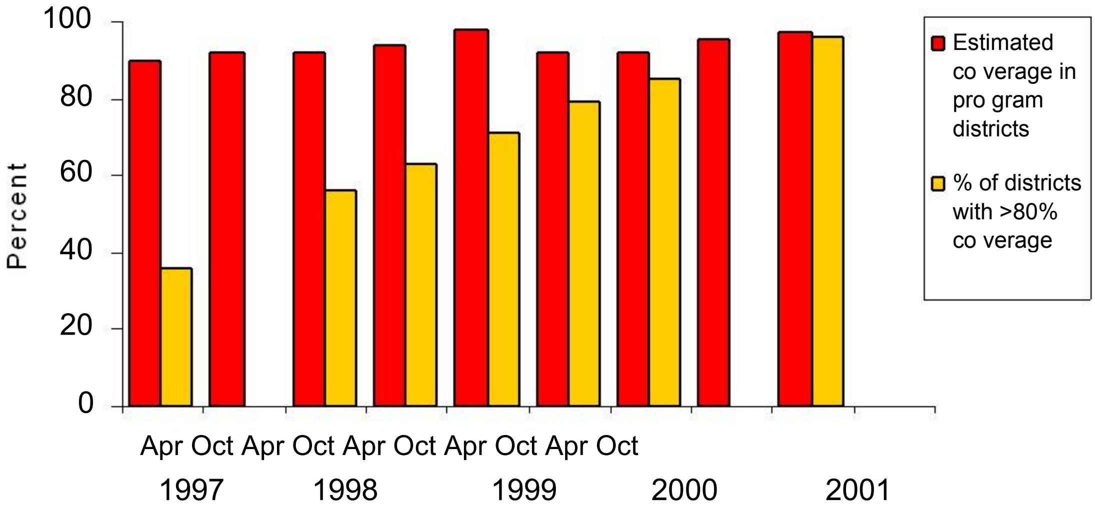
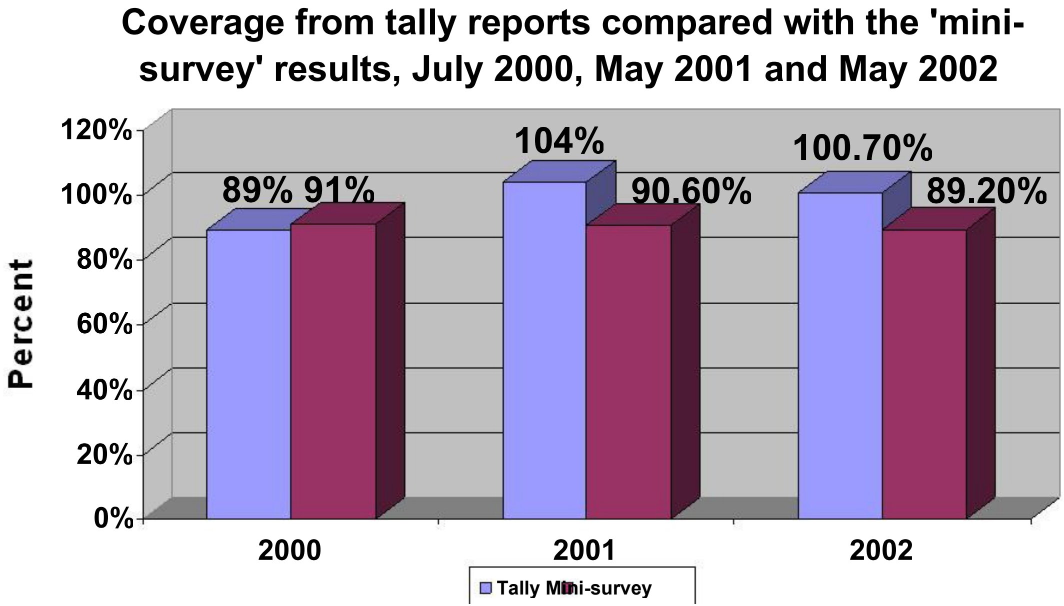
Supplement coverage in Nepal 1997-2001*



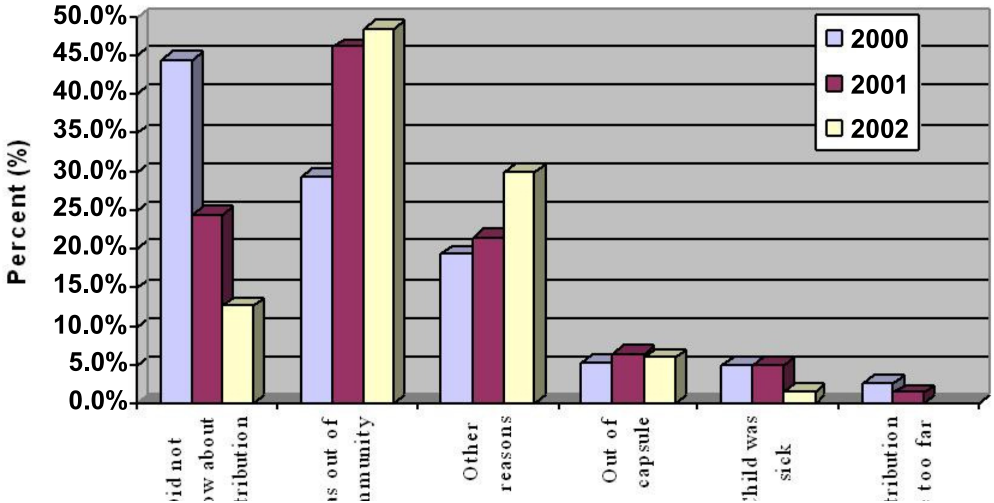
*Based on a weighted average of multiple representative district surveys applied nationally.
Data from non-NIDs vitamin A supplementation efforts in Nepal. Source Houston R, 2002.

Ghana VA supplementation 2000-2002



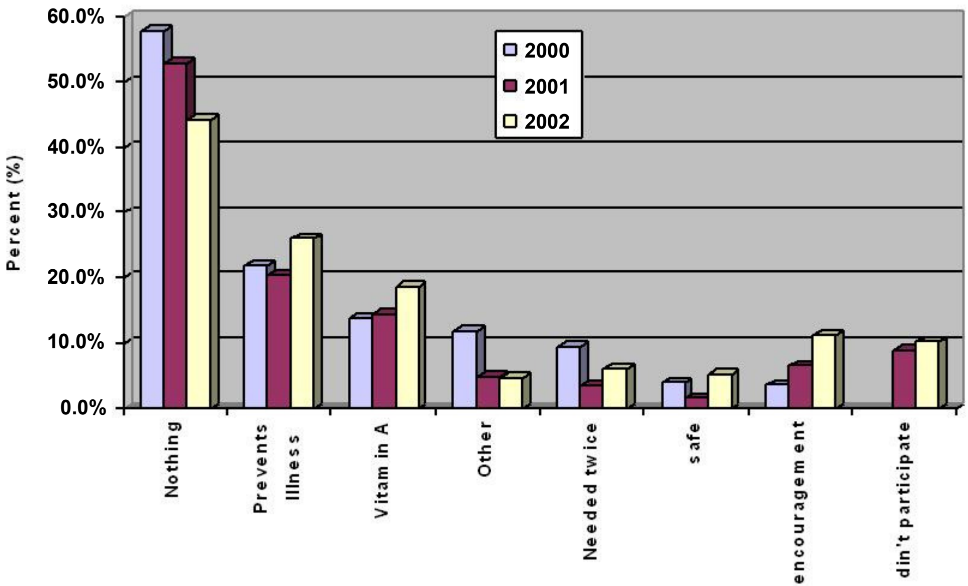
Amouful E. IVACG XXI, 2003

Reasons for not receiving Vit A supplement, Ghana (July 2000, May 2001 and May 2002)



Amouful E. IVACG XXI, 2003

What care givers reported being told (among those dosed) Ghana, (May 2000 N=2169, July 2001 N=3436 and May 2002 N=3451)



Amouful E. IVACG XXI, 2003

Sentinel Site Surveillance

Refers to the application of epidemiological surveillance to limited populations or sites to detect trends in health events, or events that mandate a specific response (e.g. polio outbreaks)

Limited in scope, less costly, less complex, but not representative

Community-based Surveillance (CBS), UNICEF in Central America, 1980s-early 1990s (Andersson et al. 1989)

- CBS as capacity building process, part of development **process: generates motivation and commitment**
- Response to limitations of data routinely collected through **health service**
- 4 components: List objectives, questionnaires, contingency

tables,
data
entry
format

The USAID Micronutrient Program

Program Costs: Increasingly important

(Austin JE 1978)

Three types

- ***Biological cost-effectiveness: e.g. $/ change in*** **infant mortality, $/ change in malnutrition**
- ***Delivery system cost-effectiveness: $/ recipient,*** **$/ target group recipient, $/ nutrient delivered, $/ nutrient deficit reduction**
- ***Operating-effectiveness measures: do not*** **incorporate costs but measure other program dimensions -- coverage, nutrients, permanency, personnel, leakages**

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Application 4: Evaluation

Measuring performance (Stoltzfus & Pillai J Nutr 2002; 132:845S-848S)
Applied framework of Habicht et al. 1999 to Iron Deficiency Anemia programs

Three questions --

Who is the evaluation for.

What questions will the evaluation answer.

How will the evaluation be conducted to generate useful **answers.**

Three designs --

Monitoring: **Severe VAD in Denmark, Pellagra in Mississippi**

Plausibility: **Effective anemia programs in Thailand**

Probability: **Progresa in Mexico**

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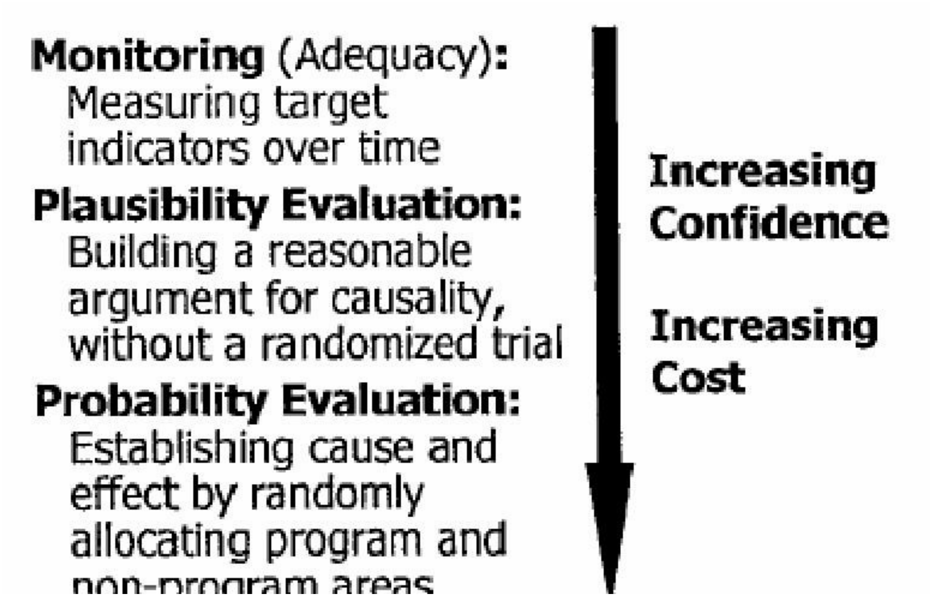
Designs for program evaluation

From Stoltzfus & Pillai 2002



non program areas

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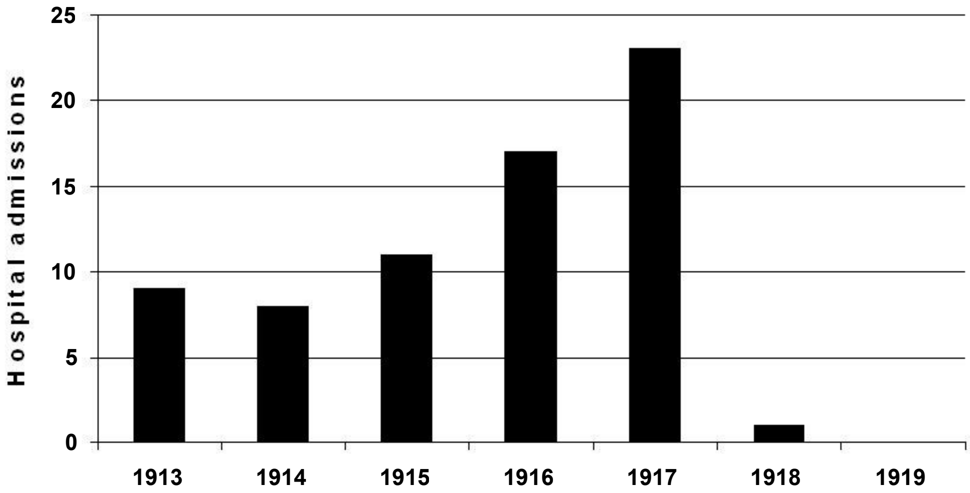
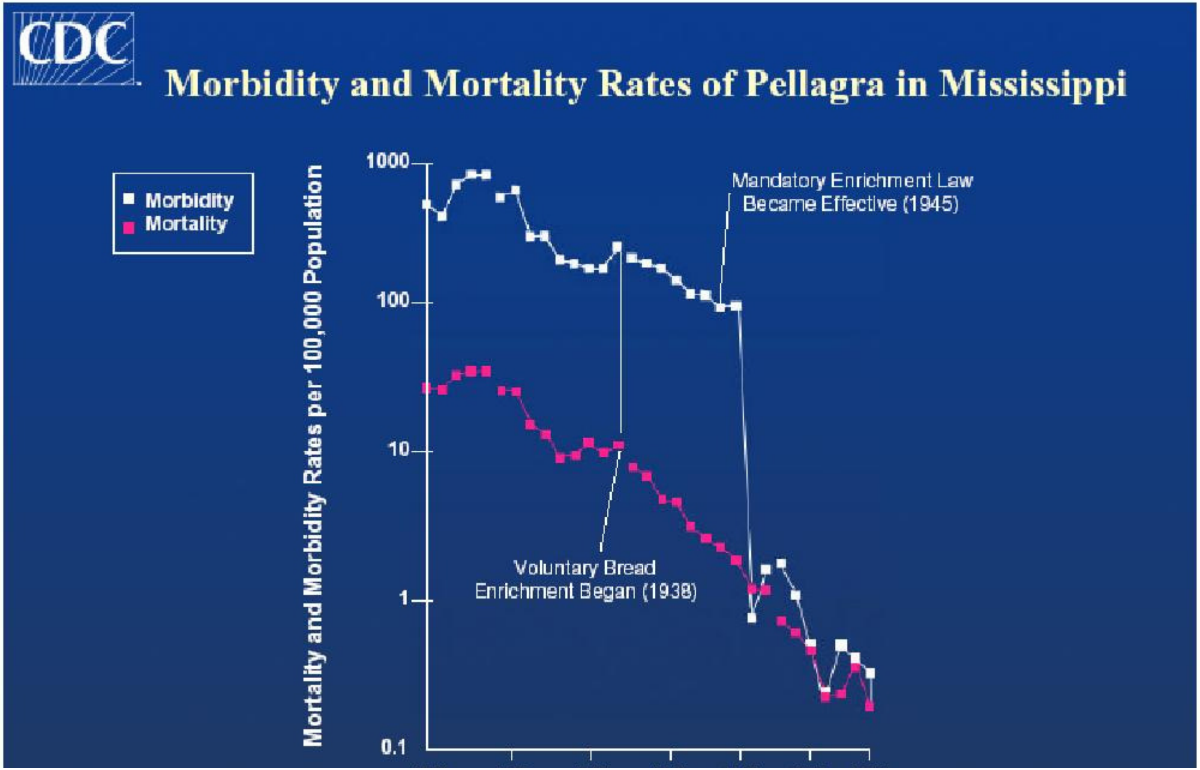
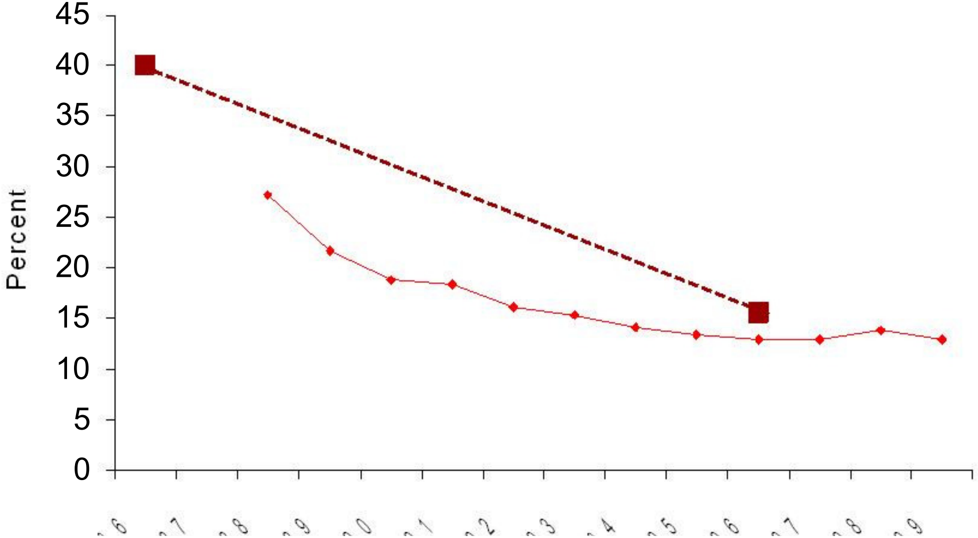
Severe vitamin A deficiency in Denmark disappeared after margarine was fortified

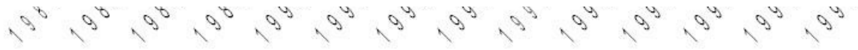



CDC
Morbidity and Mortality Rates of Pellagra in Mississippi
Morbidity
Mortality
Mortality and Morbidity Rates per 100,000 Population
1000
100
10
1
0.1
Mandatory Enrichment Law
Became Effective (1945)
Voluntary Bread
Enrichment Began (1938)

Source: *AMJ Public Health* 2000; 90:727

Thailand: Anemia prevalence in pregnant women, two national surveys and surveillance data, 1986-1999.





Modified from: Winichagoon
J Nutr 2002.

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Decrease in anemia prevalence resulted from IFA program - Plausible.

- Nutrition/anemia incorporated into national development policy & primary health care in 1970s
- Community volunteers established (cadre now 500,000)
- 98% Thai women attend ANC, 84% attend 4 times, encouraged to attend early
- Universal supplementation
- Supplies adequate, needs estimated by provinces
- Clear messages about dose, frequency, duration & coping with side effects
- Surveillance data used in

Surveillance data used in feedback

Source: Winichagoon 2002

References

WHO Methodology of nutritional surveillance WHO Tech Rep Series No. 593 WHO Geneva 1976

Austin JE; The perilous journey of nutrition evaluation Am J Clin Nutr 1978 31:2324-2338

Habicht J-P, Mason J. Nutrition Surveillance: Principles and practice. 1983

Andersson et al. 1989. The use of community-based data in health planning in Mexico and Central America. Health Policy and Planning 1989 4(3):197-206

UNICEF, Multiple Indicator Cluster Surveys, access from http://www.childinfo.org/MICS2/Gj99306k.htm

5th Report of the world nutrition situation, SCN, March 2004, http://www.unsystem.org/scn/Publications/AnnualMeeting/SCN31/SCN5Report.pdf

For more information Contact pharvey@istiinc.com or visit www.mostproject.org.

MOST The USAID Micronutrient Program

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FOOD AND NUTRITION TECHNICAL ASSISTANCE

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Global Food Security: US Food Aid from policy to programs to results

Bruce Cogill, Ph.D.

International Nutrition Class
Johns Hopkins University

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US Food Aid: from policy to programs to results

Content of lecture

A Nutrition Policy and its intent --The U.S. Food Assistance Program

How the Policy functions: Types of Food Aid-funded Development Programs (Title II) focus on Maternal and Child Health and Nutrition Programs and HIV/AIDS

What is a POLICY.

A statement by an authoritative body of an intent to act in order to maintain or alter a condition in society

3

Policy should have:

1. Statement: CLEAR, TRANSLATABLE, EVIDENCE BASED

2. Authoritative body: GOVERNMENT, UN ORGANIZATION

3. Intent: BACKED BY LEGLISLATIVE & REGULATORY COMPONENTS

4. Act: INFORM, GUIDE, INTERVENE IN AN ENABLING ECONOMIC, INFRASTRUCTRAL, SOCIAL AND POLITICAL ENVIRONMENT

5. Alter: IMPROVE OR WORSEN

6. Condition: TRADE, SECURITY, EDUCATION, or HEALTH, NUTRITIONAL, DIET, FOOD SECURITY

7. Society: DEFINED IN TERMS OF STRATA WHO

WILL BE AFFECTED, UNAFFECTED WINNERS and LOSERS

4

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The Theory:

Evidence

↓

Context

↓

Process

↓

Impact

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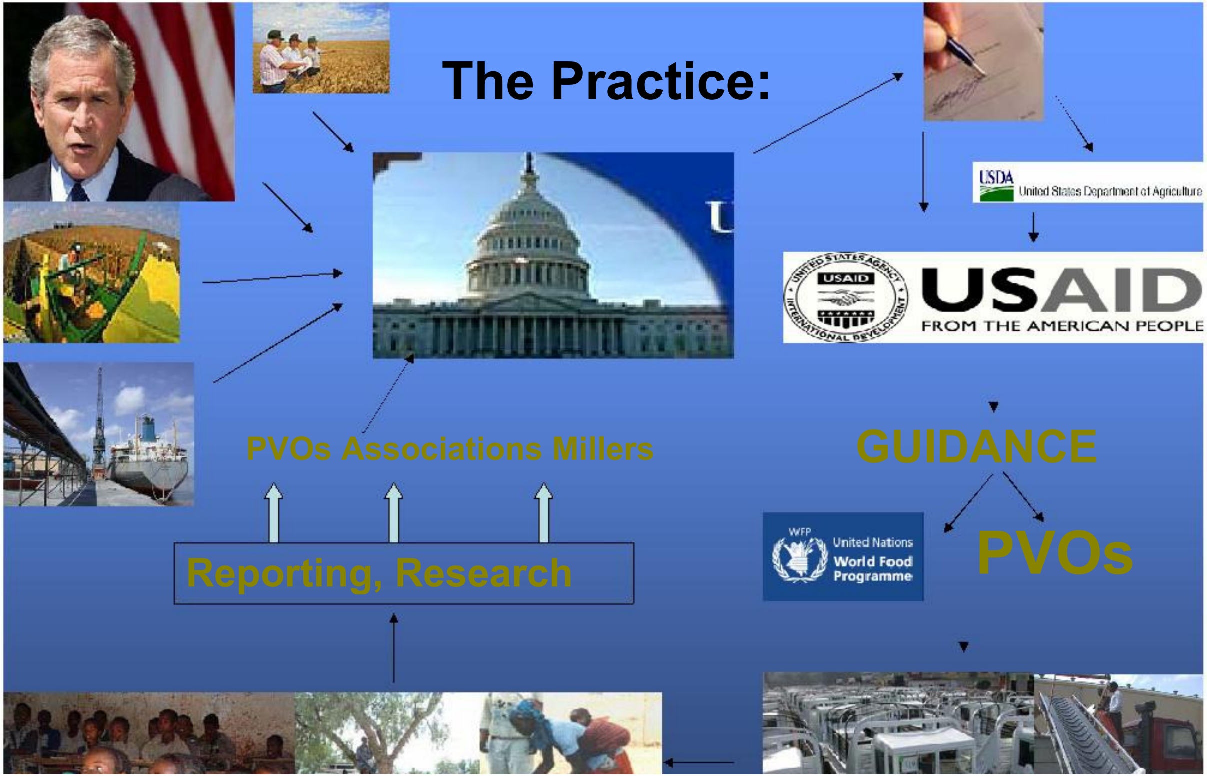


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Goals of the U.S. Food Assistance Program 1954 1990 - 2002

It is the policy of the U.S. to use its agricultural productivity to promote the foreign policy of the U.S. by enhancing the food security of the developing world through the use of agricultural commodities and local currencies accruing under the Act to:

7

Combat world hunger and malnutrition and **their causes**

Promote broad-based, equitable and **sustainable development, including agricultural development**

Expand international trade

Develop and expand export markets for **U.S. agricultural commodities**

Foster and encourage the development of **private enterprise and democratic participation in developing** participation in developing countries

8

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The Policy is:

Clear, translatable, evidence based (.) **made by an authoritative body and is**

Backed by legislative and regulatory **components**

How does it act.

Program -- Project --

Program – Project
Emergency

9

Program -Title I (FY 2004 ~ $156 million) U.S. Department of Agriculture (USDA)

Government to government long-term concessional commodity sales program

Food for Progress

Projects support efforts to introduce or expand free enterprise elements in agricultural economies

10

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Project - Title II (FY2004 > $1.6 billion) U.S. Agency for International Development

- Emergency and Non-Emergency (Development) **programs**
  - Implemented by Cooperatives & Private Voluntary Organizations (PVOs) and International relief organizations, including the World Food Programme (WFP)
- FY 2003 value of commodities, freight and cash
  - Emergency >$1.3 billion to > 75 million beneficiaries
  - Development >$400 million to > 20 million beneficiaries

11

Section 416(b) (FY2004 >$172 million)

USDA

Surplus commodities, donated to PVOs, WFP and **governments**

Proceeds from sale may be used to support agricultural, **economic or infrastructure development programs**

McGovern-Dole International Food for Education and Child Nutrition Program (GFFEI)

(FY2004 > $47 million)

USDA

Commodities used for school feeding (mainly) and **maternal and child nutrition projects**

Direct distribution or

sold
Countries committed to universal primary education

12

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Program - Title III (FY2004 - $0 million) USAID

Bill Emerson Humanitarian Trust (USDA) for emergency programming reserve 500K tons wheat etc. No releases in 2004.

13

BC2

Tinbergem Rule requires optimal policy to have

What are the technical elements of the Food Aid Policy.

What is meant by Food

What is meant by Food Security.

14

Slide 14

BC2 Tinbergen Rule "optimal policy requires one policy instrument for each objective" - Does food aid policy serve one policy objective.
Bruce Cogill, 10/14/2004

USAID Definition of Food Security

When all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life

15

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Three components +

Availability Sufficient quantities of appropriate, necessary types of food from domestic production, commercial imports, or donors are consistently available to the individuals or are in reasonable proximity to them or are within reach

Access - Individuals have adequate incomes or other resources to purchase or barter to obtain levels of appropriate foods needed to maintain consumption of an adequate diet and nutritional level

Utilization - Food is properly used, proper food processing and storage, adequate knowledge and application of nutrition and child care, and adequate health

and sanitation
services exist

+ Risk / Vulnerability / Resilience

16

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Priorities for Title II Development Food Aid Programs - Project

Programmatic focus

- Improving household nutrition, especially for children and mothers;
- Increasing agricultural productivity to alleviate one of the leading causes of hunger;
- Increasing incomes in rural and urban areas through economic and community development and by promoting sound environmental practices;

Building capacity

17

Priorities for Title II Development Food Aid Programs - Project

Target population

Vulnerable populations people who are at risk of food insecurity because of their physiological status, socioeconomic status or physical security. Also people whose ability to cope has been temporarily overcome by a shock.

- Physiological status people who are malnourished, suffering from HIV/AIDs, pregnant and lactating women, children under two.
- Socioeconomic status the poor (those who by definition do not have sufficient income to purchase an adequate diet and other basic necessities) as well as those who suffer from economic and social discrimination due to ethnicity, gender or other characteristics, and many who live in environmentally marginal

regions

Physical security refugees, internally displaced persons (IDPs), victims of war.

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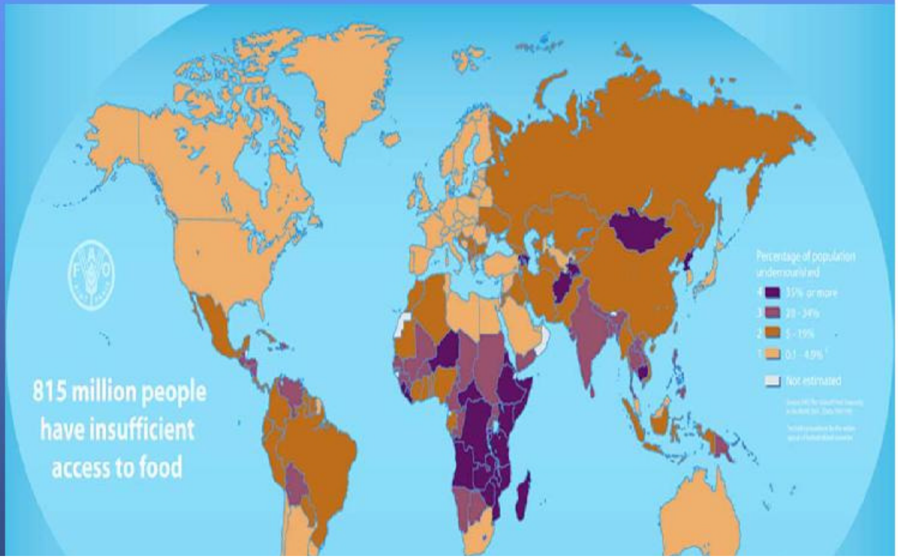
Priorities for Title II Development Food Aid Programs

Geographic **focus**

South **Asia**

Sub-**Saharan Africa**




Hunger around the world
19

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Technical focus Title II Development Programs Approximately 60% of the programs have integrated agriculture and health/nutrition components

Technical sector	% value FY 2004
Health and Nutrition incl. Water and Sanitation	41
Agriculture incl. Natural Resource Management	37
Non-emergency Humanitarian Assistance	9
Education	9

Microenterprise	5

20

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Integration of food aid and other resources

Food aid is most effective when it is programmed in conjunction with funds for technical assistance and local currencies for logistical support and grassroots development.

Food aid can also reinforce the positive impact of other development programs such as nutrition education, family as nutrition education, family

survival and child

planning, community development

projects.

FOOD AND NUTRITION TECHNICAL ASSISTANCE

Uses of rations in MCHN programs

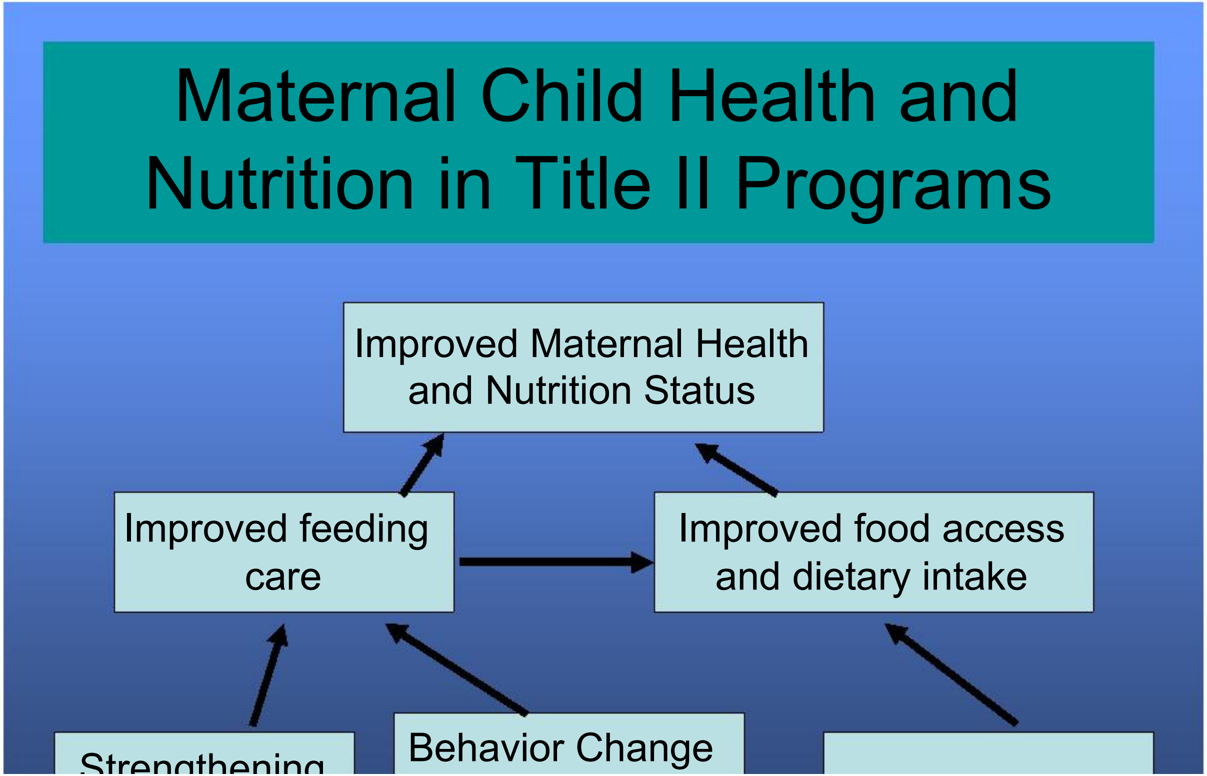
Recuperation : **Rehabilitate children suffering from** malnutrition. Malnourished children (or their families) receive food as a dietary supplement to enable them to attain normal nutritional status

Prevention : **Food is provided to households that have** vulnerable members at risk of malnutrition in order to prevent them from becoming malnourished

Incentive : **Food is used to motivate mothers to participate in** educational activities aimed at improving maternal/child health and nutritional practices and at encouraging the use of health services. Food reduces barriers to participation in these activities, since it compensates for the

activities, since it compensates for the
time women spend
attending the activities.

22


Maternal Child Health and Nutrition in Title II Programs
Improved Maternal Health and Nutrition Status
Improved feeding care
Improved food access and dietary intake
Behavior Change

Health Services

Interventions

Food
Rations

23

Title II Maternal and Child Health and Nutrition Activities

- Behavior change interventions
  - Breastfeeding
  - Complementary feeding
  - Prevention and treatment of preventable childhood **diseases**
  - Increased micronutrient consumption
  - Hygiene
- Strengthening health services
  - Immunizations
  - Growth promotion
  - Control of diarrheal diseases
  - Pre- and ante-natal care
- Supplementary feeding
  - Take-home rations

On-site feeding

Nutritional recuperation

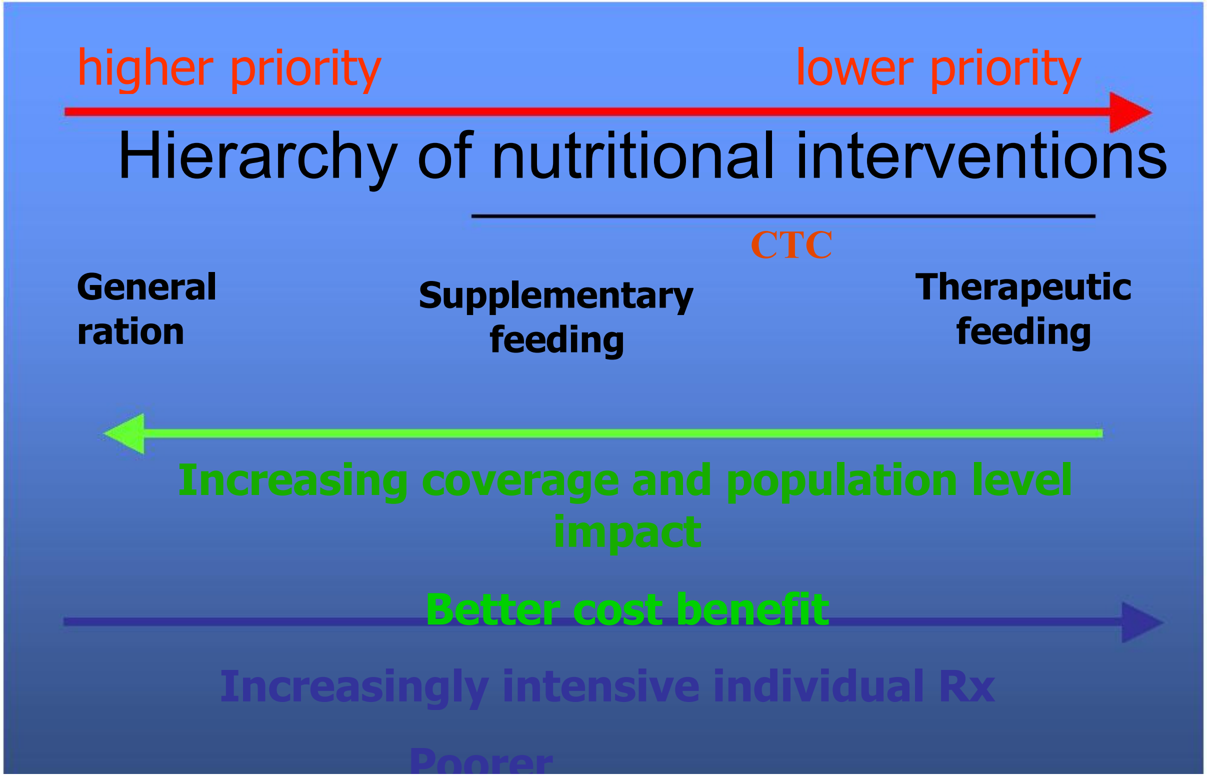
24

Title II Maternal and Child Health and Nutrition & Food Commodities

- Many Title II commodities are fortified and **can act as a vehicle for micronutrient supplementation**
  - Processed cereals (corn and wheat soy **blends, wheat flour, soy-fortified cereals) fortified with vitamin and mineral premixes (A, B-12, C, D, E, folic acid, niacin, pantothenic acid, pryidoxine, riboflavin, thiamin, calcium, iodine, iron, phosphorous, sodium, and zinc)**

Vegetable oil fortified with vitamin A

25


higher priority
lower priority
Hierarchy of nutritional interventions
CTC
General ration
Supplementary feeding
Therapeutic feeding
Increasing coverage and population level impact
Better cost benefit
Increasingly intensive individual Rx
Poorer

costs
benefit

26

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The progression

SFP **OTP** **CTC**

Screen severely malnourished
Identify & register
Wristband

Outpatient Therapeutic Feeding (OTP)

Ready to use therapeutic food

Systematic protocol

Antibiotic

Vit A, measles vaccination folic acid, mebendazole

Education


Increasing community involvement
27

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What is the evidence base for the Policy.

The impact of title II maternal and child health and nutrition programs on the nutrition status of children

Swindale et al. Occasional Paper no. 4. USAID and FANTA March 2004

Title II Maternal and Child Health and Nutrition Impacts

Average annual percentage point reduction
in stunting = 2.4

Average annual percentage point reduction
in underweight = 1.9

Average annual reduction increases
dramatically in programs greater than 3 yrs

in length

29

Title II Maternal and Child Health and Nutrition Universal Targeting of Children under Two

Prevention is better than cure

Rate of increase in prevalence of malnutrition greatest **between 6-24 months**

Able to achieve catch-up growth through 24 months, **ability diminishes through 36 months, quite low after 36 months of age**

Both risk and potential benefit from the intervention **are greatest for children < 24 months**

- Applies not only to food supplementation but also health **services and health and nutrition education**
- High prevalence of malnutrition (assumed to exist because of **focus of Title II funding on food insecure**

focus of Title II funding on food insecure populations)

indicates that most children are at risk, including yet to be born siblings

30

Other Title II Activities

Title II Disaster Mitigation and Response Activities **(Non-emergency)**

Title II Water and Sanitation Activities

Title II Food for Education

Title II Agriculture and Natural Resource **Management Activities**

Title II Micro-enterprise

Title II Micro-enterprise
Activities

31

What are some of the challenges to achieving intent of the Policy.

Conflicting objectives and legislative mandates

Title II resources will be used to increase food **security and decrease malnutrition, particularly among women and children.**

75% of programmed Title II resources will be **processed, value-added, or bagged (FY03 51%)**

A minimum of 1.85 million MT (the sub-minimum) **of Title II will be programmed for non-emergency (development) activities (FY03 1.06 million MT)**

At least 15% monetized (FY03

At least 15% monetized (FY03 61%)

32

Challenges

Concerns about dependency overstated concern

- Clearly communicated time limit (e.g. receipt of welfare **benefits is limited to 5 years total) is necessary to prevent dependence.**
- Targeting by age of child (under 2s) allows for a clear time **limit on receipt of ration that can be easily communicated to beneficiary.**
- Permit only limited reentry into the food distribution **component**
- Programs with food distribution components should be **integrated with other food security interventions (e.g. agricultural extension, infrastructure development, micro-credit programs)**
  - Sustainable sources of resources needed to fill

Sustainable sources of resources needed to fill
food deficit

become available as MCHN food distribution winds down

33

Challenges

Concerns about creating disincentives to local production

Provide value-added, blended and fortified products that **are not produced locally**

- But, ideally commodity should eventually be replaceable with **local products for weaning recipes**

Provide micronutrients usually deficient and not available **through locally produced products**

Commodity should represent a cash need of the **households**

Food for work activities take seasonality of production into **account**

- Also to avoid competing with local labor needs

Monitor prices in local markets

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US Food Aid Policy is Aimed at Reducing Hunger. According to Barrett and Maxwell (2004, Ch. 2 p. 27):

The United States governments food aid programs have always aimed to advance self-serving goals of surplus disposal, export promotion and geopolitical leverage to benefit privileged domestic interest groups. While the rhetoric of American food aid has always emphasized its altruistic appearance, the design and use of U.S. food aid programs have always been driven primarily by donor-oriented concerns, not by recipient needs. or

rights.

35

FOOD AND
NUTRITION
TECHNICAL
ASSISTANCE

www.fantaproject.org

Tel: 202 884 8000

Fax: 202 884 8432

Email: fanta@aed.org

Prepared with support from the United States Agency for International Development, Bureau for Global Health, Office of Health, Infectious Disease and Nutrition under the Food and Nutrition Technical Assistance Project (FANTA), Cooperative Agreement HRN-A-00-98-00046-00.
The opinions expressed in the presentation are those of the author and do not necessarily reflect the views of the U.S.

Agency for International Development or the Academy for Educational Development.

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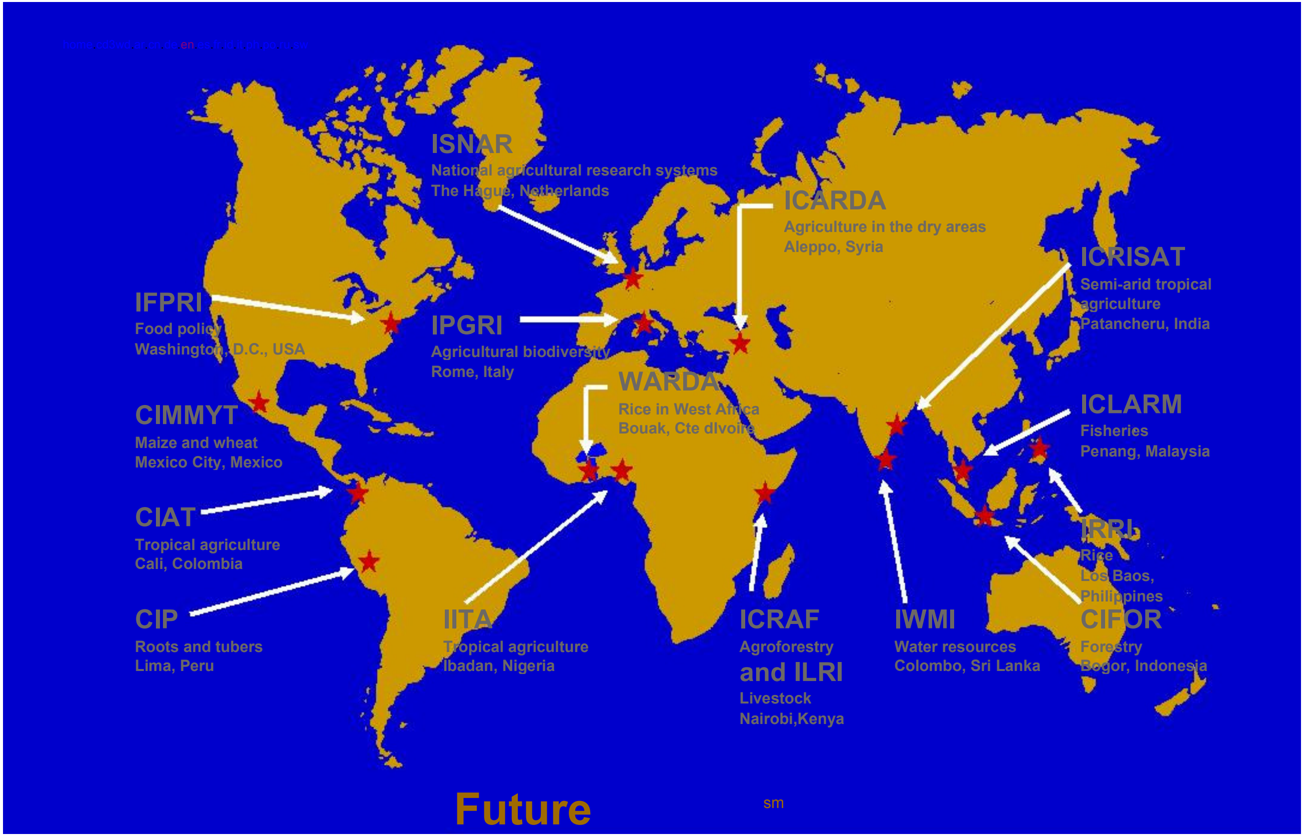
IFPRI

Economic Analysis of Human Nutrition in Developing Countries:

FOCUS ON FOOD/DIET

Howarth E.
Bouis, IFPRI

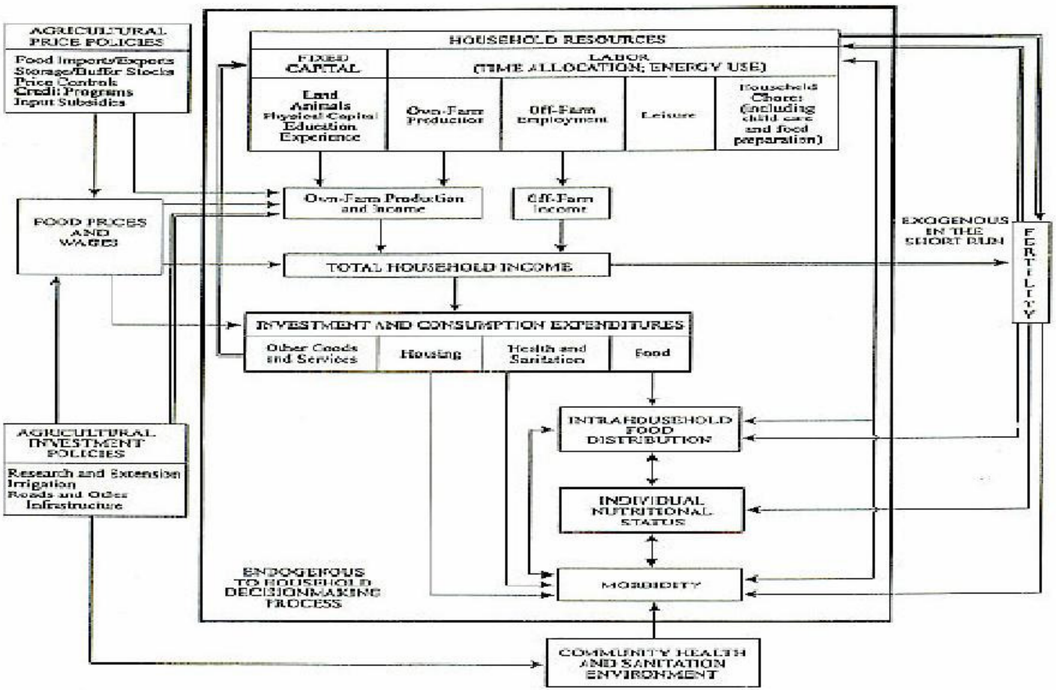

ISNAR
National agricultural research systems
The Hague, Netherlands
ICARDA
Agriculture in the dry areas
Aleppo, Syria
ICRISAT
Semi-arid tropical agriculture
Patancheru, India
IFPRI
Food policy
Washington, D.C., USA
IPGRI
Agricultural biodiversity
Rome, Italy
WARDA
Rice in West Africa
Bouak, Cte dIvoire
ICLARM
Fisheries
Penang, Malaysia
CIMMYT
Maize and wheat
Mexico City, Mexico
CIAT
Tropical agriculture
Cali, Colombia
IRRI
Rice
Los Baos,
Philippines
CIP
Roots and tubers
Lima, Peru
IITA
Tropical agriculture
Ibadan, Nigeria
ICRAF
Agroforestry
and ILRI
Livestock
Nairobi,Kenya
IWMI
Water resources
Colombo, Sri Lanka
CIFOR
Forestry
Bogor, Indonesia
Future
sm

Harvest Research Centers

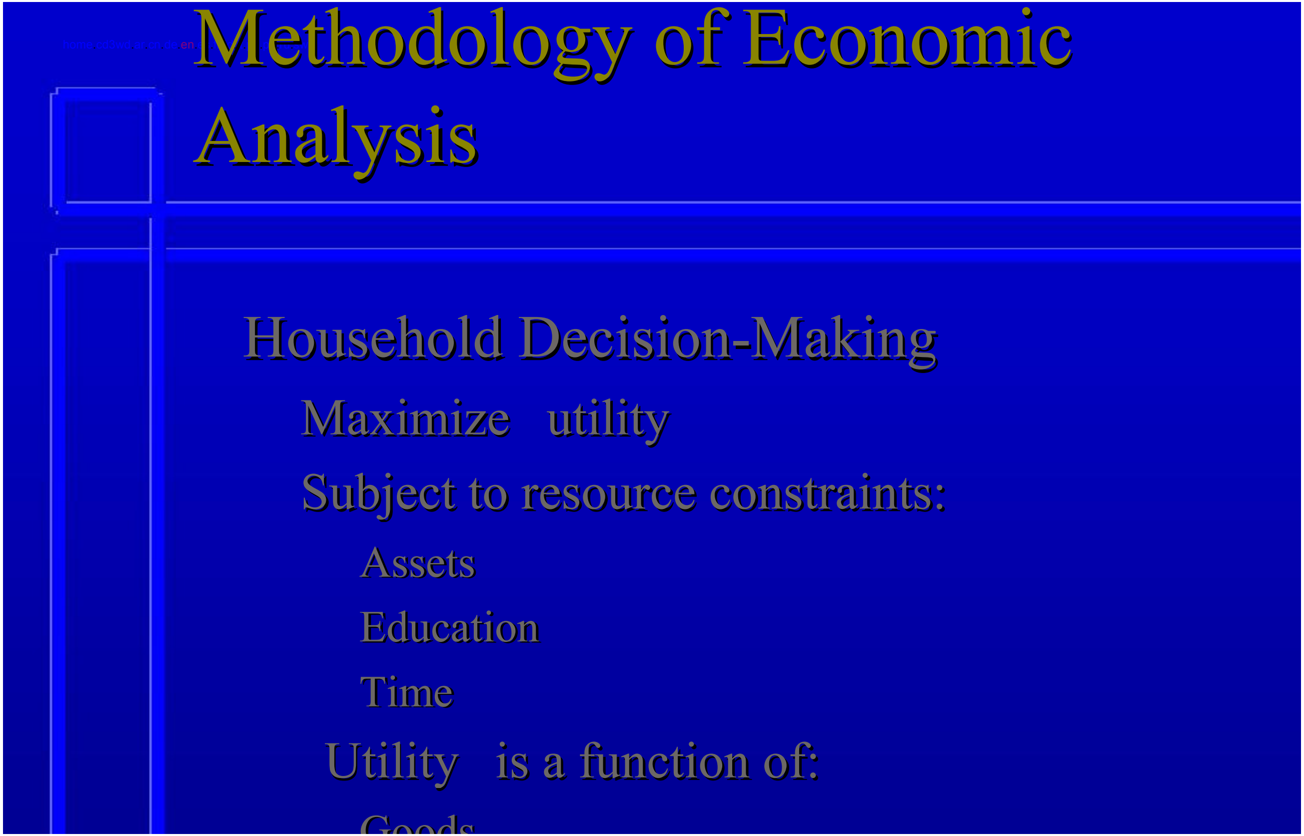
IFPRI is one of 16 research centers that receives funding from the Consultative Group on International Agricultural Research (CGIAR).

4

Figure 1—Agricultural policies, household resource allocation, and nutrition



Source: Eileen Kennedy and Howarth E. Bouis, Linkages Between Agriculture & Nutrition: Implications for Policy & Research (Washington, DC: International Food Policy Research Institute, 1993), p. 3.


Methodology of Economic Analysis
Household Decision-Making
Maximize utility
Subject to resource constraints:
Assets
Education
Time
Utility is a function of:
Goods


Goods and services consumed
Better health
Leisure

Methodology of Economic Analysis

Example of Introduction of Irrigation System

- Income goes up
- Time Allocation
  - Seasonal migration affected.
  - Different cropping pattern.
- Health/Sanitation

Groundwater (arsenic); schistosomaisis.

Food prices at region/nation.

Methodology of Economic Analysis

Estimating Calorie-Income Elasticities

DATA COLLECTED (partial list):

1. Agricultural Production, Labor And Other Input Use By Plot
2. Livestock, Backyard Gardening
3. Non-Farm Employment
4. Assets and Expenditures
5. Individual Food Intakes
6. Morbidity And Health Care
7. Nutritional Knowledge and Healthcare and Childcare Practices
8. Anthropometry
9. Blood (Micronutrient Status)
10. Women s Status (e. g. assets brought to marriage)
11.

