Changes in dietary intakes, nutrition and health status, evidence from NNMB surveys from 1975-79 to 2012

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Nutritional Challenges in India (Triple burden of Disease)

1. Protein Energy Malnutrition (PEM)

Clinical forms

- Marasmus
- Kwashiorkor
- Marasmic-kwashiorkor

Sub-clinical forms

- Underweight
- Stunting
- Wasting

3. Micronutrient Deficiency Disorders (MNDs)

- Iron deficiency anaemia (IDA)
- Vitamin A deficiency diseases (VAD)
- Iodine Deficiency Disorders (IDD)

3. Diet related chronic diseases

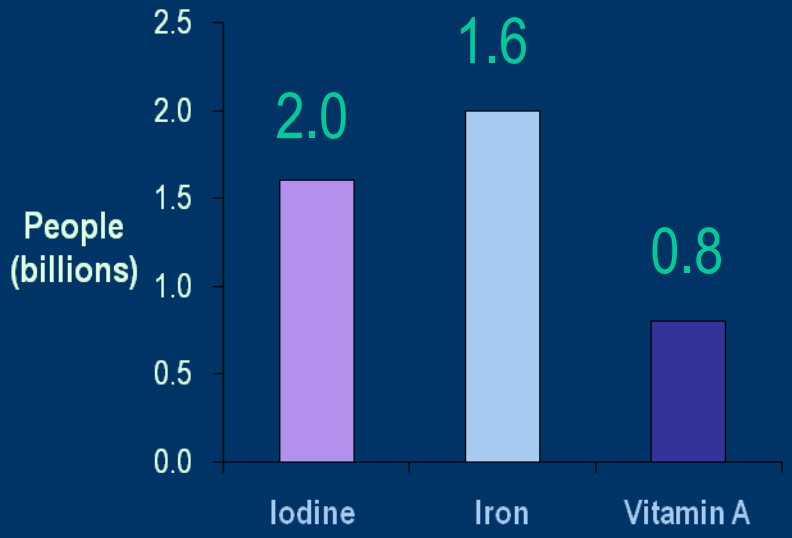
- Overweight and obesity,
- Type 2 diabetes
- Insulin Resistance
- Hypertension,
- Other cardiovascular diseases, etc.

Magnitude of the problem (Contd.)

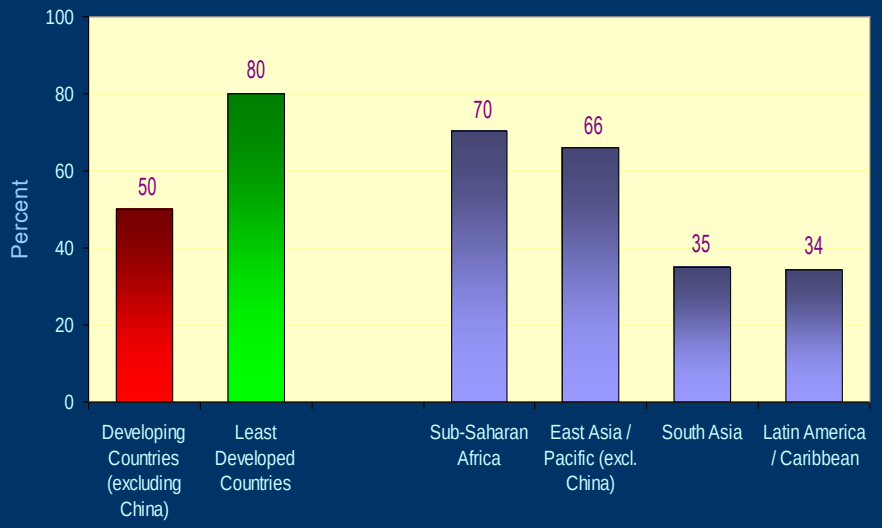
- There are 854 million people in the world (about 14% of the world population), who are chronically or acutely undernourished.
- Child undernutrition in Asia tops even sub-Saharan Africa, 30% of children under five in Asia are underweight, while in Sub-Saharan Africa, it was 28%.
- India, Bangladesh and Pakistan together account for half the World's underweight children.
- In addition, hidden hunger from micronutrient deficiencies affects more than 2 billion people worldwide.
- Undernutrition and overweight/obesity are twin problems in low and middle income countries – leading to double burden of disease.

Double Burden of Disease