Time
Allocation

12. Credit Taken and Given

13. Land Ownership and Land Rental

14. Market-Level and Village-Level

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INCOME ELASTICITY

%. Quantity (x)

%. Income

OWN-PRICE ELASTICITY

%. Quantity (x)

%. Price (x)

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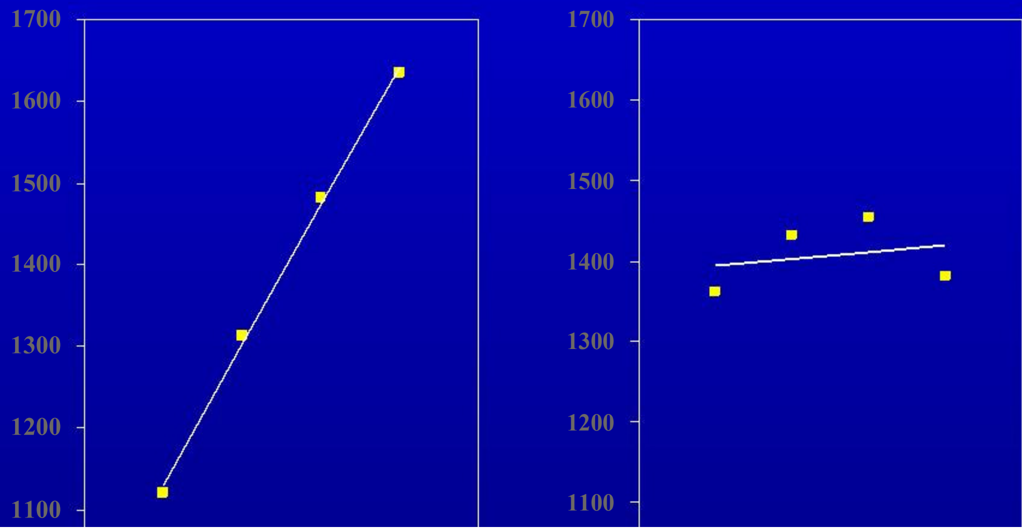
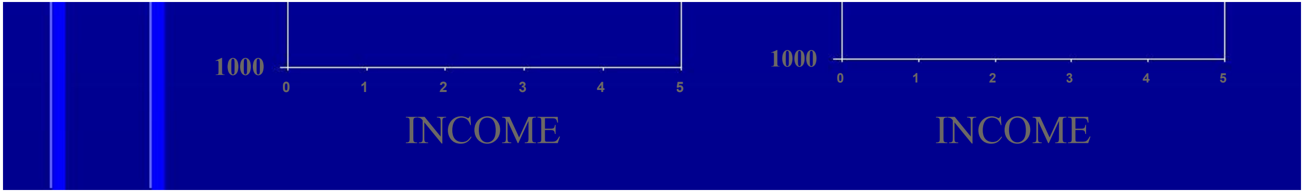
CROSS-PRICE ELASTICITY

%. Quantity (y)

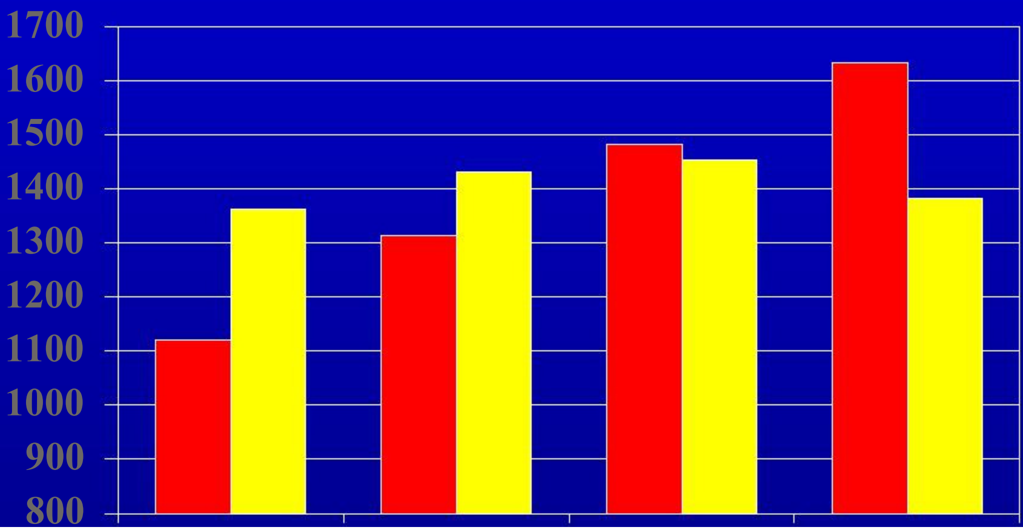
%. Price (x)

Energy Availability/Intake For Rural Philippines By Income Group




1000
0
1
2
3
4
5
INCOME
1000
0
1
2
3
4
5
INCOME

Energy Availability/Intake For Rural Philippines By Income Group




Low
Medium Low
Medium High
High
Expenditures
24-Hour Recall

FOOD DEMAND PATTERNS

An understanding of what factors drive food consumption decisions implies very different food-based approaches to solving vitamin A and iron deficiencies

FOOD EXPENDITURES FOR A RURAL PHILIPPINE POPULATION (pesos/week)

Food Category	Poorest 20%	Richest 20%
Rice	2.30	9.91
Corn	9.56	4.36
Meat, Fish	7.21	23.64
Vegetables	2.70	3.78
Fruits, Snacks	0.87	10.51

Other Foods	**3.55**	**8.44**
TOTAL	**26.19**	**60.64**

ENERGY INTAKES FOR A RURAL PHILIPPINE POPULATION
(calories per adult equivalent per day)

Food Category	*Poorest 20%*	*Richest 20%*
Rice and Corn	1771	1798
All Other Foods	337	777
TOTAL	2108	2575

PHILIPPINE POPULATION (international units per day per adult equivalent)

Food Category	*Poorest 20%*	*Richest 20%*
Rice	**0**	**0**
Corn	**10**	**2**
Meat, Fish	**1010**	**1733**
Vegetables	**3481**	**4047**
Fruits, Snacks	**121**	**124**
Other Foods	**169**	**294**

TOTAL	4972	6200
Percent of RDA	106	138

IRON INTAKES FOR A RURAL PHILIPPINE POPULATION

(milligrams per day per adult equivalent)

Food Category	Poorest 20%	Richest 20%
Rice	0.53	2.14
Corn	2.31	0.97
Other Staples	0.68	1.24
Meat, Fish	1.17	3.66
Vegetables	1.16	1.35
Other Foods	0.80	0.91

TOTAL	6.64	10.27
Percent of RDA	66	103

VITAMIN A INTAKES BY SURVEY ROUND FOR A RURAL PHILIPPINE POPULATION

Survey Round	*Adequacy Ratio*	*Percent Below 80% of RDA*
1	**1.95**	**39**
2	**1.24**	**59**
3	**1.03**	**72**
4	**0.71**	**72**
TOTAL	[illegible]	[illegible]

TOTAL	1.23	60

IRON INTAKES BY INCOME GROUP FOR A RURAL PHILIPPINE POPULATION

Income Group	*Iron Adequacy Ratios*		
	Pre-schoolers	*Mothers*	*Fathers*
1	**0.65**	**0.53**	**1.10**
2	**0.78**	**0.57**	**1.24**
3	**0.77**	**0.62**	**1.34**
4	**0.86**	**0.66**	**1.47**

5	1.07	0.76	1.67
TOTAL	0.81	0.63	1.37

CALORIES

Consumers are aware of intake fluctuations

Low income and price elasticities

IRON

- Low price elasticity due to diverse sources
- High income elasticity
- Adequacy out of reach due to low incomes
- Fortification or supplementation required

VITAMIN A

- Low income elasticity because intakes are highly-correlated with vegetables
- High price elasticity due to diet concentration
- Nutrition education effective
- Fortification or supplementation may still be depends

required on the conversion

rate between betacarotene and retinol

EFFECT OF DIETARY QUALITY ON CHILDRENS HEIGHTS FOR VIETNAM

	COEFFICIENT (T-Statistic)		
Sample Description	Animal and Fish	Non-Staple Plant	Staples
All Children 0-20	6.1 (5.5)	2.4 (3.5)	0.5 (2.6)
Children 0-6	2.9 (1.8)	2.3 (2.3)	0.4 (1.6)
Children 7-13	9.2 (5.0)	2.8 (2.4)	0.3 (1.2)
Children	6.3	0.0	0.4

14-20	(3.0)	(0.0)	(1.3)

EFFECT OF DIETARY QUALITY ON BLOOD HEMOGLOBIN IN BANGLADESH

	Preschool Children	Adult Females
Cereals	-.0002(-1.8)	-.0000(-0.5)
Non-Staple Plants	-0004(1.2)	-.0000(-0.1)
Animal and Fish	.0020(2.8)	0.0011(2.5)
[illegible]	[illegible]	[illegible]

All Foods	**-.0001(-0.7)**	**-.0000(-0.3)**

PER CAPITA ENERGY INTAKES IN SATURIA

	Income Level			
	Low	Medium	High	Total
Total	2137	2319	2418	2296
Cereals	1826	1925	1973	1910
Non-staple Plants	274	343	374	332
Animal				

and Fish	37	52	71	54

TAKA TO PURCHASE 100 CALORIES IN SATURIA

	Income Level			
	Low	Medium	High	Total
Total	0.51	0.58	0.64	0.58
Cereals	0.29	0.30	0.30	0.30
Non-staple Plants	1.31	1.40	1.48	1.41
Animal				

Animal and Fish	5.54	5.75	5.58	5.62

FOOD BUDGET SHARES FOR SATURIA

	Income Level			
	Low	Medium	High	Total
Total	100	100	100	100
Cereals	49	43	38	43
Non-staple Plants	33	36	36	35

Animal and Fish	**18**	**21**	**26**	**22**

INTRAHOUSEHOLD CALORIE INTAKES FOR SATURIA

	Income Level			
	Low	Medium	High	Total
Total Calorie				
Girls, Age2-5	1093	1097	1099	1095
Boys, Age2-5	1077	1165	1252	1168
Women, Age20-55	2134	2328	2369	2282
Men, Age20-55	3019	3032	3112	3058
Animal and Fish				
Girls, Age2-5	21	22	40	26

Boys, Age2-5	30	45	58	45
Women, Age20-55	31	43	61	46
Men, Age20-55	65	70	98	79

PREVALENCE OF ANEMIA IN SATURIA

PRESCHOOL CHILDREN Income Tercile	Boys	Girls	All
Low	40	43	41
Medium	32	37	34
High	26	26	26

ALL	**33**	**37**	**35**

PREVALENCE OF ANEMIA IN SATURIA

ADULT WOMEN

Income Tercile	Non-Preg Non-Lact.	Lact.	Preg.	All
Low	**50**	**39**	**75**	**47**
Medium	**47**	**59**	**92**	**51**
High	**48**	**42**	**92**	**49**

ALL	**48**	**47**	**86**	**49**

Calculation of Bioavailable Iron

Fe(bio) = 0.140 FeMFP +

[5 +26.804 log{(EF+100)/100}] X

CT [FeTOT 0.4 FeMFP]/100

EF = (M + F + P) + AA

CT = 10 exp [-0.22869 log

(PHYTATE)

(PHYTATE)

+0.1295]

Effect of Additional Trace M inerals On Blood Hemoglobin

Fe(bio) = f[dietary intake]

Hb = g[Fe(bio), iron supplements]

Doubling the iron in rice through biofortification has 30% the effect of iron supplements in raising blood hemoglobin

Effect of Additional Trace Minerals On Blood Hemoglobin

Iron supplements are **50 times as expensive** to deliver per person treated

To get an equal effect as bio-fortification through meat/fish consumption, poor Bangladeshi households would have to spend **$35 extra per person per year** on spend on meat/fish.

person per year

INDICES OF REAL PRICES OF SELECTED FOODS

YEAR	RICE PADDY	WHEAT	SOR-GHUM
1973-75	1.00	1.00	1.00
1976-78	0.75	0.63	0.63
1979-81	0.74	0.60	0.60
1982-84	0.76	0.69	0.58
1985-87	0.72	0.60	0.60
1988-90	0.71	0.61	0.58
1991	0.60	0.55	0.55

1994-96 93	0.59	0.57	0.61

INDICES OF REAL PRICES OF SELECTED FOODS

YEAR	LENTILS	CHICK-PEAS	COW-PEAS
1973-75	1.00	1.00	1.00
1976-78	0.94	0.74	0.66
1979-81	1.33	1.07	0.99
1982-84	1.18	1.15	0.87
1985-87	1.25	1.14	0.61
1988-90	1.39	1.26	1.25
1991-93	1.27	1.01	1.12
1994	1.41	[illegible]	[illegible]

1994-96	1.41	1.20	1.22

INDICES OF REAL PRICES OF SELECTED FOODS

YEAR	SPINACH	TOMA-TOES	PUMP-KIN	ONIONS
1973-75	1.00	1.00	1.00	1.00
1976-78	1.04	1.02	0.90	0.87
1979-81	0.81	1.20	0.81	1.36
1982-84	0.67	1.23	1.23	0.95
1985-87	0.94	1.82	1.12	1.13
1988-90	1.30	3.13	1.51	1.25
1991-93	1.10	2.18	1.71	1.46
1994-96	1.23	2.68	1.96	1.32

INDICES OF REAL PRICES OF SELECTED FOODS

YEAR	CHICKEN	EGGS	COW MILK
1973-75	1.00	1.00	1.00
1976-78	1.20	1.09	0.96
1979-81	1.24	1.13	1.08
1982-84	1.24	1.24	1.07
1985-87	1.43	1.36	1.13
1988-90	1.42	1.35	1.26
1991-93	1.55	1.28	1.08

1994-96	1.56	1.26	1.05

INDICES OF REAL PRICES OF SELECTED FOODS

YEAR	RUHI FISH	HILSA FISH
1973-75	1.00	1.00
1976-78	1.33	1.35
1979-81	1.41	1.39
1982-84	1.44	1.15
1985-87	1.86	1.38
1988-90	1.93	1.41
1991	2.21	1.54

1991	2.21	1.54
1994-96 93	2.27	1.60

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CONCLUSION

MORE OF THE SAME

Higher rural incomes

Strong linkages with non-farm economy

Energy intakes protected and increased

All things being equal, helped to improve diet

dietary
quality

CONCLUSION

STATUS QUO IS NEVER SATISFACTORY

- Pressures on prices of non-staple foods to rise
- Better understand the importance of dietary quality for human health
- Breeding for improved nutrient quality of rice can make a crucial

rice can make a crucial
contribution

RELATIVE COSTS OF BIOFORTIFICATION

Conventional Iron Fortification:

$0.10 per person per year

1.25 billion people in South Asia

to reach 40% of this population each year costs $50 million, $500 million each decade

RELATIVE COSTS OF BIOFORTIFICATION

Vitamin A Supplementation:

$0.50 per person

treat 100 million children and women in South Asia
(1 in every12.5 persons)

$50 million each year, $500 million over

a
decade

Costs of Plant Breeding

- $10 million over ten years to develop and test (say) a high-iron rice and for varieties to be adopted in a limited number of countries
- **Fixed**, **one-time** investment at a **central** location
- Iron and zinc content are highly

correlated so other trace
minerals may
be added at little extra cost

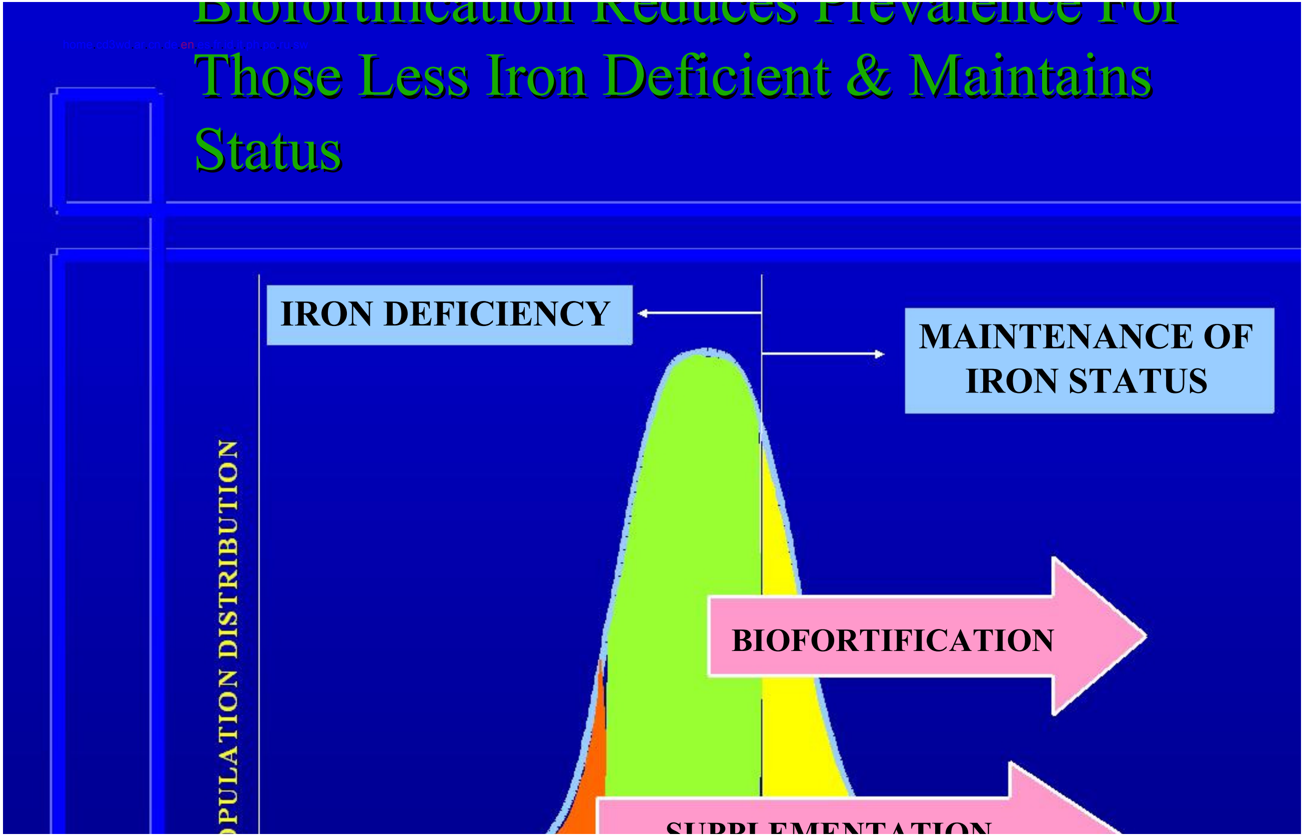
NICHE for Plant Breeding

Inexpensive, cost-effective, sustainable, long-term delivery of nutrients to the poor

Improves plant nutrition and so can raise agricultural productivity and farm incomes

Cannot deliver the **level of nutrients in a single dose** that supplements and fortification can deliver can deliver

Not a substitute for improved dietary quality


Those Less Iron Deficient & Maintains
Status
IRON DEFICIENCY
MAINTENANCE OF IRON STATUS
BIOFORTIFICATION
OPULATION DISTRIBUTION


SUPPLEMENTATION
PO
12.0
HEMOGLOBIN

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Community-based Nutrition Interventions

Parul Christian

International Nutrition

Nutrition Program s

- Growth monitoring and promotion
- Breastfeeding and complementary feeding
- Supplementary feeding
- Nutrition education or communications for behavior change or IEC
- Health related services (IMCI, EPI)
- Micronutrient supplementation (vitamin A, iron, iodine, other)

Growth Monitoring and Promotion

Definition -

the regular measurement, recording and interpretation of a childs growth in order to counsel, act, and follow-up results

Yee & Zerfas 1986

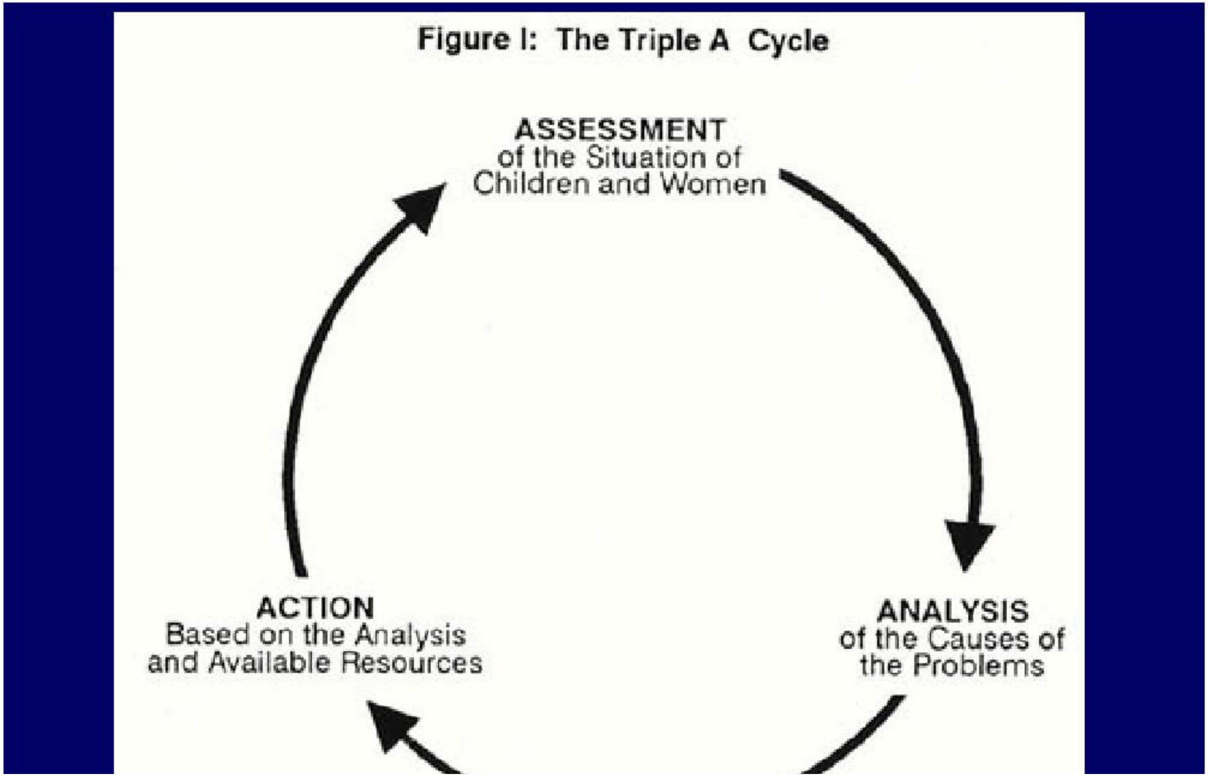


Figure I: The Triple A Cycle
ASSESSMENT
of the Situation of
Children and Women
ANALYSIS
of the Causes of
the Problems
ACTION
Based on the Analysis
and Available Resources


ADB Nutrition & Development Series

Need for GMP

- Contribution of mild-moderate malnutrition to child survival is much greater than previously thought
- If severe malnutrition were the only/major threat to child survival GM would not be needed
- Need to identify children experiencing growth faltering in a timely fashion in order

to intervene
appropriately

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Growth Monitoring at a local PHC in Malawi

Photo: Keith West

Salter Spring Balance

A lot of focus on training workers to measure weight correctly


Photo: Keith West

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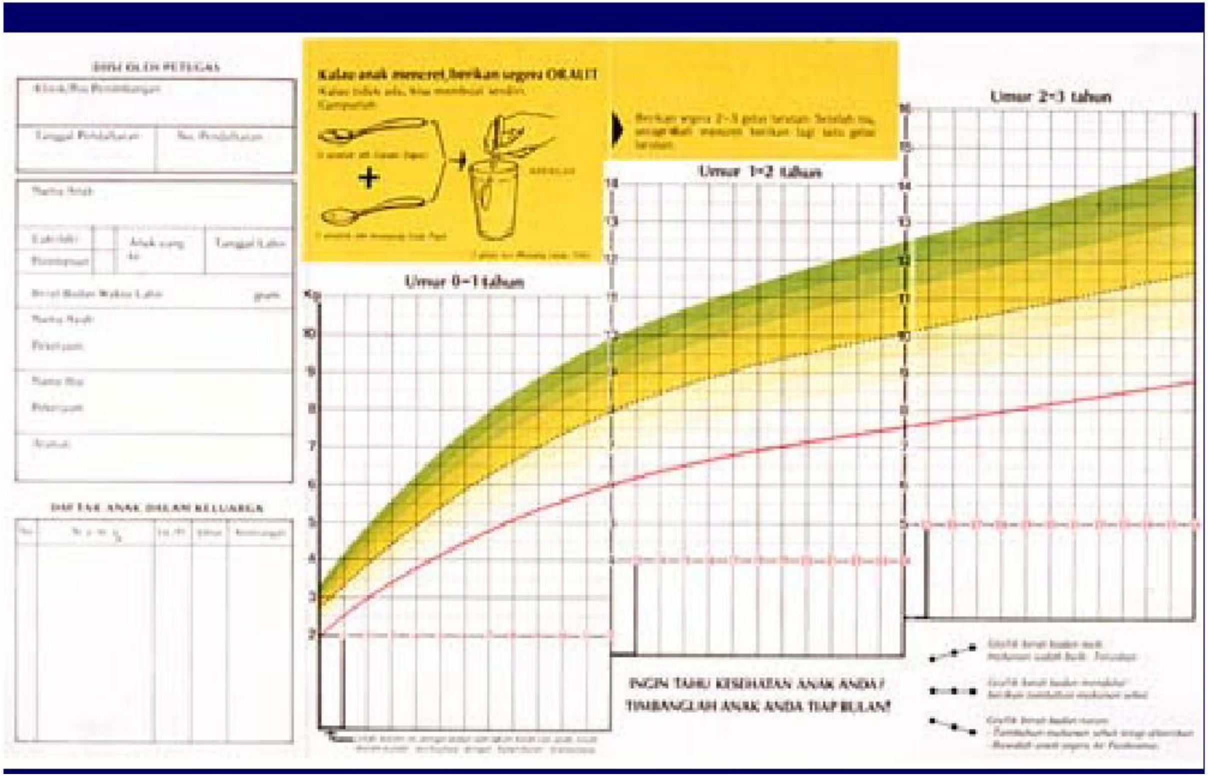
Essential features of a growth chart

- Uses weight for age
- Minimum: 50th and 3rd percentile of standard reference (NCHS)
- Monthly interval of ages
- Health care, immunizations, and illness record
- Teaching aid


Kalau anak mencret, berikan segera ORALIT
Umur 0−1 tahun
Umur 1−2 tahun
Umur 2−3 tahun
INGIN TAHU KESEHATAN ANAK ANDA?
TIMBANGLAH ANAK ANDA TIAP BULAN!

Growth Chart used in Indonesia

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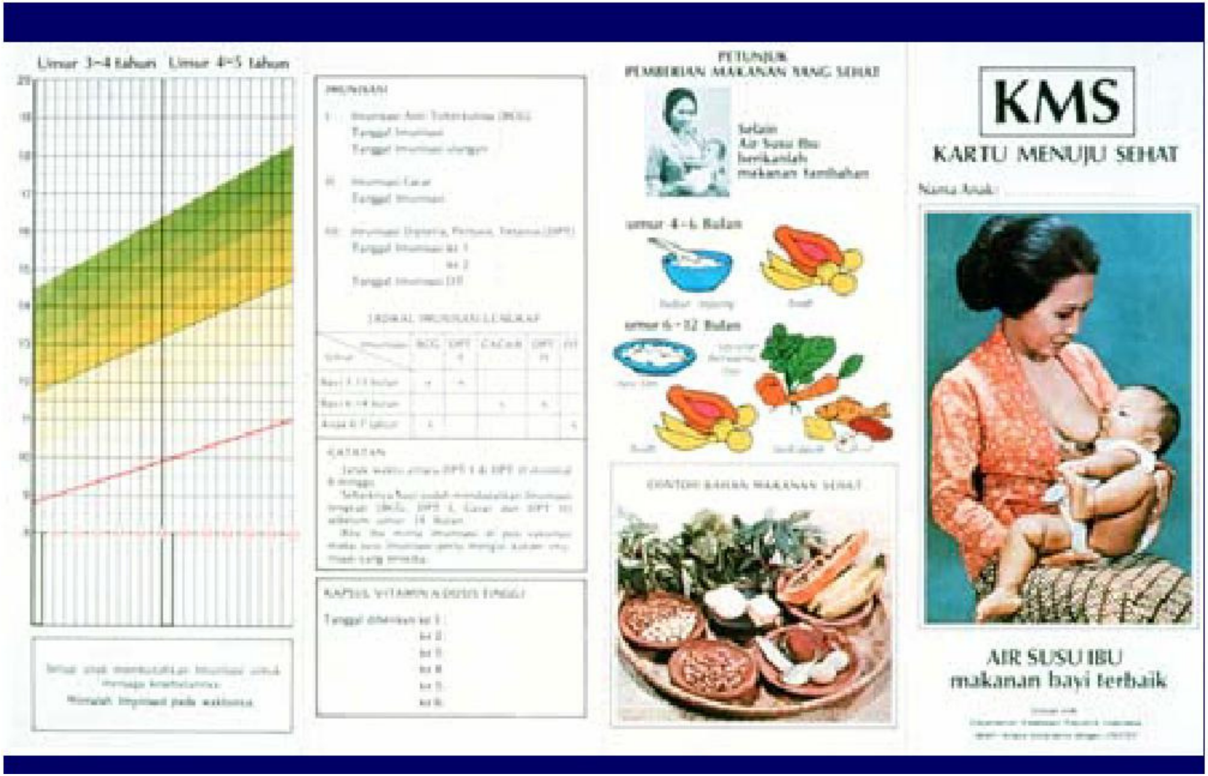

Flipside of the Indonesian GC

6 fundamental principles of GMP (WHO, UNICEF)

- weighing should be monthly, birth-24 m
- limited to 10-20 mothers/session
- home visits
- CHW training in listening and responding
- CHW supervision and support
- mechanisms in place to support community

community-
based action

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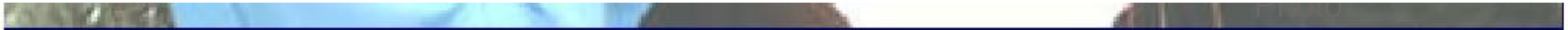
Requirements to make GMP successful

- Adequate worker knowledge and skills
- Time, communication skills and motivation of workers
- Discussion between mothers and workers regarding feasible solutions and actions
- Mothers understand messages and TRANSLATE information

into action



Indonesian Community Health Worker plotting GC in the presence of the mother and discussing the childs weight

Keith West

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Evaluation of good GM

(George et al, Lancet 1993)

- Community intervention : Villages randomized to two groups:
  - 6 GM villages (GM + NE)
  - 6 non-GM villages (NE)
- In the GM group GC were used to provide NE
- Weight was recorded in both groups every 4-5 mo

Worldwide practices in child growth monitoring

Table I. Coverage of Survey by Geographic Region

Geographic Region*	No. of Countries n=202	Response Received n (%)	Growth Charts Received n (%)
Africa	53	50 (94)	46 (87)
Asia	48	41 (85)	37 (77)
Europe	42	34 (81)	26 (62)
Latin America & Caribbean	34	30 (88)	23 (68)
Northern America	3	2 (67)	1(33)
Oceania	22	21 (95)	21 (95)
All	202	178	154

All Regions	202	178 (88)	154 (76)

* United Nations Regional Classification

Adapted from: De Onis M. et al. J Pediatr 2004;144:461-5

Table II. Anthropometric Indexes Used in Monitoring Child Growth (0 to 6 years) by Geographic Region

		Geographic Region*					
Anthropometic Index	All countries n = 145	Africa n = 46	Asia n = 34	Europe n = 21	Latin America and Caribbean n = 22	Northern America n = 1	Oceania n = 21
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Weight for Age	141 (97)	46 (100)	34 (100)	17 (81)	22 (100)	1 (100)	21 (100)
Length/Height for Age	59 (41)	4 (9)	15 (44)	19 (90)	11 (50)	1 (100)	9 (43)
Weight for Length/Height	33 (23)	4 (9)	7 (21)	9 (43)	8 (36)	1 (100)	4 (19)
Head Circumference for Age	48 (33)	1 (2)	14 (41)	18 (86)	5 (23)	1 (100)	9 (43)
Others	4 (3)		1 (3)	2 (10)			1 (5)

*United Nations regional classification.

**Head circumference for length, body mass index for age, mid-upper arm circumference for age, weight velocity for age.

Adapted from: De Onis M. et al. J Pediatr 2004;144:461-5

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Table IV. Problems Encountered by Health Care Workers with the Use of Growth Charts by geographic region

Problems Encountered	All countries n = 178	Africa n = 50	Asia n = 41	Europe n = 34	Latin American & Caribbean n = 30	Northern American n = 2	Oceania n = 21
	Geographic Region*						
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Interpreting Growth Curve	86 (48)	28 (56)	24 (59)	13 (38)	12 (40)		9 (43)
Inaccurate Plotting	71 (40)	20 (40)	18 (44)	9 (26)	12 (40)	1 (50)	11 (52)
Understanding Reference Curves	51 (29)	20 (40)	15 (37)	6 (18)	6 (20)		4 (19)
Lack of Trained Personnel or Equipment	13 (7)	5 (10)	3 (7)	2 (6)	1 (3)		2 (10)
Other Problems	44 (25)	13 (26)	9 (22)	10 (29)	8 (27)	1 (50)	3 (14)
No Problems	35 (20)	6 (12)	10 (24)	9 (26)	5 (17)		5 (24)

*United Nations Regional Classification

Adapted from: De Onis M. et al. J Pediatr 2004;144:461-5

Table 2. Adequacy of growth monitoring of children in different age categories according to the guidelines of the Integrated Nutrition Programme for South Africa*.

Age (yr)	*N*	% Monitored Adequately
0-<1	166	64
1-<2	154	70
2-<3	149	76
3-<4	146	81
4-<5	127	82

* Guidelines for minimum growth monitoring: 0-12 months, at least five times per year; 1-2 years, at least four times per year; 2-

five times per year; 1-2 years, at least four times per year; 2-
5 years, at least three times per year.

Adapted from: Faber et al; FNB 2003

Community-based GM in rural Kwazulu-Natal, South Africa

Maternal attitude using focus group:

- Poor growth was a concern, valued GM
- Learnt how to better care for children
- Good communication style of workers
- Encouraged that children were growing well
- Strong desire for project to continue

Faber et al, FNB 2003

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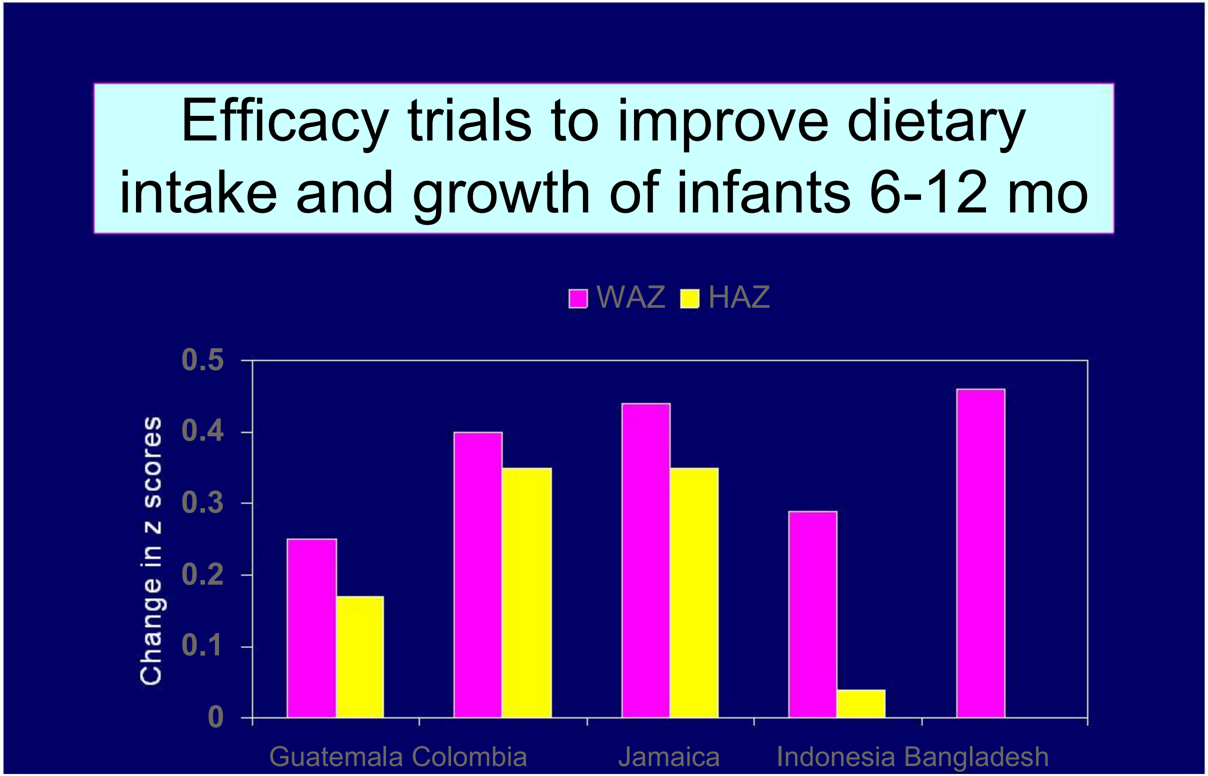
When can GMP have an impact.

When employed to take 3 types of actions

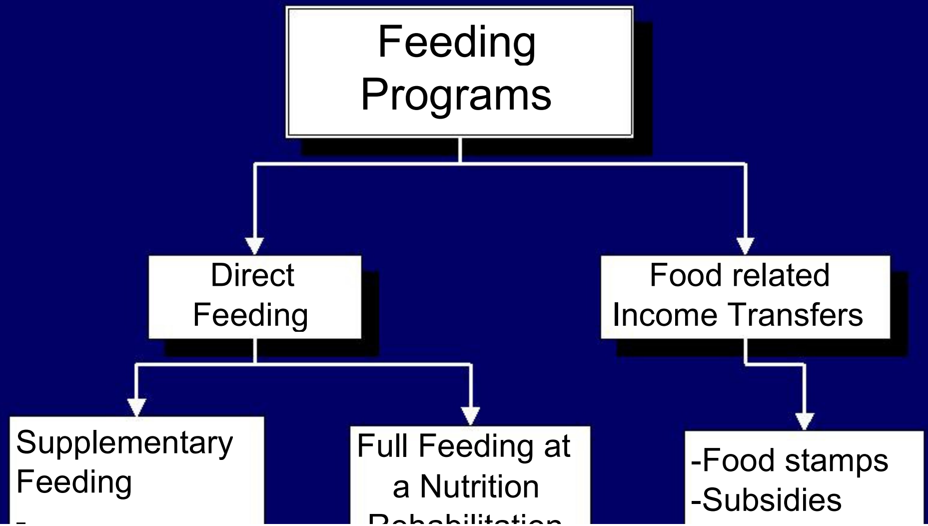
- Recommendations for individual childs care related to illness and feeding
- Community level action that can support families to maintain the growth of children
- Program activities targeted to households with special needs


Community-based
Nutrition Interventions
Supplementary feeding


Efficacy trials to improve dietary intake and growth of infants 6-12 mo
WAZ
HAZ
Change in z scores
0.5
0.4
0.3
0.2
0.1
0
Guatemala
Colombia
Jamaica
Indonesia
Bangladesh

Caulfield et al, FNB 1999

Types of feeding programs




- On-site
- Take Home
Rehabilitation Center
- Food for work

Supplementary Feeding

Purpose

To prevent or to alleviate undernutrition, through reducing the gap between an individuals actual consumption and requirements

Secondary -

To improve household food security through a food transfer effect

Supplementary Feeding

Definition:

Supplementary feeding consists of a prepared food to be consumed on-site or a food package intended for a particular target individual within a household but given to any member to be taken home

Supplementary foods

PL480 (Title II foods)
CSM corn soy milk
MPF multipurpose food
SFB soy fortified bulgar
WSB wheat soy blend
SM soy milk

Photo: Keith West

Photo: Keith West

On-site vs. take home feeding

ONSITE

- Highly targeted
- Children must be brought to feeding site
- Convenient location for a site
- Trained staff
- Food and operational

TAKE-HOME

- Fewer family demands
- Fewer feeding / food centers
- Fewer trained staff
- Less efficient
- Problems measuring success

costs

Targeting

- May be geographical, functional, individual
  - Needy areas
  - Population sub-groups (age, physiologic state)
  - Low weight for age or weight gain
- Reduces program cost (trade off between cost of screening and cost of a more expansive program)
- Selection of cut-offs (sensitivity and specificity)
- Cost effectiveness is high

Self-selection as a means of targeting

Common problems with supplementary feeding programs

- Irregular participation and delivery of food
  - Youngest and most responsive age group 6-24 mo least likely to participate
- Leakages
  - Poor targeting
  - Intrahousehold sharing
  - Substitution of normal diet
- Insufficient quantity and quality of food
- Insufficient calorie

density

Time cost (travel and waiting time)

Community Based Nutrition Interventions

Nutrition Education, Communications for Behavioral Change

Potential use of maternal size in priority setting for combating childhood malnutrition

Childrens wt/ht Z score	Mothers BMI < 18.5	Mothers BMI =18.5
Poor < -2.0	Food availability important	PH measures: maternal education
Adequate = -2.0	Maternal care good despite food deprivation	Low priority

James WPT et al EJCN, 1999

Nutrition Education : Definition

any set of learning experiences designed to facilitate the voluntary adoption of eating and other nutrition-related behaviors conducive to health and well-being.

-Contento et al 1995

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Theories and models of health behavior change

Triple A Model: Assess, Analyze, Act

5 Step Model:

- Assessment
- Planning
- Development
- Implementation
- Evaluation

Social learning theory

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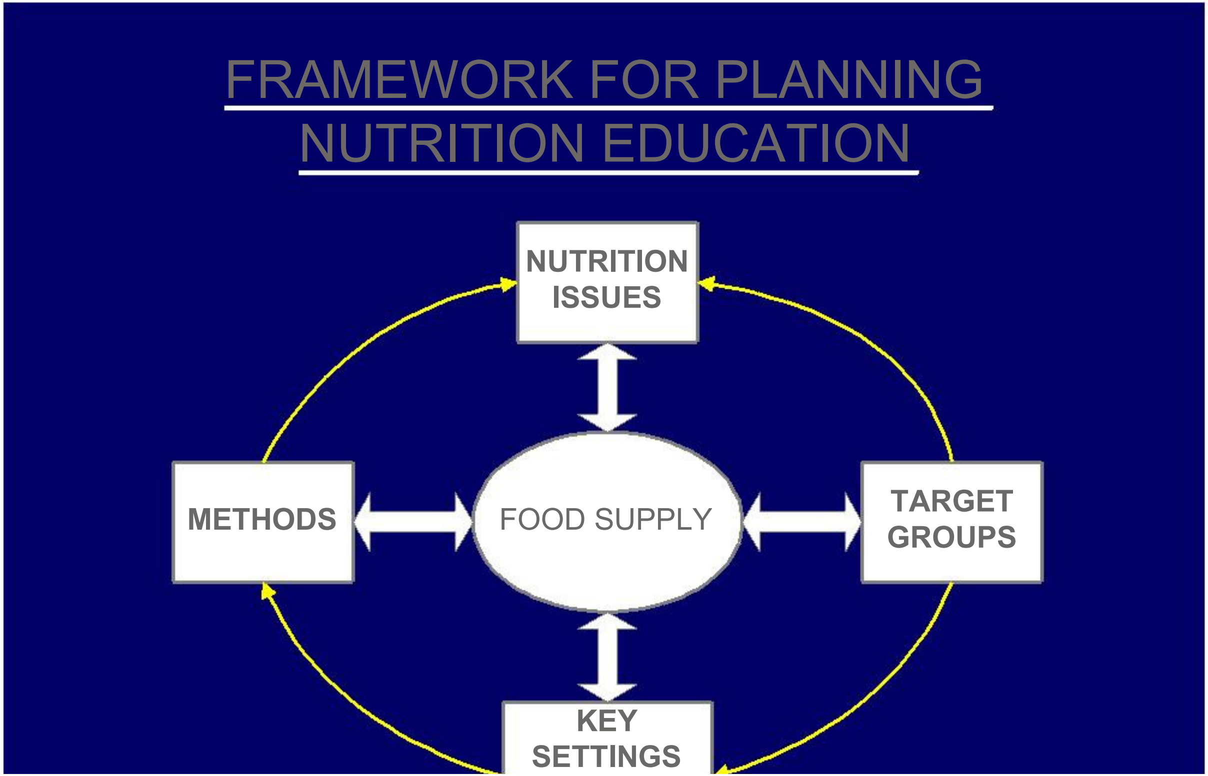

SETTINGS AND SECTORS

Food supply

Traditional role of nutrition education has been to increase the capacity of the household to use existing food resources to maximum advantage

e.g. nutrition education has focused on

- breastfeeding
- weaning
- dietary practices during infection & disease
- nutrition during pregnancy and lactation
- food

processing and
storage

Nutrition Issues

Nutritional status assessment

- Based on national nutritional **surveillance and dietary intakes**
- Use of recommended dietary intakes
- Guidelines for sub-groups

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TARGET GROUPS

PRIMARY TARGET GROUPS

POPULATION SUBGROUPS
- LIFE CYCLE APPROACH
- SPECIAL NEEDS

SECONDARY TARGET GROUPS

-TEACHERS, HEALTH WORKERS,
AGRICULTURISTS, MEDIA JOURNALISTS,
VILLAGE VOLUNTEERS ETC.

TERTIARY TARGET GROUPS

- POLITICIANS,
ADMINISTRATORS, DECISION
MAKERS

Method :SELECTION OF CHANNEL

FACE-TO-FACE

Either in groups or on one-to-one basis

MASS MEDIA

Based on marketing or communication models

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Face-to-face

ADVANTAGES

- INTERACTIVE
- RELIABLE
- PROVIDES SOCIAL SUPPORT
- ALLOWS FOR PERSONALISING
- APPROPRIATE SEQUENCING
- FOLLOW-UP EASY

DISADVANTAGES

- EXPENSIVE
- PENETRATION WEAK
- MAY ENCOURAGE DEPENDENCY
- MAY NOT BE ACCEPTABLE TO MANY PEOPLE

MASS MEDIA

ADVANTAGES

- CHEAP PER CONTACT
- LARGE NUMBERS REACHED
- MORE ACCEPTABLE
- MAY STIMULATE SELF INITIATED CHANGE

DISADVANTAGES

- WEAK ENGAGEMENT OF USERS
- UNRELIABLE
- DILUTION OF CONTENT
- FOLLOW-UP DIFFICULT

The *Positive Deviance* approach

Positive deviance refers to a phenomenon that exists in many resource-poor communities the finding that a few individuals and families employ uncommon, beneficial practices that allow them and their children to have better health as compared to their similarly impoverished neighbors

These behaviors are likely to be affordable, acceptable and sustainable by the wider community because their peers

are already
practicing them

The Hearth Model

- Haiti, Vietnam, Bangladesh
- Volunteer mothers trained to conduct feeding sessions (called hearths) in their homes
- Malnourished children fed one meal every day for 2 weeks
- Mothers observe the improvement in appetite, activity, growth of children
- Evaluations have shown significant

improvements in
nutritional status

Monitoring NE programs

Aim: to ensure that things are going well and to make mid-course changes if needed

Listing variables to be assessed

- individual program components
- activities
- workers
- media

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Evaluation of NE programs

Program evaluation assesses

- various program activities and elements
- the extent of behavior changes (and KA) in the target population as a consequence of the communication strategy
- impact on health, nutritional status, or other functional indicators

Designs: Before-After (with or without a comparison

comparison
group)

Face-to-face: Weaning food intervention-Nigeria

Guptill et al Soc Sci Med 1993

- Formative research to develop a culturally appropriate weaning food
- Recipe trials and testing acceptability
- Teaching a recipe to add toasted cowpea flour, red palm oil and sugar to maize or sorghum porridge

(eko ilera)

Evaluation of a weaning food intervention-Guptill et al Soc Sci Med 1993

Outcome	%
Knowledge	57
Trial	48

Adoption	17

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Evaluation of a NE program in the Philippines using incrementally more intensive programs

Control — Radio:
4 radio spots aired ~4xs day

Program 1 + Infant feeding course (Weaning Moments Sessions)
7 sessions on specific behaviors

Program 2 + Home Counseling
quarterly home visits by village volunteer


Klemm R, Thesis, 2002

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

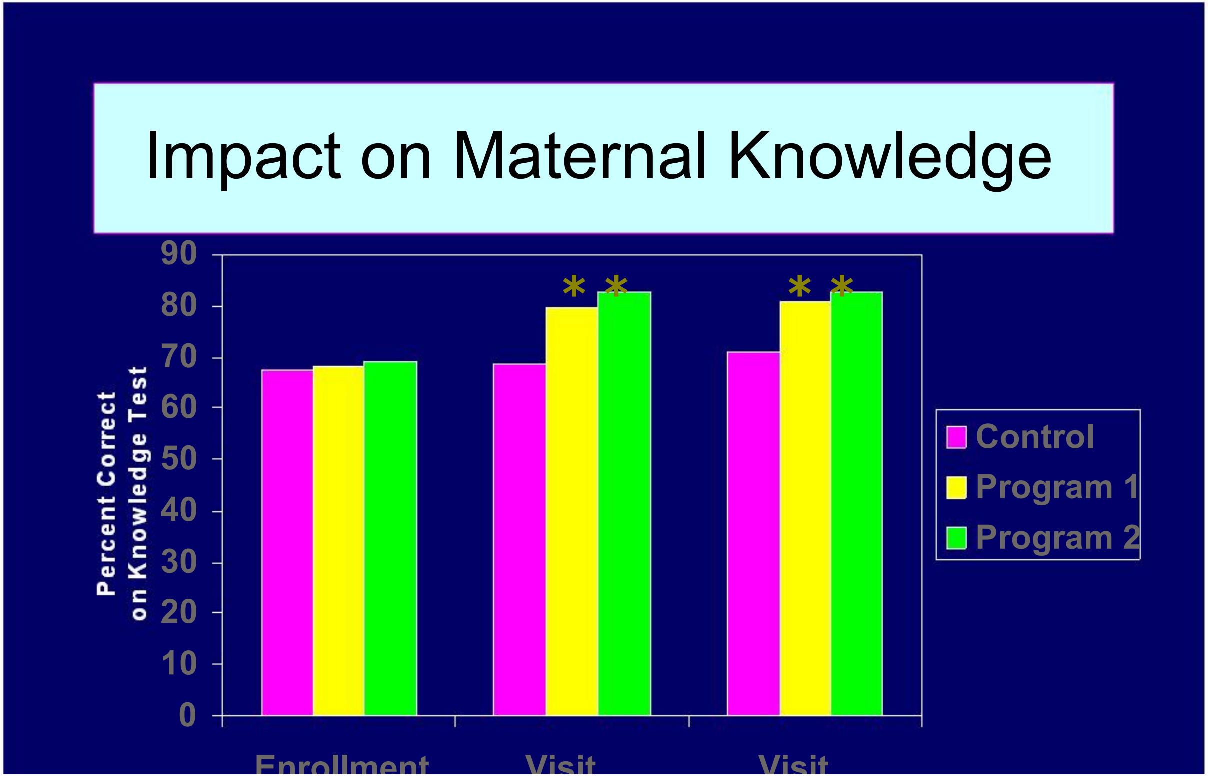
one + three

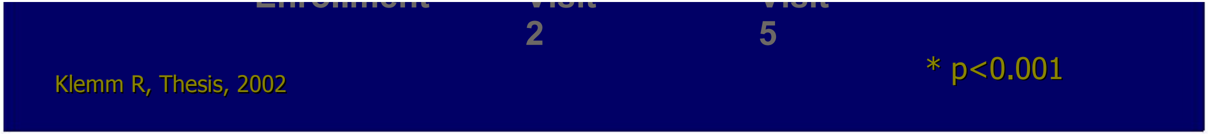
one=rice three=fish+vegetable+oil

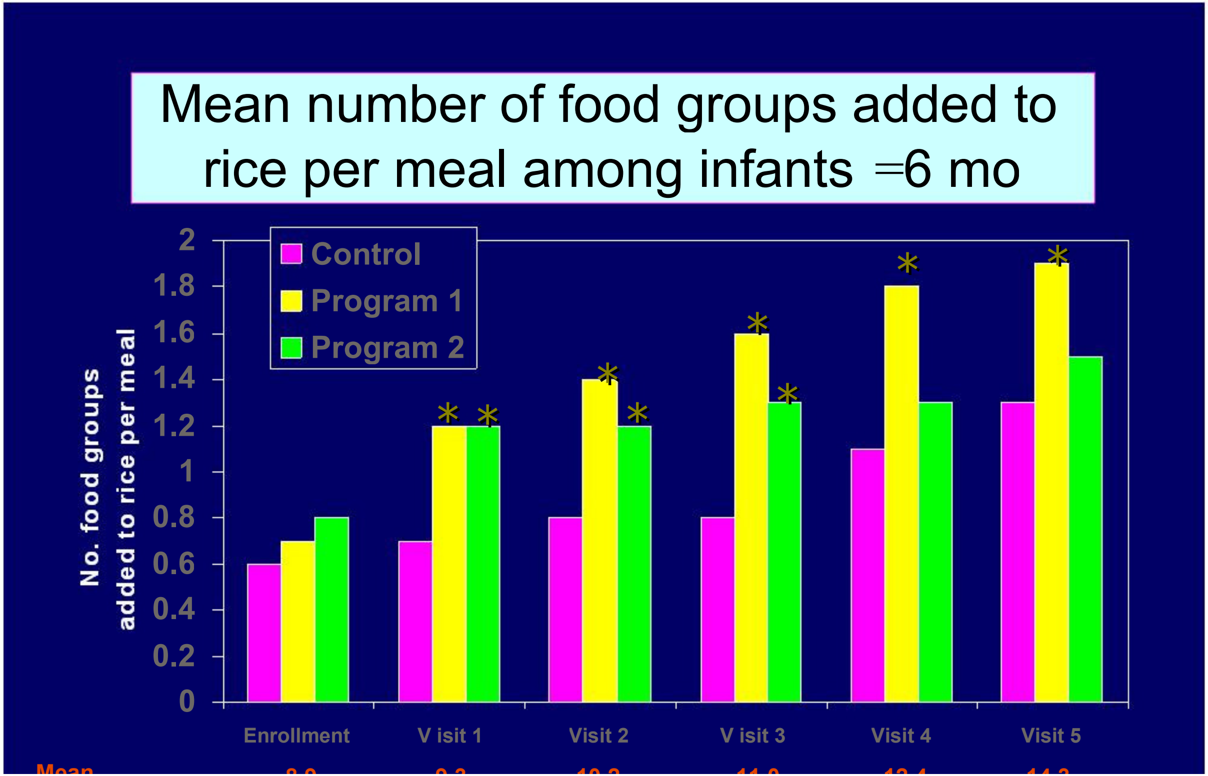
Photos: R. Klem


WEANING MOMENTS LESSONS
COUNSELLING CARDS
WEANING MOMENTS LESSONS
TRAINING ACTIVITIES
WEANING MOMENTS LESSONS
REFERENCE GUIDE
GO
GO
GO

Feeding demonstration during infant feeding course


Impact on Maternal Knowledge
Percent Correct on Knowledge Test
90
80
70
60
50
40
30
20
10
0
Enrollment
Visit
Visit
*
*
*
*
Control
Program 1
Program 2

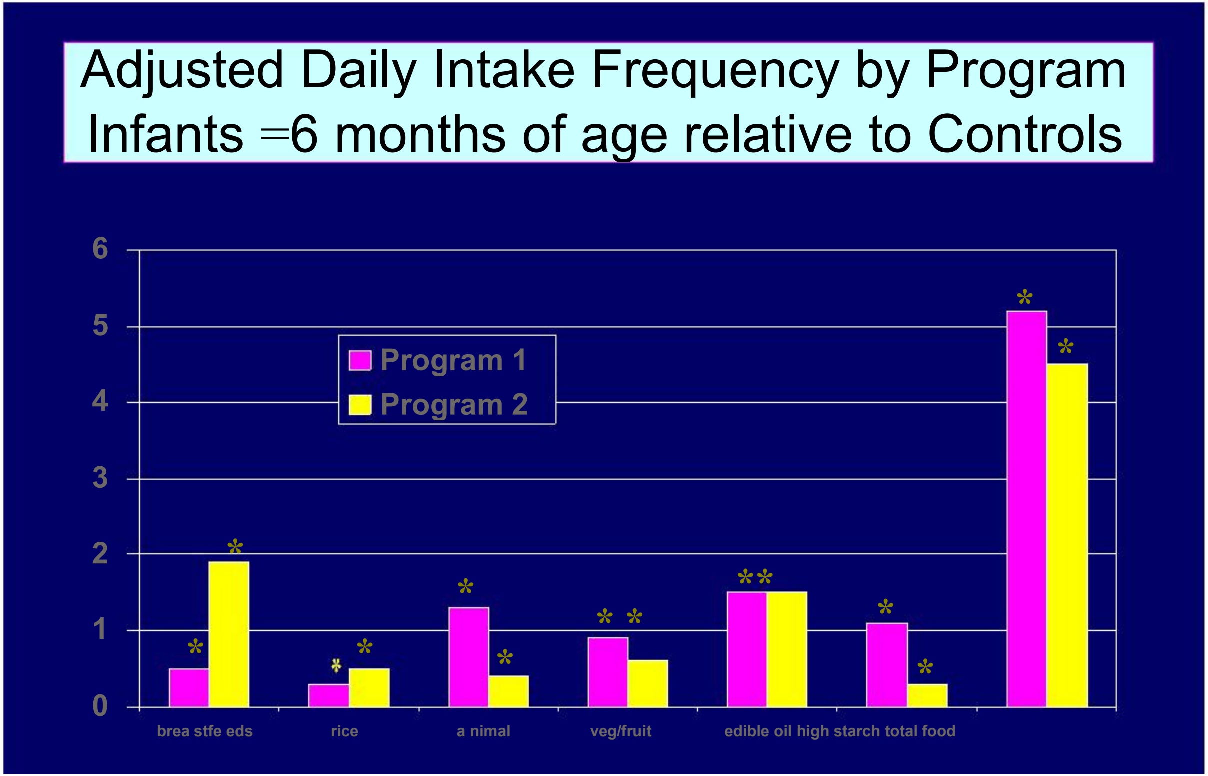

2
5
* p<0.001
Klemm R, Thesis, 2002


Mean number of food groups added to rice per meal among infants =6 mo
No. food groups added to rice per meal
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Control
Program 1
Program 2
*
Enrollment
V isit 1
Visit 2
V isit 3
Visit 4
Visit 5

Mean age at visit, months	8.9	9.3	10.2	11.0	12.4	14.3

Klemm R, Thesis, 2002

* $p<0.05$


Adjusted Daily Intake Frequency by Program
Infants =6 months of age relative to Controls
Program 1
Program 2
6
5
4
3
2
1
0
brea stfe eds
rice
a nimal
veg/fruit
edible oil high starch total food
*

Klemm R, Thesis, 2002

* $p<0.05$

Impact on linear growth

	Program 1 * (95% CI)	Program 2 * (95% CI)
Length, cm	0.32 (-0.17, 0.81)	0.62 (0.13, 1.12)
HAZ	0.11 (0.0, 0.36)	0.30 (0.15, 0.45)

*Adjusted for baseline status, age, sex, maternal education, household income, and follow-up time

Klemm R, Thesis, 2002

Characteristics of selected programs addressing malnutrition

Project	Type, Content	Coverage, Target Groups	Resources/Intensity
Bangladesh			
Bangladesh Integrated Nutrition Project (BINP)	Community-based nutrition; including supplementary food	Under 2s, pregnant and lactating women. 8M people (7% of population)	1 mobilizer (community nutrition promoter) per 1,000 population. $14M/yr. About $18/ person/yr

Overall: 10 large programs/service delivery systems are in the country study (most governmental); coverage usually <50 percent, esp. rural areas; in area covered, resources of trained and supported staff low. Expansion of coverage and increased intensity needed.

Gillespie & Haddad; ADB Nutrition and Development Series No. 4, ADB/UNU 2001

Project	Type, Content	Coverage, Target Groups	Resources/Intensity
India			
Integrated Child Development Services (ICDS)	By *anganwadi* worker (AGW) in centers in villages; includes supplementary food, health and education services	Children 0-3, 3-6 yr, pregnant and lactating women. In 3,900 of 5,300 blocks (74%). Less coverage of 0-3-yr olds	1 AGW/1,000 persons i.e. 200 children; 1 supervisor/20 AGWs. Suppl. food takes substantial resources. Nonfood costs about S2/yr
Public Distribution System (PDS)	Subsidized food and basics via fair price shops (FPSs)	Poor are targeted, but much leakage. Coverage 85% of areas	350,000 FPSs, 1/2500. About 20kg/person/yr cereals distributed
Tamil Nadu Integrated Nutrition Project (TINP)	Via paid community nutrition workers (CNWs). Feeding for underweight, plus services	Children 6-36 mo, pregnant and lactating women; those with growth failure. 40% of blocks, 20% children participated in 1990. TINP II, 0-6-yr children	$9/person/yr ('85), + $3 on food, was estimated. TINP II supervision ratio 1:10. 1 CNW: 300 children
Others: many programs, e.g., poverty alleviation (IRDP, NREP-employment guarantee-JRY) are relevant; coverage usually poor for worst-off, and $/head low.			

Overall: In a country this size, state level analysis is needed. Generally a considerable number of relevant programs with incomplete coverage (<50 percent often), usually targeted away from the most needy and under-resourced. Some content issues arise, e.g., ensuring that youngest children and pregnant women are reached; food distribution, via ICDS as supplementary, or PDS noon meals, etc., have not been evaluated for cost effectiveness and may not be optimal for nutrition.

Gillespie & Haddad; ADB Nutrition and Development Series No. 4, ADB/UNU 2001

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Project	Type, Content	Coverage, Target Groups	Resources/Intensity
Sri Lanka			
Thriposha	Supplementary food distribution, fortified via (?) health system	Pregnant women (2nd+3rd trimester), 6-12 mo, 12-48 mo children meeting eligibility criteria. 32% covered	$2/person/yr 200 kcals/person/day
Samurdhi	Income-support program, with eligibility, countrywide; also includes some nutrition work, and could be basis for wider nutrition program	Poor households (hh), from income criteria. *Samurdhi* workers are in all areas	Not given, but income support can be around $100/hh/mo
Participatory Nutrition Improvement Project (PNIP)	Pilot community-based project, with local mobilizers and external facilitators (EFs); education, referral, community development	All hhs in pilot areas, with focus on preschoolers, pregnant and lactating women	1 EF per 300 children; 1 CF/30 children Evaluation needed of cost-effectiveness

Overall: Extensive health infrastructure (e.g., 95 percent of babies delivered in facilities) and poverty alleviation (*Samurdhi*) system give great opportunity for effective nutrition work, which is still much needed even with good services. Pilot exercises need evaluation lessons to be drawn for strengthened program design.

Gillespie & Haddad; ADB Nutrition and Development Series No. 4, ADB/UNU 2001

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Project	Type, Content	Coverage, Target Groups	Resources/Intensity
Cambodia			
Community Action for Social Development (CASD)	Supported by a range of agencies, esp. UNICEF, through village development committees (VDCs); several hundred local programs. Education, food, water, health, protection of women and children, credit, employment	400,000, especially women & children, 20%. 550 villages/2,000	$4M/yr = $11/person/yr

Gillespie & Haddad; ADB Nutrition and Development Series No. 4, ADB/UNU 2001

Project	Type, Content	Coverage, Target Groups	Resources/Intensity
Viet Nam			
National Programme of PEM Control for Children (CPCC)	Community-based with village collaborators (paid). Nutrition education, growth monitoring (GM) rehabilitation, referral	Children <5yrs and pregnant women. 53 provinces. 2M children (15%) weighed in GM	1 collaborator/ 450 children (1994). \$0.8/child/yr
Pilot Community-based Child Nutrition Project	More intensive than CPCC, links to micro credit, commune steering committees	14 communes (out of 500). 10,000 covered	15-20 children/ mobilizer; \$2.6/child/yr

Gillespie & Haddad; ADB Nutrition and Development Series No. 4, ADB/UNU 2001

Evaluation of the impact of a $60 m nutrition program in Bangladesh

Table 2. Some characteristics of households in the project and non-project areas (n=6815).

	Project area (n = 4539)	Non-project area (n = 2276)	Difference in prevalence (95% confidence interval)	Adjusted two sample t-test p value
Proportion of heads of household who are male (%)	94.1	95.2	1.1 (-0.3 2.5)	---
Proportion of heads of household having some formal education (%)	41.5	43.5	2.0 (-2.3 6.3)	---
Proportion in lowest SES class (%)	71.1	74.5	3.4 (0 6.8)	---
Average bedroom size (square	288.0	299.0	---	p = 0.11

feet)				
Average family size	6.3	6.2	---	p = 0.70

Adapted from: Hossain et al; Hlth Policy & Planning 2005

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Evaluation of the BINP

Table 4. Differences in the knowledge and practice of mothers in the project and non-project areas. All questions were asked about the youngest child in the house (aged more than 6 months).

	Project (n=3872)	Non-Project (n=1967)	Difference in prevalence (95% confidence interval)
Knowledge			
Should take rest during pregnancy	77.6%	70.2%	7.4% (4.2 10.6)
Should give colostrum to newborn	63.1%	52.5%	10.6% (5.9 15.3)
Know how long to exclusively breastfeed	78.0%	69.5%	8.5% (5.5 11.5)
Know when to give complementary food	63.9%	64.7%	0.8% (-2.7 4.3)
Know benefits of iodized salt	32.4%	40.1%	7.7% (3.5 11.9)
Practice			
Take rest during pregnancy	59.9%	53.5%	6.4% (3.4 9.4)
Take iron tablets during pregnancy	58.7%	23.8%	34.9% (31.1 38.5)
Have iodized salt in the house	70.0%	62.9%	7.1% (2.4 11.8)
Give colostrum to newborn	77.6%	73.1%	4.5% (1.4 7.6)
Exclusively breastfeed for 5/6 months	3.7%	4.8%	1.1% (-0.6 2.8)
Give complementary food at 5/6 months	56.9%	48.5%	8.4% (4.8 12.0)

Attend at least three antenatal checkups	42.1%	31.6% (28.1 35.5)	10.3%
Dispose of faeces correctly	30.2%	20.6%	9.6% (4.7 14.5)

Adapted from: Hossain et al; Hlth Policy & Planning 2005

Evaluation of the BINP

Table 3: The prevalence of severe and moderate underweight, stunting, and acute malnutrition in project and non-project areas in children aged 6-23 months (n=2388).

	Project (n = 1598)	Non-project (n = 790)	Difference in prevalence (95% confidence interval)
Severe low WAZ (< - 3 z-scores)	11.4%	12.1%	0.7% (-2.2 3.6)
Moderate low WAZ (= - 3 z-scores and < -2 z scores)	35.2%	36.3%	1.1% (-3.3 5.5)
Severe low HAZ (< - 3 z-scores)	11.6%	12.4%	0.8% (-2.4 4.0)
Moderate low HAZ (= - 3 z-scores and < -2 z scores)	27.5%	27.6%	0.1% (-3.8 4.0)
Severe low WHZ (<- 3 z-scores)	1.0%	1.1%	0.1% (-0.7 0.9)
Moderate low WHZ (= - 3 z-scores and <	13.4%	14.3%	0.9% (-2.2 4.0)

-2 z scores)

WAZ = weight-for-age z-scores; HAZ = height-for-age z-scores; WHZ = weight-for-height z-scores.

Adapted from: Hossain et al; Hlth Policy & Planning 2005

Methods of community participation used in 17 nutrition programs

(ACC/SCN 1991)

Method	n
Village committees (created or strengthened)	11
Local community members as staff	14
Community contribution of other resources	7
Linkage to other	7

Linkage to other community organizations 7

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Examples

Nutrition and PHC Program in Thailand:

Food production for supplementary feeding is done at village level with proceeds from sale of excess harvest put into a nutrition fund

Weaning Food Project in Ghana:

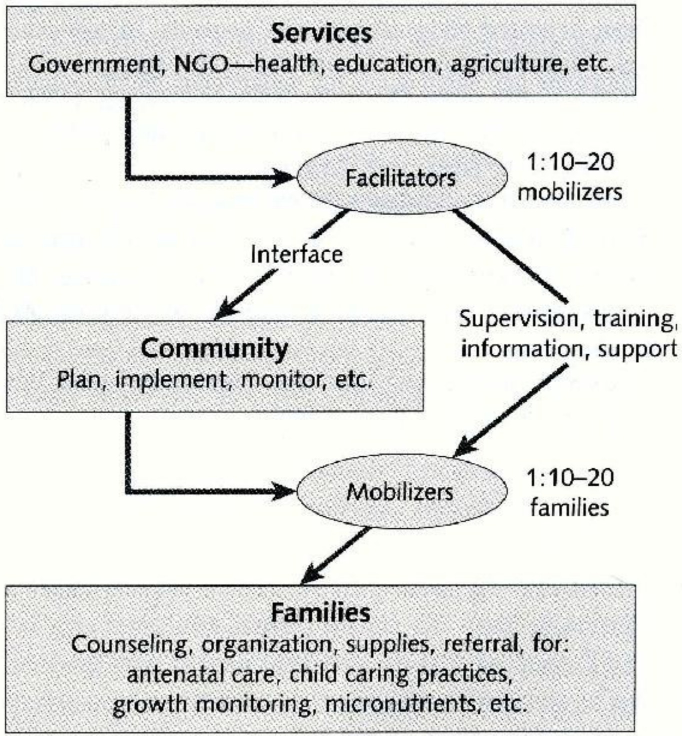
Village committees run and maintain corn mills and supervise Weanimix preparation

Family Nutrition Improvement Program in Indonesia:

Community responsible for running

weighing posts and record keeping activities

aid for GMs



Mason et al; ADB Nutrition and Development Series No. 3, UNU 2001

FIG. 4.1. General structure for community-based programs, based on Thailand. Source: adapted from K. Tontisirin, personal communication, 1996; and ref. 9, p. 50

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Comparing costs per beneficiary (US$) for selected programs

Project, Country	Components	Cost $
NNCHP, Costa Rica	SF, NE	21
ISHN, The Gambia	GM, SF, NE	55
TINP, India	GM, SF, NE	9-12
UPGK, Indonesia	GM, SF	2, 11
JSNP, Tanzania	GM	17

JSNP, Tanzania	GM	17

Cost effectiveness

Should costs be considered in terms of all recipients, the needy (target group) recipients, or recipients in whom a measurable improvement is observed: e.g.

Cost per child per y : US$ 13-94

Cost per needy child (with calorie deficit): US $ 15-112

Cost per malnourished child: US $ 45-290

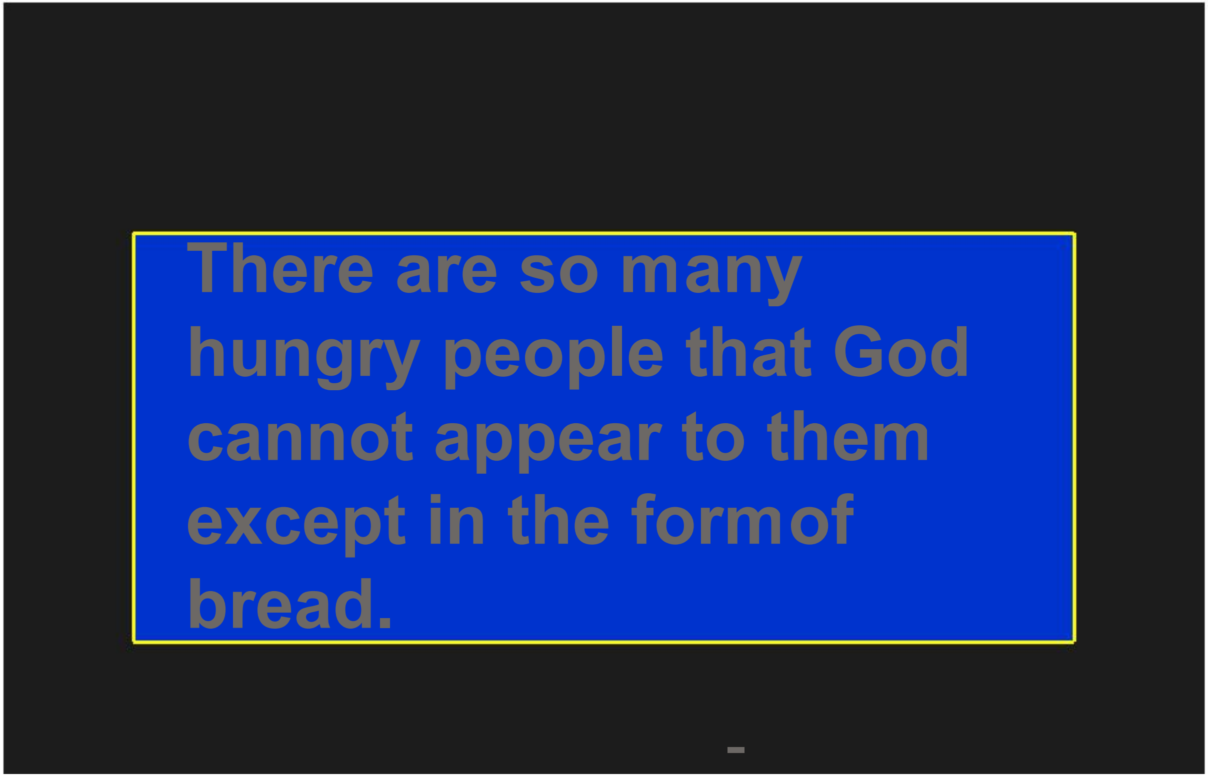
JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

International Nutrition

FAMINE

Keith P. West, Jr. DrPH, MPH


Photo: Keith West


There are so many hungry people that God cannot appear to them except in the formof bread.


Gandhi

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Pathophysiology of Starvation

- Muscle wasting
- Appetite diminishes
- Growth slows/stops
- Weight lost
- Behavior changes:


listless,
apathetic, confused
Photo: Keith West

Definitions of Famine

(Food supply based: inadequate)

- Widespread food shortage leading to significant rise in regional death rates (Blix et al, 1971)
- Sudden, sharp reduction in food supply resulting in **widespread** hunger (Brown & Eckholm, 1974)
- A community syndrome (Curry, 1978)

1978)

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Definitions of Famine
(Food consumption-based)

Sudden collapse in level of food consumption of large numbers of people (Scrimshaw, 1987)

Lack of food over **large geographical areas** sufficiently **long and severe** to cause **widespread disease and death from starvation** (Chambers Encyclopedia)

Encyclopedia)

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Famine Definition

(Mortality based)

Unusually **high mortality** with unusually severe threat to food intake of **some segments** of a population

**M.
Ravillion,
1997**

Famine Definition
(Food consumption based)

A **set of conditions** that occurs when **large numbers** of people in a region **cannot obtain sufficient food**, resulting in **widespread, acute malnutrition**

Fred Cuny, 1999

By the year 2000 eliminate

- Famine and related deaths
- Starvation
- Man-made disaster-induced deficiencies
- Iodine deficiency
- Vitamin A deficiency

- ICN, Rome, 1992

Early Biblical Famine Accounts

Genesis 12:10	Famine grievous in the land
Genesis 41:15-57	Joseph interprets Pharoahs dream/ predicts famine
Genesis 47:4-26	Joseph manages

famine

Biblical Famine: Forerunner of Modern Concepts

7 fat and 7 lean kine

Lean kine ate fat kine

Officers appointed to collect 1/5th of crops in years of plenty

Joseph SOLD stores to Eygptians

Israelites sojourned from Canaan to Egypt

Money failed; bread for livestock

Early Warning System: 7 yr of plenty & 7 yr of famine

Food stock depletion

Famine commission; taxes to build buffer stocks

Food aid (Title 2or Title 1!)

Mass migration

Failure of monetary economy

Bartering

Seed distributed
to sowers
Pharoah's new land

away
Land transfers, indenturing
live
assets

Famines have Influenced Power Struggles throughout Human History

Famine swelled ranks of **Crusades** (12th C)

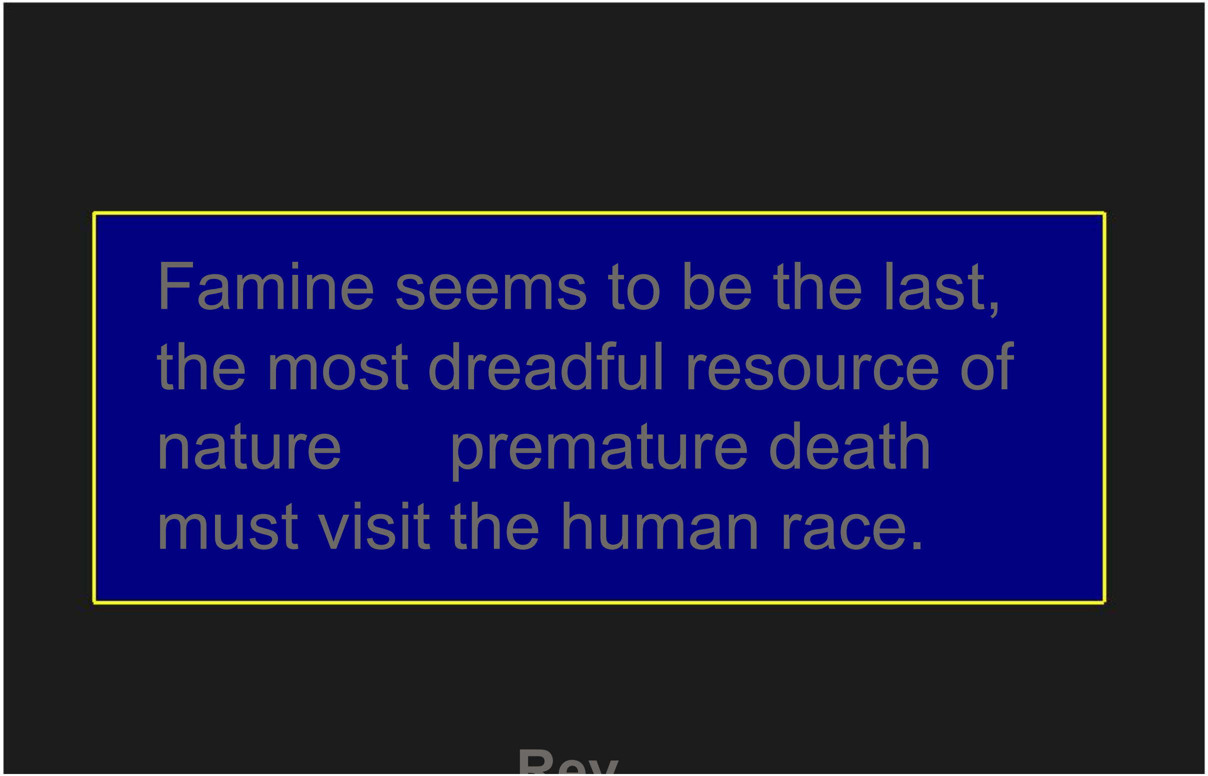
Peasants stormed **Bastille** following spikes in bread prices (Fr Revolution) (1789)

Famines preceded **Bolshevik** Revolution

Great Leap Famine preceded the Cultural Revolution in China (1958-59)

Ethiopian famine preceded the overthrow of Haile Selasi (1974)

Famine (possibly) brought **N Korea** regime to fully understand potential consequences


Famine seems to be the last,
the most dreadful resource of
nature premature death
must visit the human race.

Rev. T. Malthus, 1798

The Great Irish Famine
From 1846-48.

Attributed to failure of potato crop due to a fungus

~1.5 million died
~1.5 million migrated

Class famine (market failure): Farming peasantry

most
affected

Ireland: 1846-47

Potato blight

No money among peasants

No effective demand for food

No peasant markets

No food for peasantry

Plus Food exports

Laissez Faire policy

Several Major Famines in the 20th Century

China: 1959-60
Russia: 1918-21
Ukraine: 1931-34
India: 1943
Bangladesh: 1974
Ethiopia: 1974; 1984-85
Somalia: 1992-93
Sudan:1984-85; 1998
East

East Timor: 1978

North Korea: 1997-98

Famine in Post Czarist Russia 1918-1921

- Lenin empowers Commissariat of Food to extract grains from peasants
- Peasant uprisings
- Communists wage class warfare
- Grain production fell to 1/2 of 1914
- Massive international relief in 1921

Stalins Reign of Terror

1928: Stalin initiated collectivization

1929: Peasant land merged into factory-farms
Peasants organized into brigades

Rich peasants (kulaks) killed
Grain stocks seized
Peasants rebelled, destroyed livestock/grains

$\Bigg\}$ Destroyed food production capacity and markets in grain belt (esp the Ukraine)

1930-33: Massive food shortages

7 million died

Ukraine Famine: 1931-34

- Stalin used famine to crush Ukraine Nationalism/Cossack rebellion
- Militia guarded grain stores
- Grains shipped out of Ukraine
- Ukraine covered with corpses
- Widespread reports of cannibalism
- 5 (of 7) m who died in Russia in 1933-4 from famine died in

Ukraine

Covered up for decades

Famine in China

108 BC to 1911 AD:

1828 major famines

J.

Becker,
1996

Northwest China: Famine of 1927

60 million affected; 3-6 million perished

Horrid descriptions of famished in rural areas

But also there were

Rich men, grain hoarders, money-lenders, landlords with armed guards to defend them

Cities with plenty of grain

and food

China Intl Famine Relief Commission

Western China: Famine of 1929

Famine started with severe drought

Destitution caused by millions of armed men, crushing exactions from landlords, enforced taxation and poor government

Intl

American Red Cross

Famine
Relief
Commission

Great Leap Famine in China 1959-1961

- Worst famine in human history ; until recently, least well-known
- Estimated 30 million deaths
- Followed a decade of investment in heavy industry vs agriculture, state monopolization, land reform, collectivization and commune formation, heavy

taxation, market restrictions

DL Yang, Calamity & Reform in China 1996

The Great Leap Famine: References

Yang DL. Calamity and Reform in China: State, rural society and Institutional Change since the Great Leap Famine. Stanford, CA: Stanford University Press, 1996.

Becker J. Hungry Ghosts: Mao's Secret Famine - The First Full Account of the Tragedy that Claimed over 30 Millions Victims. New York: The Free Press/Simon & Schuster, Inc 1996.

Newman LF (ed). Hunger in History: Food Shortage, Poverty and Deprivation.

Oxford: Blackwell, 1992.

Indian Famines

Vulnerable groups

Agricultural laborers

Rural artisans

Bengal Famine of 1943

Cause: Shortage of rice supply for consumption

- Famine Inquiry

- Famine Inquiry
Commission

Bengal Famine of 1943

Rice Supply

~5% lower than previous 5 years

13% higher than 1941

9% higher per capita than 1941

Amartya Sen, 1978

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Bengal Famine of 1943

Class Famine

Rural event: . prices + . wages

Target groups: fisherman, transport workers, agricultural labor

War economy: fears of invasion fueling stockpiling, hoarding,

trade
restrictions A. Sen, 1978

Famine in Bangladesh: 1974

Need to know abnormal conditions from normal stresses


Courtesy of CIA World Factbook

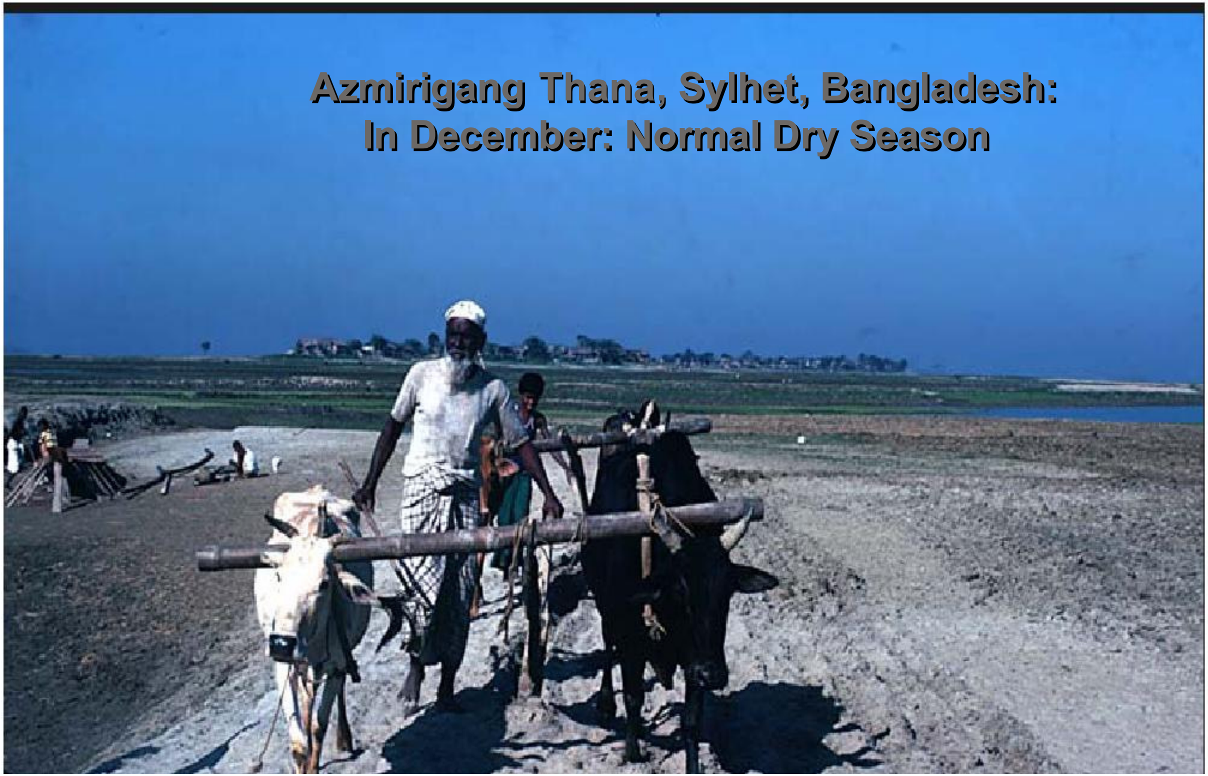
Azmirigang Thana, Sylhet, Bangladesh:
In December: Normal Dry Season


Photo: Keith West

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Photo: Keith West

Bangladesh: Pre-1974 Famine

1970	War, refugee migration
1971	Partial crop failure
1972	Continued crop failure More refugees
1973	Partial monsoon failure

1974	Flood

Estimated Production of Rice in Bangladesh During 1967-1974

Year	Total Domestic Production
1967-1968	110.53
1968-1969	112.57
1969-1970	119.19
1970-1971	110.79
1971-1972	98.87 (~15% decline)
1972-1973	100.20 (~15% decline)
1973 a	118.01 (Famine

-	year: normal food prodn)
1974	

[a] Estimated. M. Rahman, Ecol of Food & Nutr 1978

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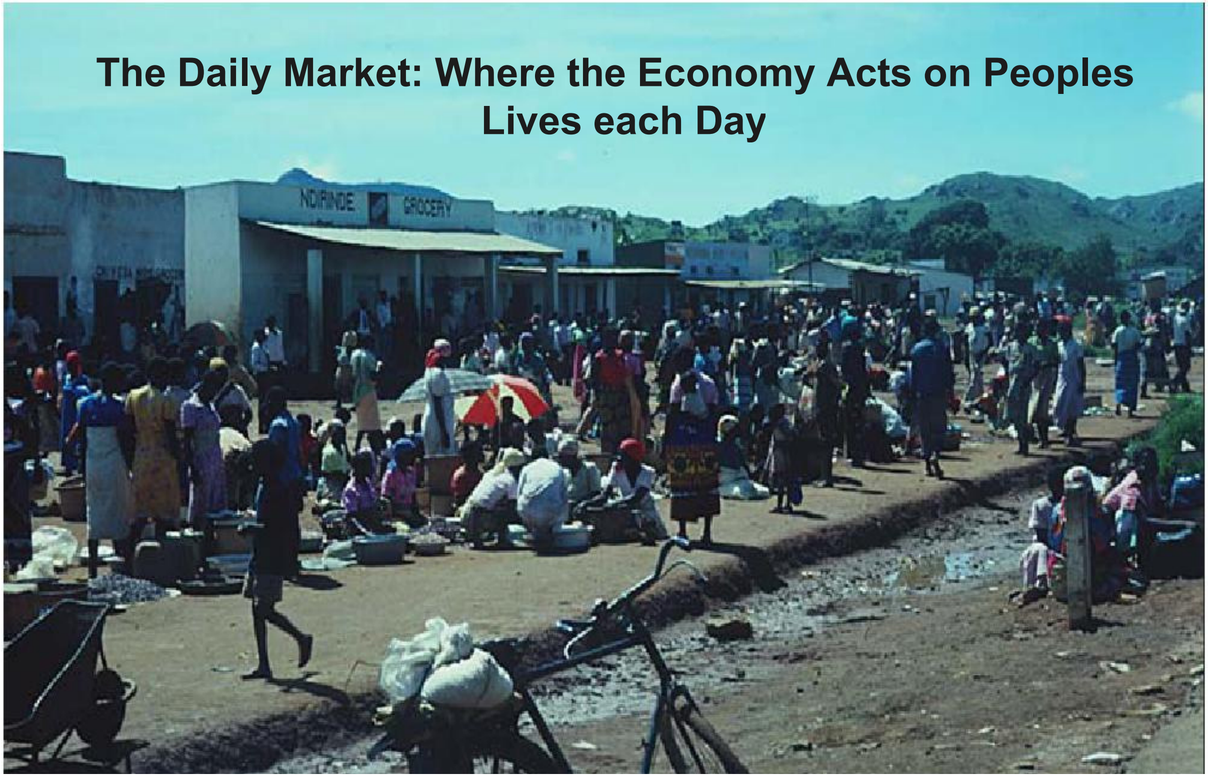
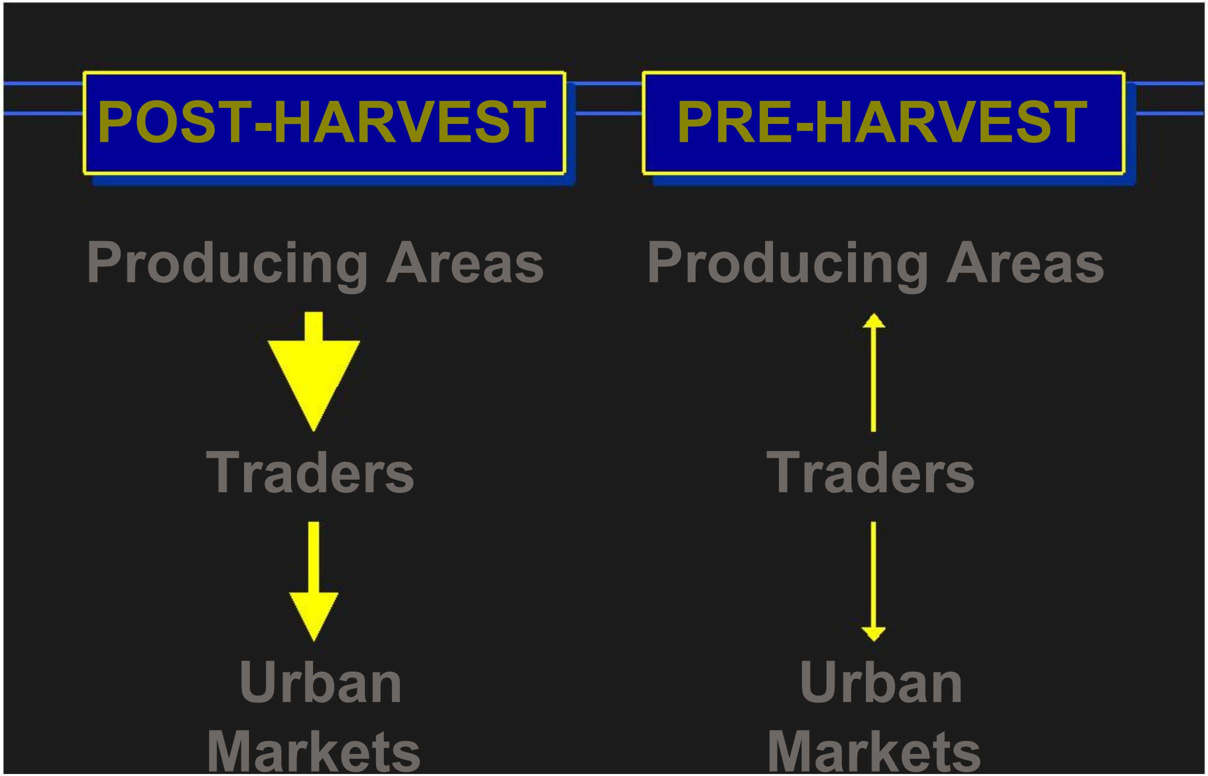
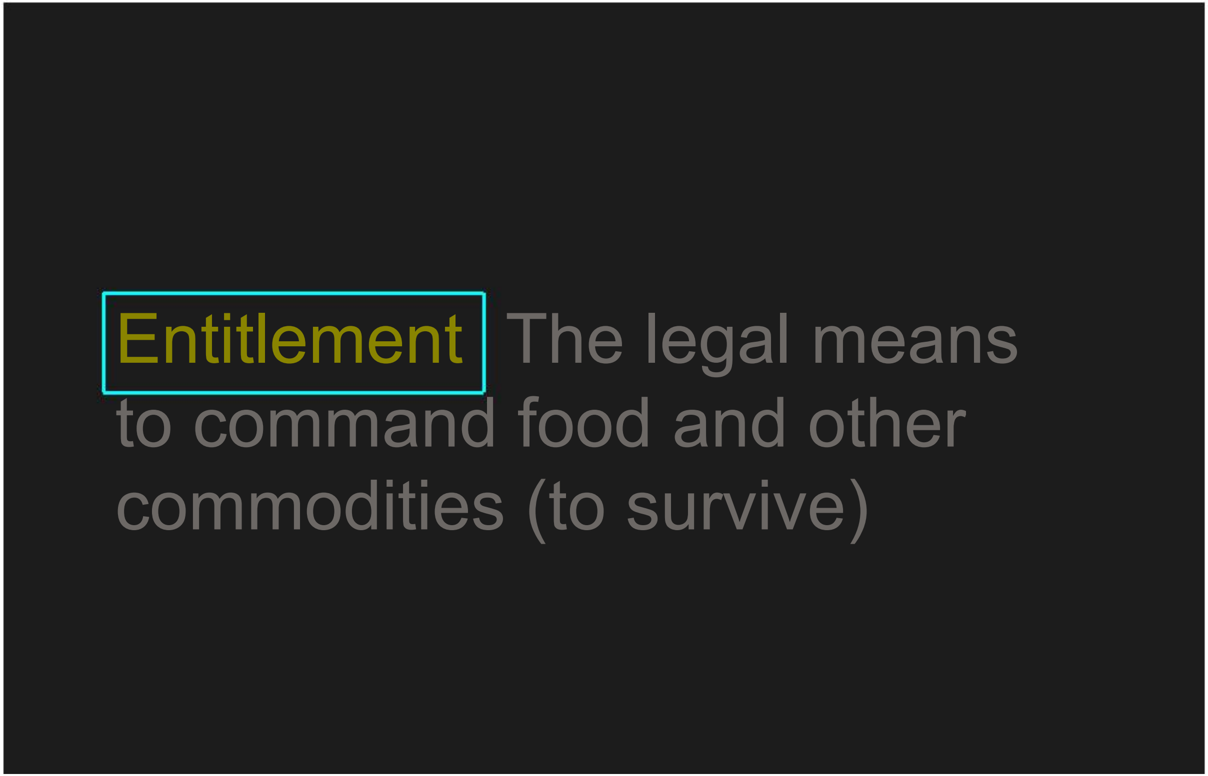



Photo: Keith West


POST-HARVEST
PRE-HARVEST
Producing Areas
Traders
Urban Markets
Producing Areas
Traders
Urban Markets

Starvation is a matter of not **having** enough food to eat, not a matter of there **being** enough food to eat.

A.K.
Sen


Entitlement The legal means
to command food and other
commodities (to survive)

Entitlement has two components:

Endowm **ent**

(resources to exchange; internal)

Exchange Opportunities

(cost of living; external)

Endowment

Labor (ability to perform work)

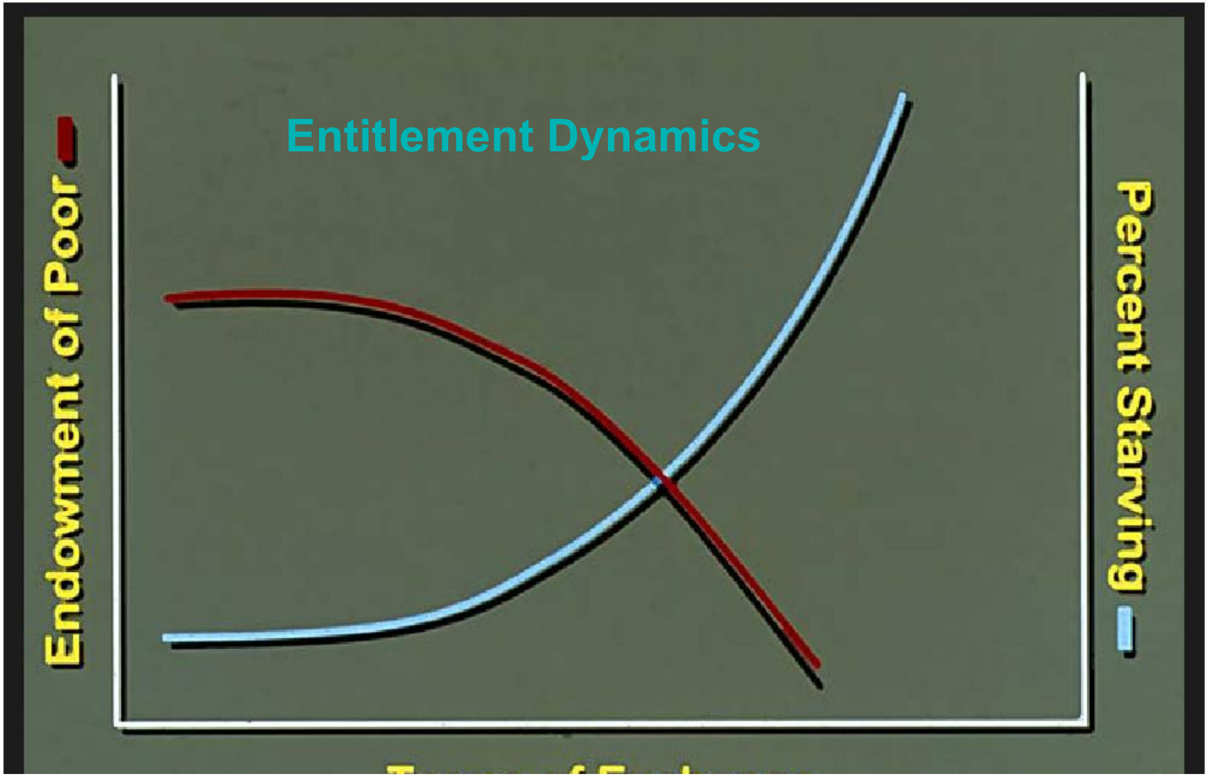
Cash or credit

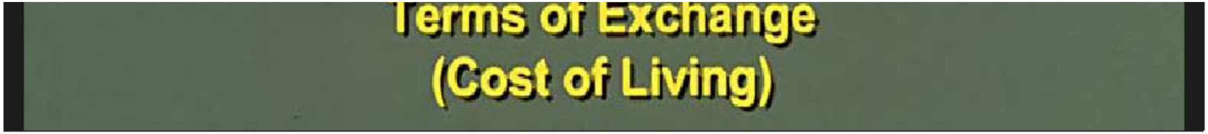
Assets (to exchange for food)

Food Exchange Entitlements

Opportunities the market offers to a person to exchange other commodities (money, labor, barter, etc.) for food.

A.K. Sen


Entitlement Dynamics
Endowment of Poor
Percent Starving


Terms of Exchange
(Cost of Living)

Households cope with changes in food production, prices, wages and employment by:

- Changing cropping patterns
- Intensifying off-farm work
- Remitting food aid for income
- Drawing on savings
- Selling assets
- Borrowing money
- Migrating for work
- Cutting

back
Reducing non-food spending
meals

Coping Strategies Phases: Buffers FromFam ine

Risk Insurance minimize risk/ manage shortfalls

Endowment Loss depleting key assets to survive this crisis

Destitution migrating to

survive

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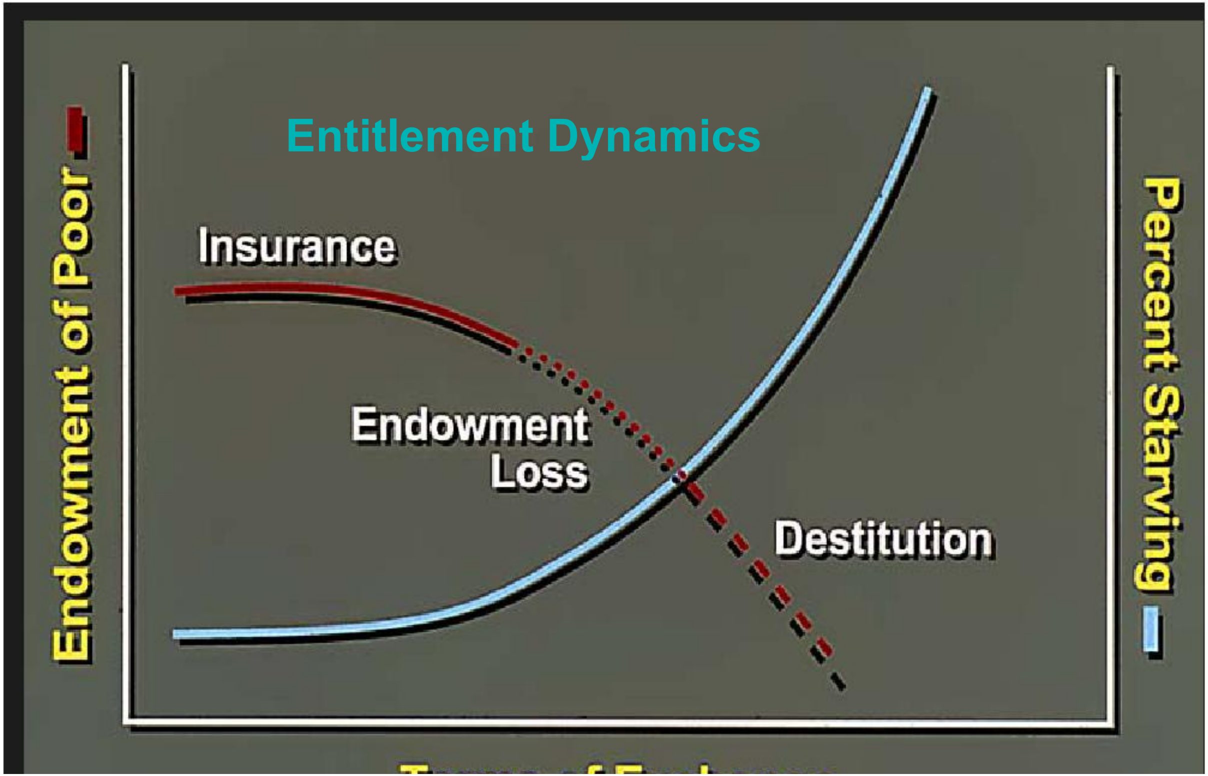

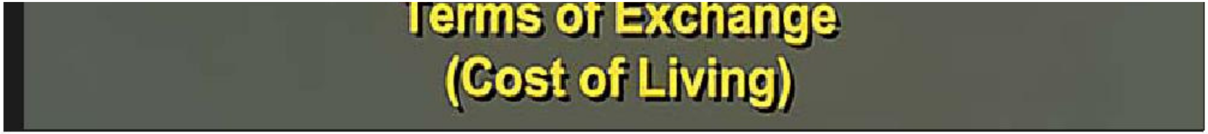
Terms of Exchange
(Cost of Living)

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Risk Insurance Phase

- Increase buffer stocks (good years)
- Alter cropping system
- Restructure herds for drought resistance
- Diversify income sources
- Labor

Labor migration

Risk Insurance (with asset depletion)

- Loans via indigenous/social networks
- Sale of small livestock
- Sale of household assets
- Include famine foods in diet
- Accept lower wages

Nyeka root from bed of Shire River is consumed in southern Malawi during severe dry seasons

Photo: K West

Endowment Loss Phase

Sale of productive HH assets

Sale of large livestock

Sale/mortgaging of land

Indenturedness

Dietary

Dietary restriction

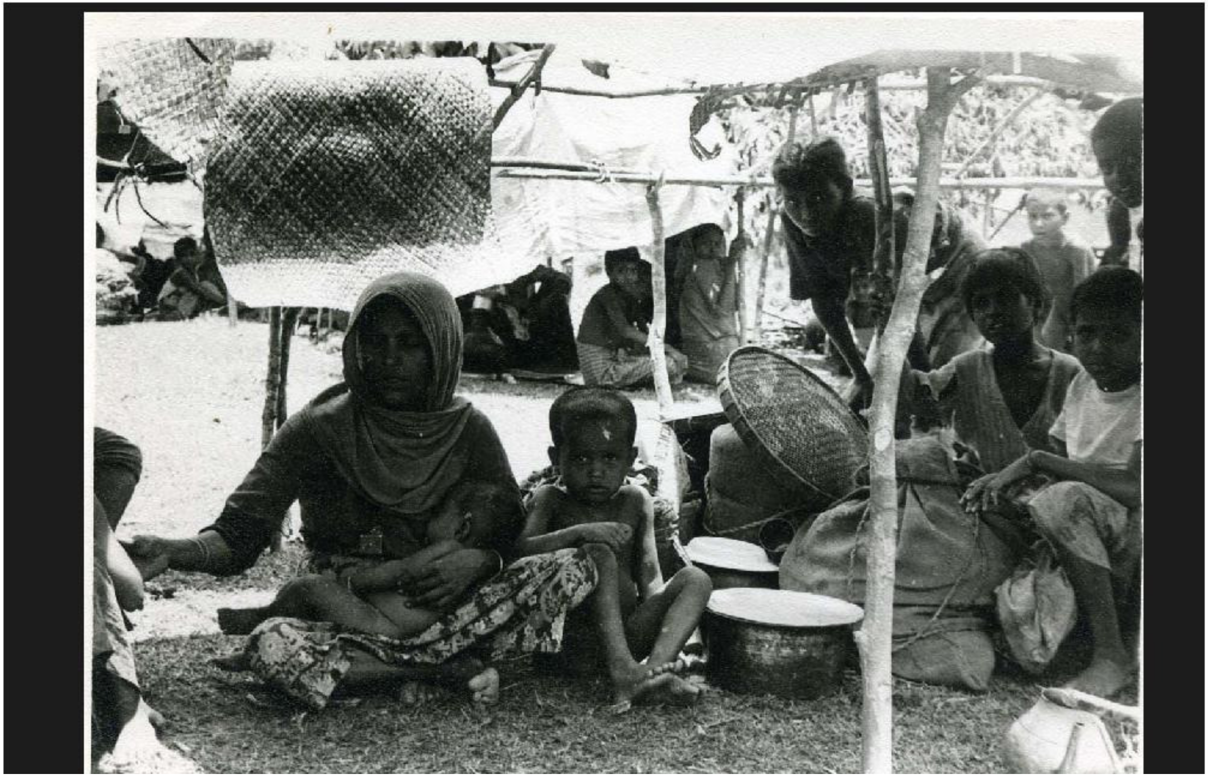

Land transactions at the Land Transfer Office,
Sundarganj, Northwestern Bangladesh


Photo: Keith West

Destitution Phase

Distress migration: to camps, urban centers

Death of most vulnerable



Destitute Burmese refugees in Bangladesh, 1978

Photo: Keith West

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Armed Conflict: A Cause of Famine

Disrupts agricultural production
- Kampuchea (1979)
- Mozambique (1980s)
- Southern Sudan (1990s)
- Somalia (1990's)

Hinders food distribution/ economic recovery

Exacerbates famine conditions

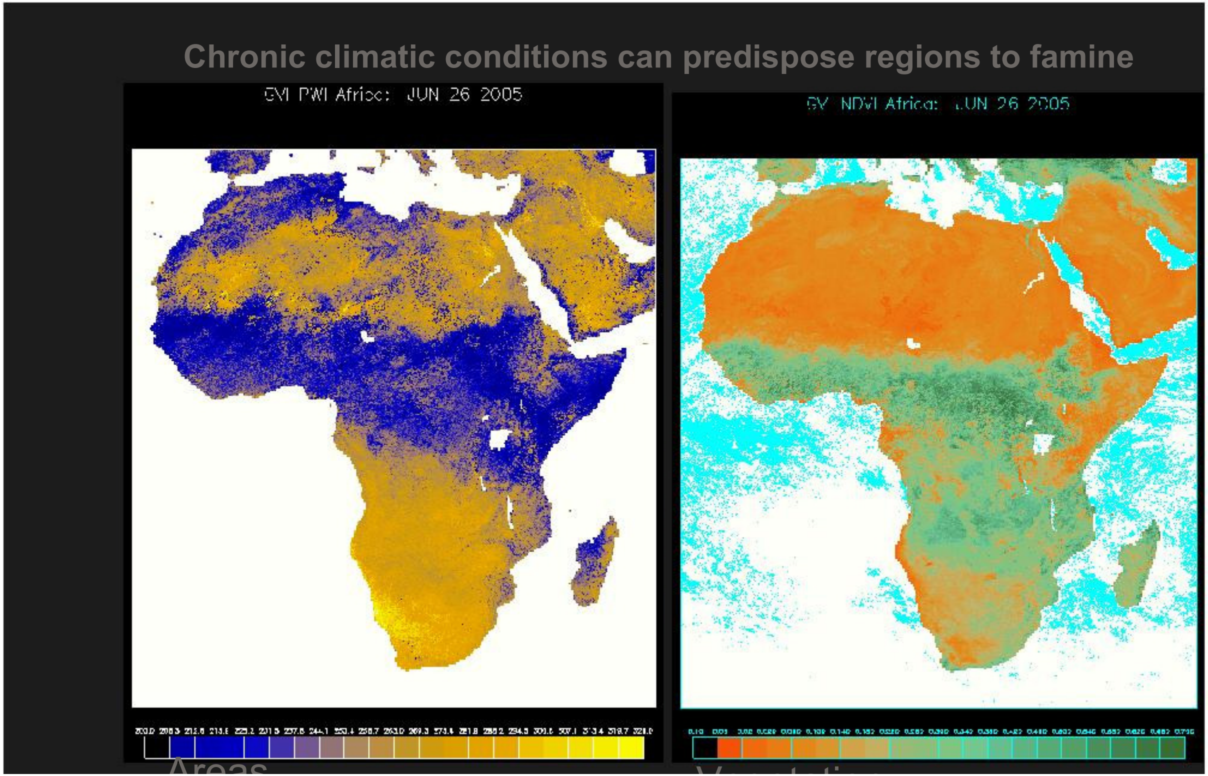
Somalia: Conflict . Food Insecurity 1990

1. Fighting destroyed harvests
2. Militia looted assets needed to plant and sow
3. Bandits closed trade routes
4. Bandit attacks discouraged food growing
5. Fighting paralyzed relief efforts

S. Hansch, et al., 1994

Somalia: Excess Deaths Due to Complex Causes

Late 1991:	Conflict-induced mortality
Early 1992:	Famine and infectious diseases


Chronic climatic conditions can predispose regions to famine
GVI PWI Africa: JUN 26 2005
GV NDVI Africa: JUN 26 2005
Areas

Areas of chronic low rainfall in Africa

Vegetation Index in Africa

Maps courtesy of NOAA, http://www.noaa.gov.

Famine (Complex Emergencies) in Africa

Preconditioned by

Subsistence agriculture

Poor transport infrastructure

Weak popular participation

Armed conflict

Economic disruptions

Drought

Drought

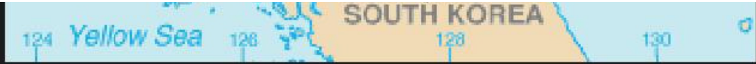
Von Braun, IFPRI, 1991

North Korea (DPRK)

- 24 million population (1996) 60% urban
- 123 sq km, 20% arable
- Centralized socialist system
- Life expectancy ~74 yr
- Adult literacy 100%

GNP $970 per capita
(1996)

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw



Courtesy of CIA World Factbook.

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North Korea Famine: Complex Causes

Historically famine-proned region

1989 Collapse of Soviet Union

1994 Kim Il Sung dies

1995 Extensive flooding/crop damage

145/200 counties; 1.7 MMT grain lost/ 5.9 MMT grain affected

1996 Floods destroy ~12% of crops

1997 Drought/tidal waves

Acute vs Non-acute Nutritional Status
Katona-Apte & Mokdad, 1998

	Cases (110)	Control (108)	RPR
WHZ, mean	-2.4	-0.8	
Fa dead	15%	2%	7.5
Mo dead	3%	1%	8.0
Either dead	22%	3%	7.3
Hospitalized			

p 3 mo	80%	12%	6.7

RPR = relative prevalence ratio

North Korean Migrant Survey March, 1998

Yanbian Prefecture, China

1.5 sites/NGO assisted

Migrant and non-migrant HHs

HH composition, food, mortality

C. Robinson, et al., Lancet, 1999

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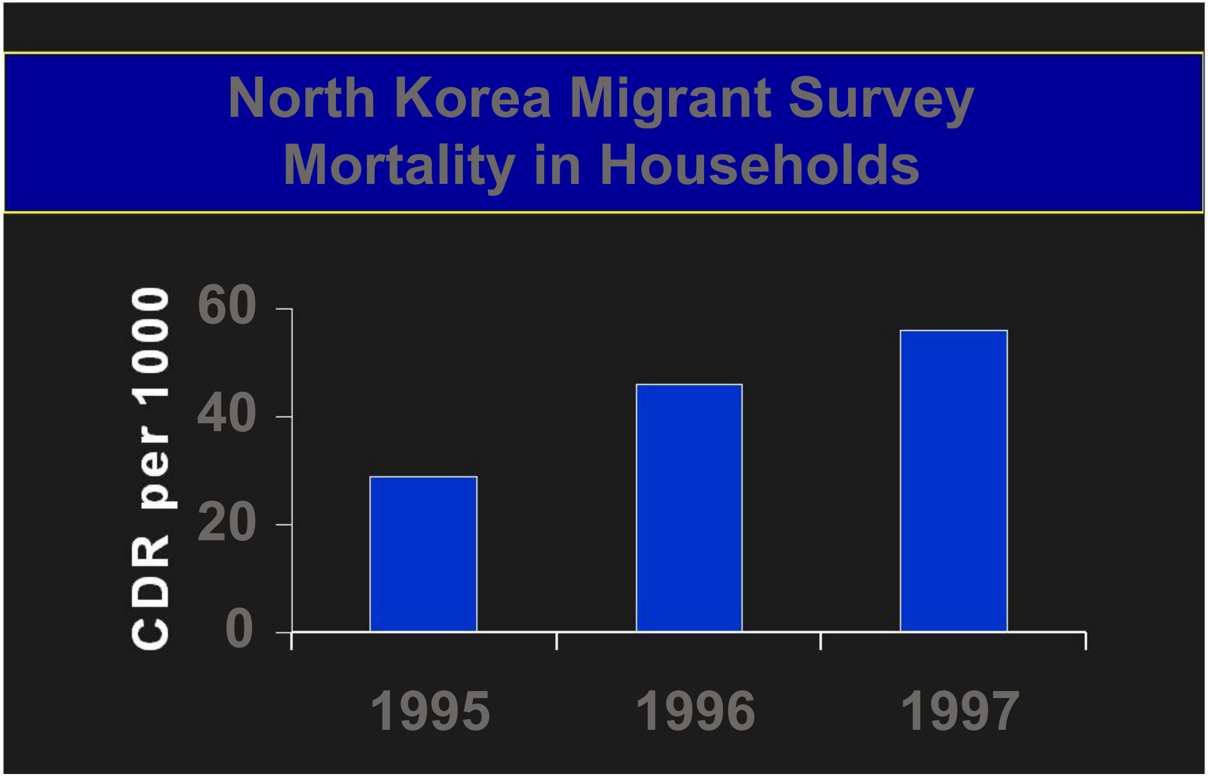

Robinson, et al., 1999

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

North Korea Famine Responses

1995 Bilateral appeals for food aid
- Japan, Egypt, S. Korea
- Cutbacks in Chinese aid

1997 WFP $95 m appeal for 200,000 MT food

1998 UNICEF/WFP/EU surveys

show
moderate
malnutrition

WFP/FAO/UNICEF Survey, August, 1997

n = 3965 <7 y/o children

40 kindergartens/nurseries in 18 countries (selected)

weight, height measured

110 cases acute MN/108 controls

Katona-Apte & Mokdad, 1998

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Classic Chain of Causation

Food Shortage → Starvation → Famine

Modern Concept of Causation

Food Shortage → Initiating/ Intervening Factors → Normal / Pre-famine / Famine

(.)

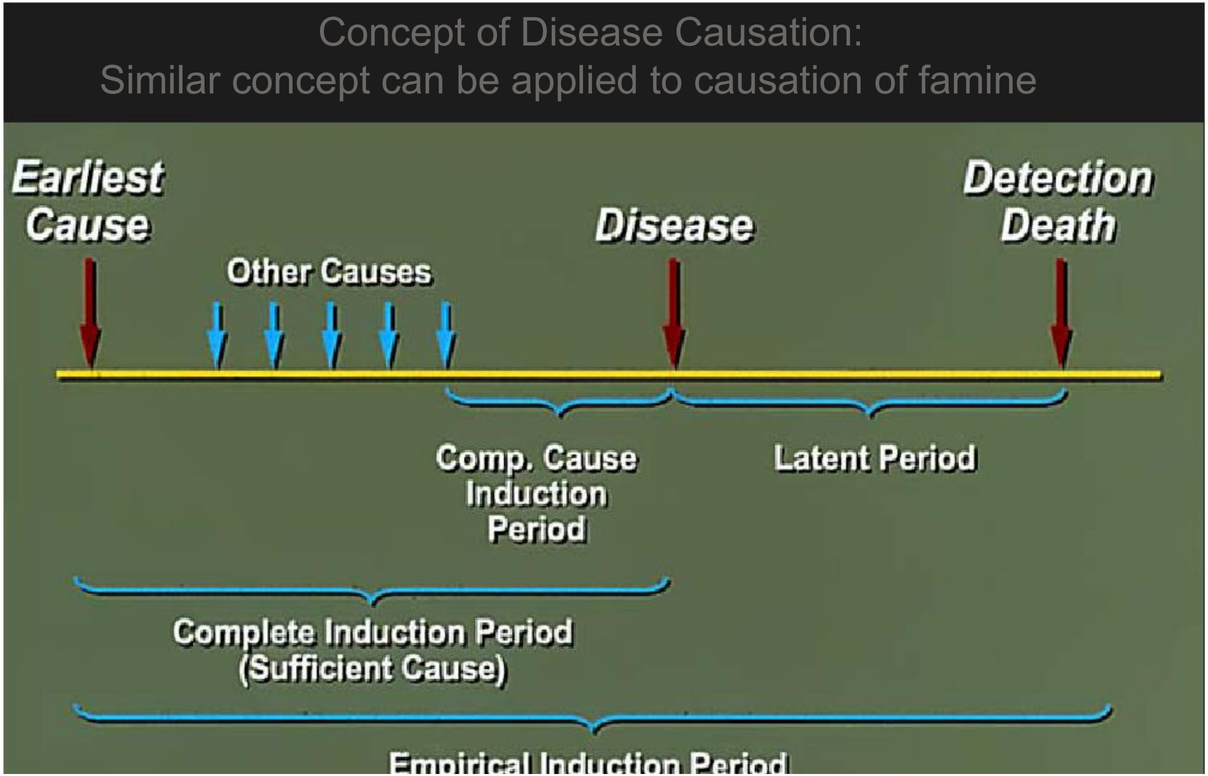
Food availability decline (FAD)

Market Dynamics

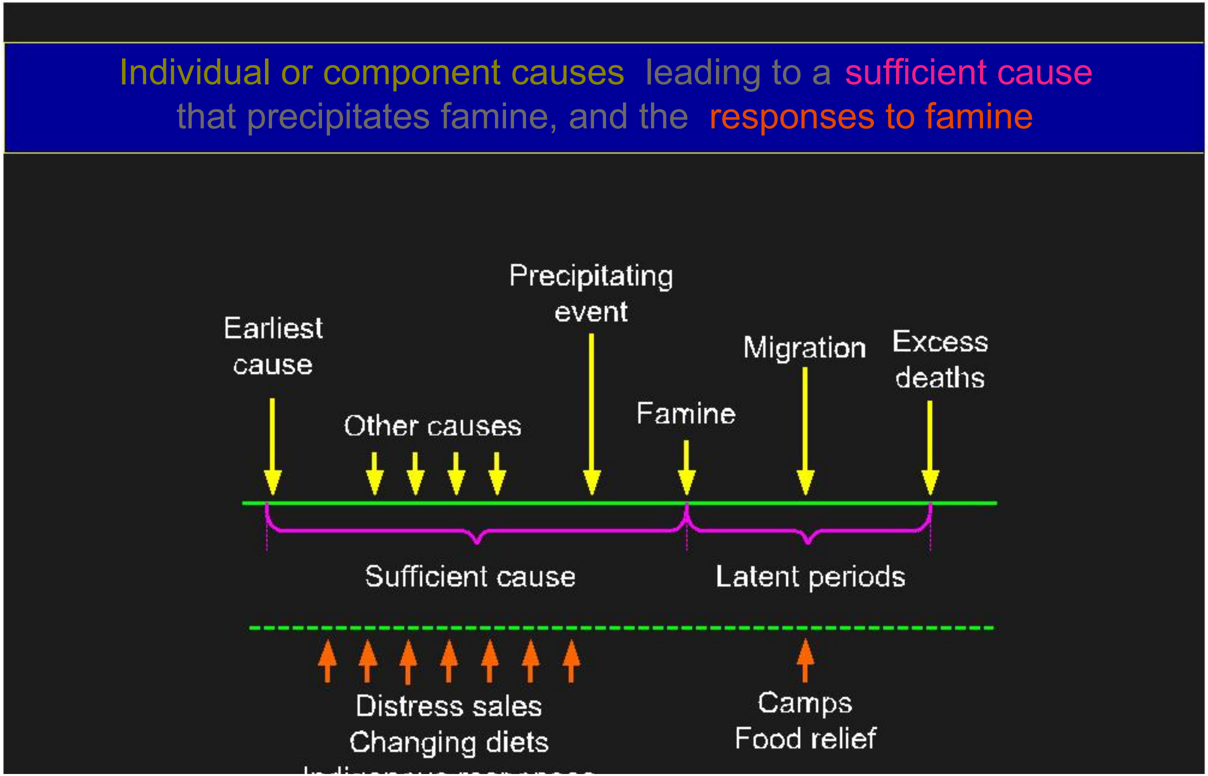
Govt/ Intl

Response

War


Concept of Disease Causation:
Similar concept can be applied to causation of famine
Earliest Cause
Other Causes
Disease
Detection Death
Comp. Cause Induction Period
Latent Period
Complete Induction Period (Sufficient Cause)
Empirical Induction Period


K. Rothman, 1980


Individual or component causes leading to a sufficient cause
that precipitates famine, and the responses to famine
Precipitating event
Earliest cause
Other causes
Famine
Migration
Excess deaths
Sufficient cause
Latent periods
Distress sales
Changing diets
Camps
Food relief

Indigenous responses
Migrating labour

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Some Component Causes of Famine

- Crop Failure (eg, due to weather, flood)
- Market Failure (ie, ineffective demand)
- Failed Central Economy
- Conflict-Anarchy
- Lack of free press

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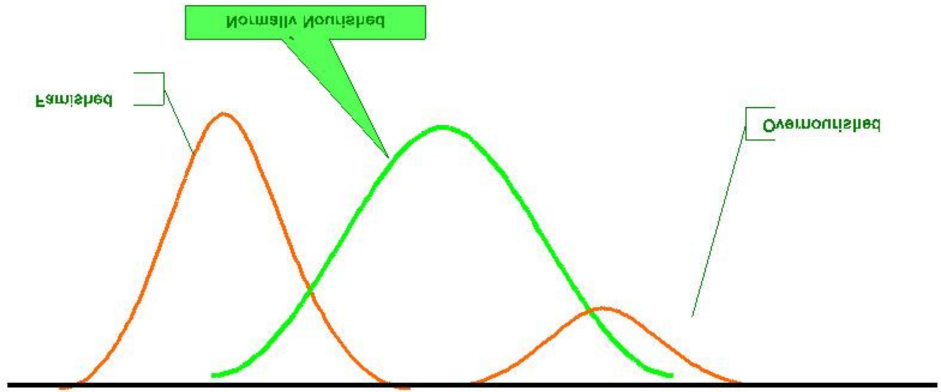
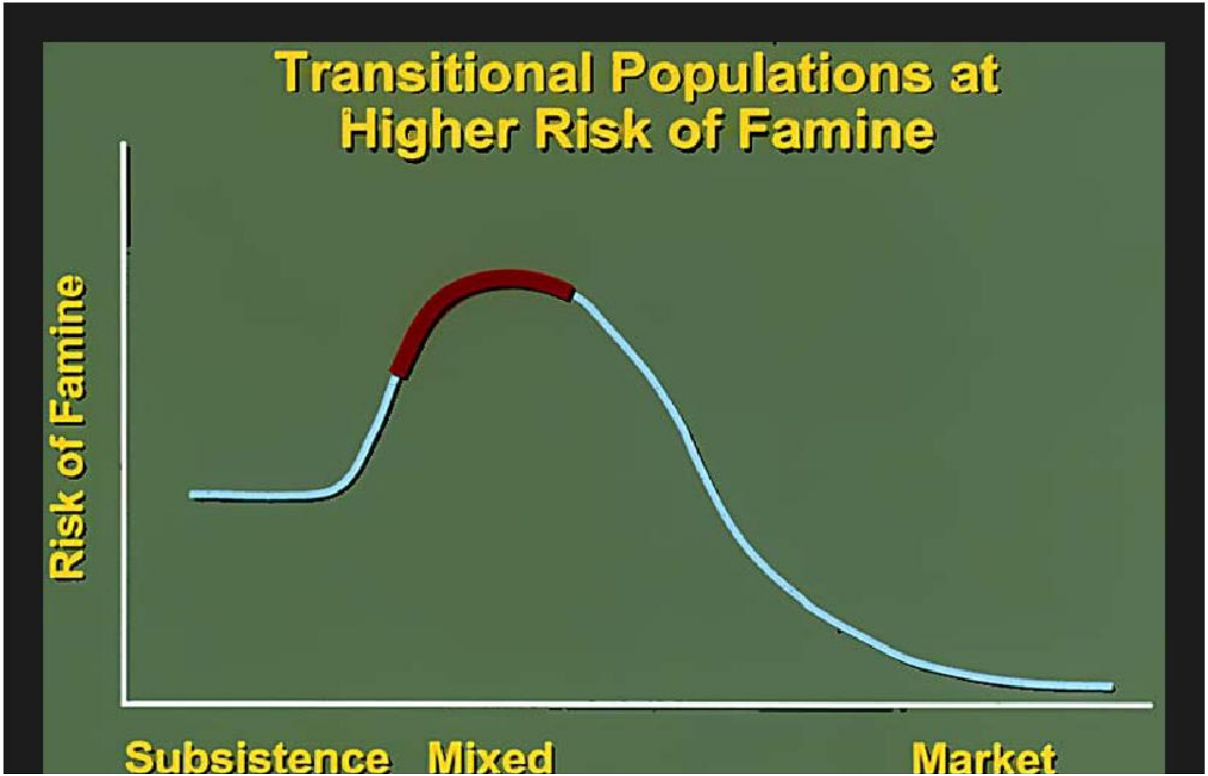
Population Distributions of Nutritional Status During Times of Famine

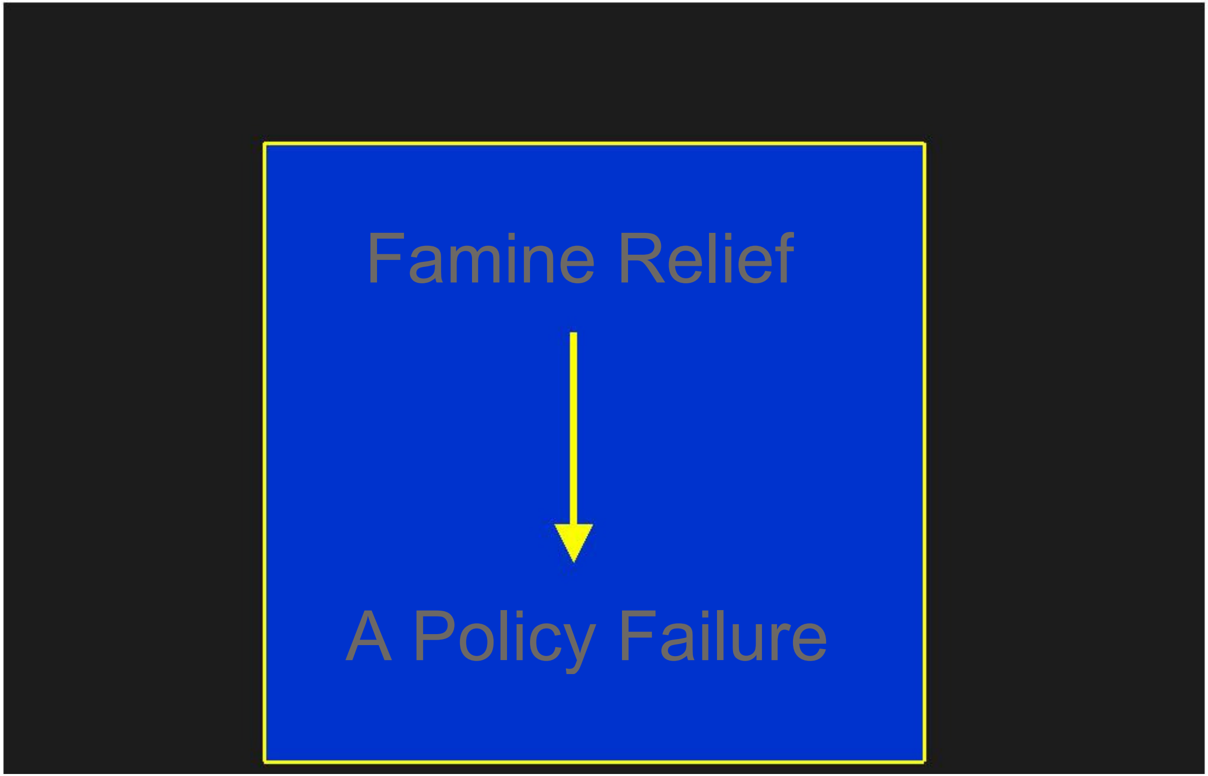


Shifting of a population toward starvation with increasingly severe prefamine and famine conditions


Famine
Population


Transitional Populations at Higher Risk of Famine
Risk of Famine
Subsistence
Mixed
Market


FOOD ECONOMY


Famine Relief
A Policy Failure

Policy Issues

- Civil conflict resolution
- Drought (flood) management
- Dry season farming and development
- Animal husbandry

Pest control

Policy Issues

Tax relief

Pastoral protection

Early warning system

Food support mechanisms

Good governance/Democracy

Freedom of

speech/press

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Famine prevention policies should support indigenous capacity to withstand (cope with) a variety of stresses.

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Nutrition and Reproductive and Pregnancy-Related Health

Parul Christian
International Nutrition

Percent <145 cm in stature among 15-45 y old women, ACC/SCN 1970-1990

Region	Countries	n	%
Sub-Saharan Africa	15	7,795	6.1
Middle East, N. Africa	4	5,906	3.3
South Asia	3	42,634	20.8
Southeast Asia	6	7,079	17.8
Central America	4	15,668	17.1
South America	2	44,462	6.0
China	1	19,574	1.8
All	**35**	**143,299**	**15.6**

	35	143,299	15.6
Regions			

Percent underweight among 15-45 year-old women, ACC/SCN 1970-1990

Region	Countries	n	BMI<18.5 %
SS Africa	9	7,597	18.2
South Asia	2	16,112	34.3
Southeast Asia	5	6,231	28.2
C. America	4	21,659	13.1
South America	3	62,233	11.4
China	1	101	19.0

All Regions	26	114,200	20.3

Mid-upper Arm Circumference of Women 15-45 Years Old ACC/SCN 1970-1990

Region	Countries	n	< 22.5 cm %
Sub-Saharan Africa	9	8,256	15.2
Middle East, N. Africa	2	196	38.5
South Asia	2	14,120	49.7
Southeast Asia	2	438	29.3
Central America	1	700	17.5
South America	2	1,076	12.0

All Regions	18	24,786	28.1

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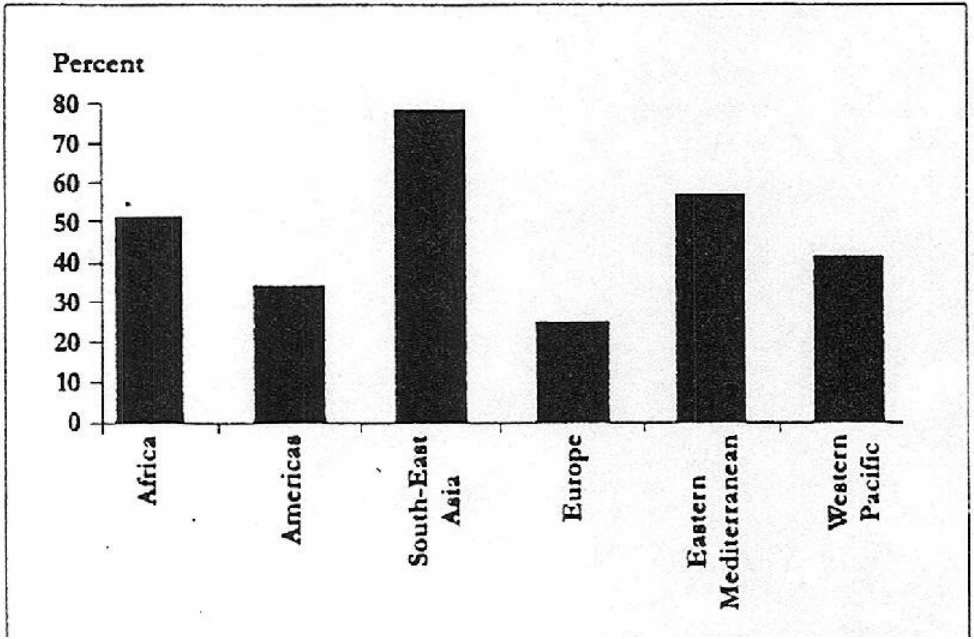
FIGURE 2.3 : Prevalence of anaemia in pregnant women by WHO region, 1998



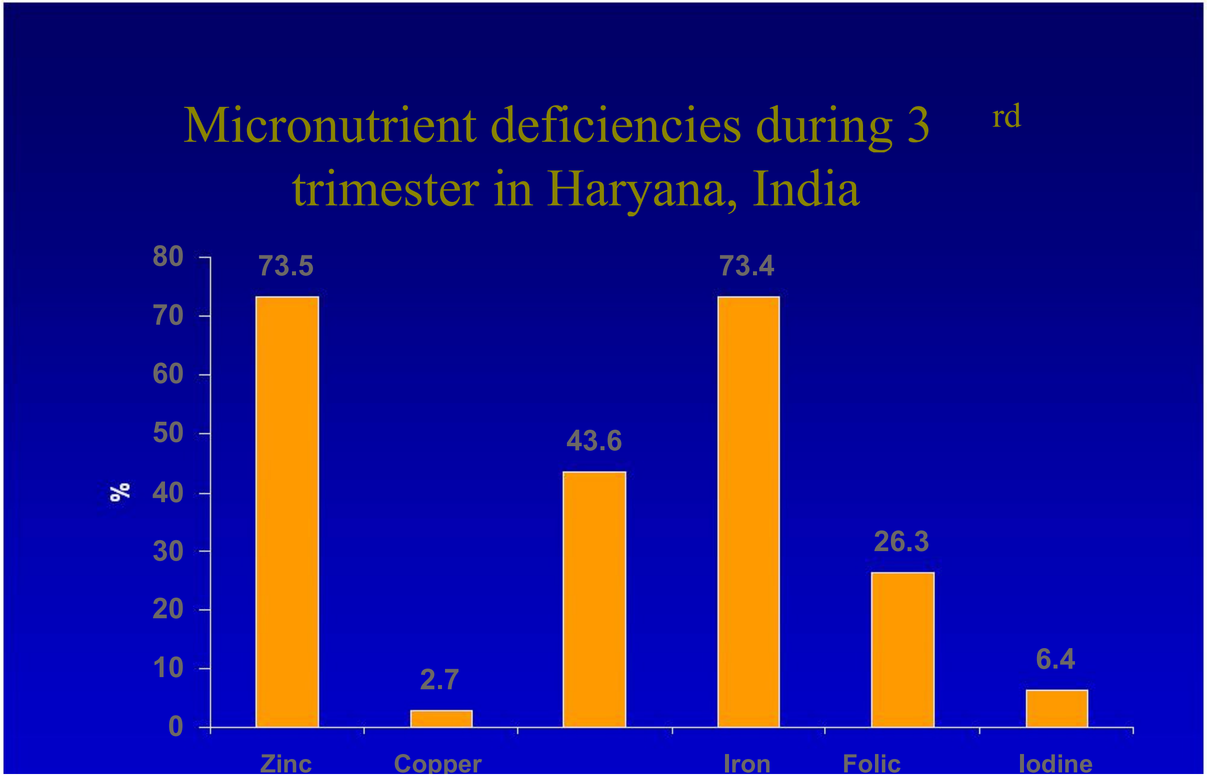
Source: 9.

Source: ACC/SCN

Prevalence of maternal night blindness

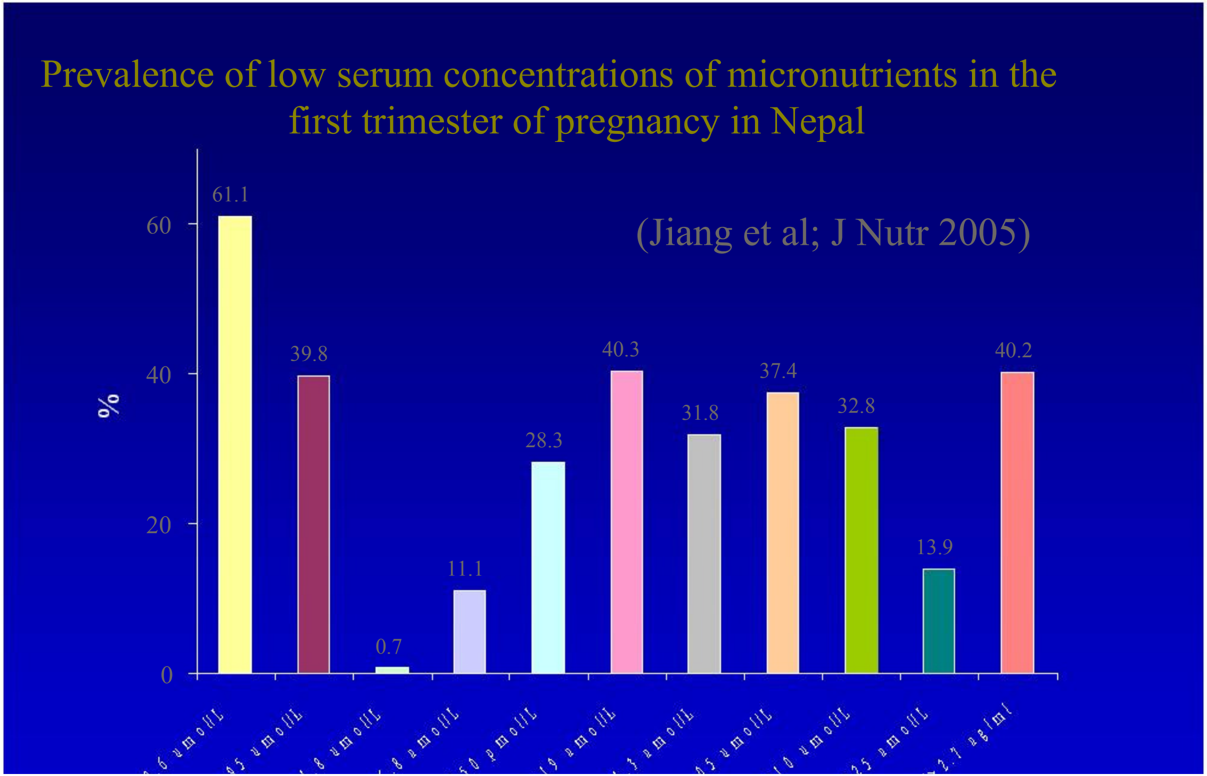
Country	%
NEPAL	12-18
INDIA	12.1
BANGLADESH	6.8
PHILLIPINES	8.6
LAOS	11.5
CAMBODIA	4.8
THAILAND (NE)	7.5
ZAMBIA	11.6

ZAMBIA	11.0


Micronutrient deficiencies during 3rd trimester in Haryana, India
%
80
70
60
50
40
30
20
10
0
73.5
2.7
43.6
73.4
26.3
6.4
Zinc
Copper
Iron
Folic
Iodine

Magnesium	acid

Pathak et al; Indian J Pediatr 2004


Prevalence of low serum concentrations of micronutrients in the first trimester of pregnancy in Nepal
(Jiang et al; J Nutr 2005)
%
0
20
40
60
61.1
39.8
0.7
11.1
28.3
40.3
31.8
37.4
32.8
13.9
40.2


Zinc
Iron
Copper
Folate
B12
B6
Riboflavin
Retinol
Vit E
Vit D
PIVKA-II

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Nutritional and health status of women by region

	S Asia	SSA	Dev. C
Weight<45kg	63	23	5-6
Height<145 cm	21	6	3-4
BMI <18.5	34	18	4
MUAC<22.5 cm	50	15	-
Anemia (preg)	70	50	17
Maternal XN	10	3-4	-
LBW	33	15	6
IMR /1k	76	107	6
U5MR /1k	114	173	6

MMR /100k	420	640	8

Adverse Health Outcomes

Maternal

Complications of labor ↔	Stunting
Anemia, hemorrhage ↔	Iron
Hypertensive disorders ↔	Ca, Vit C, E
Infection ↔	Vit A, Zinc
Mortality ↔	Iron, Vit A

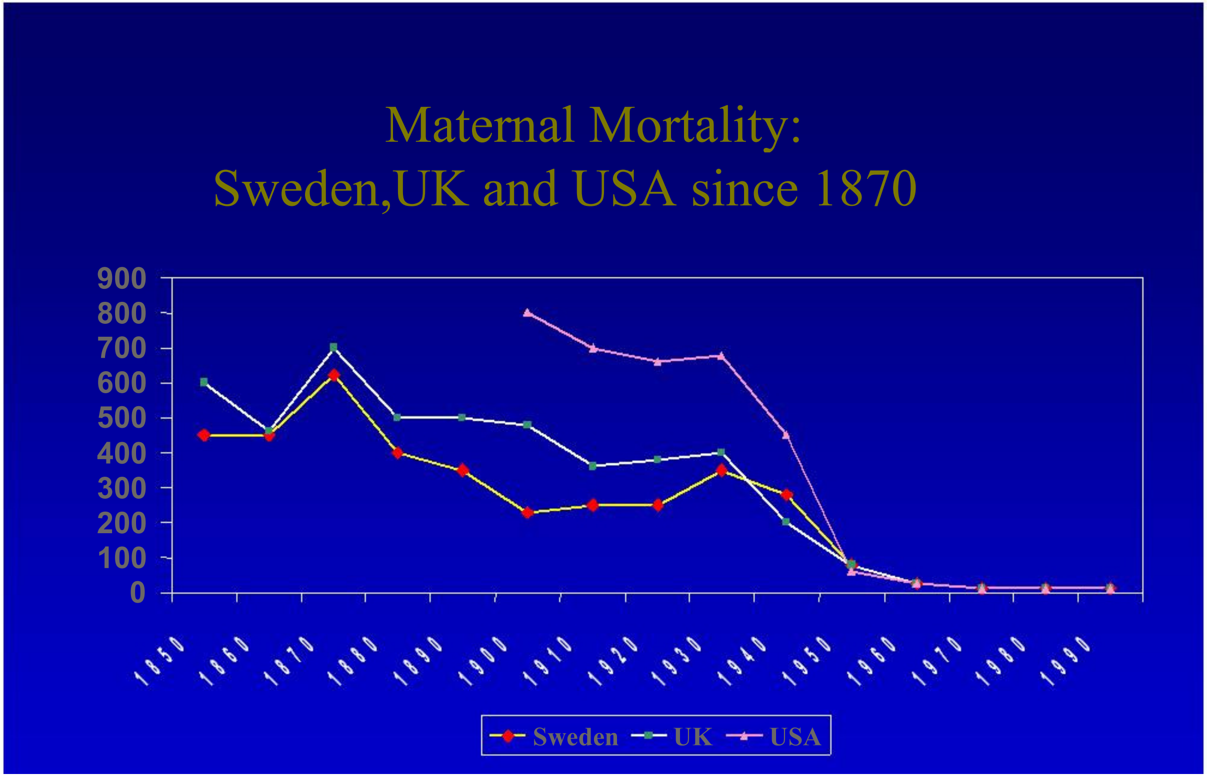

Adverse Health Outcomes
Fetal/Infant
Stillbirth
Pre-term delivery
IUGR
Congenital malformations
Infection
Death

Estimates of Maternal Mortality by United Nations Regions (1990)

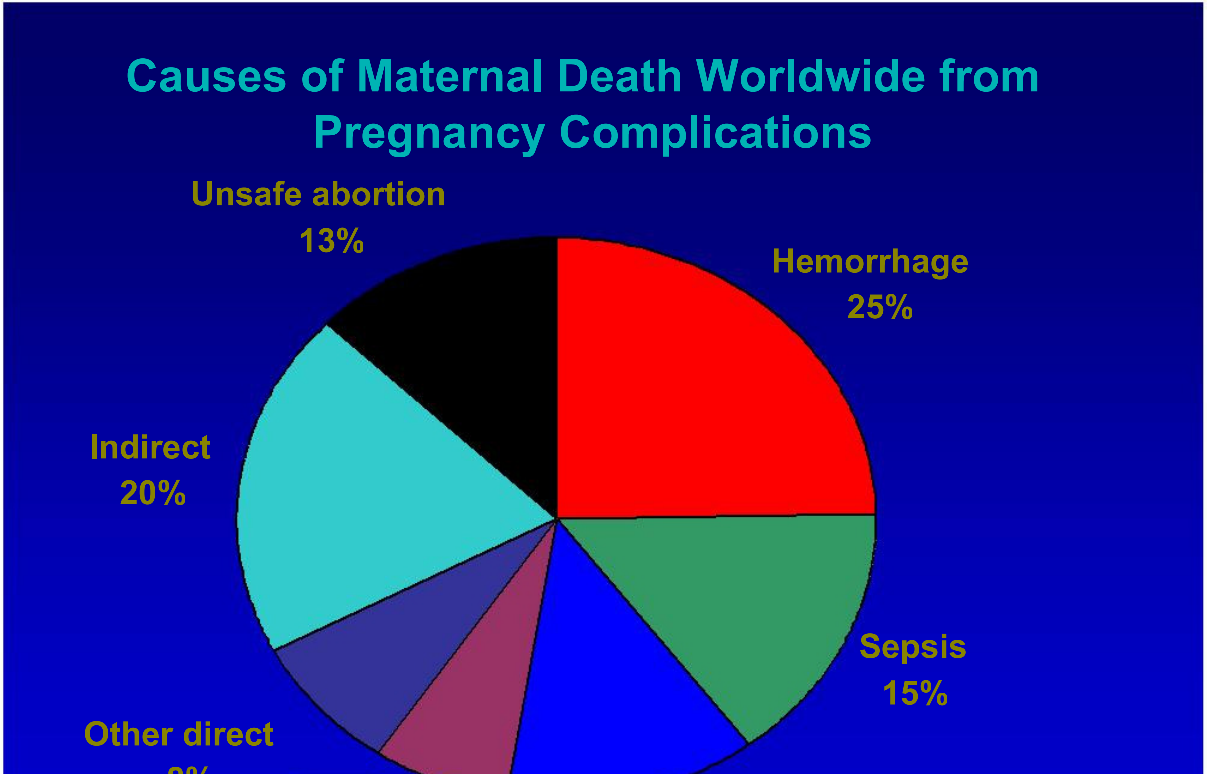
Location	***Maternal Mortality Ratio*** *(Maternal Deaths per 100,000 live births)*
Africa	870
Asia	390
Europe	36
Latin America & The Caribbean	190
North America	11
Oceania	680

Defn: Death of a woman while pregnant or within 42 d of termination of pregnancy, from any cause but not from accidental or incidental causes

Adapted from: Ronsmans, In:Nutr & Hlth in Dev Countries, Humana Press, 2001


Maternal Mortality:
Sweden,UK and USA since 1870
900
800
700
600
500
400
300
200
100
0
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
Sweden
UK
USA

Source: van Lerberghe; de Brouwere,
Technical Consultation on Safe
Motherhood 1997


Causes of Maternal Death Worldwide from Pregnancy Complications
Unsafe abortion 13%
Hemorrhage 25%
Indirect 20%
Sepsis 15%
Other direct


8%
Obstructed labor
7%
HDP Eclampsia
13%

Factors related to maternal mortality

Socioeconomic status/poverty

Maternal education

Age, parity, inter-pregnancy interval

Family planning

Prenatal care

TBA

Professional delivery care/Emergency Obstetric Care

Ronsmans C. In:Nutr & health in developing countries. 2001

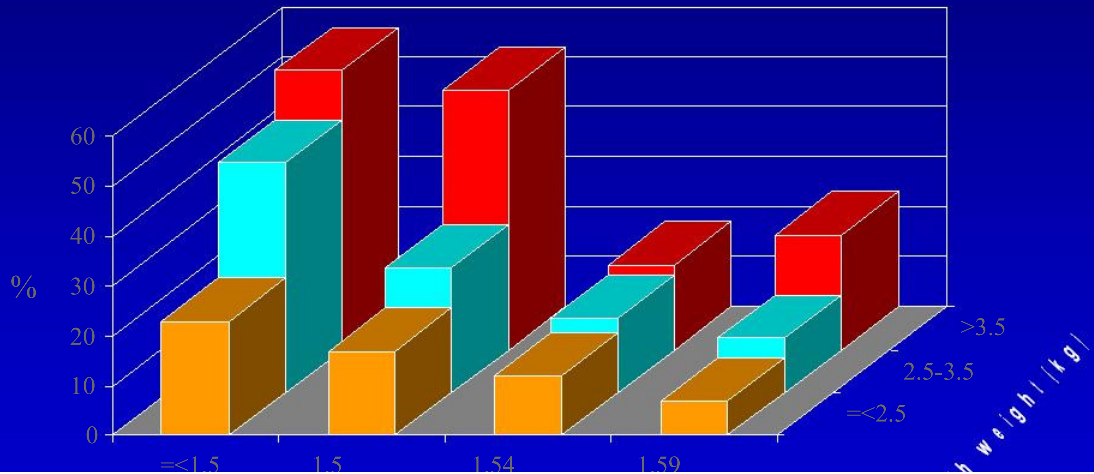
Nutrition and Obstructed Labor

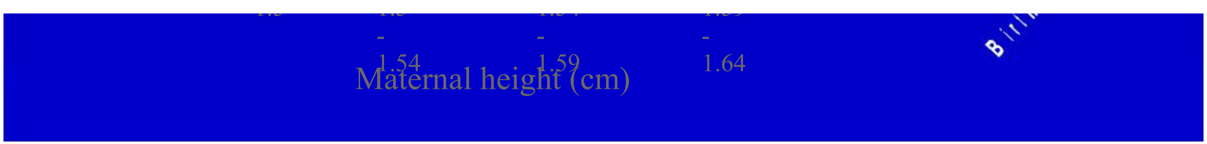
Maternal height and cephalopelvic disproportion -Nigeria

Maternal height (m)	N (%)
< 1.50	166 (19.9)
1.5-1.54	315 (12.4)
1.55-1.59	323 (7.1)
=1.60	260 (1.9)

Harrison et al, Br J Obstet Gyn 1985

Operative delivery rate by maternal height and birth weight (Harrison et al, 1985)




-
1.54
-
1.59
-
1.64
Maternal height (cm)

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Is stunting in childhood reversible.

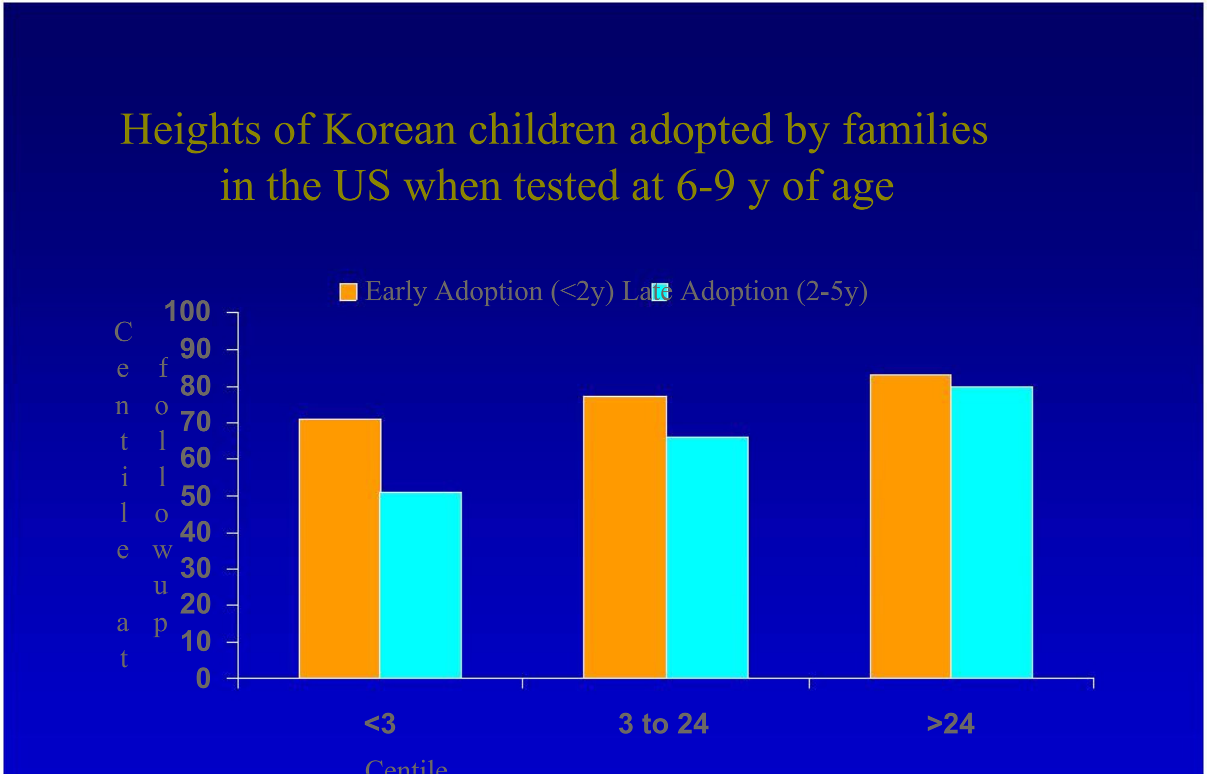
- Continued residence in the environment that gave rise to stunting
- Continued residence in the same environment with improvements in nutrition
- Relocation from the environment that gave rise to stunting

Impact of nutritional supplementation on height, Guatemalan children

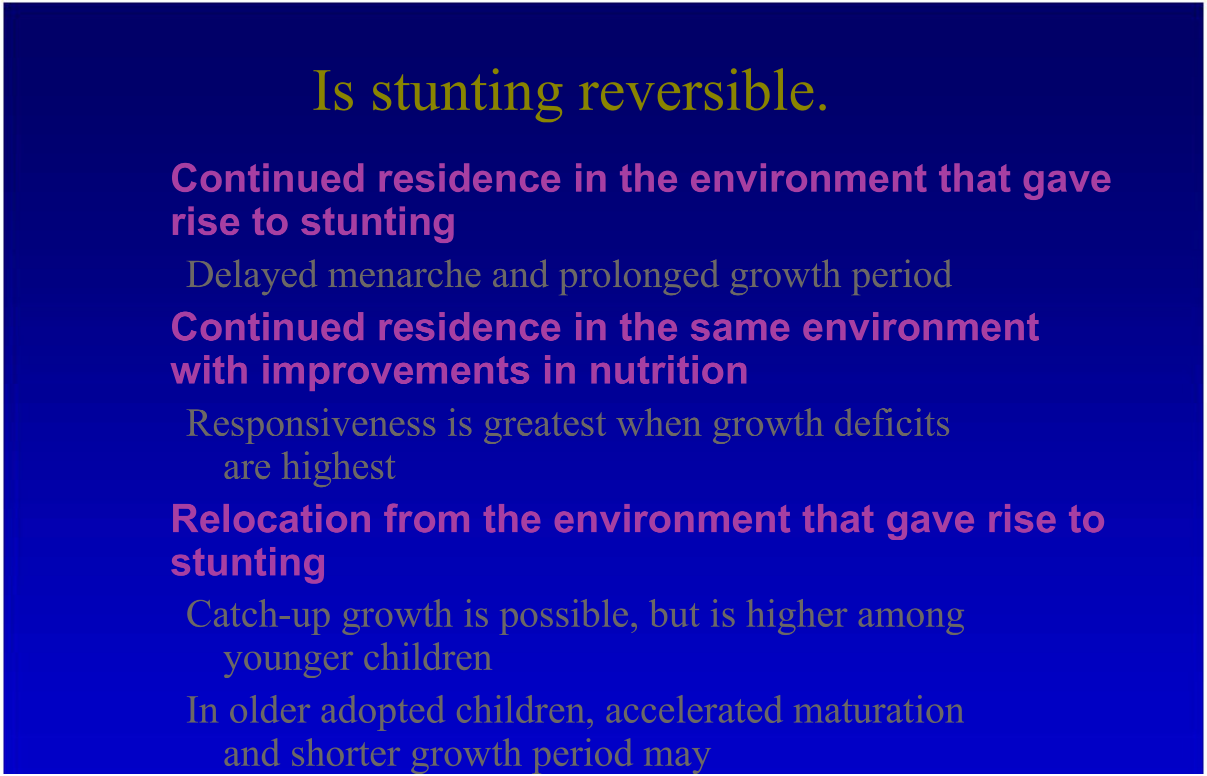
Schroeder et al, J Nutr 1995

Age during supplementation	Height increments mm/y	cm/100kcal
3-12 mo	9	9
12-24 mo	10	5.5
24-36 mo	4	3.7

3-7y	0	<1


Heights of Korean children adopted by families in the US when tested at 6-9 y of age
Early Adoption (<2y)
Late Adoption (2-5y)
Centile at follow up
100
90
80
70
60
50
40
30
20
10
0
<3
3 to 24
>24
Centile

Centile at admission using Korean standards	Winick et al 1975; Lien et al 1977


Is stunting reversible.
Continued residence in the environment that gave rise to stunting
Delayed menarche and prolonged growth period
Continued residence in the same environment with improvements in nutrition
Responsiveness is greatest when growth deficits are highest
Relocation from the environment that gave rise to stunting
Catch-up growth is possible, but is higher among younger children
In older adopted children, accelerated maturation and shorter growth period may

lead to short adult

stature

Vitamin A - Puerperal Infection

Vitamin A is a known anti-infective agent

- Green et al (1931) : Vitamin A supplementation in late pregnancy through first wk postpartum reduced incidence of puerperal infection
- Hakimi et al (1999) Maternal vitamin A supplementation reduced episodes of elevated body temperature (=38 °C) by 78%, RR=0.22

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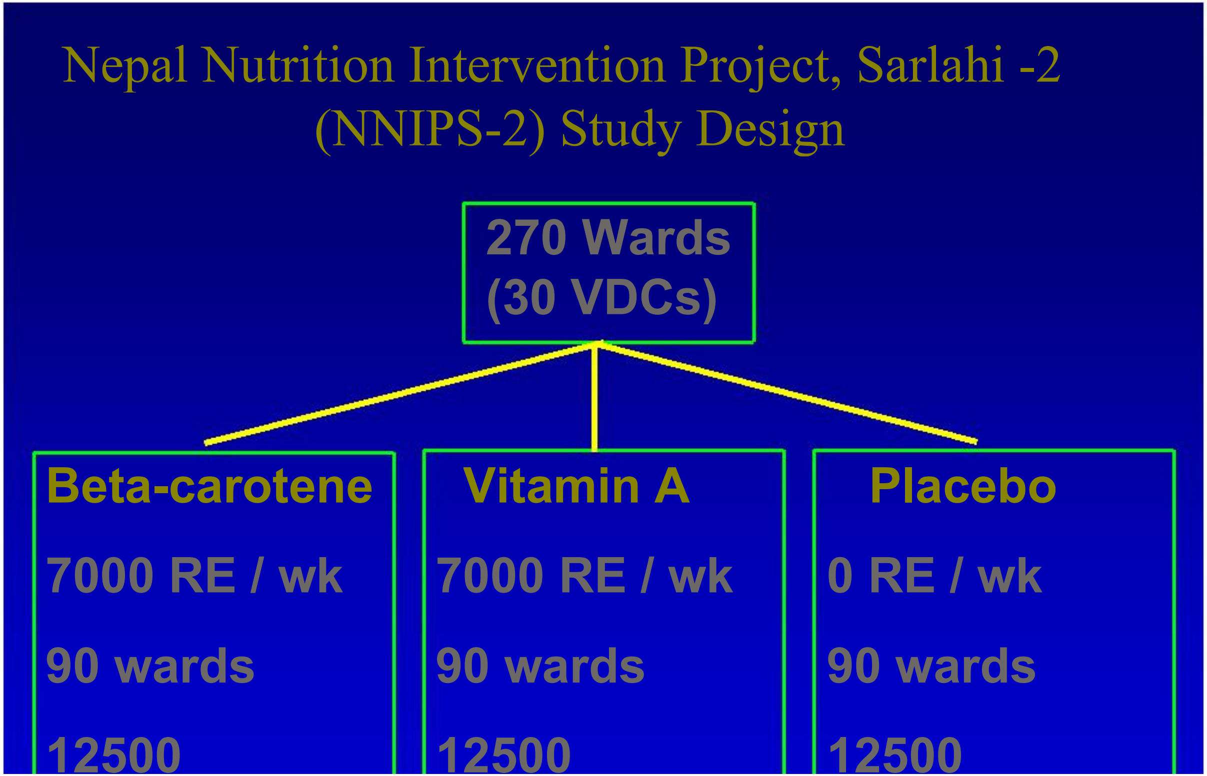


women
women
women
West et al, BMJ 1999

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Impact on Pregnancy-related Mortality in Rural Nepal

	Placebo (7241)	Vitamin A (7747)	-carotene (7201)
No. deaths	51	33	26
MR/100,000	704	426	361
RR	1.0	0.60	0.51
95% CI	-	0.37-0.97	0.30-0.86
%	-	40	49

reduction

West KP et al, BMJ 1999

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Odds ratios of illness during pregnancy by supplementation group

	Vitamin A	-Carotene
Pregnancy		
UTI/RTI	0.88*	1.02
Nausea/Vomiting	0.82*	0.92
Faintness	0.75*	1.02
Postpartum		
Diarrhea	0.78*	0.74*

Diarrhea	0.78*	0.74*

*p<0.05

Christian et al; J Nutr 2000

Labor and delivery complications and postpartum illness

	PL	VA	C
Length of labor (h)		Mean	
Parity 0	14.0	12.4*	13.8
Parity 1+	8.2	7.5*	8.6
Pre-eclampsia	4.4%	1.8%	3.9%
Temperature >37.8 °C	2.9%	1.2%	0.9%*

*p <0.05

Christian et al; J Nutr 2000

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NNIPS-2: Risk of Anemia Was Less among Women with No/Mild Hookworm in Pregnancy

	Relative Prevalence Ratio			
Hookworm	None/Mild		Mod/Heavy	
	VA	-C	VA	-C
Hb <110 g/L	0.83	0.79	1.00	1.05
Hb <100 g/L	0.68	0.69	1.03	1.10
SF <10 g/L	0.76	0.83	0.92	0.98

VA/ -C reduced anemia 17-32% and low Fe stores

~20% if little/no hookworm

Dreyfuss et al, Doctoral Thesis 1998

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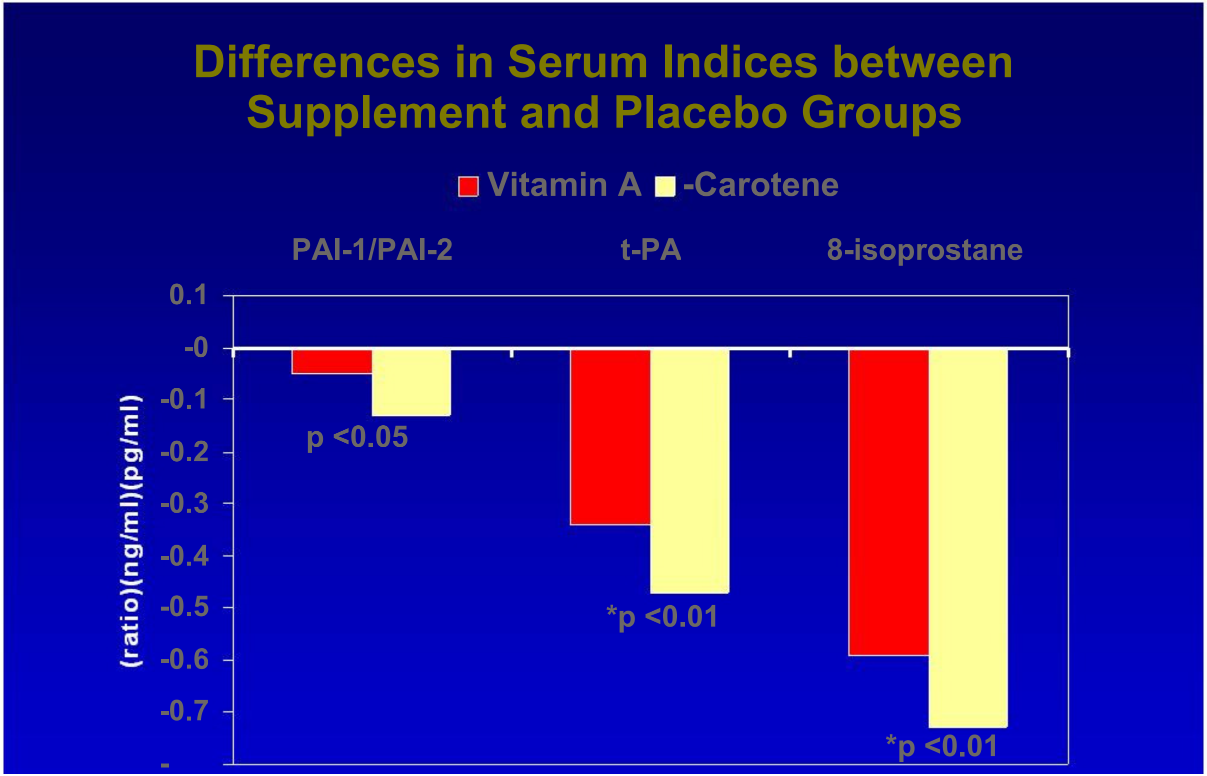

0.8

Adjusted for gestation, parity, DGLV intake and husband literacy

Jiang et al, FASEB J, 2004 (abstract)

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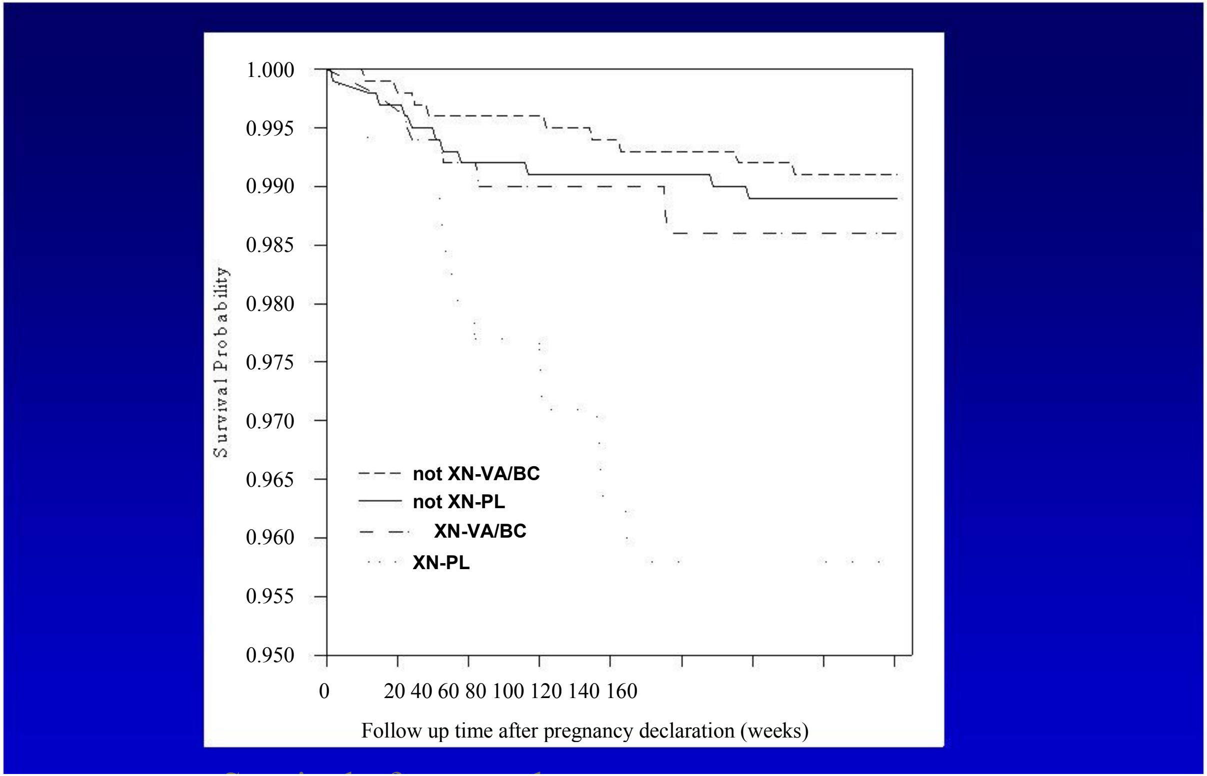
Night blindness and morbidity history

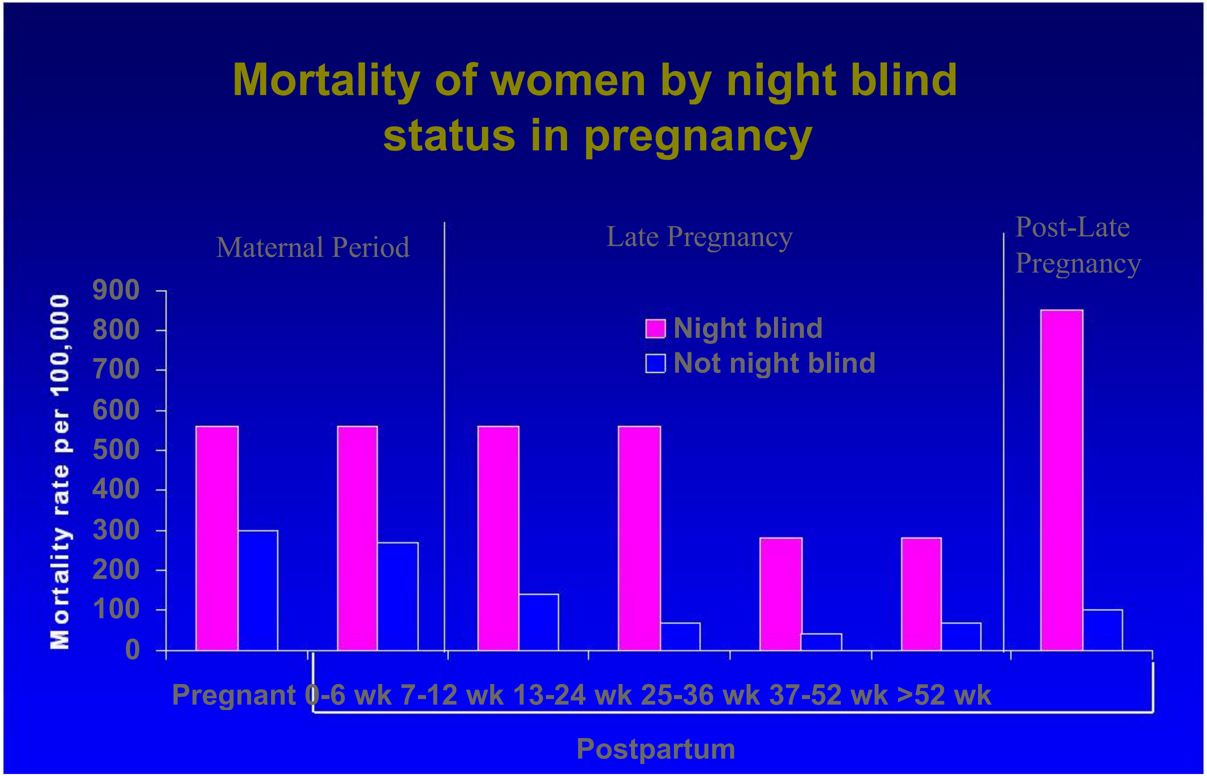
	Adjusted Odds Ratio	
	During XN	Prior to XN
UTI	2.1*	1.9*
Diarr/Dysent	3.4*	0.6
Pre-/Eclampsia	1.7	2.5*
Naus/Vmt/Appt	2.1*	2.7*

*95% CI excludes 1.0


1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
0.960
0.955
0.950
Survival Probability
not XN-VA/BC
not XN-PL
XN-VA/BC
XN-PL
0 20 40 60 80 100 120 140 160
Follow up time after pregnancy declaration (weeks)

Survival of women by night blindness status during pregnancy and treatment allocation

Christian et al; AJE 2000


Mortality of women by night blind status in pregnancy
Maternal Period
Late Pregnancy
Post-Late Pregnancy
Mortality rate per 100,000
900
800
700
600
500
400
300
200
100
0
Night blind
Not night blind
Pregnant 0-6 wk 7-12 wk 13-24 wk 25-36 wk 37-52 wk >52 wk
Postpartum

Christian, et al., Am J Epi, 2000

Proximate cause of female death by night blindness status

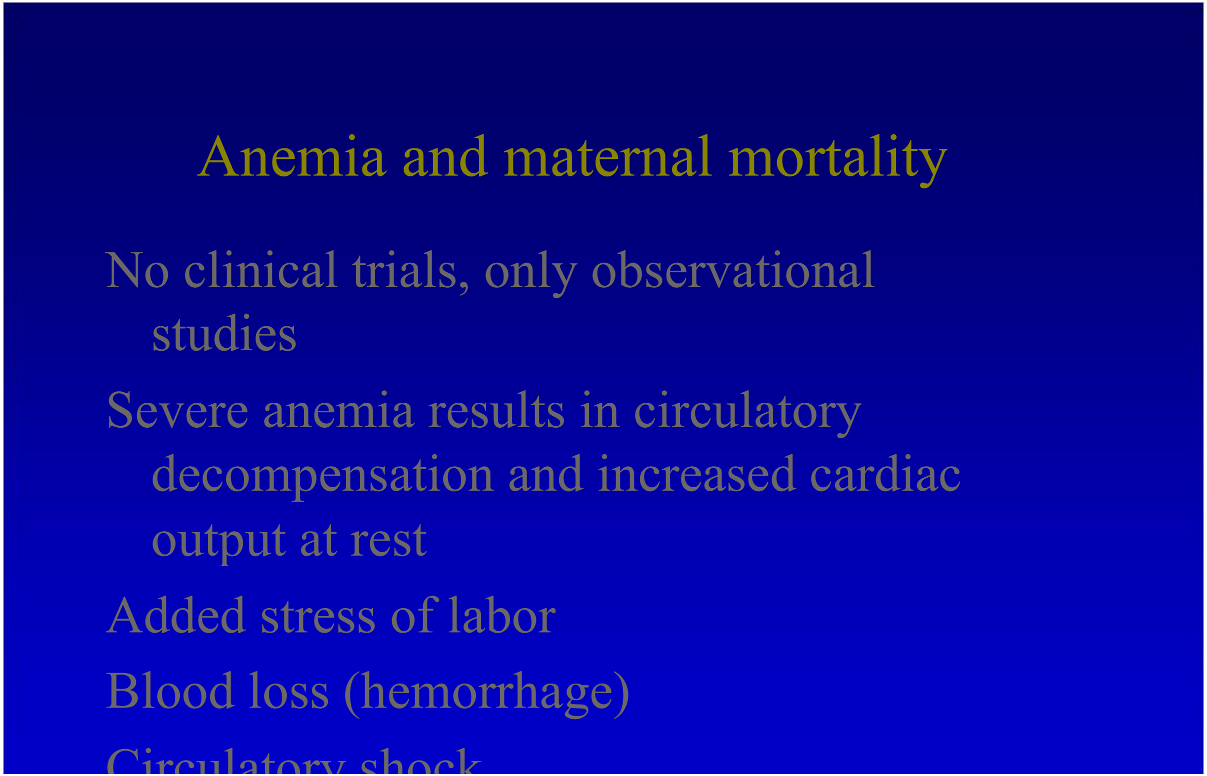
	Not night blind	Night blind	RR (95%CI)
	MR per 100,000		
Infection	251	1254	5.0 (2.2-10.6)
Obstetric	283	342	1.2 (0.2-3.9)
Injury	73	0	-

Misc	115	342	3.0 (0.5-11.2)

VAD and maternal mortality: Possible mechanisms

- Improved immunocompetence and resistance to severe infection
- Hematopoeitic effects leading to reduced anemia, possibly less severe hemorrhage, fewer OB complications
- Potential antioxidant effects of -carotene: BC raised serum VE, other carotenoids, lowered serum MDA,

sVEGF receptor 1 & 8-
iso-prostane


Anemia and maternal mortality
No clinical trials, only observational studies
Severe anemia results in circulatory decompensation and increased cardiac output at rest
Added stress of labor
Blood loss (hemorrhage)
Circulatory shock

Circulatory shock
and death

RR and PAR of maternal mortality for moderate and severe maternal anemia

	RR	95% CL	PAR (5%)	PAR (20%)
Moderate (Hb 40-80 g/L)	1.35	0.92, 2.00	0.017	0.065
Severe (Hb 27-47 g/L)	3.51	2.05, 6.00	0.111	0.334

Brabin et al, J Nutr 2001

Calcium and Pre-eclampsia

Pre-eclampsia: Pregnancy associated hypertension, proteinuria and edema

Low Ca intake . High blood pressure

By stimulating PTH or renin release which increases intracellular Ca in vascular smooth muscles resulting in intensified reactivity causing vasoconstriction

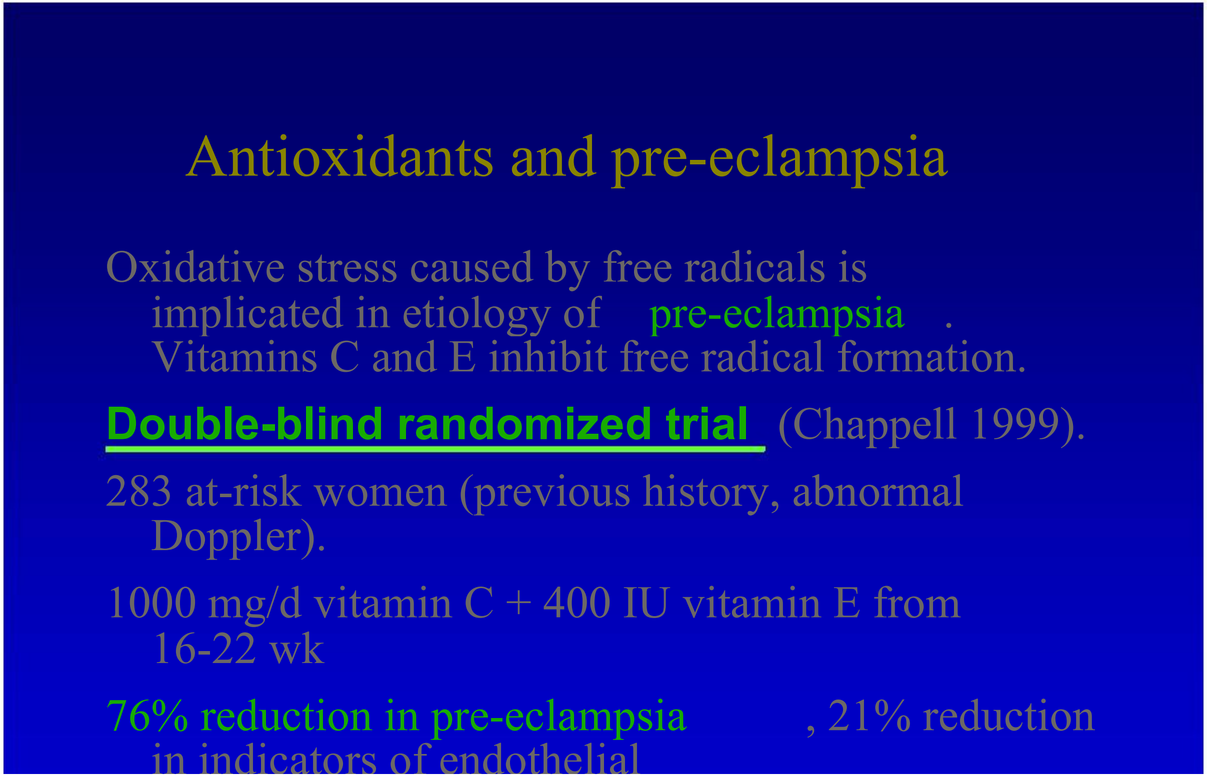
Ca and toxemia of pregnancy

Bucher et al JAMA 1996: Meta-analysis - 14 RCT, n=2459

- 60% reduction in Pre-eclampsia (PE)
- 70% reduction in hypertension

Levine et al NEJM 1997: RCT, n=4589

- No impact on PE or hypertension


Antioxidants and pre-eclampsia
Oxidative stress caused by free radicals is implicated in etiology of pre-eclampsia. Vitamins C and E inhibit free radical formation.
Double-blind randomized trial (Chappell 1999).
283 at-risk women (previous history, abnormal Doppler).
1000 mg/d vitamin C + 400 IU vitamin E from 16-22 wk
76% reduction in pre-eclampsia, 21% reduction in indicators of endothelial

activation and
placental dysfunction.

Magpie Trial: MgSO4 supplementation among pre-eclamptic women

	MgSO4 N=5055	Placebo N=5055	RR
Eclampsia	40 (0.8%)	96 (1.9%)	0.42
Maternal death	11 (0.2%)	20 (0.4%)	0.55
Baby death	576(12.7%)	558 (12.4%)	1.02

Magpie Trial Collaborative Group. Lancet 2002; 359:1877-90

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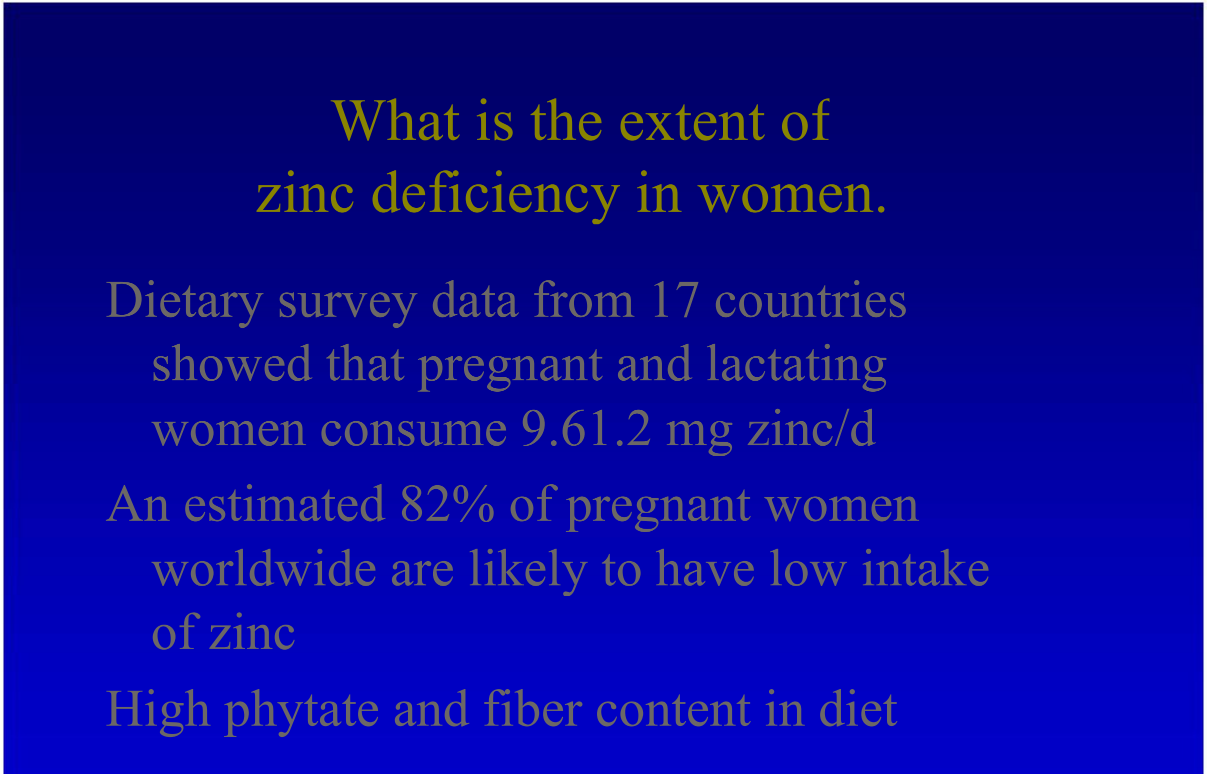

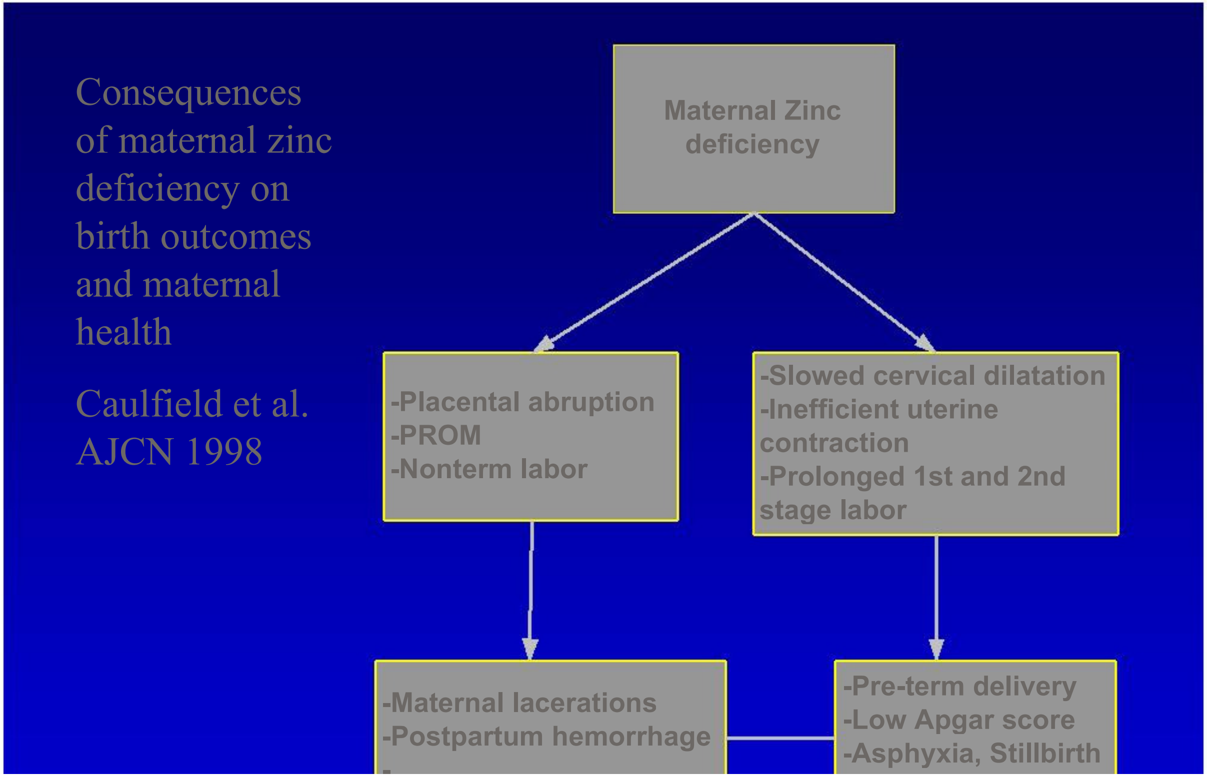
Consequences of maternal zinc deficiency on birth outcomes and maternal health
Caulfield et al. AJCN 1998
Maternal Zinc deficiency
-Placental abruption
-PROM
-Nonterm labor
-Slowed cervical dilatation
-Inefficient uterine contraction
-Prolonged 1st and 2nd stage labor
-Maternal lacerations
-Postpartum hemorrhage
-Pre-term delivery
-Low Apgar score
-Asphyxia, Stillbirth

- Postpartum infections
- Neonatal sepsis

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Zinc deficiency and labor and delivery complications

TABLE 1

Contribution of zinc deficiency to labor and delivery complications based on observational studies[1]

Study	Study size	Zinc status indicator	Labor/delivery complication	OR (95% CL)
Poland, Lublin (5)	PROM, n = 19 No PROM, n = 51	Zinc status index <5.0 (using zinc measured in whole blood, scalp, pubic hair, colostrum)	PROM	4.1 (1.4, 12.2)
United States, Camden, NJ (6)	818 pregnant women	Zinc intake <6 mg/d	PROM Very preterm	3.5 (1.0, 11.5) 5.4 (1.6, 18.9)
United States, Cleveland, OH (7)	279 pregnant women	Low zinc status index created using plasma zinc, alkaline phosphatase, erythrocyte zinc	Protracted labor (active phase) Labor >20 h 2nd stage > 2.5 h 3rd degree lacerations	1.8* 4.4* 8.9* 5.0*
Spain, Pamplona (8)	336 pregnant women	Plasma zinc	Length of active phase, mode of delivery	Not available. (Significant differences in mean zinc concentration by outcome)

[1] Abbreviations: OR, odds ratio; CL, confidence limit; PROM, premature rupture of membrane; RCT, randomized clinical trial. * $P < 0.05$.

Christian, J Nutr 2003

Zinc deficiency and labor and delivery complications

TABLE 2

Contribution of zinc deficiency to labor and delivery complications based on supplementation trials[1]

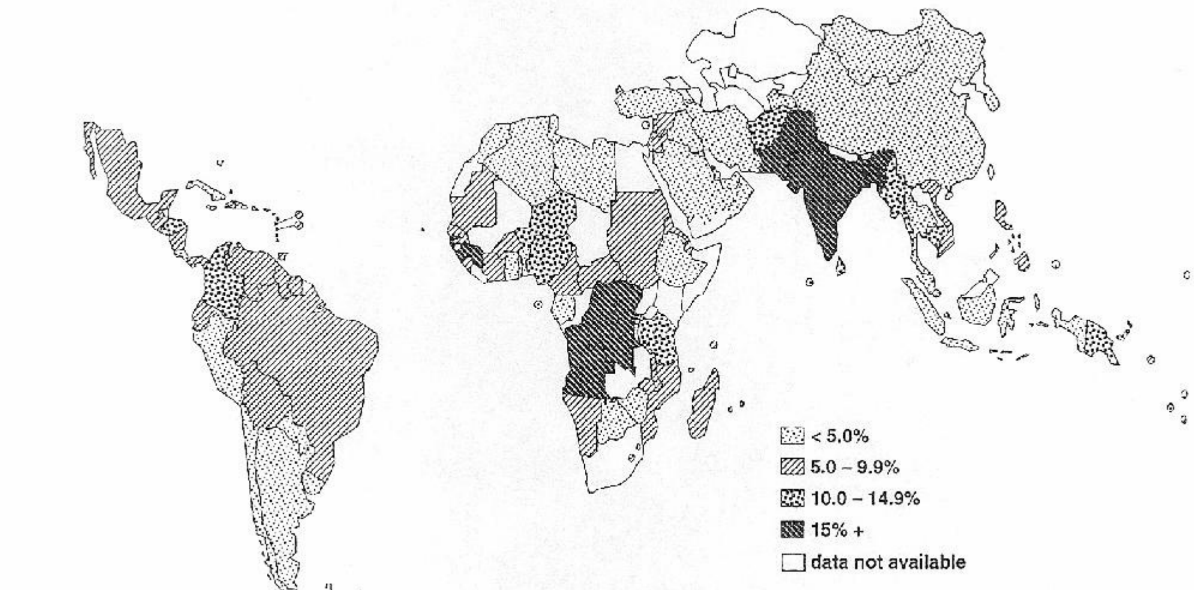
	Study design		RR (95% CI)
United Kingdom, Bristol (9)	Placebo controlled RCT Zinc (20 mg), *n* = 246 Placebo, *n* = 248	Induced labor/caesarian section PROM Hemorrhage Infection	0.97 (0.7, 1.4) 0.94 (0.6, 1.4) 1.6 (0.8, 3.2) 1.1 (0.4, 3.1)
Germany (10)	Not randomized, masked Oral zinc (20 mg), *n* = 179 Controls, *n* = 345	PROM Preterm labor Premature separation of placenta Vaginal bleeding	0.92 (0.6, 1.3) 0.2 (0.0, 1.4) 0.35 (0.1, 1.2) 0.4 (0.1, 1.2)
Sweden (11)	Not randomized, women with low serum zinc received zinc therapy (22–90 mg). Control subjects were women who did not have low serum zinc	Preterm	0.83 (0.5, 1.3)
United Kingdom, Asian (12)	RCT, Zinc (22.5 mg), *n* = 30 Placebo, *n* = 26 High rate of noncompliance, small sample size	Induced labor Caesarian section	0.26 (0.06, 0.9) 0.21 (0.02, 1.1)

[1] Abbreviation: RR, relative risk.

Christian, J Nutr 2003

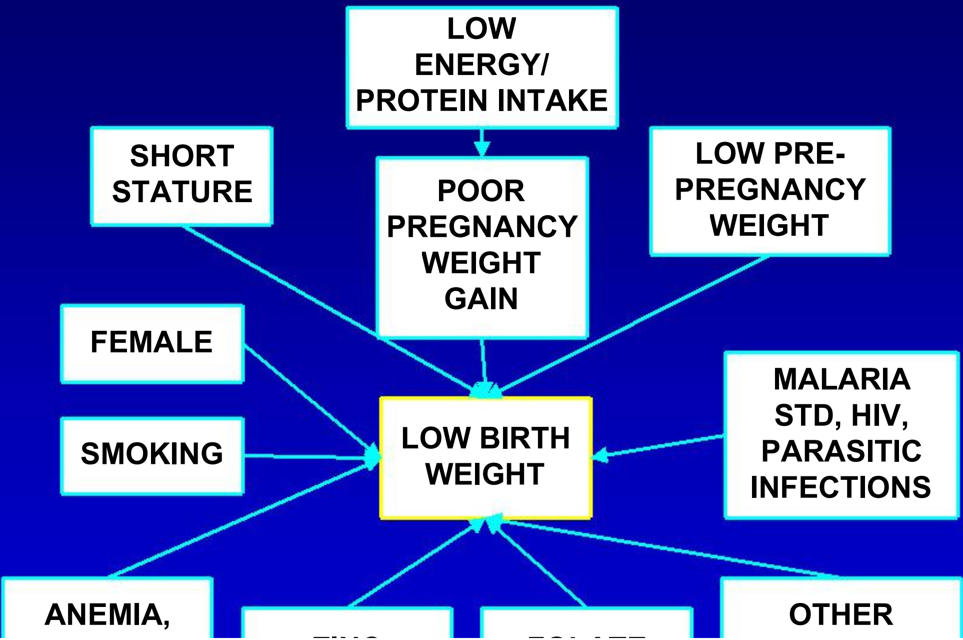
Fetal and Infant Outcomes

Incidence of IUGR-LBW in developing countries, 1985-1995.

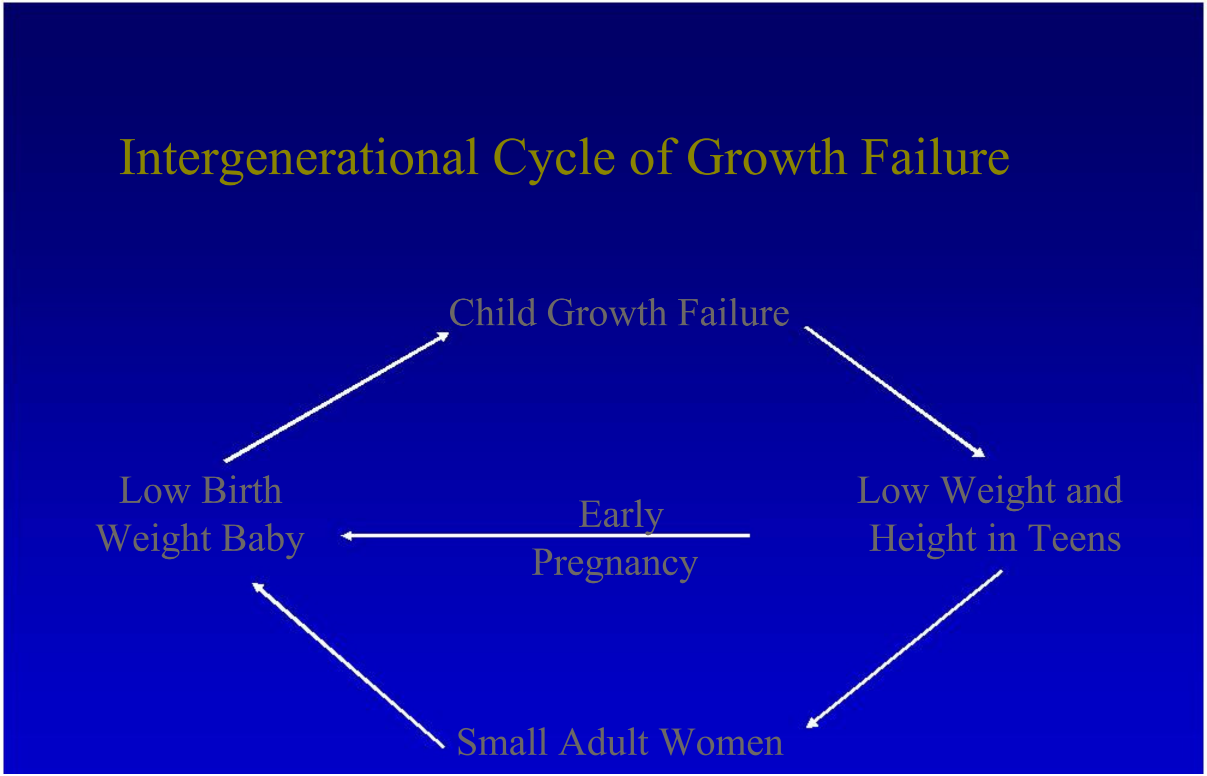


Source: ADB Nutrition & Development Series

Determinants of low birth weight



IRON DEFICIENCY | ZINC DEFICIENCY | FOLATE DEFICIENCY | NUTRIENT DEFICIENCIES


Intergenerational Cycle of Growth Failure
Child Growth Failure
Low Weight and Height in Teens
Early Pregnancy
Low Birth Weight Baby
Small Adult Women

Food supplementation

25-86 g increase in birth weight per every 10,000 kcal increase in energy consumption

Pooled estimate from 7 small studies of energy/protein supplementation showed a 23% reduction in sga babies (RR: 0.77, 95% CL: 0.58, 1.01)

Food supplementation trial in the Gambia (Ceesay et al, BMJ 1997)

Daily food supplement (peanut biscuits) containing 1000 kcal, 22 g protein, and 56g fat

	Birth wt g .	% LBW .
All year	136	39
Harvest season	94	36
Hungry season	201	42

Perinatal mortality	44% .

Maternal iron supplementation and pregnancy outcomes

- Maternal anemia is associated with low birth weight and preterm delivery
- High Hb concentrations are also associated with adverse outcomes
- Evidence from 21 intervention trials does not demonstrate a causal relationship between ID/IDA and IUGR (Rasmussen J Nutr 2002)

Risk of adverse birth outcomes for non-anemic, iron-replete women is reduced by 2-3 mo. of iron supplements

Outcome	+ Iron	Placebo	Difference
Birth wt	3277	3072	206**
% low BW	4.3	16.7	-12.4***
Gest. age (wk)	38.9	38.3	0.6*
% preterm	12.8	12.5	ns
%	6.8	17.7	-

SGA			10.9*

Cogswell et al; AJCN 2004

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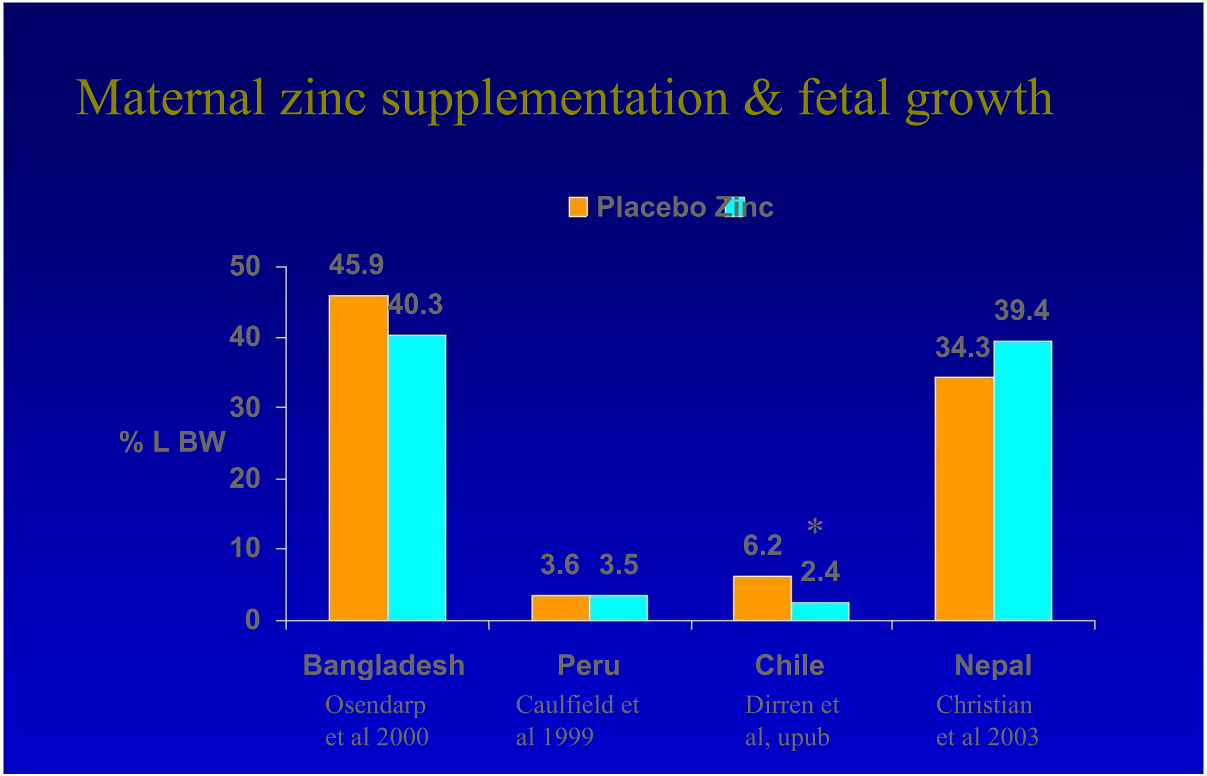
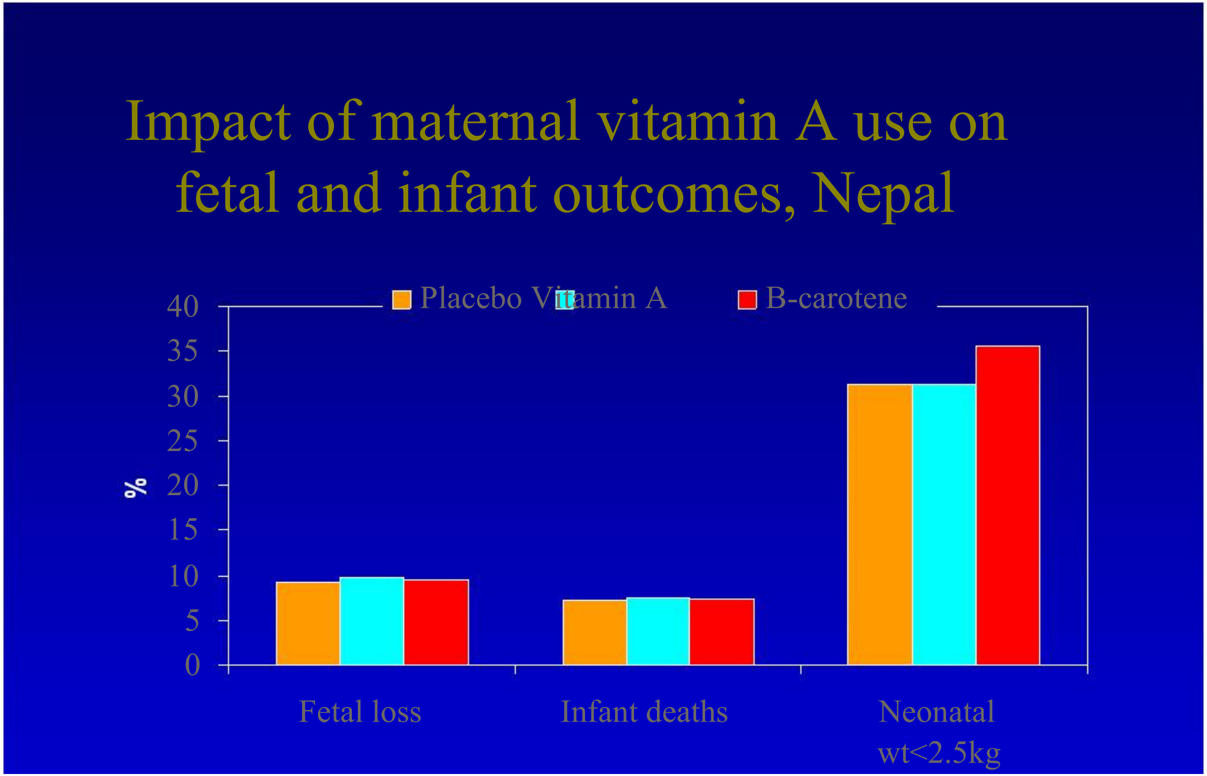


Three other unpublished trials in Ecuador, Peru and West Java have found no birth weight effects with zinc

Impact of maternal zinc supplementation on illness among infants, Bangladesh

	All infants	LBW infants
	RR	
Acute diarrhea	0.84	0.68
Dysentery	0.36	0.26
ALRI	0.89	0.97
Impetigo	0.53	0.39

Osendarp et al. Lancet 2001


Impact of maternal vitamin A use on fetal and infant outcomes, Nepal
Placebo
Vitamin A
B-carotene
%
40
35
30
25
20
15
10
5
0
Fetal loss
Infant deaths
Neonatal wt<2.5kg

Katz et al 2000, West et al, unpublished

Studies of vitamin A supplementation among HIV-1 infected women

	Country	Outcome	Effect/RR
Fawzi et al, 1998	Tanzania	LBW	0.89
		Preterm	1.06
		Fetal death	0.89
Coutsoudis et al, 1999	S. Africa	LBW	0.85
		Preterm	0.60*
Kumwenda et al,	Malawi	LBW	0.67*

2002

Maternal multiple micronutrient deficiency

- Common in developing countries
- Biologic plausibility for individual micronutrient benefits on fetal/neonatal outcomes exists
- Despite this, evidence for individual nutrients benefits is patchy and contradictory
- Effects of MM supplementation is being

tested

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Early vitamin-mineral use in pregnant adolescents in New Jersey

N = 1430 low income adolescents.

Compared with non-users of supplements:

If started supplements trimester I,

- 2x . preterm, 4x . very preterm
- 2x . LBW, 7x . VLBW (<1500g)

If started supplements trimester II,

- 2x . preterm, 2x . very preterm
- 2x . LBW, 6x . VLBW (<1500g)

(Scholl et al, AJCN 1997)

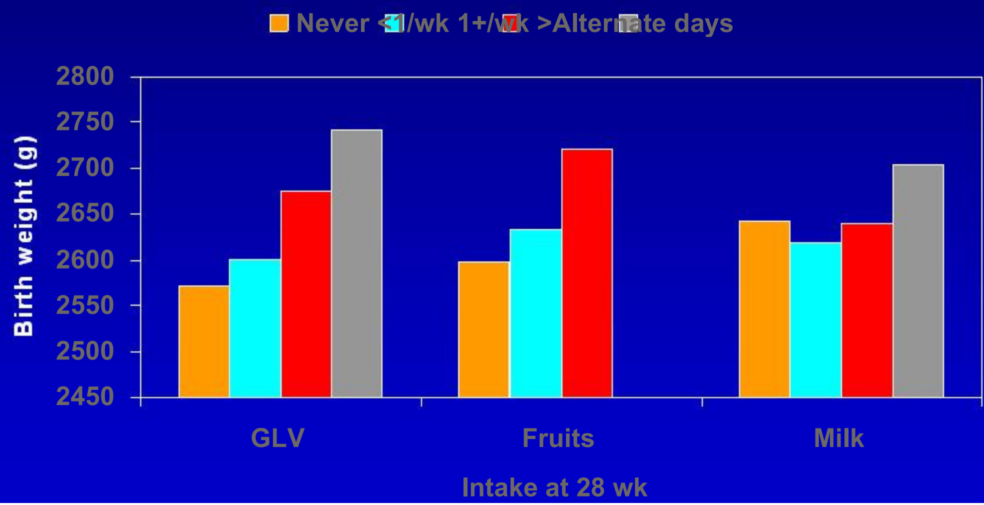
Multiple micronutrients

Fawzi et al, Lancet 1998

- HIV-1 infected population
- Placebo, VA, Multivitamins (MV), VA+MV
- No impact of VA
- MV supplementation resulted in a 40% reduction in
  - Low birth weight and sga
  - Fetal

Fetal
deaths

Pune Maternal Nutrition Study



Adj $p<0.005$ for GLV, $p<0.1$ for fruits, $p<0.1$ for milk

Fall et al; J Nutr 2003

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Nepal Nutrition Intervention Project, Sarlahi 3 (NNIPS-3)

Cluster randomized, masked, controlled trial

To examine effects of daily, antenatal and postnatal supplementation with different combinations of micronutrients on:

- Birth weight
- Fetal loss
- Infant mortality

Maternal morbidity

NNIPS-3 Supplement Groups

C	Control (Vitamin A, 1000 RE/d)
FA	VA + Folic acid (400 g)
FAFe	VA + FA + Iron (60 mg)
FAFeZn	VA + FAFe + Zinc (30 mg)
MN	VA + FAFeZn + 11 other nutrients

NNIPS-3 Key findings

Treatment	BW Diff (g)	LBW	3-mo mortality
C	2587	43%	56/1000
FA	-20	0%	22%.
FAFe	37	16%.	21%.
FAFeZn	-11	4%.	13%.
MM	64	14%.	7% .

Christian et al, BMJ 2003, Christian et al, AJCN 2003

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Birth asphyxia as a cause of mortality.

	Live births	Deaths	NMR	RR
C	876	14	16.0	-
FA	777	7	9.0	0.56
FAFe	772	7	9.1	0.57
FAFeZn	827	3	3.6	0.23*
MM	870	19	19.5	1.22

Christian et al; AJCN 2003

NNIPS-3: Labor and Delivery

	C	FA	FAFe	FAFeZn	MM
	%	-----------Relative Risk---------			
Dysfunctional labor	18.6	0.90	0.94	1.05	1.22*
PP Hemorrhage	5.4	0.67	0.57*	0.85	1.14
PROM	11.0	0.75	0.88	0.80	0.66*
Eclampsia	1.3	0.52 +	0.62	0.66	0.90
Retained placenta	5.4	1.08	0.88	0.95	0.89

*$p<0.05$, +$p<0.1$ using GEE to adjust for the design effect

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NNIPS3 - Puerperal (10-d) Morbidity

	C	FA	FAFe	FAFeZn	MM
	%	----------Relative Risk-------			
Infection 1	15.1	0.89	0.70	0.61*	0.48*
Infection 2	13.6	1.06	0.62*	0.70*	0.77
Fever (24 h hx)	30.8	0.92	0.79*	0.80*	0.82
GIT infection	17.4	0.86	0.74*	0.84	0.80

*p<0.05, using GEE to adjust for the design effect

Antenatal multiple micronutrient supplementation effects in Nepal (Janakpur)

	FeFA	MM	Diff/RR (95%CI)
N	600	600	
Birth weight (g)	2733	2810	77 (24, 130)
Birth length (cm)	48.6	48.9	0.3 (-0.1, 0.6)
% LBW	25	19	0.75 (0.60, 0.94)
% Preterm	10	8	0.86 (0.60, 1.26)

Osrin et al; Lancet 2005

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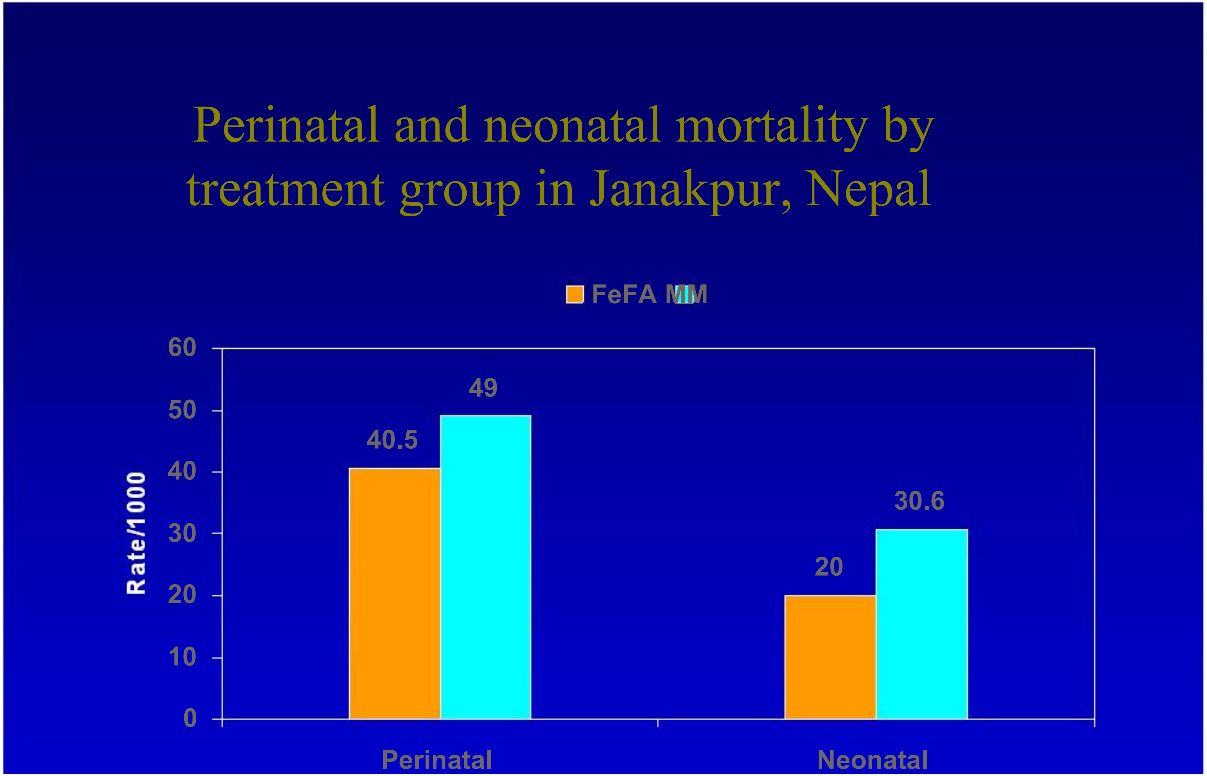


Osrin et al; Lancet 2005

Antenatal multiple micronutrient supplementation effects in Zimbabwe

	Placebo	MM	Diff/RR (95% CI)
N	542	564	
Birth weight (g)	3004	3053	49 (-6, 104)
Birth length (cm)	48.5	48.8	0.2 (-0.1, 0.5)
% LBW	11.4	9.6	0.84 (0.6, 1.2)
% Preterm	18.3	15.1	0.82 (0.6, 1.1)
Birth	HIV		26

Birth weight (g)	HIV - uninfected	26 (-38, 91)

Friis et al, AJCN 2004

Antenatal multiple micronutrient supplementation effects in Mexico

	Fe	MM
N	322	323
Birth weight (g)	2977	2981
Birth length (cm)	48.6	48.7
% LBW	8.9%	8.5%
% Preterm	6.5	7.5

Ramakrishnan et al, AJCN 2003

Effect of multivitamin use on preterm delivery (PINS, 1995-2000)

Crude	RR	95% CI
Preconceptional users	0.43	0.2, 1.1
Periconceptional users	0.86	0.6, 1.3
Prenatal users	1.04	0.7, 1.5
Nonusers	1.00	-
Adjusted		
Preconceptional users	0.58	0.2, 1.2
Periconceptional users	1.02	0.6, 1.8
Prenatal users	1.22	0.7, 2.0

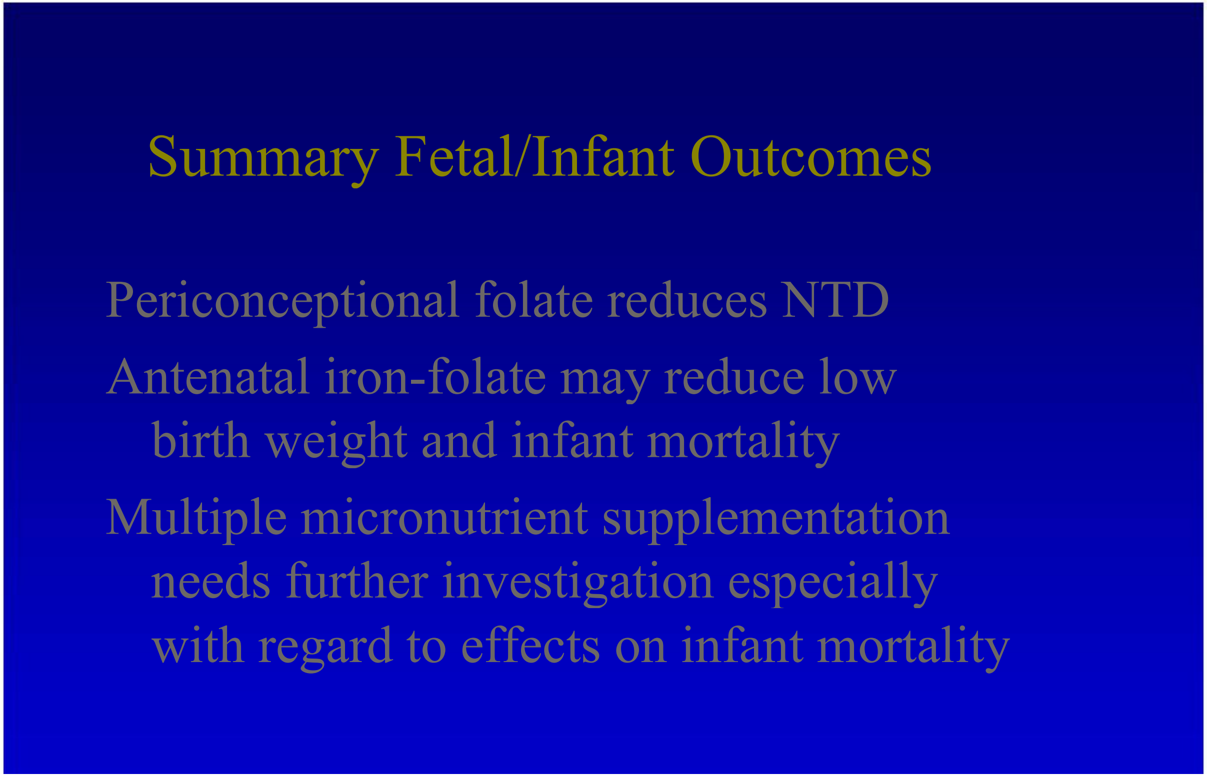
Nonusers	1.00	-

Vahratian et al; AJE 2004

Summary Maternal Outcomes

- Stunting need to break the intergenerational cycle of malnutrition
- Severe anemia indirect cause of 10-12% of maternal mortality in developing countries
- VA supplementation to prevent maternal mortality - awaits results from replicate trials
- Calcium may reduce pre/eclampsia effective dose for developing countries under investigation
- Effects of zinc

Effects of zinc
equivocal


Summary Fetal/Infant Outcomes
Periconceptional folate reduces NTD
Antenatal iron-folate may reduce low birth weight and infant mortality
Multiple micronutrient supplementation needs further investigation especially with regard to effects on infant mortality

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Zinc Deficiency

Robert E. Black, M.D., M.P.H.
Edgar Berman Professor and Chair
Department of International Health
Johns Hopkins Bloomberg School of Public Health

Effects of Zinc Deficient Diets in Early Experiments in Rats

1922-27: Studies with equivocal effects

1933 (Newell & McCollum): Zinc is probably not an essential nutritional factor in the growth of the rat

1934 (Todd et al): Reduced the rate of growth

1940 (Day & McCollum): Impaired growth and eczema

Zinc Biology

Essential trace element

Several hundred zinc metalloenzymes

Zinc fingers in transcription proteins determine binding to DNA

Intracellular regulation, e.g., cellular growth, differentiation and death

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Considerations Regarding Dietary Zinc

Breast milk, beef, oysters, crabmeat, poultry are good sources

Phytates, fiber and lignin reduce bioavailability of zinc from cereals, legumes and tubers

Calcium and casein may reduce bioavailability of zinc from cows milk

Causes of Excess Zinc Losses or Shifts

Fever/catabolism increases muscle breakdown and urinary zinc losses

Diarrhea causes excess losses

Proinflammatory cytokines induce metallothioneins, which binds zinc and results in shift to liver

Factors Suggesting Zinc Deficiency in a Population

High phytate staple foods
Low intake of flesh food
Prevalent stunting
High rate of diarrhea
Nutritional iron deficiency
Geophagia

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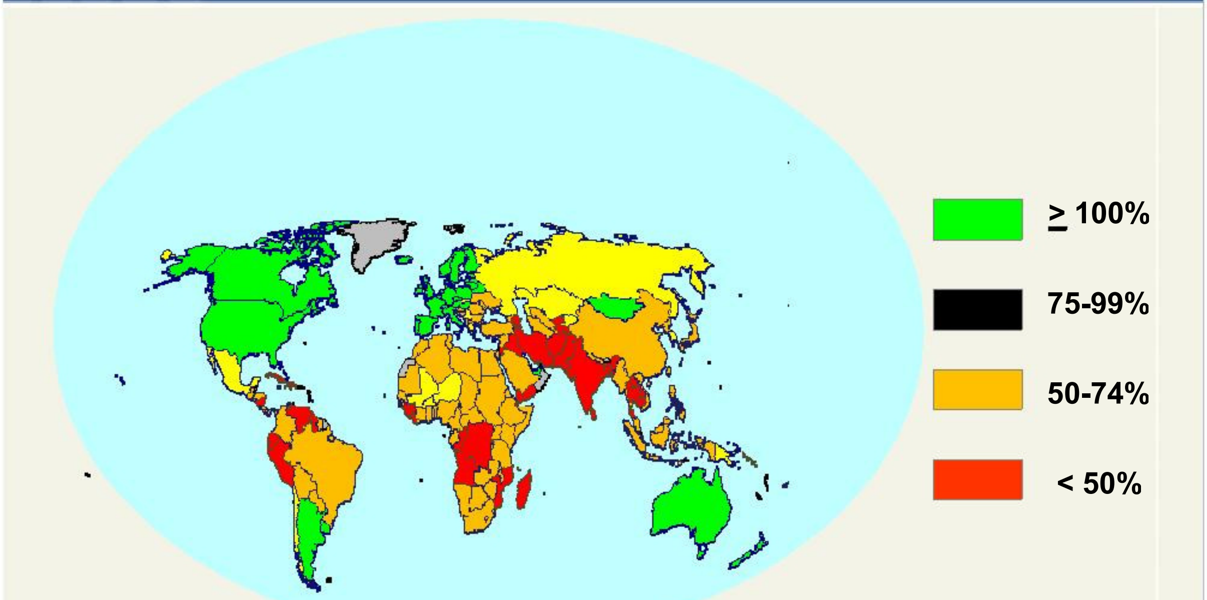
Recommended Daily Intake of Zinc

Age Group	High Bioavailability (US)	Low Bioavailability (WHO)	(IZiNCG)
0-5 mo	2.2 mg	7.1 8.0 mg	--
6-11 mo	3.0 mg	7.0 8.0 mg	5.0 mg
12-59 mo	3.0 5.0 mg	7.9 9.2 mg	3.0 5.0 mg

Zinc in the national food supply, as % weighted mean per capita requirement
(adjusting for estimated zinc absorption from food supply)



Clinical Spectrum of Human Zinc Deficiency

Adolescent nutritional dwarfism: hepatosplenomegaly, hypogonadism, dwarfism, described by Prasad in Iran and Egypt

Severe zinc deficiency: hypogonadism, growth retardation, dermatitis, alopecia, mental disturbances, infections, death

Mild-moderate zinc deficiency: hypogonadism, growth retardation, decreased immune function, infections

Meta-analysis of Randomized Controlled Trials of Zinc Supplementation Effects on Growth in Prepubertal Children*

33 data sets

10 from US/Canada, Europe, Japan

23 from 16 low- and middle-income countries

Zinc dose 1-20 mg/d for 2-15 mo

*Brown KH et al., Am J Clin Nutr, 2002

Effects of Zinc Supplementation on Growth

Overall highly significant effects of zinc on weight and height increments

Effects greater in underweight or stunted children

Absolute difference in height (for 25 studies with average initial age of 2.8 y and 6 mo. supplementation) was 0.72 cm (similar to food supplementation trials)

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Effects of Zinc Deficiency on Immune Function

Reduced nonspecific immunity, including PMN and NK function and complement activity

Reduced T and B lymphocytes

Multiple effects on function, including suppressed delayed hypersensitivity, cytotoxic activity and antibody production

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Randomized Controlled Trials of Zinc Supplements for Prevention or Therapy

Prevention supplements of zinc given daily to all children in population where there is some indication of zinc deficiency to assess prospectively rates of infectious diseases

Therapy supplements of zinc given to children who have an infectious disease to examine benefits for that episode and sometimes subsequent illness

Preventive Effects of Zinc Supplements for Diarrhea, Pneumonia and Malaria

Analysis of 9 trials with diarrhea outcomes

Analysis of 5 trials with pneumonia outcomes

Analysis of 2 trials with malaria outcomes

Trials Evaluating the Preventive Effects of Zinc Supplementation on Diarrhea and Pneumonia

Countries: Burkina Faso, Ethiopia, Guatemala, India (2), Jamaica, Mexico, PNG, Peru, Vietnam

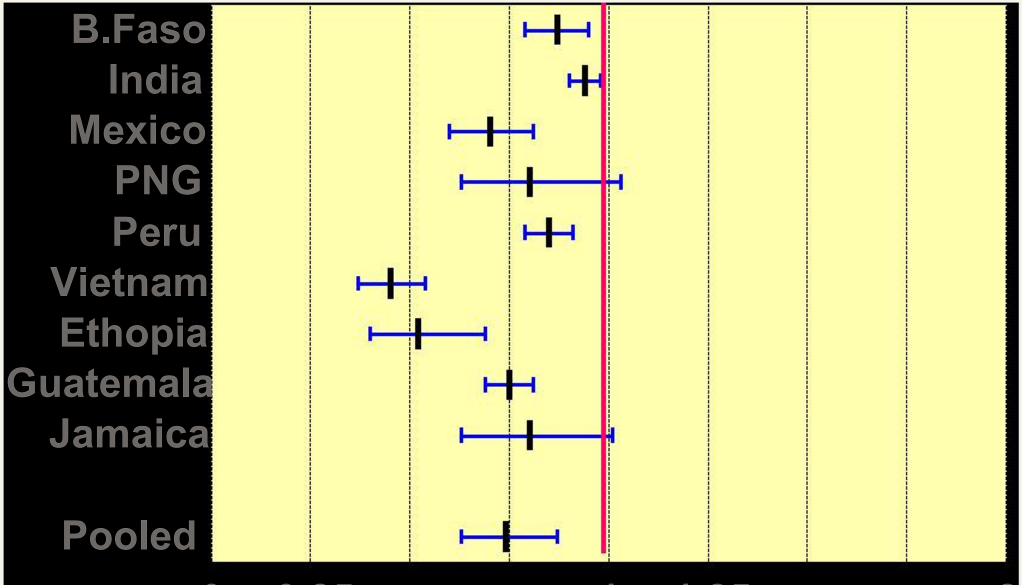
Age groups: 4-60 mo

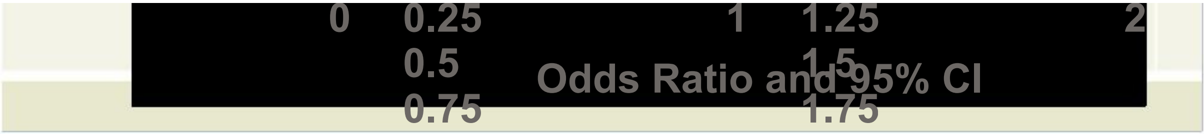
Dose of zinc: 10mg/d (range 5-20 mg/d)

Provision of Vitamins and Minerals to Both Zinc and Control Groups in Preventive Trials of Zinc Supplementation

Trial	Vitamins/Minerals
India	Vit. A,B,D,E
India	Vit. A
Jamaica	Vit. A,B,C,D
Mexico	Half given iron
PNG, Peru, Vietnam, Guatemala, Ethiopia, Burkina Faso	None

Preventive Effect of Zinc Supplementation on Diarrheal Prevalence in Continuous Supplementation Trials




0 0.25 1 1.25 2
0.5 1.5
0.75 1.75
Odds Ratio and 95% CI

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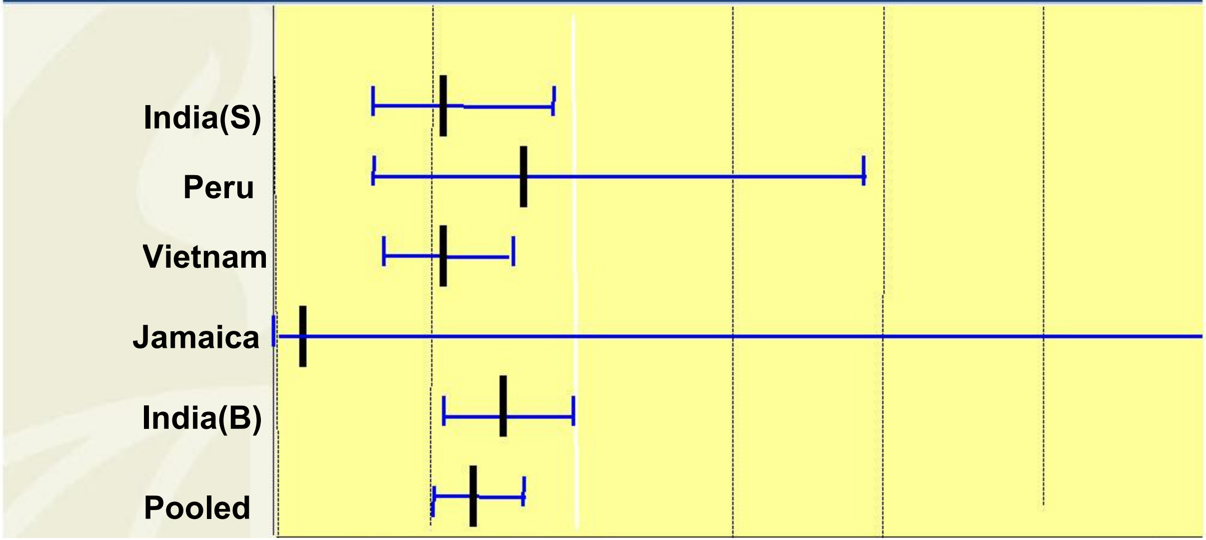
Preventive Effect of Zinc Supplementation on Pneumonia Incidence in Continuous Supplementation Trials




0
0.5
1
1.5
2
2.5
3
Relative Risk and 95% CI

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Effect of Zinc Supplementation on Malaria in Children

Location	Reduction in Clinic Visits for Malaria
The Gambia	32% ($p=0.09$)
Papua New Guinea	38% ($p<0.05$)
Combined	36% (CI 9-55%, $p<0.05$)

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Trial of Zinc or Vitamin/Iron Supplementation in Term, SGA Infants in India

Term, below 10th percentile W/A

4 Groups supplemented 1-9 mo. of age
- **Riboflavin**
- **Riboflavin, zinc**
- **Riboflavin, folate, iron, calcium, phosphorus**
- **Riboflavin, zinc, folate, iron, calcium, phosphorus**

68% lower mortality in zinc-supplemented groups (5 vs 15 deaths, $p=0.028$)

Sazawal, Black, Menon et al, Pediatr, 2001

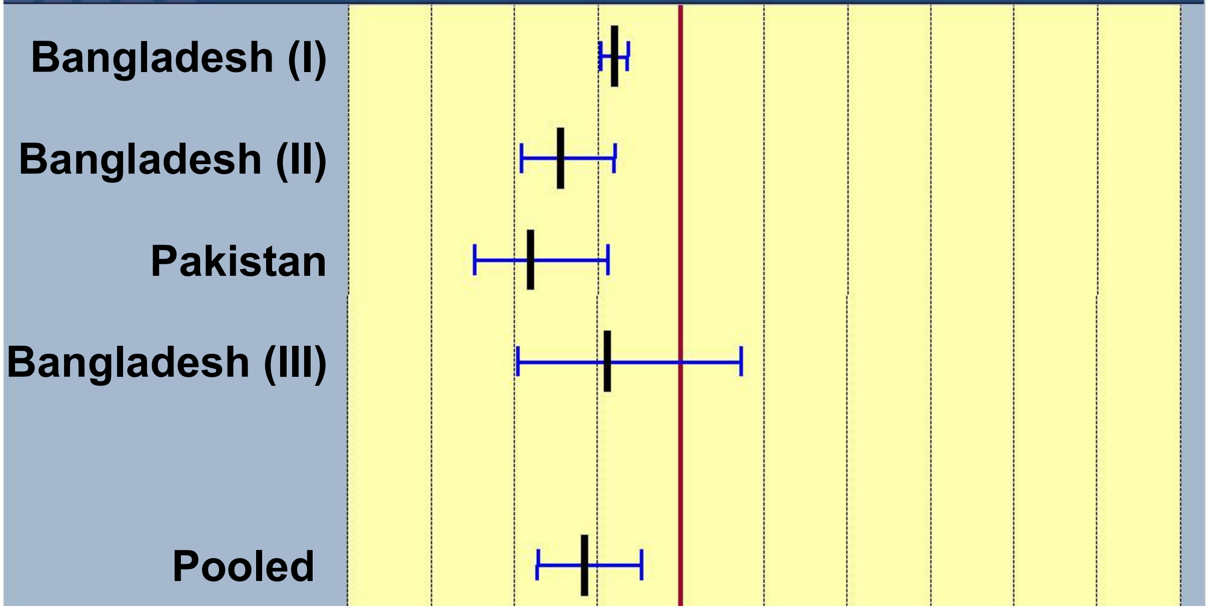
Trials in Bangladesh Evaluating the Preventive Effect of Weekly Zinc Supplementation

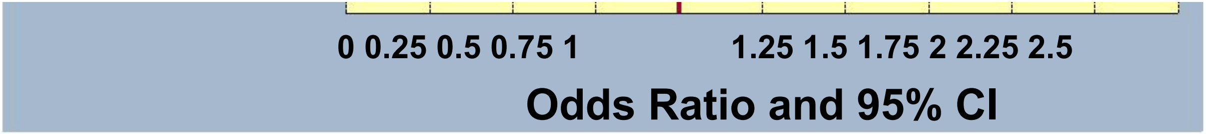
6-11 mo. old infants <-1z W/A, weekly zinc (20mg) had non sig. reduction in diarrhea and ALRI, but zinc plus iron (20 mg) had sig. 30% less diarrhea and 40% less ALRI[1]

1-23 mo. old children, weekly zinc (70 mg) had sig. 6% less diarrhea, 17% less pneumonia, 49% less severe pneumonia and 42% less otitis media, as well as sig. 85% less mortality [2]

[1]Baqui et al, J Nutr, 2004, [2]Brooks et al, submitted

Preventive Effect of Zinc Supplementation on Diarrheal Incidence in Short - Course Supplementation Trials




0 0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.25 2.5
Odds Ratio and 95% CI

Trial of Zinc or Vitamin/Iron Supplementation in Term, SGA Infants in India

Term, below 10th percentile W/A

4 Groups supplemented 1-9 mo. of age
- Riboflavin
- Riboflavin, zinc
- Riboflavin, folate, iron, calcium, phosphorus
- Riboflavin, zinc, folate, iron, calcium, phosphorus

68% lower mortality in zinc-supplemented groups (5 vs 15 deaths, p=0.028)

Sazawal, Black, Menon et al, Pediatr, 2001

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Efficacy Trials of Zinc Supplementation on Child Mortality

Zanzibar and Nepal

Children 1-35 mo. old (>60,000 child-years)

Randomized, controlled trials

Daily 10 mg zinc (5 mg if <12 mo old)

All children receive vitamin A

Trial to be completed in Zanzibar in September, 2005 and Nepal in January, 2006

Therapeutic Effects of Zinc Supplements in Diarrhea, Pneumonia, and Malaria

12 trials in acute diarrhea

5 trials in persistent diarrhea

2 trials in pneumonia

1 trial in measles

Multi-center trial in malaria

Trials on the Therapeutic Effect of Zinc on Acute Diarrhea

Countries: Bangladesh (3), Brazil, India (6), Indonesia, Nepal

Age groups: 3-60 mo

Dose of zinc: 20 mg/d (range 5-45 mg/d)

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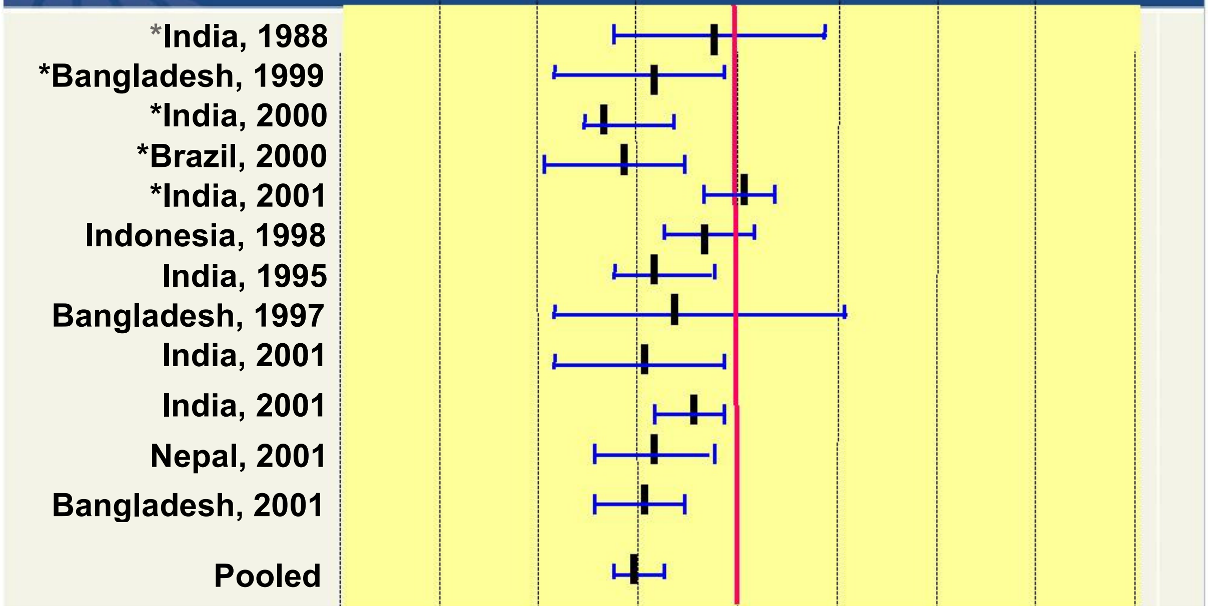
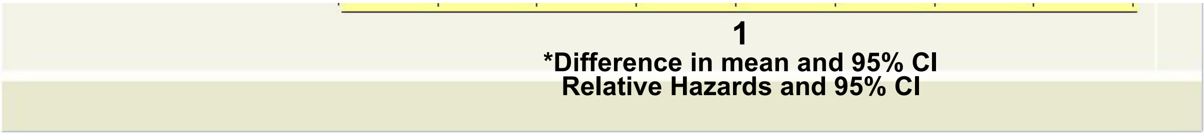
Effect of Zinc Supplementation on Duration of Acute Diarrhoea/Time to Recovery




1
*Difference in mean and 95% CI
Relative Hazards and 95% CI

Therapeutic Effects of Zinc Supplementation on Acute Diarrheal Severity

Country	Diarrhea Outcome	Percent Reduction
India	Frequency	18
India	Frequency	39
Bangladesh	Output	28
India	Output	38
Brazil	Frequency	59

Trials on the Therapeutic Effect of Zinc on Persistent Diarrhea

Countries: Bangladesh (2), India, Pakistan, Peru

Age Groups: 3-36 mo

Dose of zinc: 20 mg/d

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Effect of Zinc Supplementation on Duration of Persistent Diarrhea Episode

Analysis	Effect Measure	Effect Size (95% CI)
Pooled Analysis (n=4)	Lower probability of continuing diarrhea	24% (9%, 38%)
Meta-Analysis (n=5)	Reduction in mean duration	29% (6%, 52%)

Community-based Trial of Zinc Supplementation During Diarrhea

In rural Bangladesh, 30 health worker areas randomized

8,070 3-59 mo. old children, 11,880 child-years

ORT alone vs. ORT and 20 mg/d zinc

Duration of episodes: RH 0.77 (0.69, 0.86)

Diarrhea hospitalization: RR 0.81 (0.65, 1.00)

Mortality: RR 0.49 (0.25, 0.94)

Baqui, Black, Arifeen, et al., BMJ, 2002	

Effects of Zinc Supplementation Started During Acute Diarrhea in Bangladesh*

Outcome	Zinc (%)	Control (%)
Treated with ORS	75	50
Antibiotic use	13	34
Other drug use	15	45
Care from pharmacy	16	33
Care from village doctors	12	27
Care from homeopaths	6	13

*Baqui, Black, Arifeen et al, J Health Pop Nutr, 2004
All comparisons $p<0.01$

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Zinc and/or Vitamin A in the Treatment of Acute Lower Respiratory Infection*

- Indian children 2-24 mo old
- 153 randomized to 10 mg zinc/d, 10,000 ug RE vitamin A, both or placebo
- Zinc supplemented boys had faster recovery (Recovery rate ratio from very ill status (2.6; 1.4, 5.1); no effect in girls
- Vitamin A supplementation had no benefit on recovery

*Mahalanabis et al, AJCN, 2004

Efficacy of Zinc in Therapy of Severe Pneumonia*

Bangladeshi children <2y old with severe pneumonia

270 randomized to 20mg zinc/d or placebo along with standard antibiotics (amp./gent.)

Zinc group had shorter duration of severe pneumonia (RH 0.81; 0.67, 0.99) and of chest indrawing, elevated RR and hypoxia

* Brooks et al, Lancet, 2004

Efficacy of Zinc in Therapy of Measles and Malaria

Indian study found no effect of 20mg zinc/d in therapy of measles[1]

Multi-center study (Ecuador, Ghana, Tanzania, Uganda, Zambia) found no effect of 20/40 mg zinc/d in therapy of malaria[2]

[1]Mahalanabis et al, AJCN, 2002
[2]Zinc Against Plasmodium Study Group, AJCN, 2002

Summary of Prevention and Therapy
Beneficial Effects of Zinc

Prevention

- Consistent effects on diarrhea and pneumonia morbidity; possible effects on malaria and otitis
- Two trials show mortality reduction

Therapy

- Consistent effects with diarrhea; possible effects with pneumonia
- One trial shows mortality reduction

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Zinc Supplementation in Pregnancy

Countries: Bangladesh, Chile, Ecuador, Indonesia (3), Peru (2)

Initiation: generally from 2 nd trimester

Dose: 25 mg/d (range 15 30 mg/d)

From: Osendarp, West, Black, J Nutr, 2003

Results of Zinc Supplementation in Pregnancy

Intrauterine growth evidence negative

Labor and delivery complications, gestational age at birth, fetal neurobehavioral development evidence conflicting or limited

Neonatal immune status, early neonatal morbidity-evidence positive

From: Osendarp, West, Black, J. Nutr, 2003

Supplementation to Improve Zinc Nutriture in Developing Countries

Dose

- Approximately one RDA
- Range of safety and benefit unknown
- - probably - 2 RDA daily
- - unknown for weekly

Supplementation to Improve Zinc Nutriture in Developing Countries

Form of zinc

- **most trials done with sulfate, then gluconate and acetate**

Combination with other micronutrients

- **some adverse interaction in both directions when given with iron in a supplement**

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Supplementation to Improve Zinc Nutriture in Developing Countries

Frequency

- Clear effects of daily
- Similar change in plasma zinc with daily or weekly
- Benefits with two weeks of supplement for 2 - 6 months
- Benefits of weekly supplements of 20 mg or 70 mg
- Benefits of 2 weeks of supplement for 2-6 months

Supplementation to Improve Zinc Nutriture in Developing Countries

Presentation of supplement for children

Syrup -	**acceptability good, but expensive and difficult logistics**
Dispersible tablets-	**acceptability good**
Tablets/ capsules -	**only for school age children**

Fortification to Improve Zinc Nutriture in Developing Countries

Addition of nutrient to maintain or improve quality of food

Can improve zinc intakes in population

Low cost

Must assure that target population consumes enough

Alternative Fortification Approaches for Zinc

Commercial foods e.g., baby cereal

Special foods, e.g., sachet of powdered food or fat-based food with micronutrients added

Staple foods, e.g., wheat flour in Indonesia or maize flour in Mexico

Addition of micronutrients to home-prepared foods, e.g., a sprinkle being evaluated

Implication for Global Burden of Disease

Burden attributable to zinc deficiency includes 779,000 child deaths and 27 million DALYs annually, about 2% of global DALYs

Either preventive or therapeutic use of zinc supplements has the potential to reduce infectious disease illness and death if effective delivery systems can be deployed

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

NUTRITION AND HIV INFECTION

Richard D. Semba, MD MPH
Johns Hopkins School of Medicine
Baltimore, Maryland

HIV PANDEMIC - 2004

39.4 million people living with HIV/AIDS

4.9 million newly infected with HIV in 2004

3.1 million deaths in 2004

64% of cases in sub-Saharan Africa

18% of cases in south Asia, southeast Asia

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Their answer was clear and unanimous: food. Not care, not drugs for treatment, not relief from stigma, but food.

-- Peter Piot, UNAIDS

OBJECTIVES

to explain the relationship between HIV infection and malnutrition

to demonstrate the associations of malnutrition with clinical outcomes during HIV infection

to show specific studies and situations: micronutrient supplementation trials, wasting syndrome, TB and HIV infection, breastfeeding

to demonstrate the potential effects of malnutrition and HIV infection on food security and famine, especially in southern Africa

to discuss

to discuss
possible
solutions

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HIV AND NUTRITIONAL STATUS

REDUCED INTAKE

central nervous system disease and anorexia

oral and esophageal candidiasis with painful swallowing (odynophagia)

fatigue, decreased productivity, poverty, reduced

INCREASED LOSSES

urinary losses of vitamin A

loss of zinc in gastrointestinal tract

loss of iron in gastrointestinal tract

food
availability

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HIV AND NUTRITIONAL STATUS

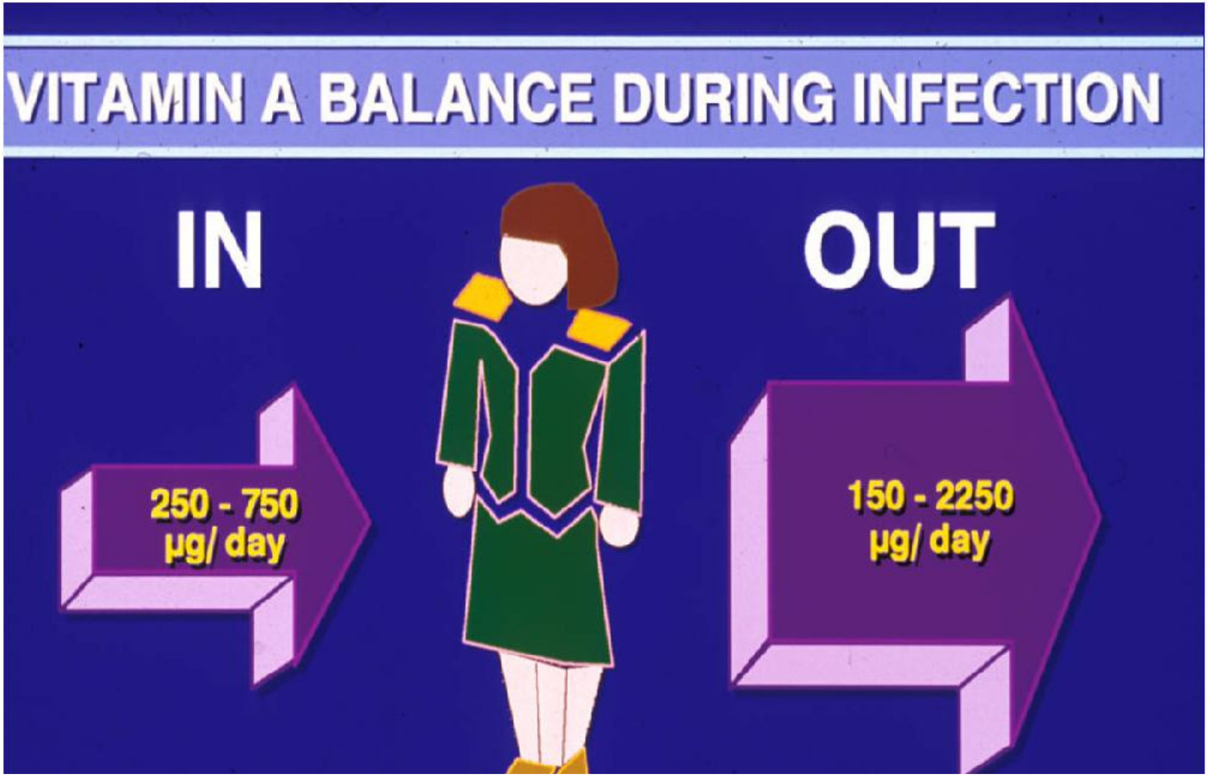
FAT MALABSORPTION

- pre-HAART: 40-60% of children and adults with steatorrhea
- reduced absorption of fat-soluble vitamins and nutrients

CARBOHYDRATE MALABSORPTION

- pre-HAART: 25% of symptomatic children with carbohydrate malabsorption
- gut integrity related to vitamin A and zinc status


nutrients

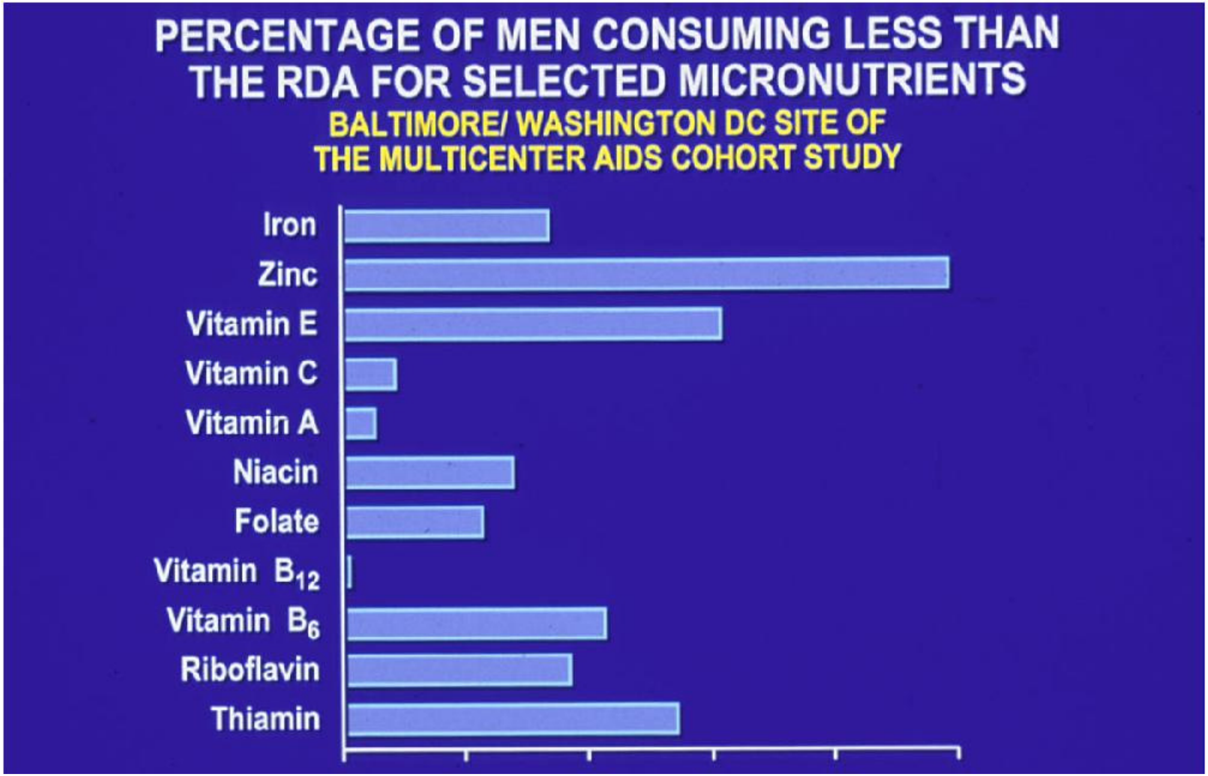

VITAMIN A BALANCE DURING INFECTION
IN
OUT
250 - 750
µg/ day
150 - 2250
µg/ day

NUTRIENT REQUIREMENTS

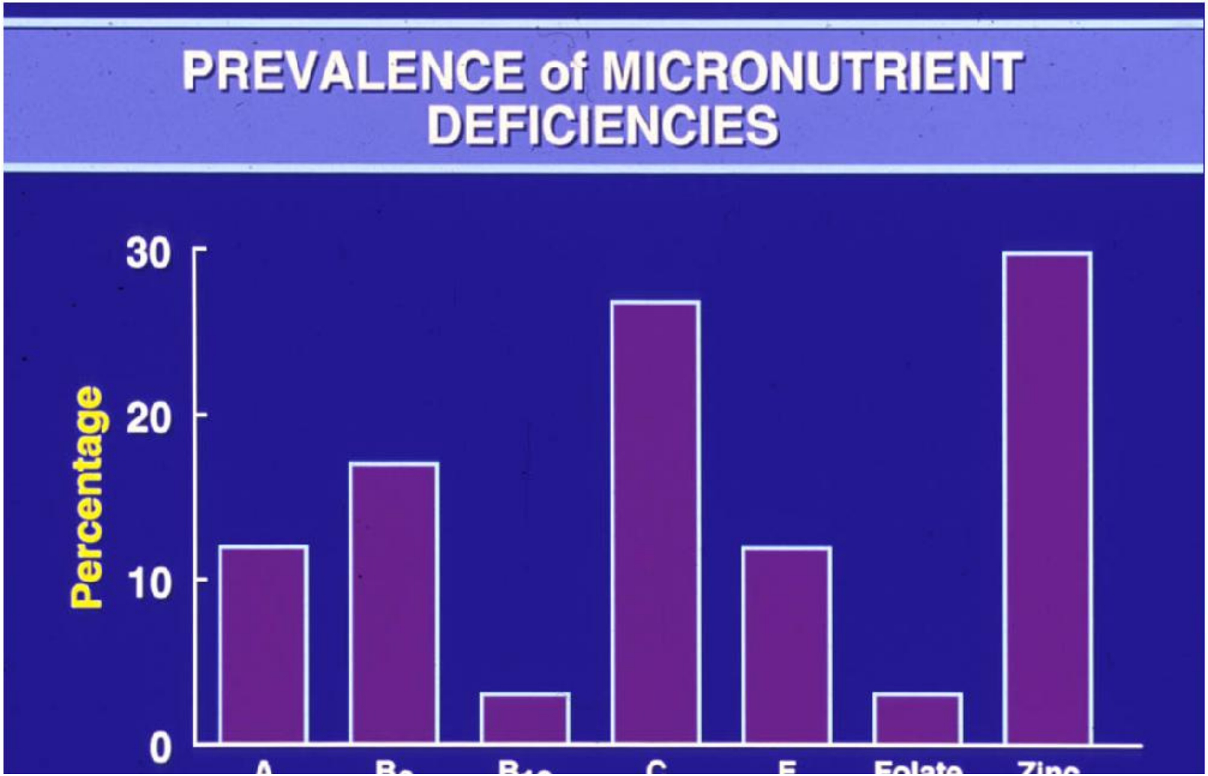
Recommended Dietary Allowance (RDA): adequate to meet the known nutrient needs of practically all healthy persons

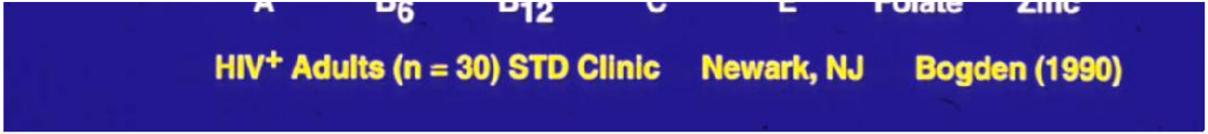
nutrient requirements are higher during HIV infection (Baum & colleagues)

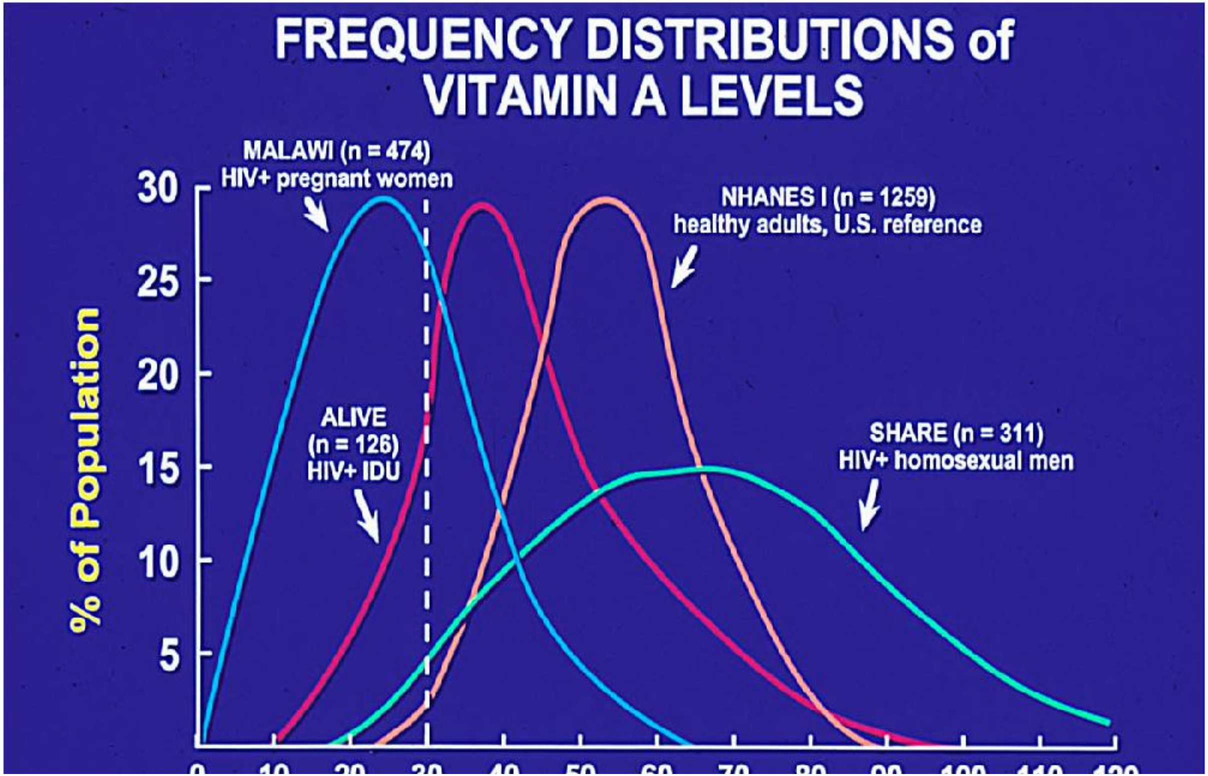
rationale: decreased absorption, increased losses, higher metabolism of nutrients


PERCENTAGE OF MEN CONSUMING LESS THAN THE RDA FOR SELECTED MICRONUTRIENTS
BALTIMORE/ WASHINGTON DC SITE OF THE MULTICENTER AIDS COHORT STUDY
Iron
Zinc
Vitamin E
Vitamin C
Vitamin A
Niacin
Folate
Vitamin B12
Vitamin B6
Riboflavin
Thiamin

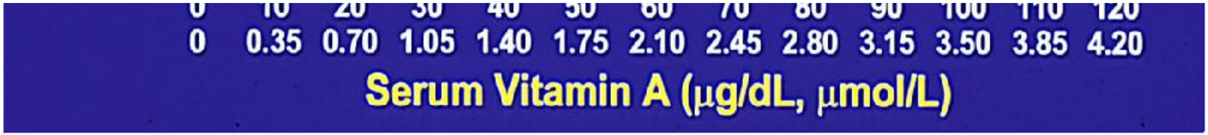

0 10 20 30 40 50
Percent Consuming Less Than One RDA


PREVALENCE of MICRONUTRIENT DEFICIENCIES
Percentage
30
20
10
0


HIV+ Adults (n = 30) STD Clinic Newark, NJ Bogden (1990)



FREQUENCY DISTRIBUTIONS of VITAMIN A LEVELS
MALAWI (n = 474)
HIV+ pregnant women
NHANES I (n = 1259)
healthy adults, U.S. reference
ALIVE
(n = 126)
HIV+ IDU
SHARE (n = 311)
HIV+ homosexual men
% of Population
30
25
20
15
10
5


0 0.35 0.70 1.05 1.40 1.75 2.10 2.45 2.80 3.15 3.50 3.85 4.20
Serum Vitamin A (µg/dL, µmol/L)

POTENTIAL IMPACT OF POOR NUTRITIONAL STATUS

increased HIV disease progression

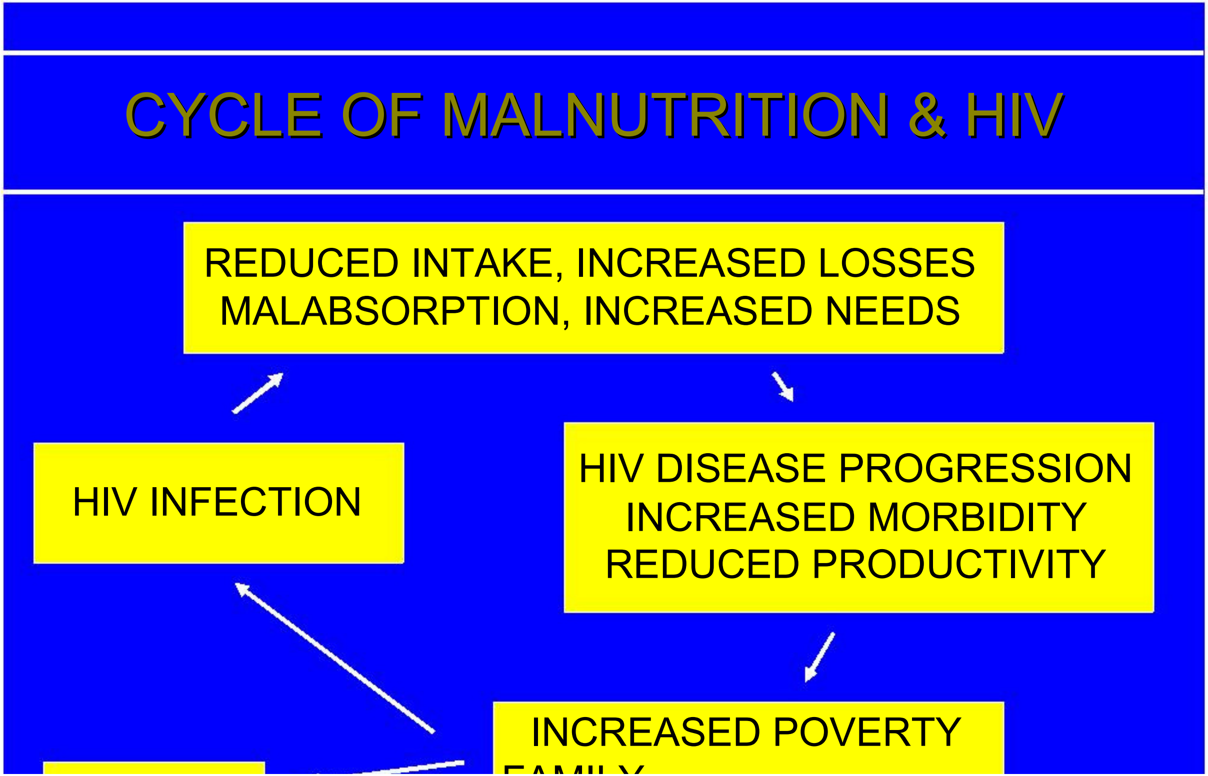
further immune decline

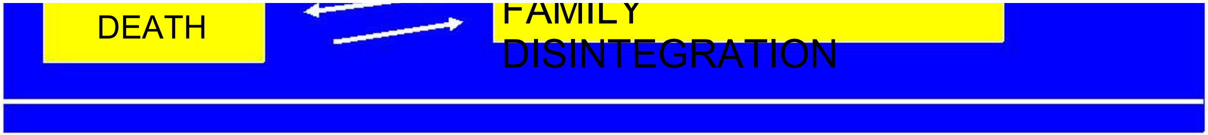
increased infectious disease morbidity

anemia, fatigue, reduced productivity

low birth weight, growth failure

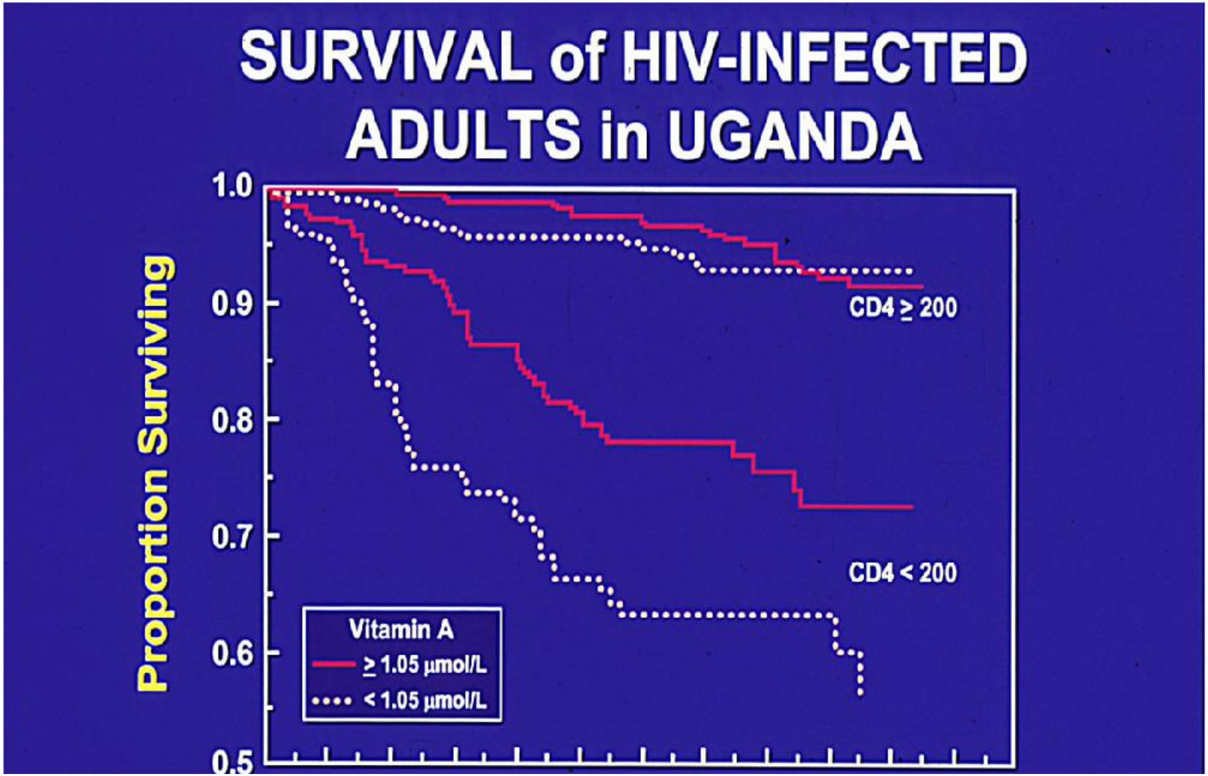
increased mortality


CYCLE OF MALNUTRITION & HIV
REDUCED INTAKE, INCREASED LOSSES
MALABSORPTION, INCREASED NEEDS
HIV INFECTION
HIV DISEASE PROGRESSION
INCREASED MORBIDITY
REDUCED PRODUCTIVITY
INCREASED POVERTY

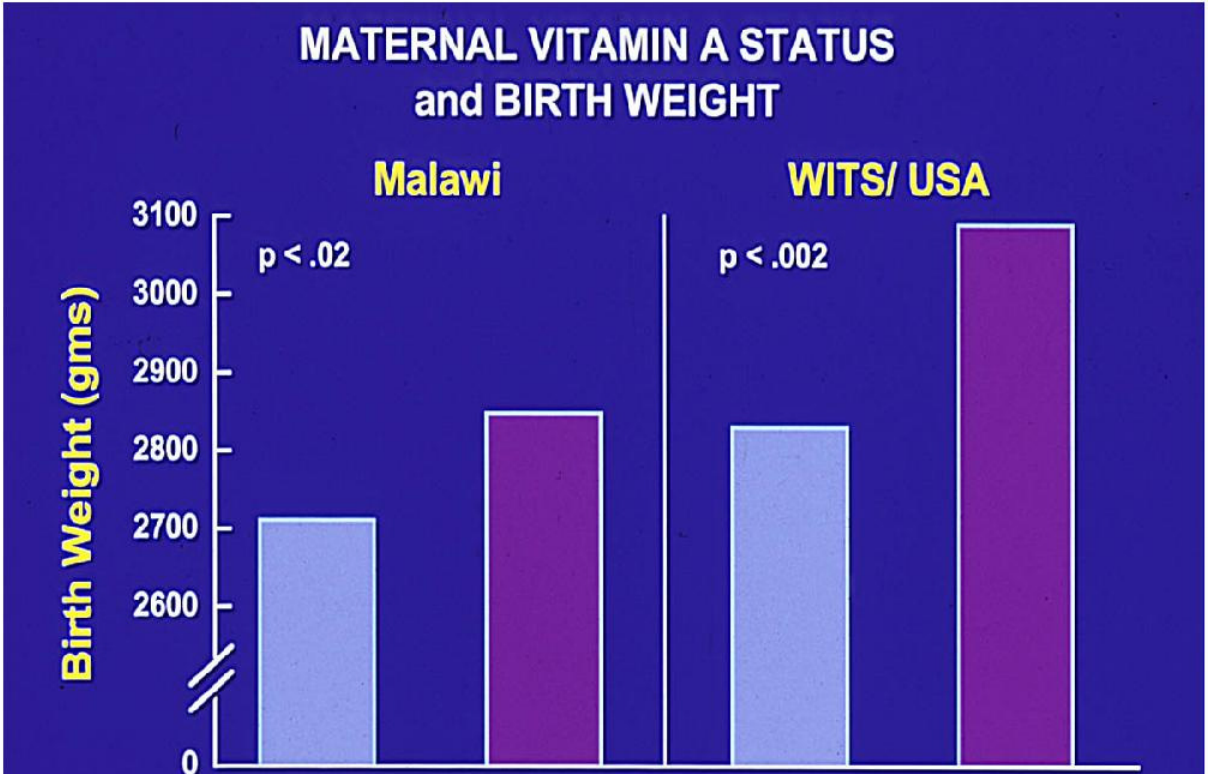

DEATH
FAMILY
DISINTEGRATION

VITAMIN A & IMMUNITY

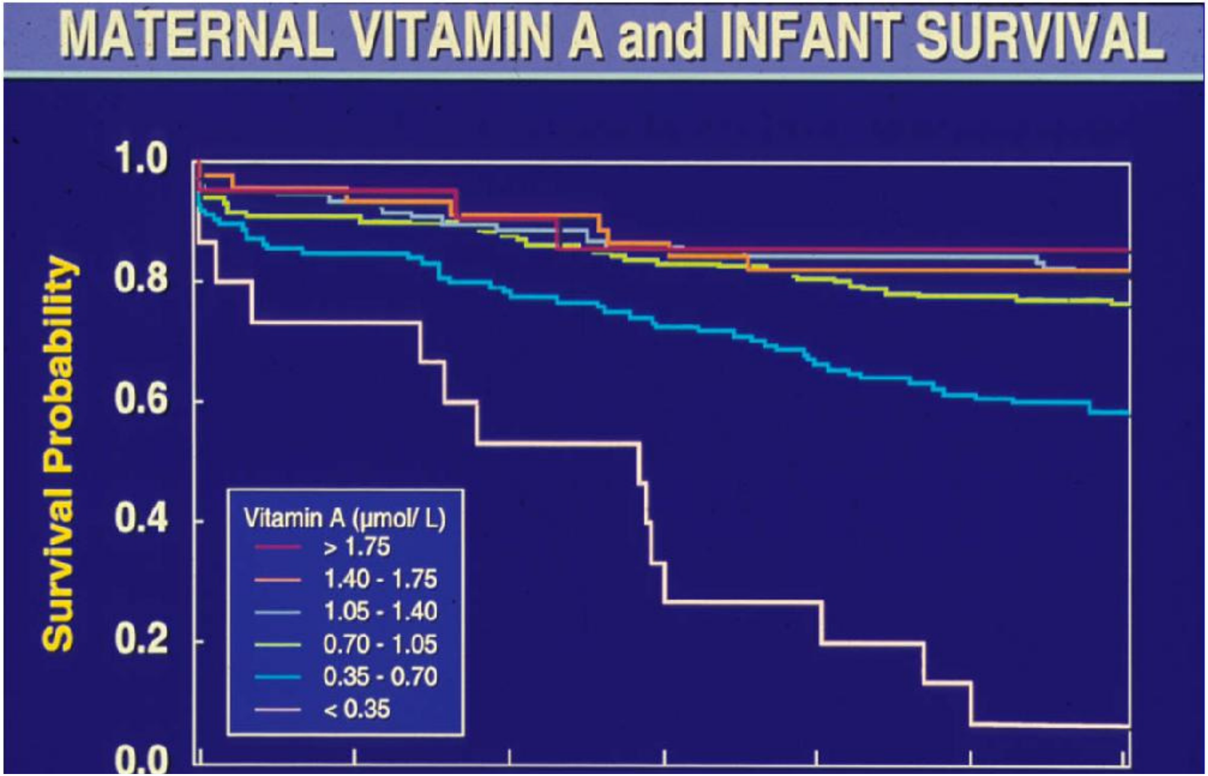
- maintenance of mucosal surfaces; mucus and ciliated epithelium of respiratory tract, mucus and villi in gastrointestinal tract, epithelium of the genitourinary tract
- function of T and B lymphocytes
- generation of antibody responses
- lymphopoiesis (generation of lymphocytes)

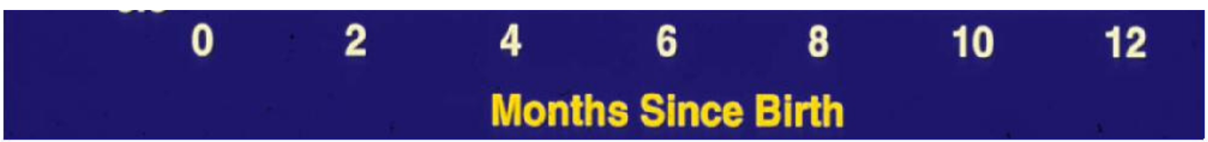

SURVIVAL of HIV-INFECTED ADULTS in UGANDA
Proportion Surviving
1.0
0.9
0.8
0.7
0.6
0.5
CD4 ≥ 200
CD4 < 200
Vitamin A
≥ 1.05 µmol/L
< 1.05 µmol/L

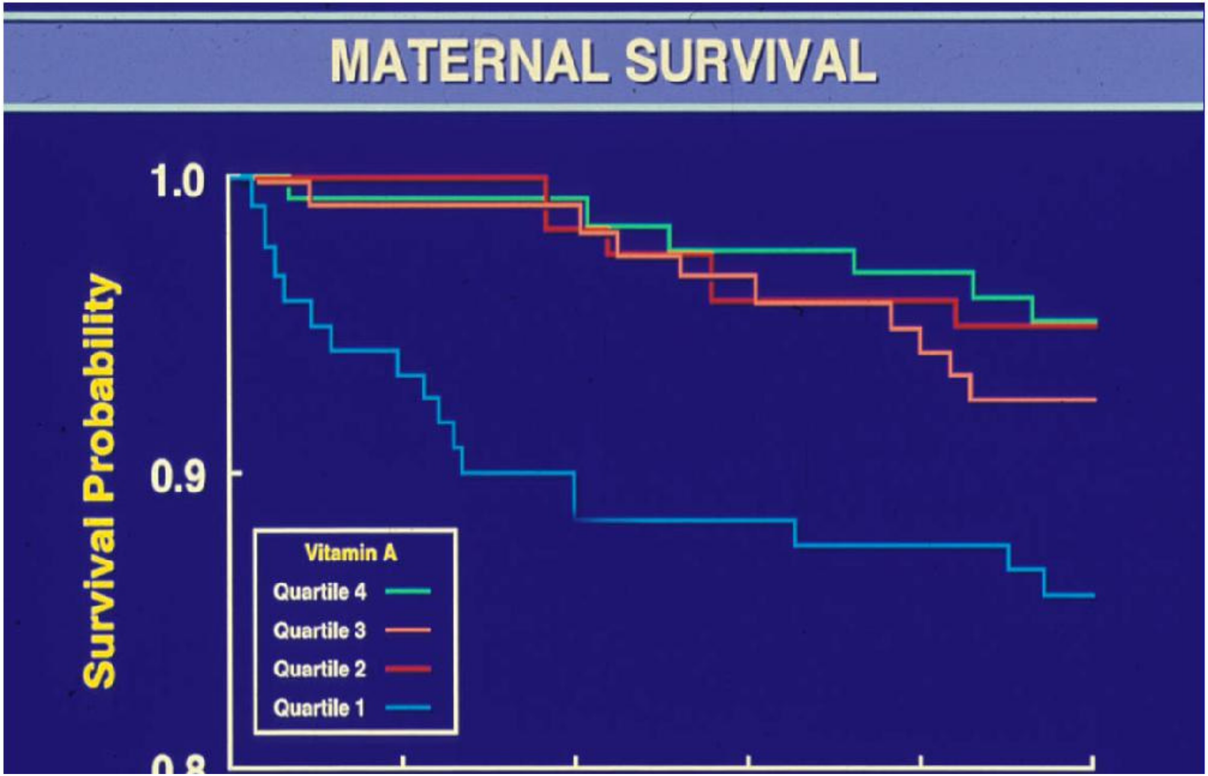

0 3 6 9 12 15 18 21 24 27 30 33 36
Months Since Study Entry


MATERNAL VITAMIN A STATUS
and BIRTH WEIGHT
Malawi
WITS/ USA
Birth Weight (gms)
3100
3000
2900
2800
2700
2600
0
p < .02
p < .002

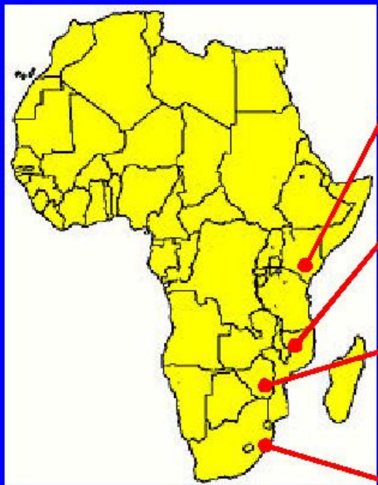

Deficient
n = 300
NonDeficient
n = 174
Deficient
n = 100
NonDeficient
n = 382


MATERNAL VITAMIN A and INFANT SURVIVAL
Survival Probability
1.0
0.8
0.6
0.4
0.2
0.0
Vitamin A (µmol/ L)
> 1.75
1.40 - 1.75
1.05 - 1.40
0.70 - 1.05
0.35 - 0.70
< 0.35


0
2
4
6
8
10
12
Months Since Birth


MATERNAL SURVIVAL
1.0
0.9
0.8
Survival Probability
Vitamin A
Quartile 4
Quartile 3
Quartile 2
Quartile 1


0
10
20
30
40
50
Months After Delivery



Tanzania

n = 1075

Beta-carotene + vitamin A, multivitamin, vs placebo, factorial design

Malawi

n = 697

Vitamin A vs control

Zimbabwe

n = 360

Multivitamin vs placebo

South Africa

n = 728

Beta-carotene + vitamin A vs placebo

CLINICAL TRIAL OF MICRONUTRIENT SUPPLEMENTATION FOR HIV -INFECTED WOMEN IN TANZANIA

phase III randomized, double-blind, placebo-controlled trial to examine effect of micronutrients on: (1) pregnancy outcomes, (2) mother-to-child transmission of HIV, (3) HIV disease progression, and (4) mortality

1075, 1078, 1083, or 1085 (4 different sample sizes published) pregnant women four antenatal clinics in Dar es Salaam, Tanzania

CLINICAL TRIAL OF MICRONUTRIENT SUPPLEMENTATION FOR HIV -INFECTED WOMEN IN TANZANIA

pregnant women screened for HIV-1 infection at 12-27 weeks gestation

women assigned in 2 x 2 factorial design to daily:

- beta-carotene + vitamin A
- multivitamin alone
- multivitamin with beta-carotene + vitamin A
- placebo

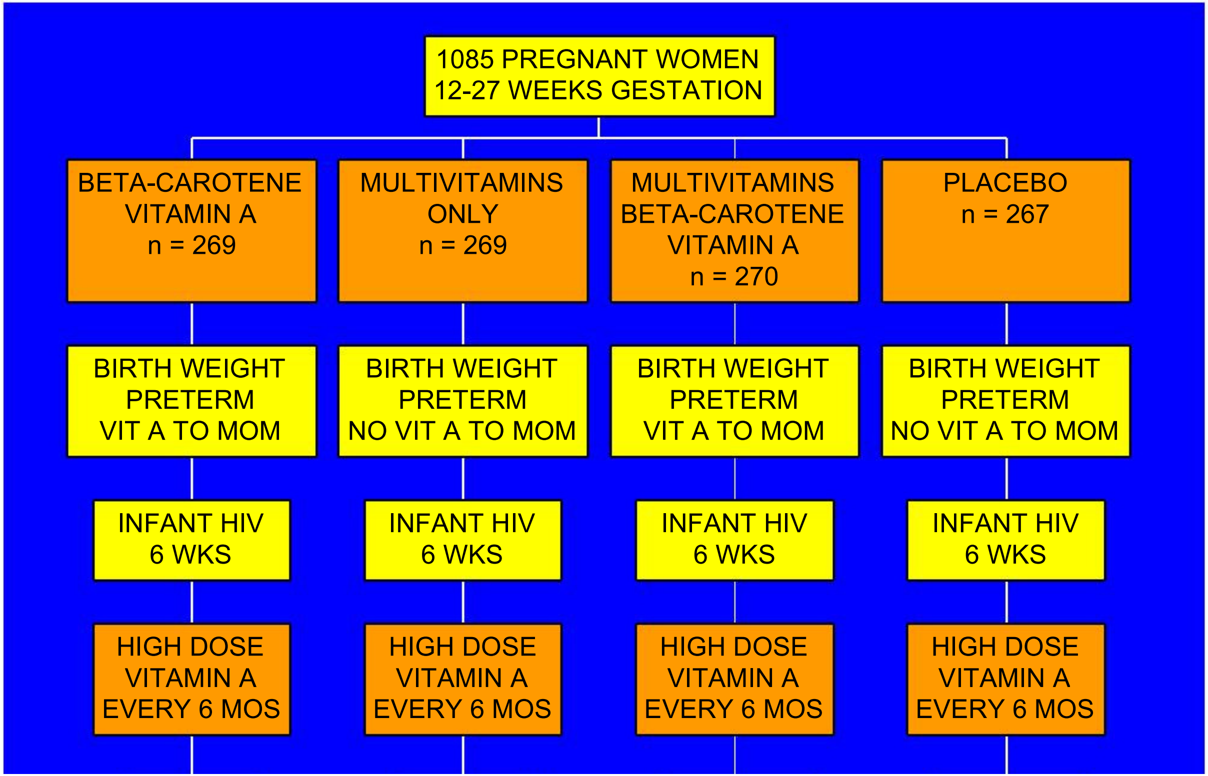
duration of supplementation: 6-8 years

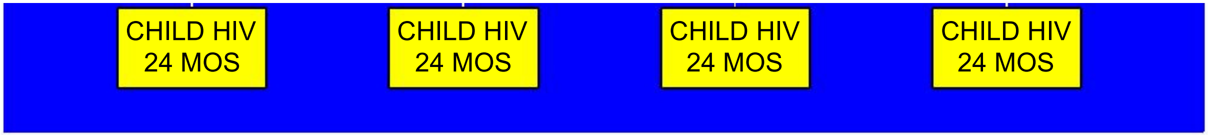
MEGA-DOSE MICRONUTRIENT FORMULATION IN TANZANIA TRIAL

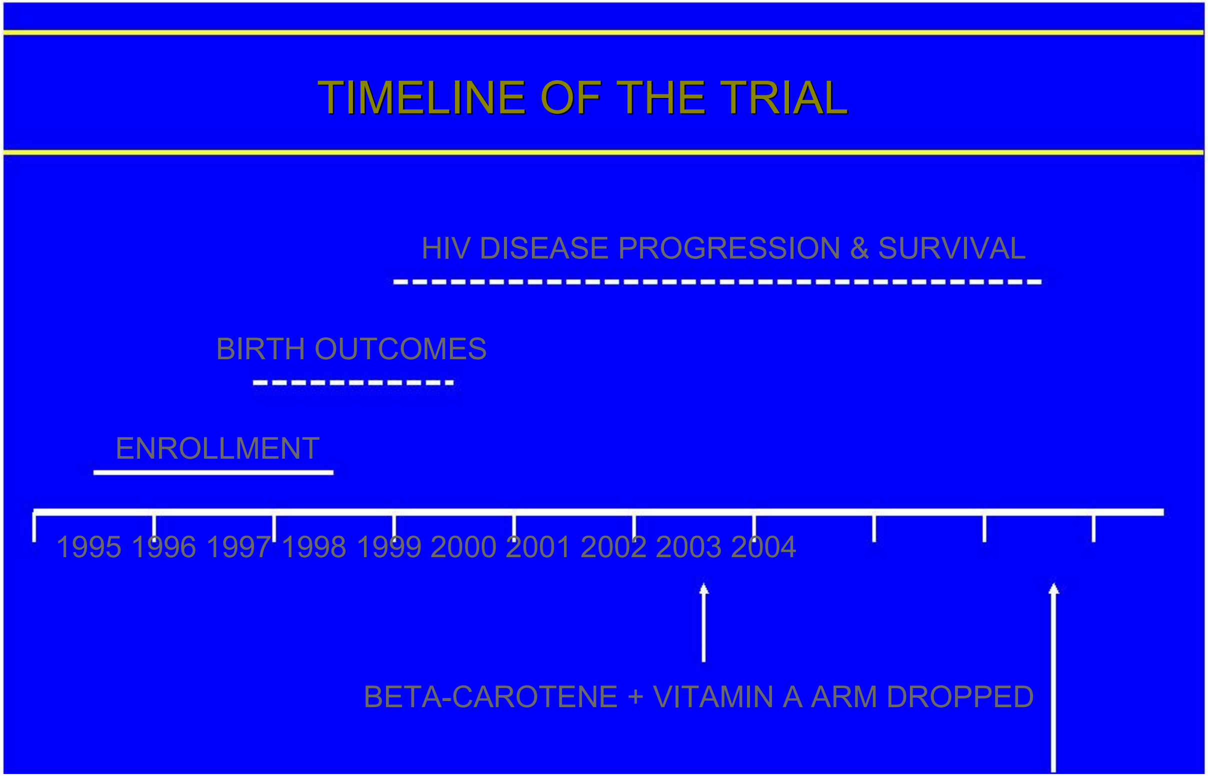
NUTRIENT	SUPPLEMENT	RDA	MULTIPLE OF RDA
Beta-carotene (mg)	30	---	---
Vitamin A (mg RE)	1.5	0.8	1.9
Vitamin E (mg)	30	10	3.0
Vitamin C (mg)	500	70	7.1
Thiamin (mg)	20	1.5	13.3
Riboflavin (mg)	20	1.6	12.5
Vitamin B_6 (mg)	25	2.2	11.4
Vitamin B_{12} (ug)	50	2.2	22.7

12

Niacin (mg)	100	17	5.9
Folate (mg)	0.8	0.4	2.0


1085 PREGNANT WOMEN
12-27 WEEKS GESTATION
BETA-CAROTENE
VITAMIN A
n = 269
MULTIVITAMINS
ONLY
n = 269
MULTIVITAMINS
BETA-CAROTENE
VITAMIN A
n = 270
PLACEBO
n = 267
BIRTH WEIGHT
PRETERM
VIT A TO MOM
BIRTH WEIGHT
PRETERM
NO VIT A TO MOM
BIRTH WEIGHT
PRETERM
VIT A TO MOM
BIRTH WEIGHT
PRETERM
NO VIT A TO MOM
INFANT HIV
6 WKS
INFANT HIV
6 WKS
INFANT HIV
6 WKS
INFANT HIV
6 WKS
HIGH DOSE
VITAMIN A
EVERY 6 MOS
HIGH DOSE
VITAMIN A
EVERY 6 MOS
HIGH DOSE
VITAMIN A
EVERY 6 MOS
HIGH DOSE
VITAMIN A
EVERY 6 MOS


CHILD HIV
24 MOS
CHILD HIV
24 MOS
CHILD HIV
24 MOS
CHILD HIV
24 MOS


TIMELINE OF THE TRIAL
HIV DISEASE PROGRESSION & SURVIVAL
BIRTH OUTCOMES
ENROLLMENT
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
BETA-CAROTENE + VITAMIN A ARM DROPPED

MICRONUTRIENT TRIAL IN TANZANIA

Fawzi WW, et al. *JAIDS* 2000; 23: 246-54 and *AIDS* 2002; 16: 1935-44.

OUTCOME	MULTIVITAMIN		
	YES	NO	*P*
Fetal death (%)	5.9	9.6	0.02
Stillbirth (%)	3.5	6.1	0.05
Birth weight			
<2500 g (%)	8.8	15.8	0.003
Preterm (%)	21.1	24.5	0.23
HIV+, 6 wk (%)	21.8	18.6	0.39
HIV+, 24 mo (%)	30.7	28.9	0.76

MICRONUTRIENT TRIAL IN TANZANIA

Fawzi WW, et al. *JAIDS* 2000; 23: 246-54 and *AIDS* 2002; 16: 1935-44.

OUTCOME	BETA-CAROTENE + VITAMIN A		
	YES	NO	*P*
Fetal death (%)	7.3	8.2	0.59
Stillbirth (%)	4.8	4.8	1.00
Birth weight			
<2500 g (%)	11.6	13.0	0.54
Preterm (%)	23.4	22.1	0.66
HIV+, 6 wk (%)	22.2	18.2	0.30
HIV+	34.2	25.3	0.009

HIV+, 24 mo (%)	34.2	[illegible]	[illegible]

Complication	**Multivitamin**		**Multivitamin Beta-carotene + vitamin A**		**Beta-carotene + vitamin A**	
	HR	*P*	HR	*P*	HR	*P*
Oral thrush	0.47	0.001	0.58	0.008	0.69	0.10
Oral ulcer	0.44	0.001	0.54	0.009	0.94	0.78
Odynophagia	0.16	0.001	0.68	0.07	1.25	0.21
Nausea/vomiting	0.69	0.03	0.76	0.08	0.98	0.91
Diarrhea	0.83	0.18	0.86	0.29	0.95	0.71
Dysentery	0.66	0.03	0.82	0.29	0.90	0.54

Fawzi WW, et al. *N Engl J Med 2004; 351: 23-32* .

COMMENTS BY THE INVESTIGATORS

AIDS 2002; 16: 1935-44. *N Engl J Med* 2004; 351: 23-32

the possible increased risk of HIV-1 infection we reported may mean that individuals offered vitamin A might also need to receive HIV-1 counseling and testing.

adding vitamin A to the multivitamin supplement apparently reduced the benefit of the latter regimen, raising questions about the safety of including vitamin A in supplements for HIV-infected adults.

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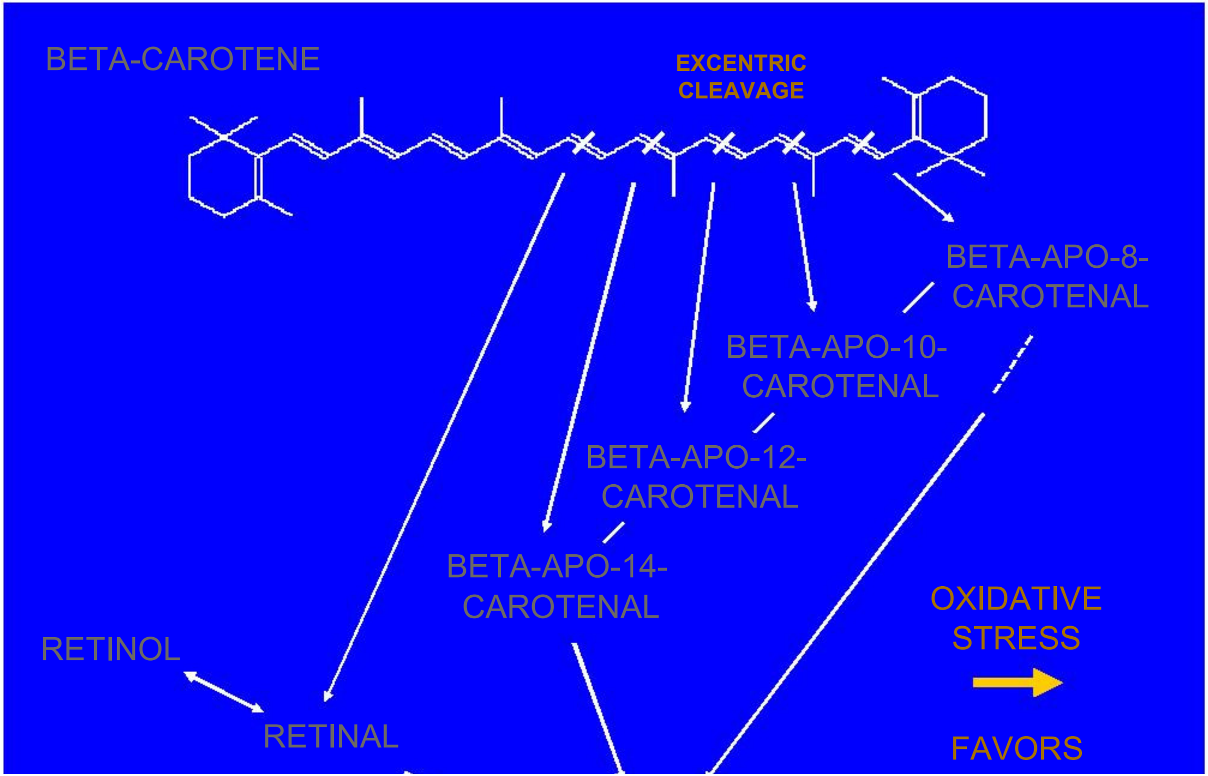


RETINOIC ACID
EXCENTRIC
CLEAVAGE

Beta-apo-carotenoic acids possess their own biologic activity

Mechanism of action is not via RAR gene expression

Appear to modulate cell cycle regulatory proteins, AP-1

MEGA-DOSE BETA-CAROTENE AND ADVERSE OUTCOMES

ATBC Study	17% increased risk of death from lung cancer	ATBC (1994)
CARET Study	28% increase in lung cancer incidence; 17% increased risk of death	Omenn (1996)
Physicians Health Study	no increase in lung cancer incidence	Hennekens (1996)

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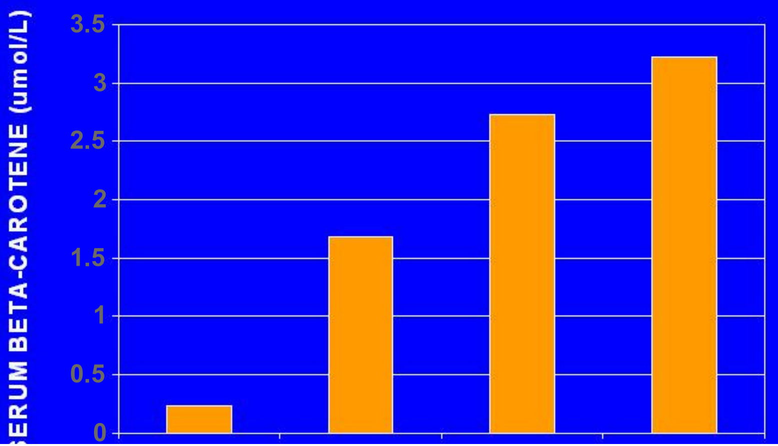
MEGA-DOSE BETA-CAROTENE SUPPLEMENTATION REDUCES ANTIOXIDANT ENZYMES IN ADULTS

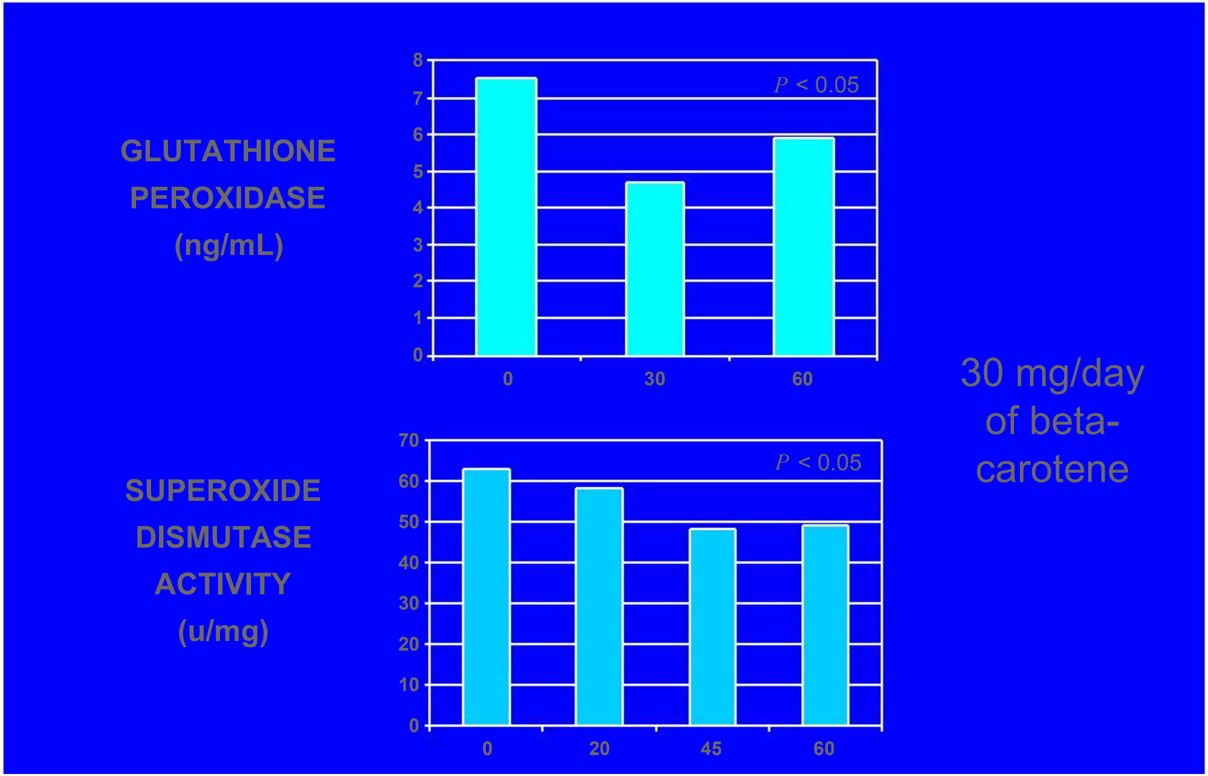
McGill CR et al. *J Nutr Biochem* 2003; 14: 656-62.



30 mg/day of beta-carotene


0
10
30
60
TIME IN DAYS

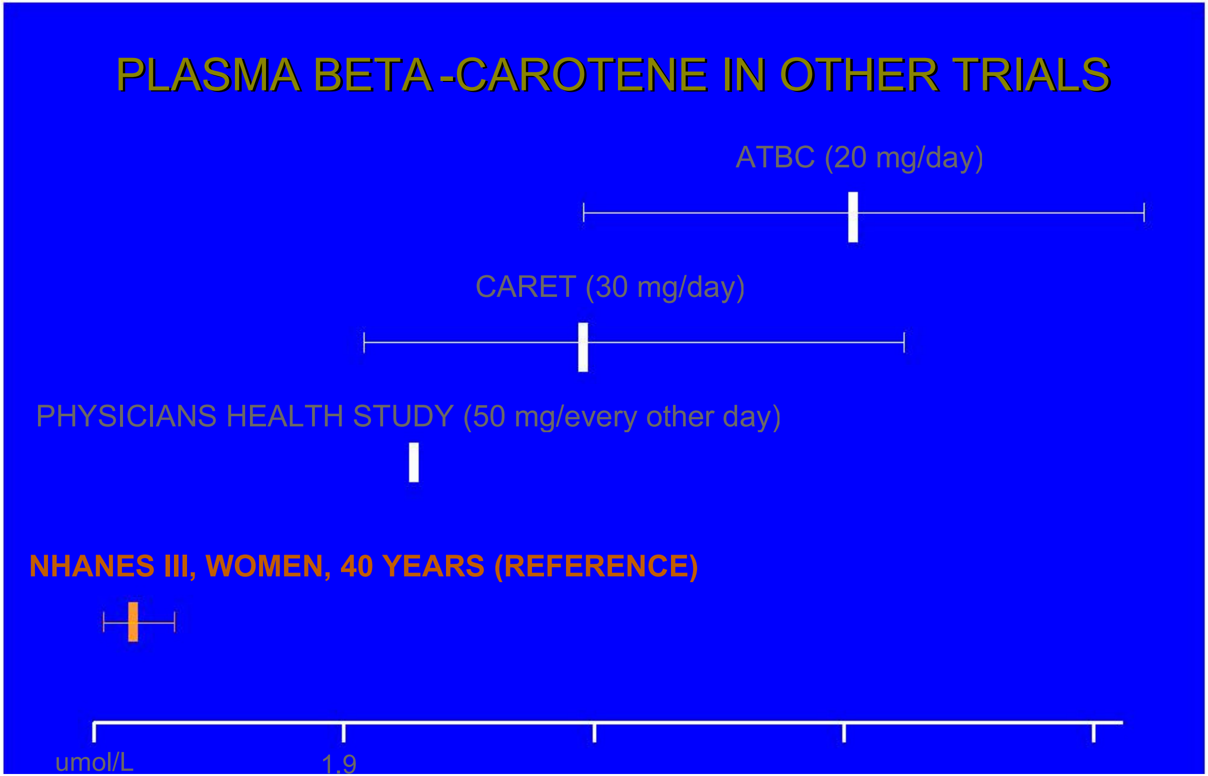
home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw



TIME IN DAYS

McGill CR et al. *J Nutr Biochem* 2003; 14: 656-62.

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw




ug/dL
3.8
(100) (200) (300) (400)
5.6
7.5
PLASMA BETA-CAROTENE

CLINICAL TRIAL OF MICRONUTRIENT SUPPLEMENTATION FOR HIV -INFECTED WOMEN IN ZIMBABWE

Friis H et al. *Am J Clin Nutr* 2004; 80: 178-84

- phase III randomized, double-blind, placebo-controlled trial to examine effect of micronutrients on birth weight and length, gestational length, birth size
- 1669 pregnant women (360 HIV-positive women with birth data)
- 22-36 wk

gestation

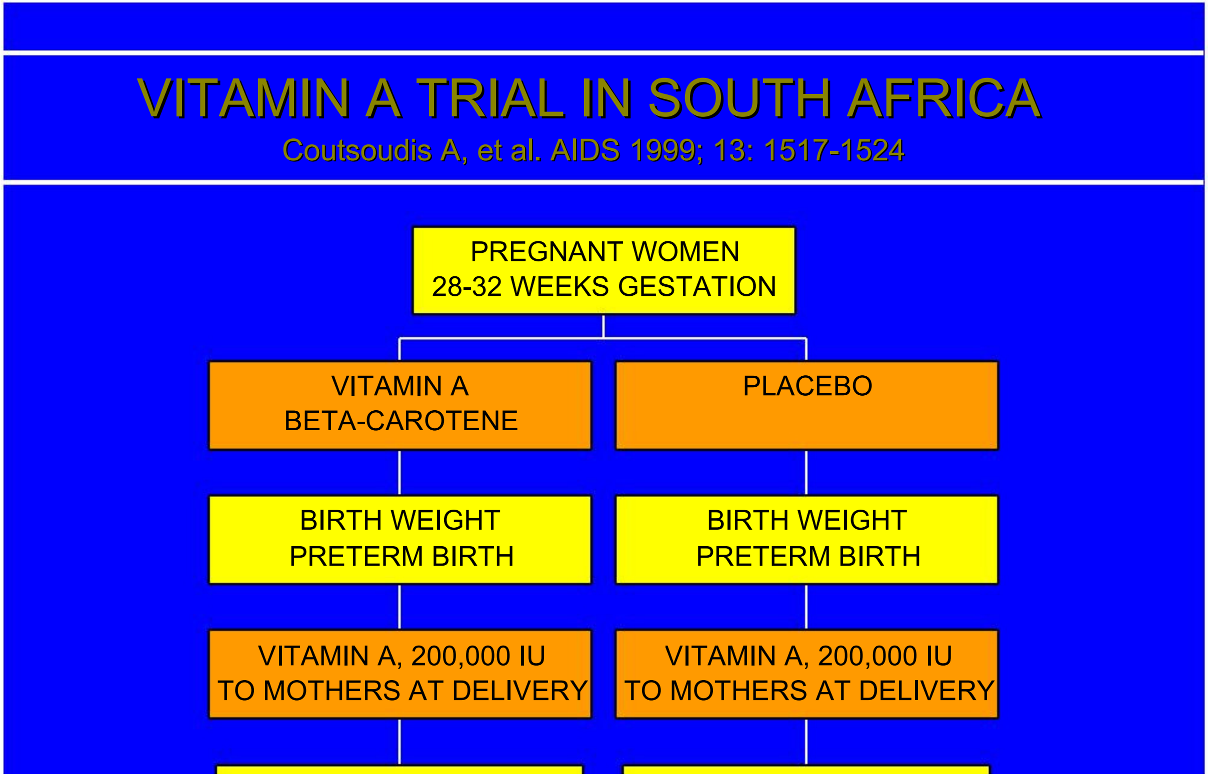
NUTRIENT	SUPPLEMENT	RDA	MULTIPLE OF RDA
Beta-carotene (mg)	3.5	---	---
Vitamin A (mg RE)	3	0.8	3.75
Vitamin E (mg)	10	10	1
Vitamin C (mg)	80	70	1.1
Vitamin D (ug)	10	10	1
Thiamin (mg)	1.5	1.5	1
Riboflavin (mg)	1.6	1.6	1
Vitamin B_6 (mg)	2.2	2.2	1
Vitamin B_{12} (ug)	4.0	2.2	1.8
Niacin (mg)	17	17	1
Zinc (mg)	15	15	1

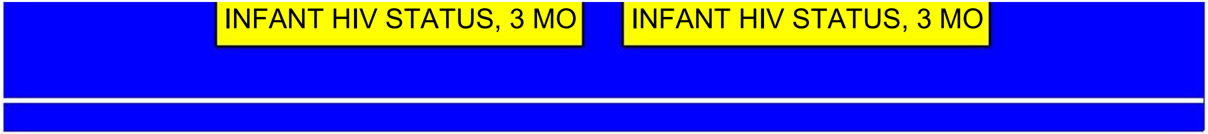
Copper (ug)	1.2	---	---
Selenium (ug)	65	65	1

MICRONUTRIENT TRIAL IN ZIMBABWE

Friis H et al. *Am J Clin Nutr* 2004; 80: 178-84

	MULTIVITAMIN		
	YES	NO	
OUTCOME	*n* = 189	*n* = 171	*P*
Birth weight (g)	3017	2916	0.057
Birth weight <2500 g (%)	14.8	14.6	0.96
Birth length (cm)	48.3	48.3	0.89
Preterm (%)	20.1	22.2	0.62


VITAMIN A TRIAL IN SOUTH AFRICA
Coutsoudis A, et al. AIDS 1999; 13: 1517-1524
PREGNANT WOMEN
28-32 WEEKS GESTATION
VITAMIN A
BETA-CAROTENE
PLACEBO
BIRTH WEIGHT
PRETERM BIRTH
BIRTH WEIGHT
PRETERM BIRTH
VITAMIN A, 200,000 IU
TO MOTHERS AT DELIVERY
VITAMIN A, 200,000 IU
TO MOTHERS AT DELIVERY


INFANT HIV STATUS, 3 MO
INFANT HIV STATUS, 3 MO

VITAMIN A TRIAL IN SOUTH AFRICA

Coutsoudis A, et al. AIDS 1999; 13: 1517-1524

OUTCOME	VITAMIN A BETA-CAROTENE	PLACEBO	P
Birth weight, g	3085	3069	N.S.
Preterm delivery (%) 37 wk	11.4	17.4	0.03
Preterm delivery (%) 34 wk	1.6	4.8	0.02
HIV+, 3 months (%)	20.3	22.3	N.S.
Preterm and	17.0	22.8	<0.05

Preterm and HIV+ (%)	17.9	33.8	<0.05

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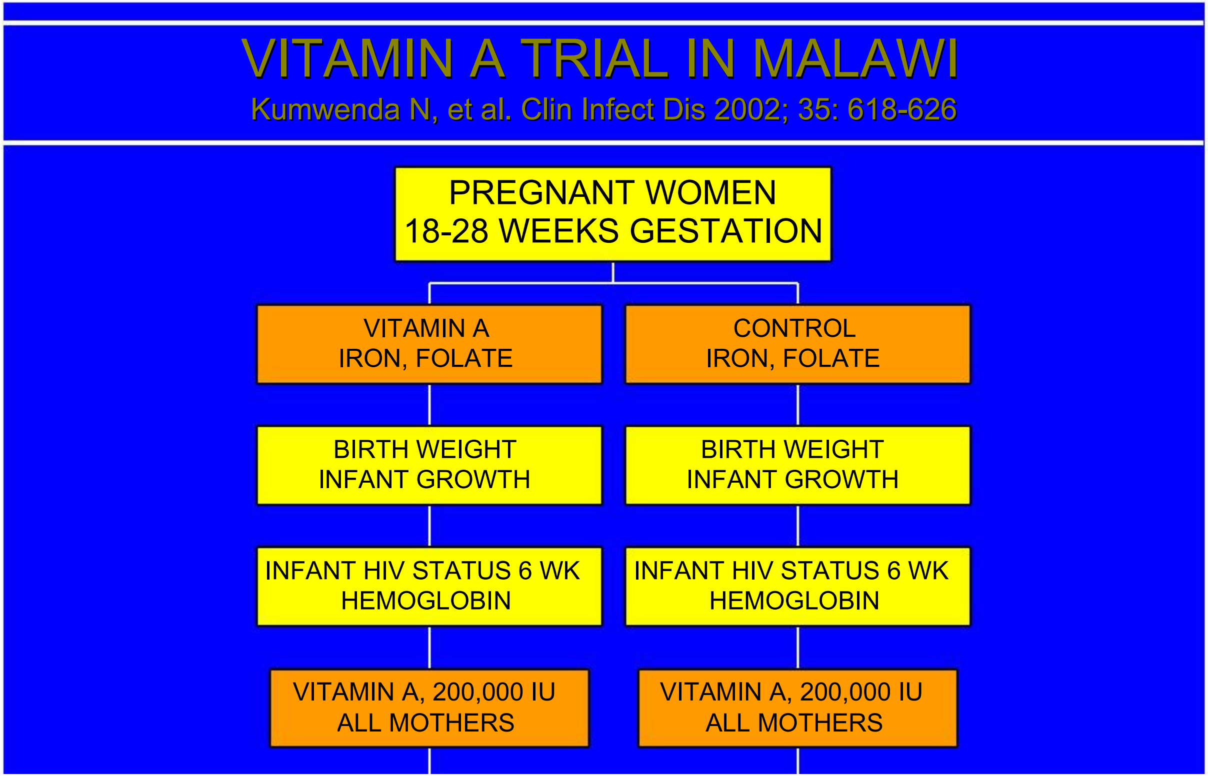

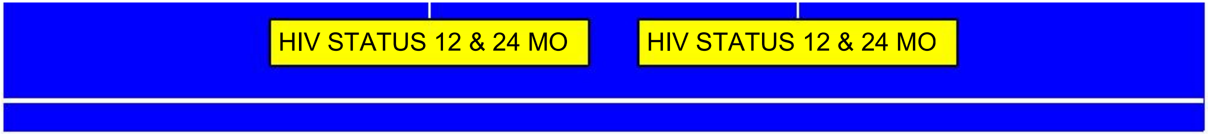
HIV STATUS 12 & 24 MO
HIV STATUS 12 & 24 MO

VITAMIN A TRIAL IN MALAWI

Kumwenda N, et al. Clin Infect Dis 2002; 35: 618-624

OUTCOME	VITAMIN A		CONTROL		P
Birth weight, g	2895	31	2805	32	0.05
<2500 g (%)	14.0		21.1		0.03
Weight, 6 wk	4627	55	4458	55	0.03
Length, 6 wk	53.7	0.2	53.0	0.2	0.03
Hemoglobin, g/L	116	1	112	1	0.04
HIV+, 6 wk (%)	26.6		27.8		0.76
HIV+, 12 mo (%)	27.3		32.0		0.25
HIV+,	27.7		32.8		0.21

24 mo (%)			

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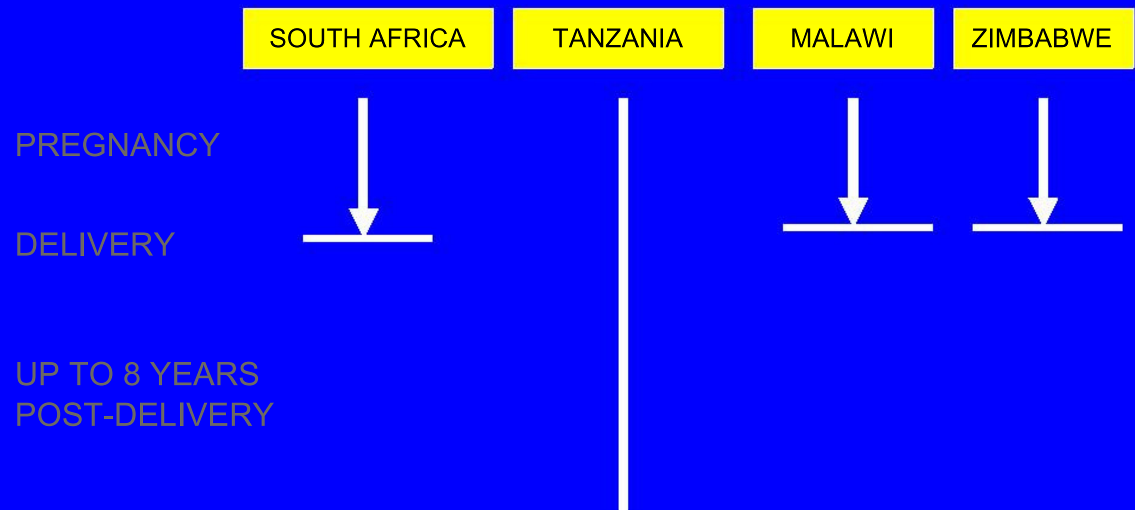
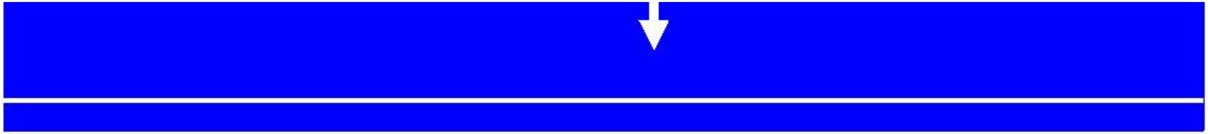
COMPARISON OF 4 TRIALS:
PERIOD OF SUPPLEMENTATION





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COMPARISON OF 4 TRIALS:
TYPE OF SUPPLEMENT USED

NUTRIENT	S AFRICA	TANZANIA	ZIMBABWE	MALAWI
Vitamin A (IU)	5000	5000	5000	10000
Beta-carotene (mg)	30	30	3.5	
Vitamin E (mg)		30	10	
Vitamin C (mg)		500	80	
Thiamin (mg)		20	1.5	
Riboflavin (mg)		20	1.6	
Vitamin B_6 (mg)		25	2.2	
Vitamin B_{12} (mg)		50	4.0	
Niacin (mg)		100	17	

Folate (mg)	0.8	- -
Selenium (ug)	--	65

VITAMIN A SUPPLEMENTATION FOR HIV-INFECTED CHILDREN

randomized, double-blind, placebo-controlled clinical trial in Kampala, Uganda

to determine if vitamin A supplementation, 60 mg RE every 3 months, reduces morbidity and mortality in HIV-infected children

181 HIV-infected children followed from 15 to 36

36
months
of age

Characteristic	Vitamin A	Placebo
Maternal age (y)	25.6 3.9	25.9 4.7
Breastfeeding terminated (%)	29.0	30.7
Weight-for-age Z score	- 2.1 1.2	- 2.2 1.5
Height-for-age Z score	- 2.4 1.0	- 2.3 1.4
Weight-for-height Z score	- 0.7 1.1	- 1.0 1.3
CD4+ lymphocytes (cells/uL)	1200 604	1322 941
Log plasma HIV load	5.8 0.6	5.6 0.8
Hemoglobin	92	90 13

(g/L)	14		
Plasma vitamin A (umol/L) 0.23	0.58	0.20	0.56

ZINC & IMMUNITY

function of >300 metalloenzymes, DNA replication, growth hormone binding

generation of antibody responses

function of T and B lymphocytes, natural killer cell function

lymphopoiesis

B COMPLEX VITAMINS

VITAMIN B_6

reduced natural killer cell function (Baum 1991)

use of supplements linked with increased survival in HIV infection (Tang 1997)

VITAMIN B_{12}

megaloblastic anemia

deficiency associated with two-fold increased risk of progression to AIDS (Tang 1997)

SELENIUM

trace element, found in various amounts in locally grown foods, closely related to soil selenium deficiency

higher risk of mortality in selenium-deficient HIV-positive children (Campa 1999)

greater shedding of HIV-1-infected cells in genital tract of selenium-deficient women (Baeten 2001)

selenium deficiency hypothesized

selenium deficiency hypothesized

to account for

greater spread of HIV in Africa (Foster 2003)

CLINICAL TRIAL OF SELENIUM

(Burbano X, et al. HIV Clin Trials 2002; 3: 483 -491)

- double-blind, placebo-controlled clinical trial
- 186 HIV-positive men and women in Miami
- clinical evaluations every 6 months for 2 years
- results: 62% reduction in total admission rates (*P* = 0.002) and hospitalizations due to infections (*P* = 0.01) in

selenium group

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OXIDATIVE STRESS

imbalance in pro-oxidants and anti-oxidants that results in overproduction of reactive oxygen intermediates (ROIs): superoxide radicals, hydroxyl radicals, hydrogen peroxide, etc.

overproduction of free radicals will damage cell membranes, DNA, increased apoptosis, and enhance HIV replication

major dietary antioxidants: carotenoids, vitamin E, vitamin

C, selenium

MICRONUTRIENT SUPPLEMENTATION FOR HIV-INFECTED ADULTS

Jiamton S, et al. AIDS 2003; 17: 2461 -2469

randomized placebo-controlled clinical trial

481 HIV-infected adults in Bangkok, Thailand, randomized to multiple micronutrient supplement or placebo

follow-up for 48 weeks

RESULTS

Jiamton S, et al. AIDS 2003; 17: 2461 -2469

79 participants lost to follow-up (16%)

23 participants died (5%)

mortality HR 0.53 (95% CI 0.22-1.25) overall

mortality HR 0.37 (95% CI 0.13-1.06) for CD4 <200 cells/ L

mortality HR 0.26 (95% CI 0.07-0.97) for CD4 <100 cells/ L cells/ L

CONCLUSIONS

Jiamton S, et al. AIDS 2003; 17: 2461 -2469

- study suggestive but not definitive: unacceptably high loss to follow-up compared with mortality in study

- high doses of micronutrients (multiples of RDA) used in the supplement

- study suggests that HIV-infected adults with most advanced HIV disease will benefit most from micronutrient supplementation

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WASTING SYNDROME

Definition: weight loss >10% of normal body weight, with >30 days fever and diarrhea; slim disease in Uganda (Serwadda 1985)

increased resting energy metabolism; hypermetabolism; loss of lean body mass

gastrointestinal disease and malabsorption

associated with micronutrient deficiencies

WASTING SYNDROME USA

PRE-HAART (1987-1991) (Nahlen 1993)

CONDITION	O.R.	(95% C.I.)
Isosporiasis	3.6	2.9-4.6
Esophageal candidiasis	3.0	2.9-3.1
HIV encephalopathy	2.8	2.6-2.9
Cytomegalovirus retinitis	1.5	1.4-1.6
Mycobacterium avium complex	1.5	1.4

complex	1.5	
		- 1.6

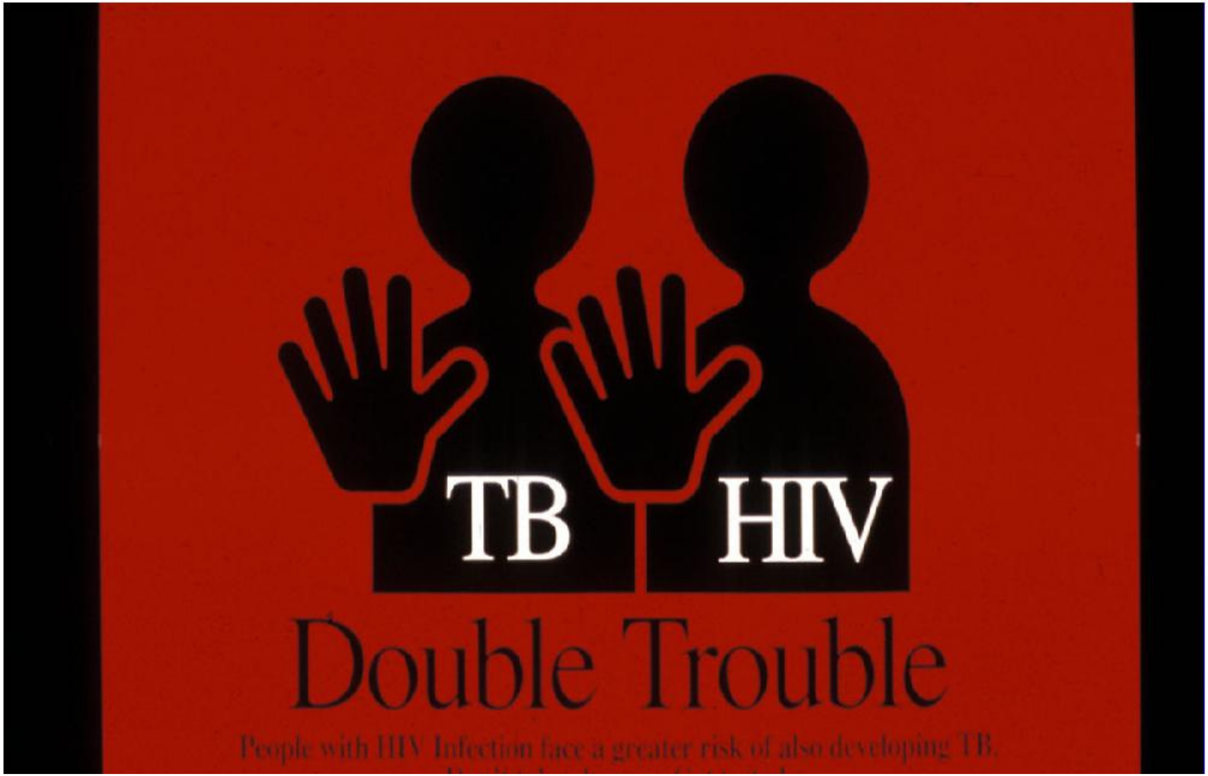
TREATMENT OF WASTING SYNDROME

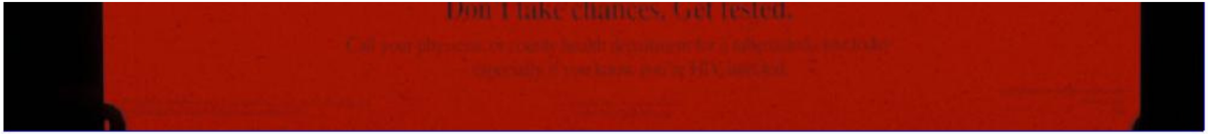
treat the underlying infection

total parenteral nutrition ($$, complicated)

appetite stimulants
- megestrol ($100/week)
- marinol ($60/week)

highly active anti-retroviral therapy
(HAART) ($$$)


TB
HIV
Double Trouble
People with HIV Infection face a greater risk of also developing TB.


Don't take chances. Get tested.

TRIPLE TROUBLE
MALNUTRITION + HIV + TB

Van Lettow M, Fawzi WW, Semba RD. Nutr Reviews (2003)

tuberculosis accounts for 3 millions deaths/year worldwide

7-8 million people develop tuberculosis per year, mostly in sub-Saharan Africa and Asia

in many areas, three-quarters of the adults who present with tuberculosis are HIV-positive

malnutrition is a main determinant in the expression of active

of active
tuberculosis

NUTRITIONAL STATUS AND HIV/TB

(Van Lettow M et al *Int J Tub Lung Dis* 2004; 8: 211-7)

CHARACTERISTIC	MEN			WOMEN		
	HIV+ [100]	HIV- [49]	*P*	HIV+ [136]	HIV- [34]	*P*
body mass index	18.3	18.6	0.56	18.4	18.7	0.59
BMI <19 (%)	62.0	65.3	0.69	61.0	61.7	0.93
body cell mass	39.2	40.6	0.02	33.0	32.8	0.70

MICRONUTRIENT DEFICIENCIES IN 557 HIV+ ADULTS WITH PULMONARY TB

(Van Lettow M et al. ***BMC Inf Dis*** *2004; 4: 61*)

PLASMA MICRONUTRIENT	
Vitamin A <0.70 mol/L (%)	62.6
Vitamin E <11.6 mol/L (%)	12.9
Zinc <11.5 mol/L (%)	84.3
Selenium <0.89 mol/L (%)	89.2

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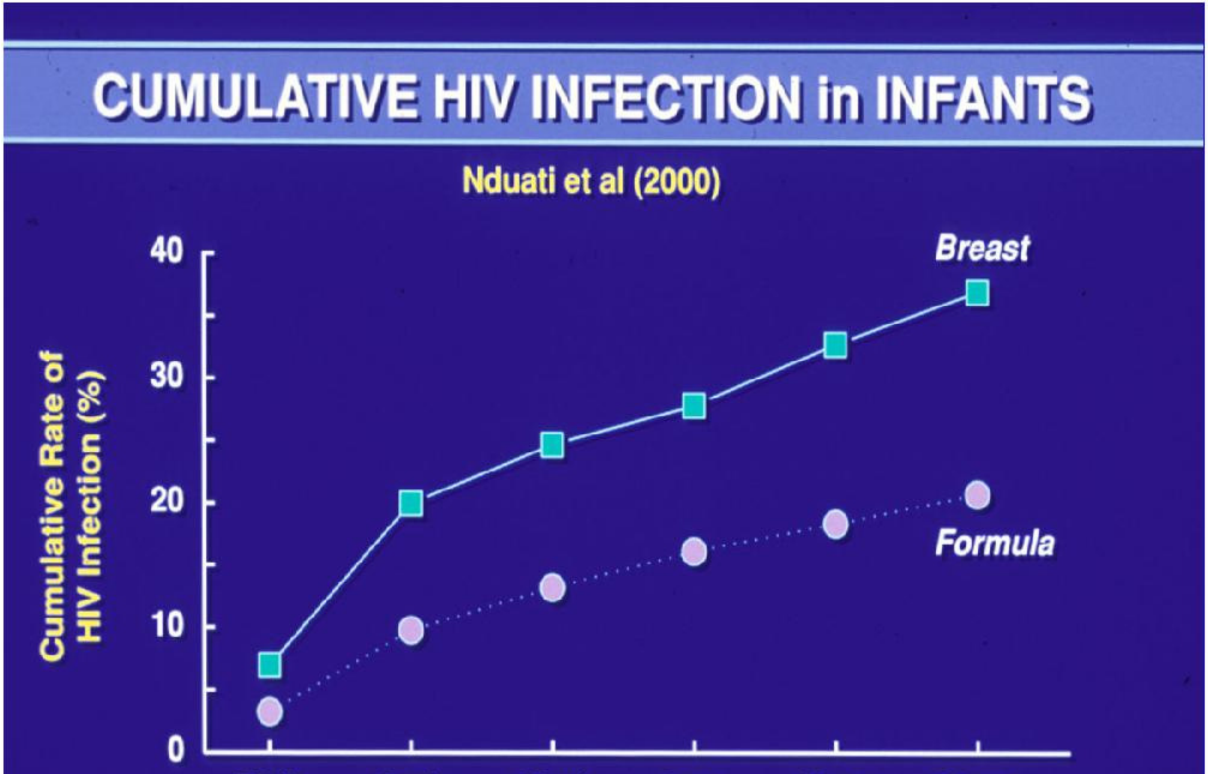
THE BREASTFEEDING DILEMMA

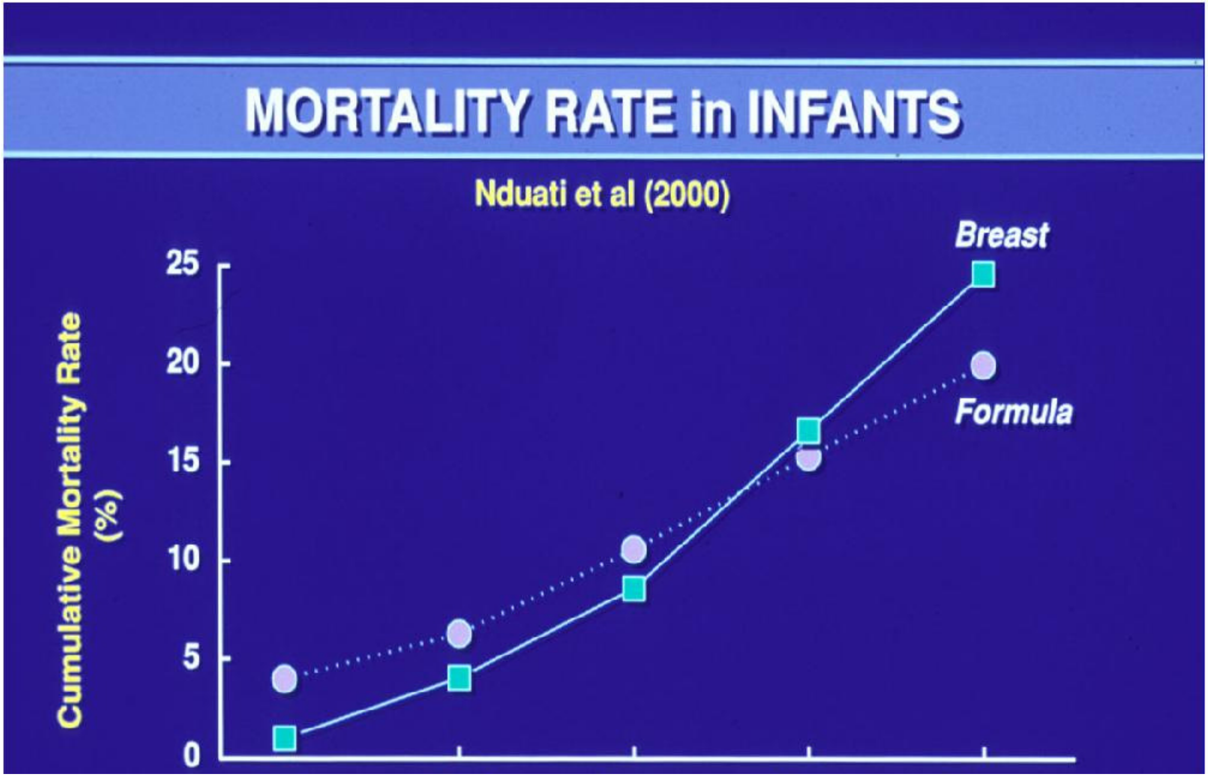
one third of HIV transmission from mother to child through breast milk

Kenya trial (Nduati and colleagues) breastfeeding vs formula feeding; 425 HIV-positive women; outcomes were infant HIV infection and infant mortality

Durban trial (Coutsoudis and colleagues); exclusive breastfeeding, mixed feeding, formula feeding compared; infant HIV status at 3 months


CUMULATIVE HIV INFECTION in INFANTS
Nduati et al (2000)
Cumulative Rate of HIV Infection (%)
40
30
20
10
0
Breast
Formula


Birth
6 wk
14 wk
6 mo
12 mo
24 mo
Time


MORTALITY RATE in INFANTS
Nduati et al (2000)
Breast
Formula
Cumulative Mortality Rate (%)
25
20
15
10
5
0


6 wk
14 wk
6 mo
12 mo
24 mo
Time Since Birth

RESULTS AND IMPLICATIONS

- non-compliance a problem (1/4 of women in formula group)
- formula use resulted in 44% reduction of HIV transmission
- six months of infant formula in Kenya costs $300; annual family incomes in sub-Saharan Africa, $100-$200/year
- low access to clean water
- poor hygiene, limited privacy in housing

DURBAN TRIAL

597 HIV-positive women divided in 3 groups

HIV status determined at 3 months

never breastfed:	18.8%
mixed feeding:	24.1%
exclusive breastfeeding:	14.6%

conclusion: exclusive breastfeeding is protective against HIV transmission

HIV INFECTION AND FOOD SECURITY

ADULT SICK WITH HIV

↓

REDUCED WORK OUTPUT

↓

REPLACEMENT


LABOR
NEEDED

HIV INFECTION AND FOOD SECURITY

HEALTH EXPENSES RISE (DRUGS, TRANSPORT)

↓

HOUSEHOLD FOOD CONSUMPTION DROPS

↓

NUTRITIONAL

NUTRITIONAL
STATUS
DETERIORATES

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HIV INFECTION AND FOOD SECURITY

ADULT CANNOT WORK

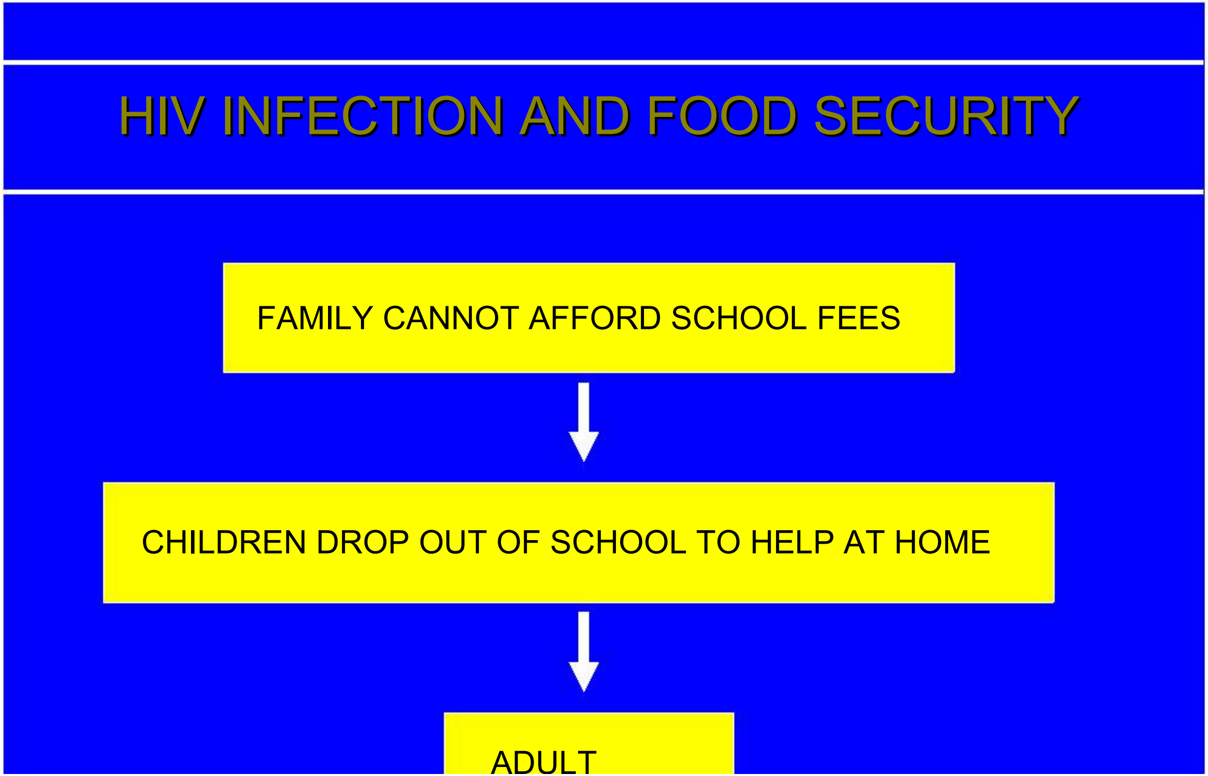
↓

HOUSEHOLD EXPENSES DIVERTED TO SICK ADULT

↓

DIVISIBLE ASSETS (LIVESTOCK,

CHICKENS) DISPOSED


HIV INFECTION AND FOOD SECURITY
FAMILY CANNOT AFFORD SCHOOL FEES
CHILDREN DROP OUT OF SCHOOL TO HELP AT HOME
ADULT


DIES


QUEEN ELIZABETH
CENTRAL HOSPITAL
T E S
Transport
Equipment Suppliers
CHIPATA A AVENUE
WHITE DOVE
FUNERAL


SUPPLIES

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HIV INFECTION AND FOOD SECURITY

EXPENSES NEEDED FOR FUNERAL

LOSS OF TRANSFER OF AGRICULTURAL KNOWLEDGE
REDUCED AGRICULTURAL PRODUCTIVITY

LAND

IS
LEFT
FALLOW

HIV INFECTION AND FOOD SECURITY

FURTHER REDUCTION OF HOUSEHOLD INCOME
INABILITY TO PAY RENT, EVICTION
SEIZURE OF PROPERTY OR CHILDREN FROM WIDOW

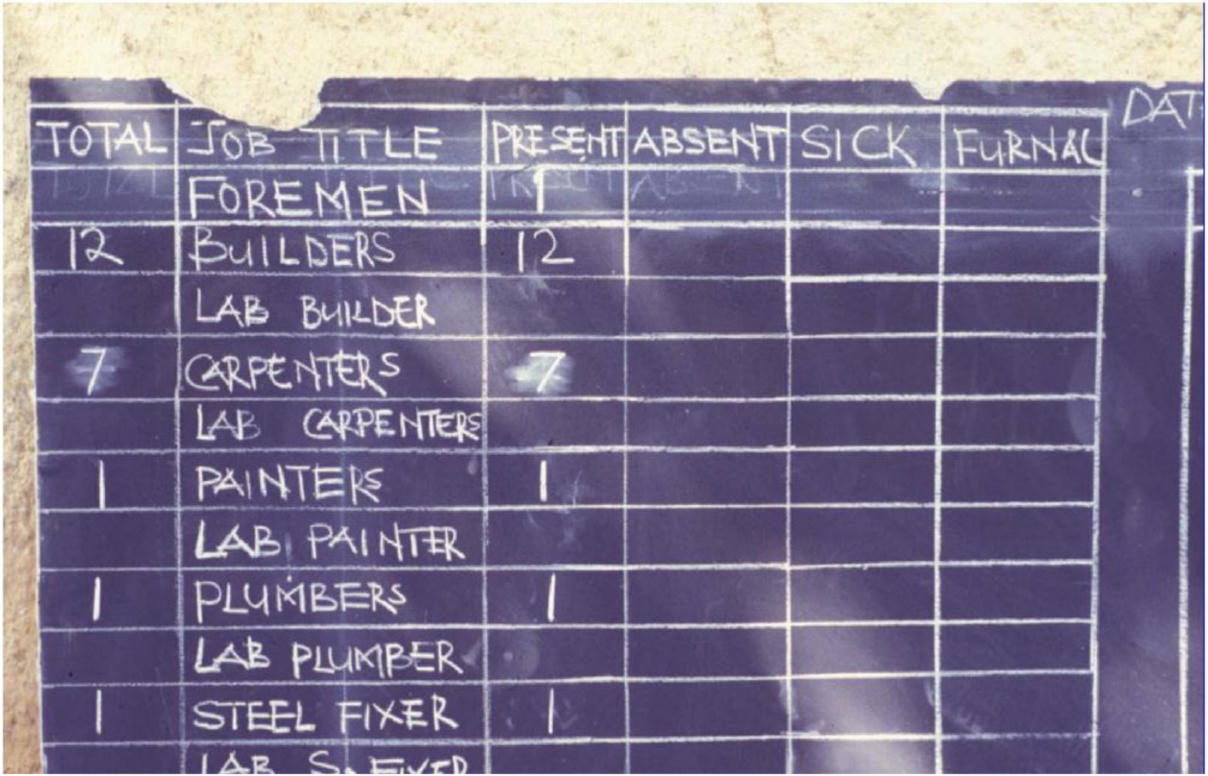
↓

MIGRATION OF WOMEN

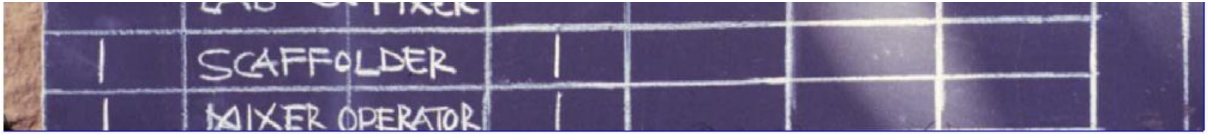
↓

REDUCED


FOOD
SECURITY



TOTAL	JOB TITLE	PRESENT	ABSENT	SICK	FURNAL	DAT
	FOREMEN	1				
12	BUILDERS	12				
	LAB BUILDER					
7	CARPENTERS	7				
	LAB CARPENTERS					
1	PAINTERS	1				
	LAB PAINTER					
1	PLUMBERS	1				
	LAB PLUMBER					
1	STEEL FIXER	1				
	LAB S. FIXER					


SCAFFOLDER
MIXER OPERATOR

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POSSIBLE SOLUTIONS

micronutrient supplementation in some scenarios: pregnant women (multivitamins), children (vitamin A), adults (multivitamins)

better food security, transmission of horticultural knowledge

highly active antiretroviral therapy (HAART)

HAART AND DIETARY ANTIOXIDANTS

Tang A, et al. *JAIDS* 2000; 23:321-6

	ANTIRETROVIRALS				
ANALYTE (ug/dL)	0	1	2+	HAART	*P*
Alpha-carotene	0.74	0.57	0.80	1.06	0.05
Beta-carotene	5.2	4.2	6.4	8.8	0.03
Beta-cryptoxanthin	2.5	2.1	2.8	3.8	0.02
Lycopene	17.8	15.6	20.1	22.1	0.28
Lutein/zeaxanthin	14.5	12.7	13.4	15.2	0.46
Alpha-tocopherol	778	760	865	2076	0.0008

HAART AND ANEMIA

Semba RD, et al. *AIDS Patient Care STDs* 2001; 15: 473-80

anemia is largely result of chronic disease, micronutrient deficiencies, inflammation; anemia is good overall marker for infection

study of women in Human Immunodeficiency Virus Epidemiology Research Study (HERS)

HAART (protease inhibitor + 2 nucleoside analogues OR 1 non-nucleoside reverse-transcriptase + 1 nucleoside analog) vs non-HAART antiretroviral therapy,

vs no
therapy

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EFFECTS OF HAART

- many opportunistic infections have nearly disappeared: cytomegalovirus, *Cryptosporidium* , etc.
- wasting syndrome has nearly disappeared
- reduced oxidative stress (Tang 2002)
- burden of anemia is reduced (surrogate indicator of inflammation, chronic disease, infection, micronutrient deficiencies) (Semba 2001a, 2001b)

HAART IN DEVELOPING COUNTRIES

HAART is more than drugs (testing, monitoring, infrastructure)

possible in some countries (Brazil, Thailand); implementation limited in other countries (Uganda)

competing priorities and limited budgets: HAART for one person or basic immunizations for hundreds of children

donor

donor fatigue

CONCLUSIONS

HIV infection can worsen nutritional status:

anorexia, malabsorption, increased utilization, increased nutrient losses, wasting syndrome

malnutrition can exacerbate outcomes during HIV infection:

progression to AIDS, immune suppression, morbidity, mortality, activation of tuberculosis

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CONCLUSIONS

HIV/AIDS is contributing to the food security problem in parts of sub-Saharan Africa

micronutrient supplementation showing promise: HIV-infected children and adults

no easy solution for breastfeeding dilemma

HAART may improve nutritional status and overall health, but difficult to implement on wide scale

The Nutrition Transition

Benjamin Caballero, M.D., Ph.D.
Center for Human Nutrition
Johns Hopkins Bloomberg School of Public Health

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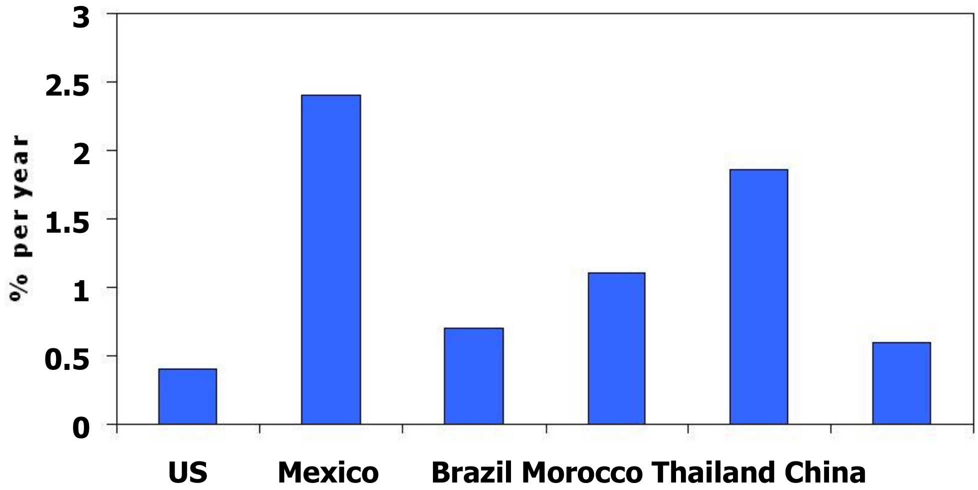
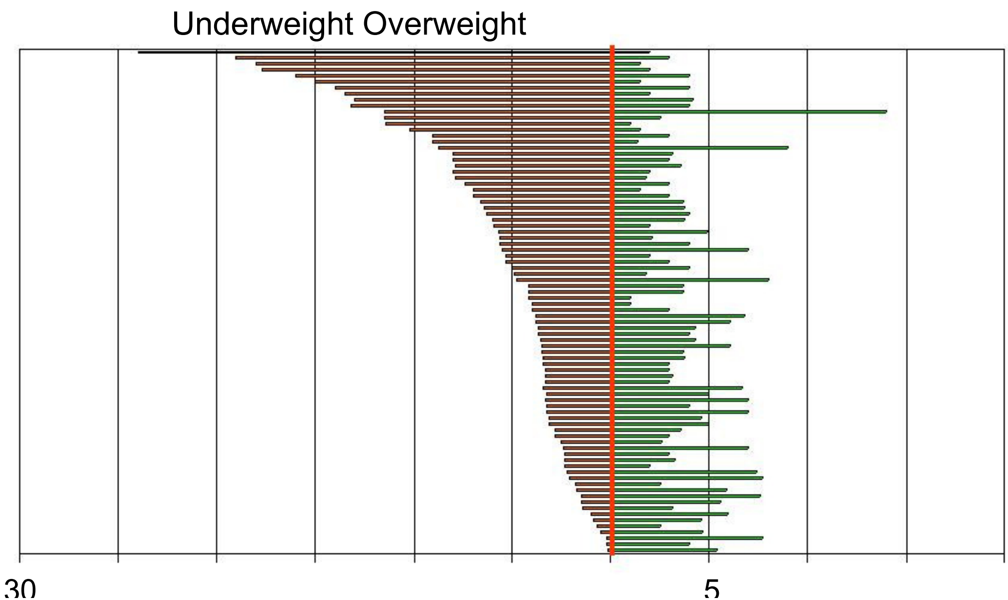
Annual increase in obesity rates in selected countries (women)



Popkin and Gordon-Larsen, 2004

Under- and overweight, 0-5 yr/old children



25
20
15
10 5

%

10
15
20

Is the world shifting from undernutrition to overnutrition .

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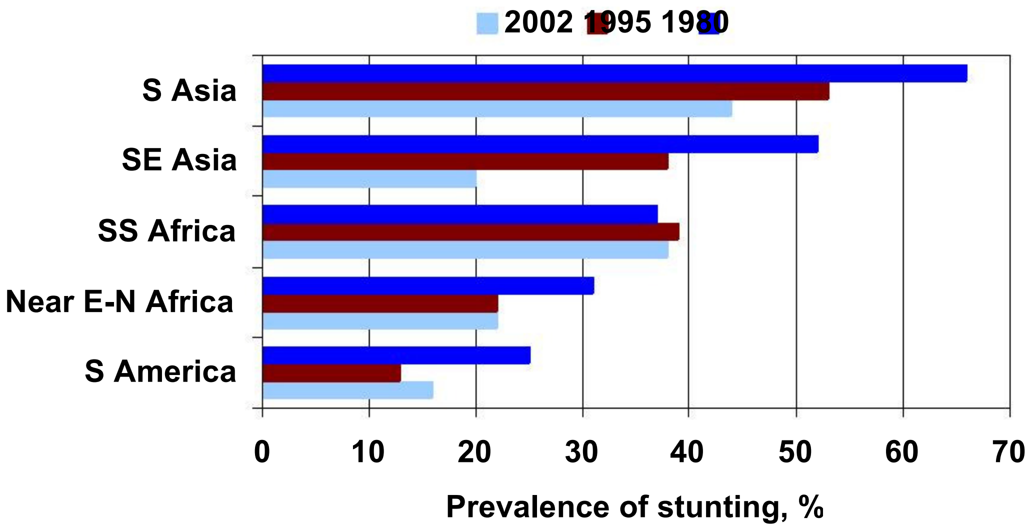
Prevalence of stunting in < 5 yr/old children



SCC/SCN, UNICEF, 2004

World poverty, 1981-2001
% of people living with <US$2 per day

	1981	1990	2001
South Asia	89.1	85.5	77.2
Sub-Saharan Africa	73.3	75.0	76.6
South E Asia & Oceania	84.8	69.9	47.4
Latin American & Caribbean	26.9	28.4	24.5
North Africa & Middle E	28.9	21.4	23.2
Europe & Central Asia	4.7	4.9	19.7

World Bank, 2004

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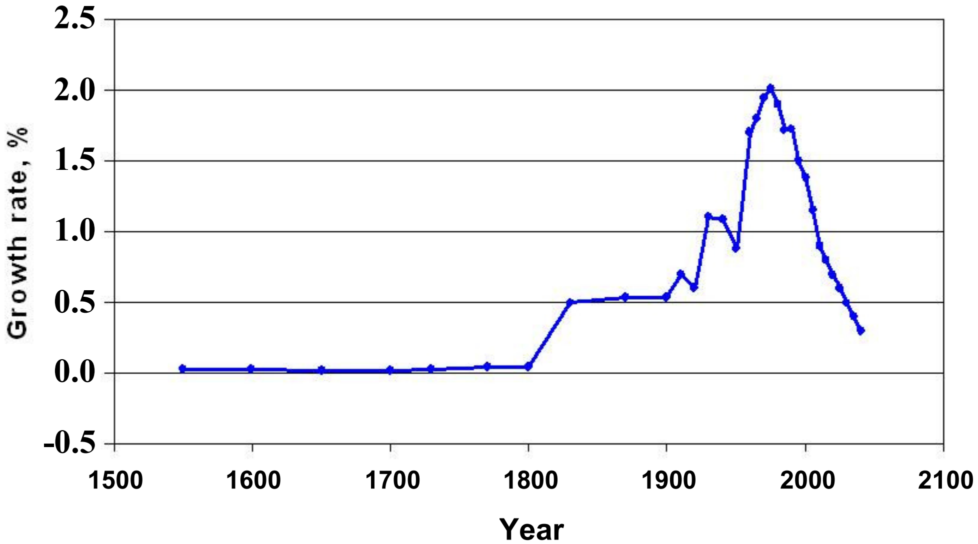
The Nutrition Transition

- Demographic trends
- Food availability and cost
- Lifestyle

Demographic trends

- Urbanization
- Increase in life expectancy
- Reduction in infant mortality

World population growth, 1500-2100



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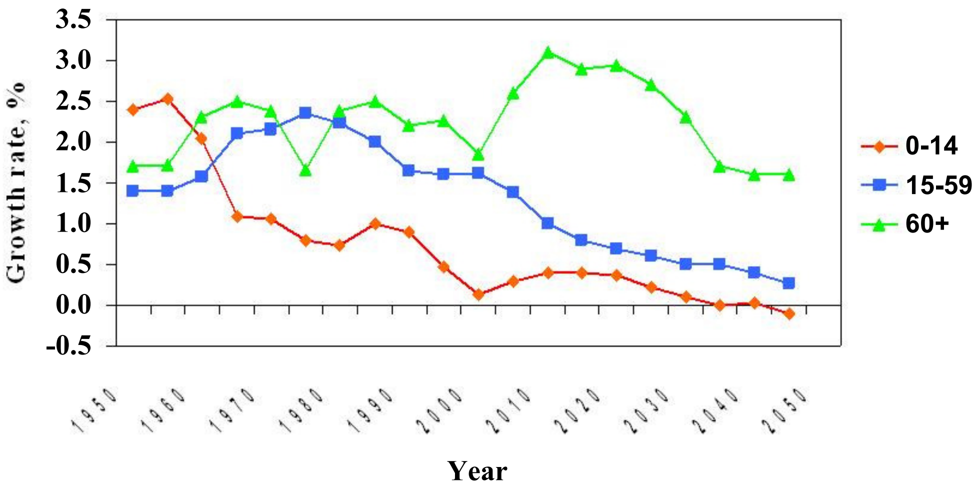
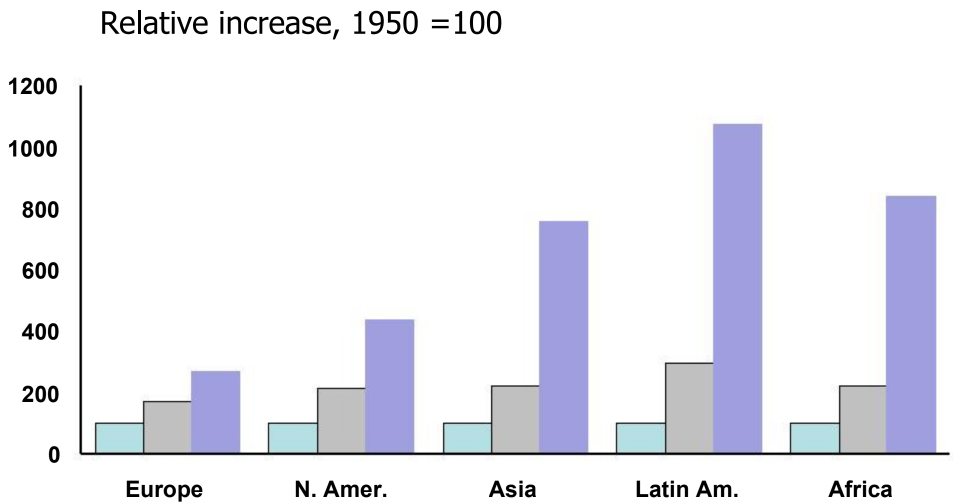
Age shifts in world population



Zlotnik, UN Population Div.

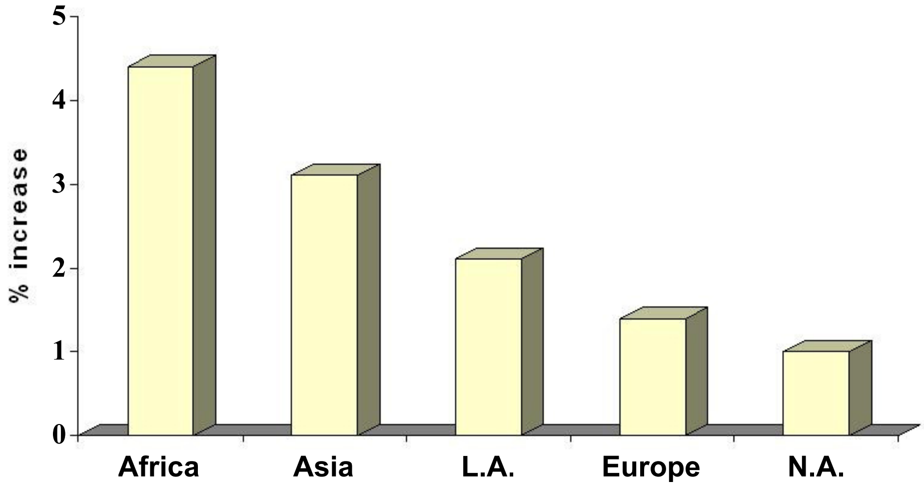
Population over 59 years



1950 1985 2025

Urban growth

Annual increase, 1990-2000



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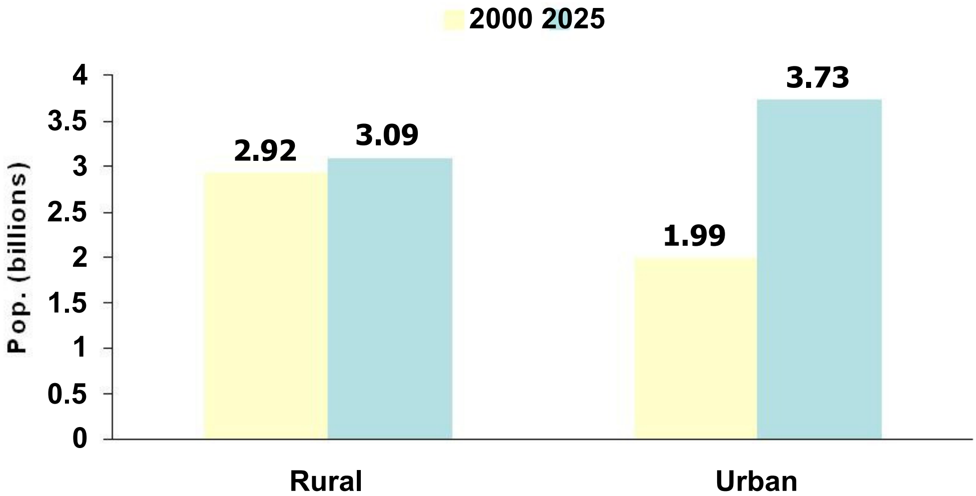
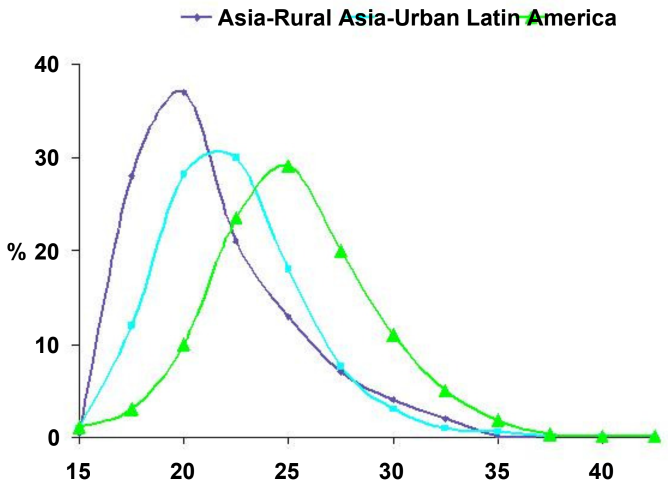
Projected population growth in the developing world, 2000 - 2025



United Nations, 1998

Urbanization and body mass index



BMI

INCLEN, 1996

GROWTH OF VENEZUELAN CHILDREN
Weight/age

Percentiles	Rural (%)	Urban (%)
< 10th	27.69	17.99
10 th> <90th	67.21	72.93
> 90th	5.09	9.06

Lopez Blanco et al, 1992

Dietary changes

- Changes in food type, availability and cost
- Changes in eating behaviors

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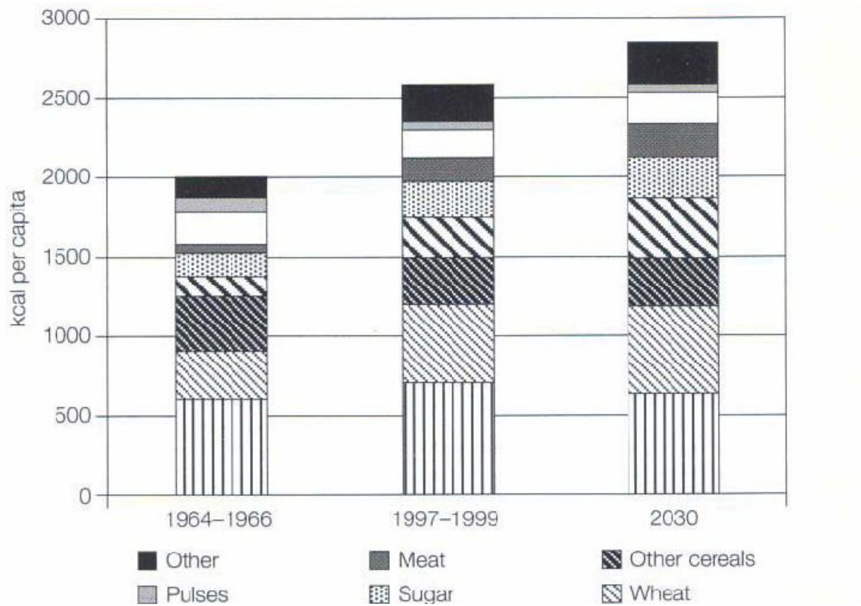
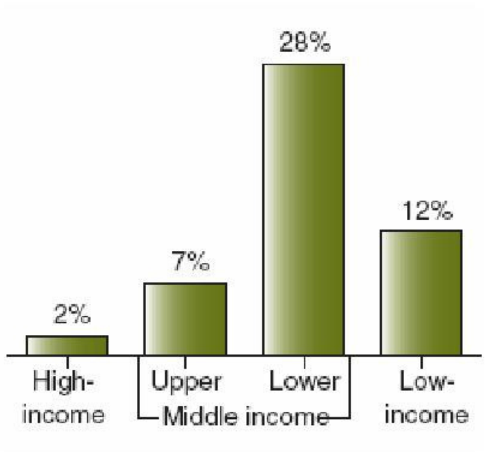
Food commodities Global trends



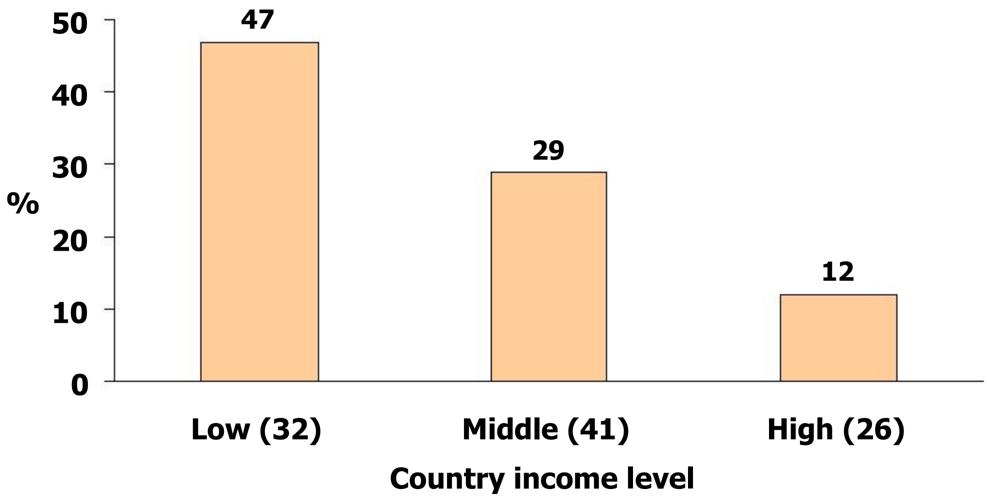
FAOSTAT, 2002

Growth in processed food market by GNI 1996-2002



USDA ERS-Euromonitor, 2003 World Bank country classification

Food cost: household budget share



L=<15%, M=15-50%, H=>50% of U.S. median *USDA ERS WRS-01-1*

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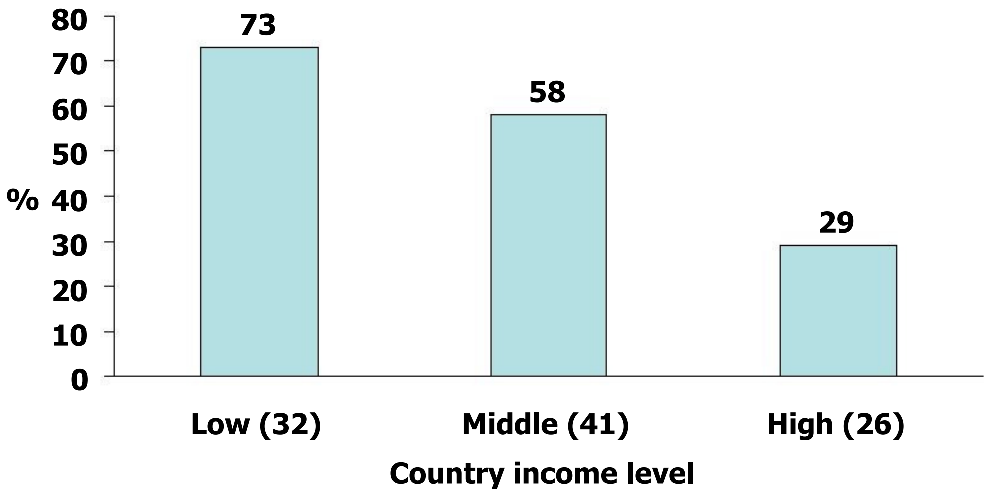
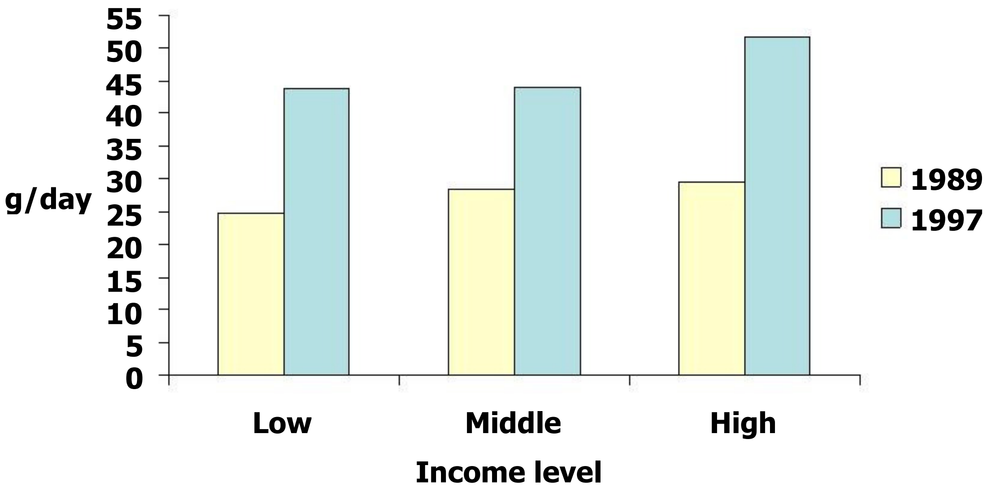
Food cost: income elasticity



L=<15%, M=15-50%, H=>50% of U.S. median *USDA ERS WRS-01-1*

China: dietary trends
Consumption of edible oils



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Lifestyle changes

- Reduction in energy demands at work
- Reduction in energy demands of daily survival activities
- Limited leisure physical activity
- Television

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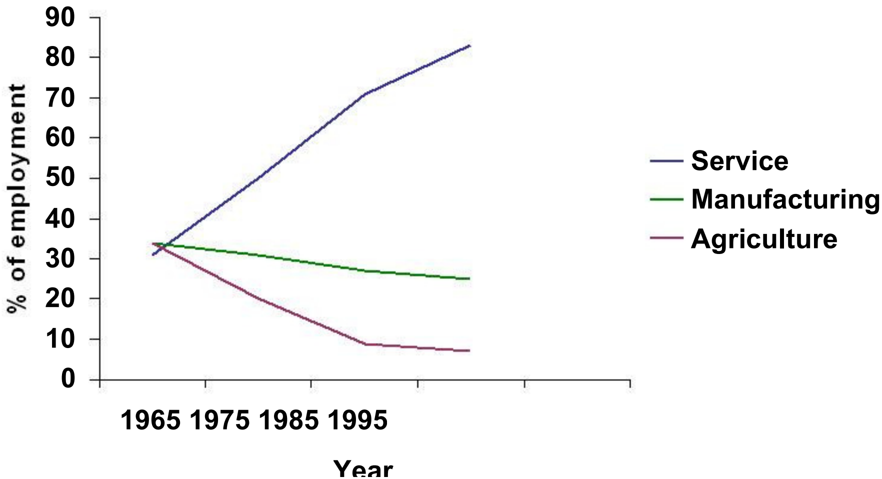
Trends in employment type in South Asian transitional countries



Popkin et al, 1998

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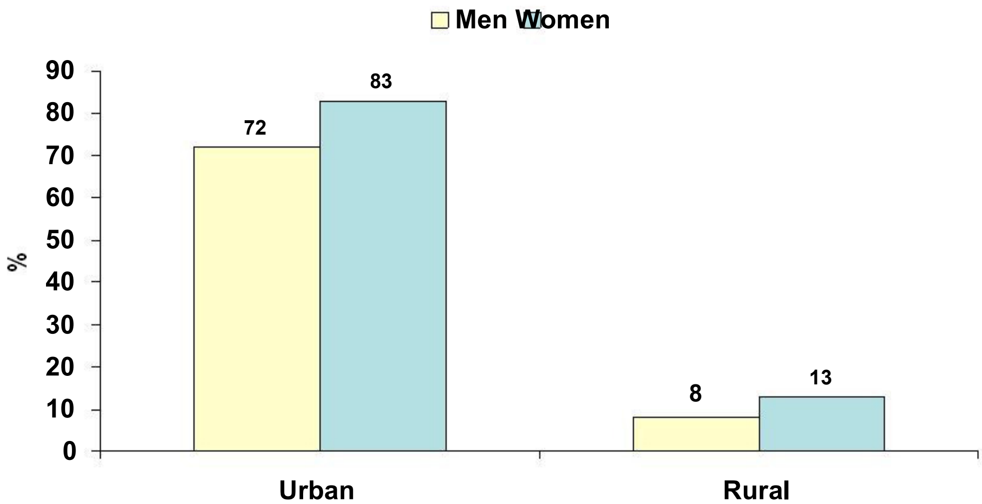
The nutrition transition in China: Prevalence of sedentary occupational activity



The added risk of early undernutrition

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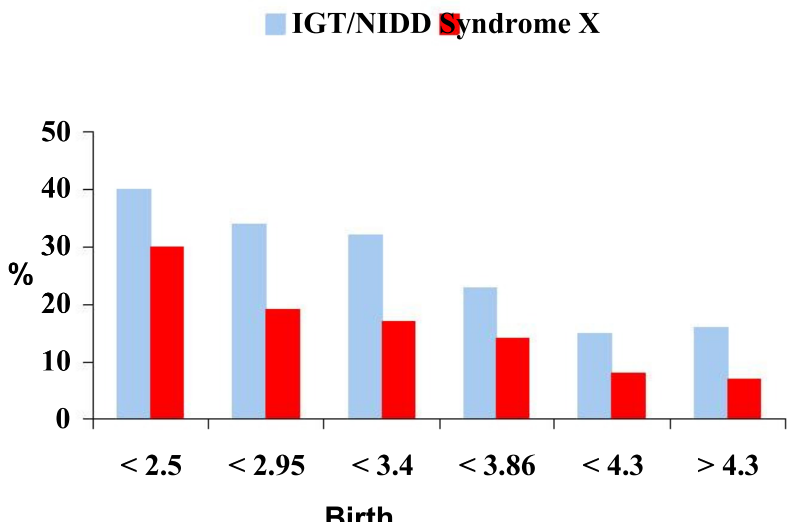
Birth weight and risk of diabetes and Syndrome X



Birth weight (kg)

Phipps et al, 1993

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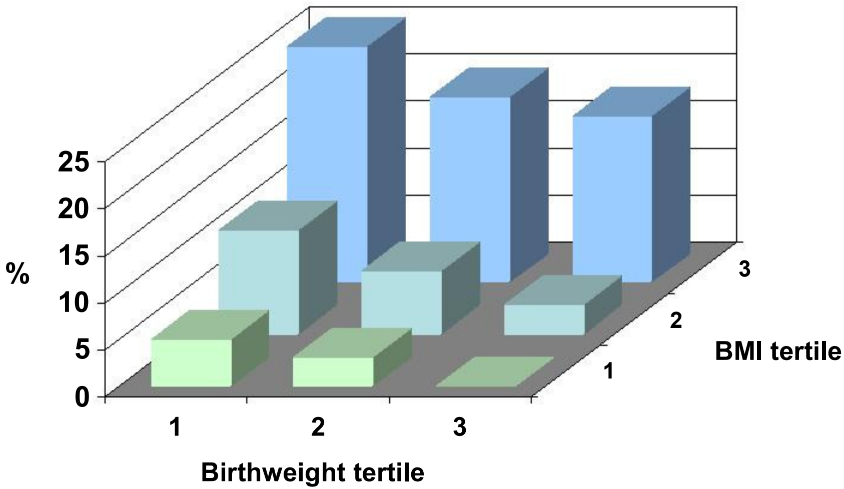
Effects of birthweight and adult BMI on prevalence of the insulin resistance syndrome

The San Antonio Heart Study



Valdez et al, Diabetologia, 1994

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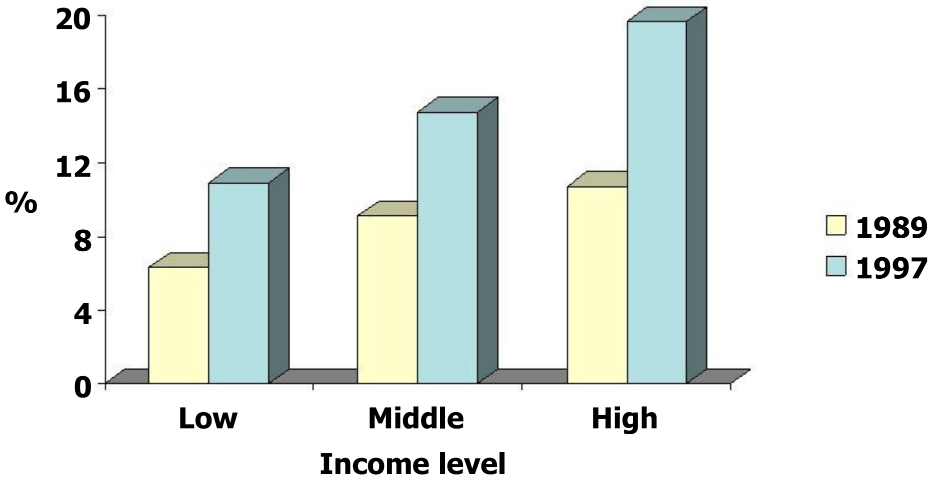
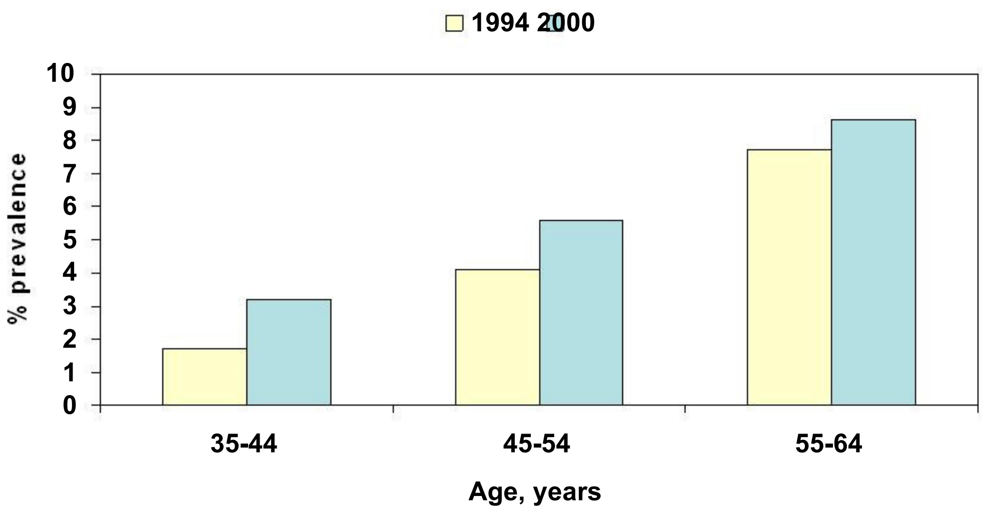
China: trends in obesity

Population with BMI > 25



Du et al, SSM 2004

Trends in diabetes in China
Adults



China National Survey, InterAsia Study

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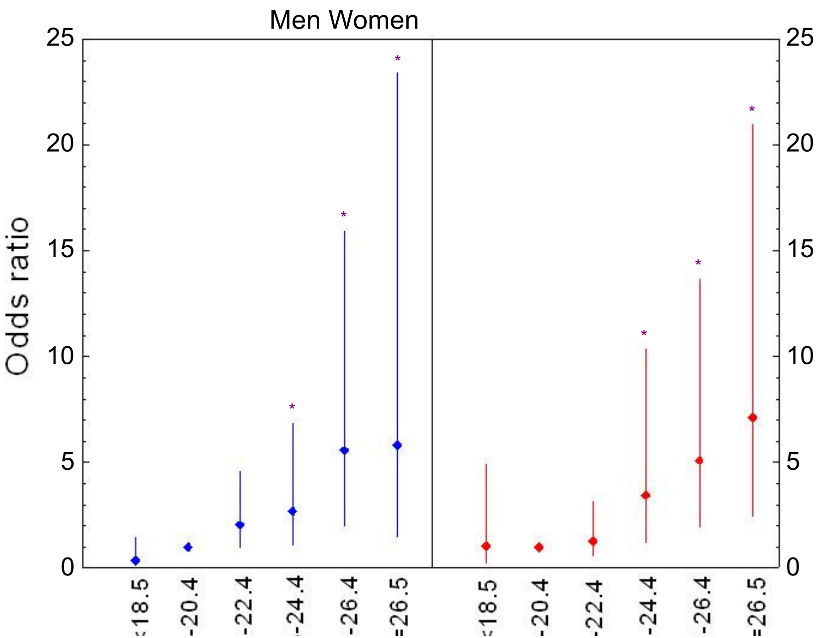
China NTP: metabolic syndrome and BMI (urban and rural)



* Significantly higher than 1, p<0.05

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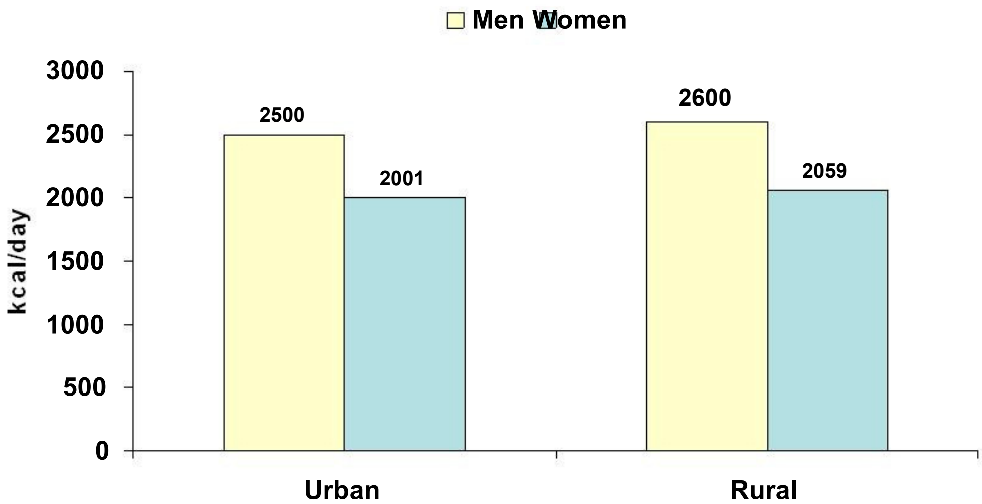
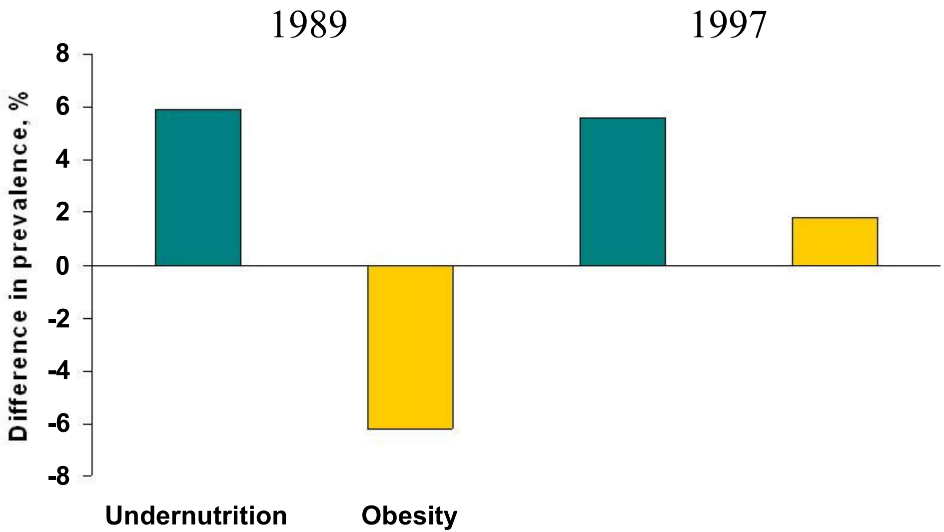
Age-adjusted urban-rural differences in lifestyle factors: Energy intake



Recent trends

- In intermediate-income countries, obesity is increasing more among the poor
- Obesity prevalence in rural populations is approaching the rates of urban areas

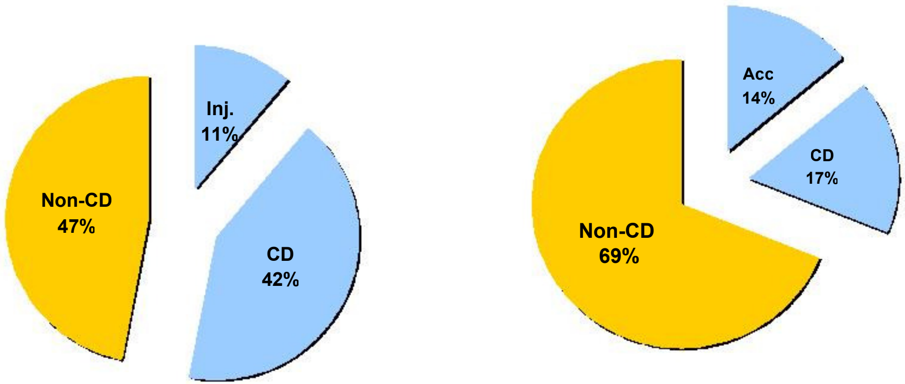
Difference in prevalence of underweight and obesity, low vs. high SES - Brazil



Monteiro, AJPH 2004

Disease burden in the developing world

1990 2020



Murray & Lopez, 1996

The big picture

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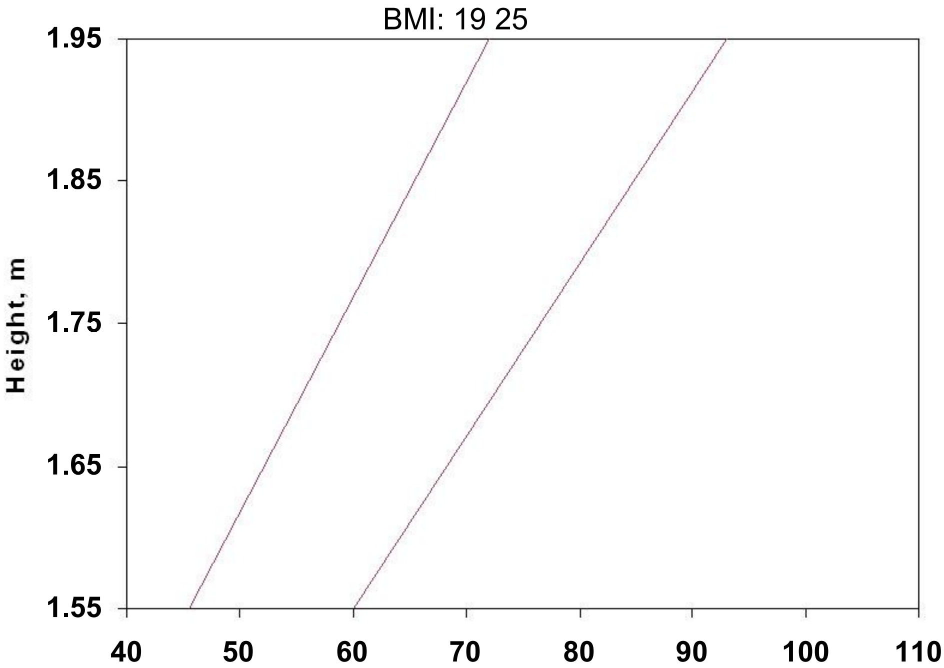
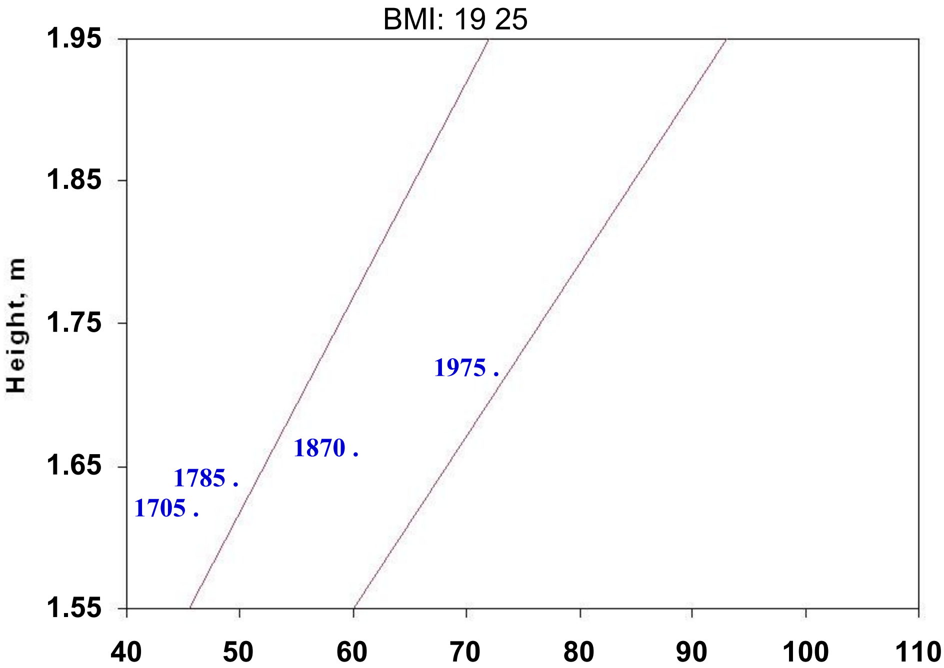
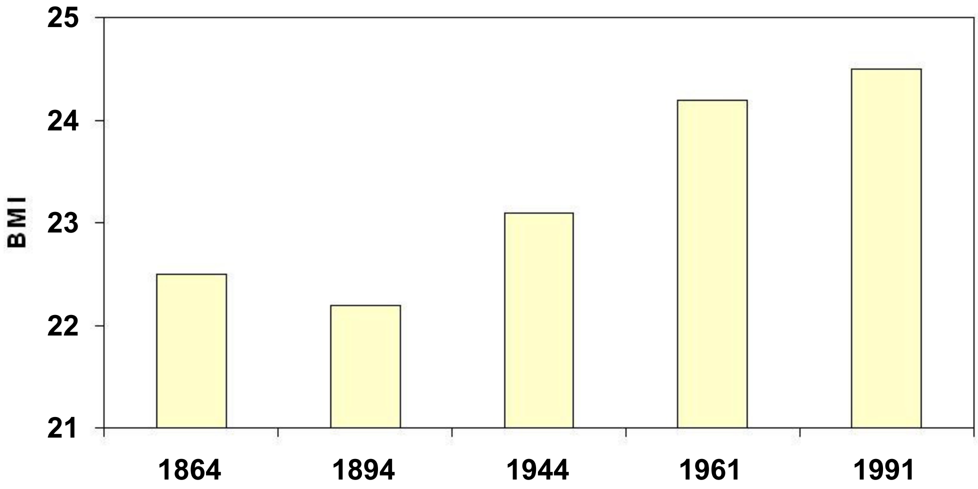


Weight, kg


BMI: 19 25
1.95
1.85
1.75
1.65
1.55
Height, m
1975 .
1870 .
1785 .
1705 .
40
50
60
70
80
90
100
110

Weight, kg

Mean BMI in 27 yr-old U.S. males



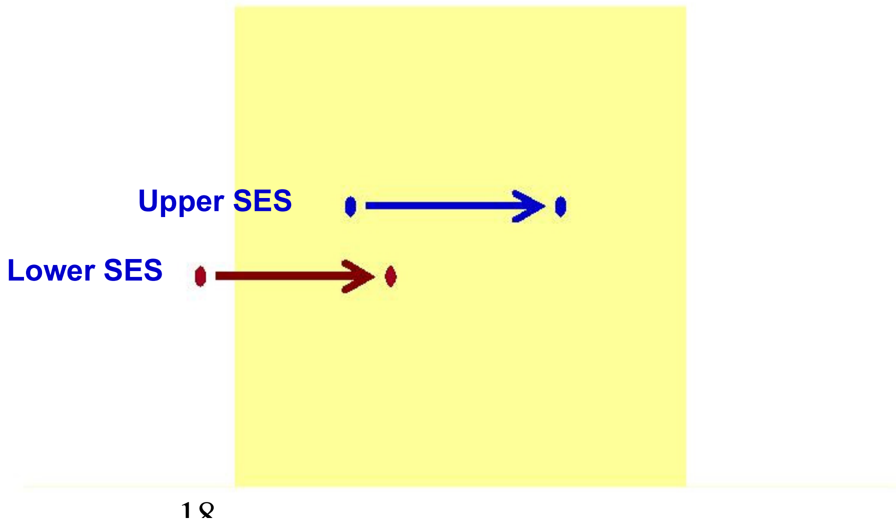
Costa

&
Fogel,
1997

Trends in BMI in China

Modeling from regional and national data

1960 . 1990



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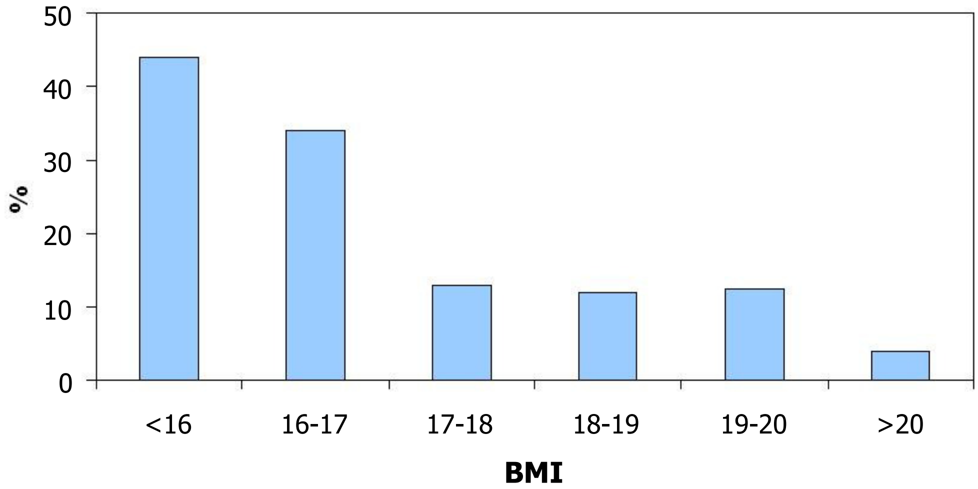
% of men not working on the previous month due to illness (excluding accidents) - Bangladesh



Pryer, Eur J Clin Nutr, 1993

UN Millenium Development Goals

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empower women
- Reduce child mortality
- Improve maternal health
- Combat HIV/AIDS, malaria, and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development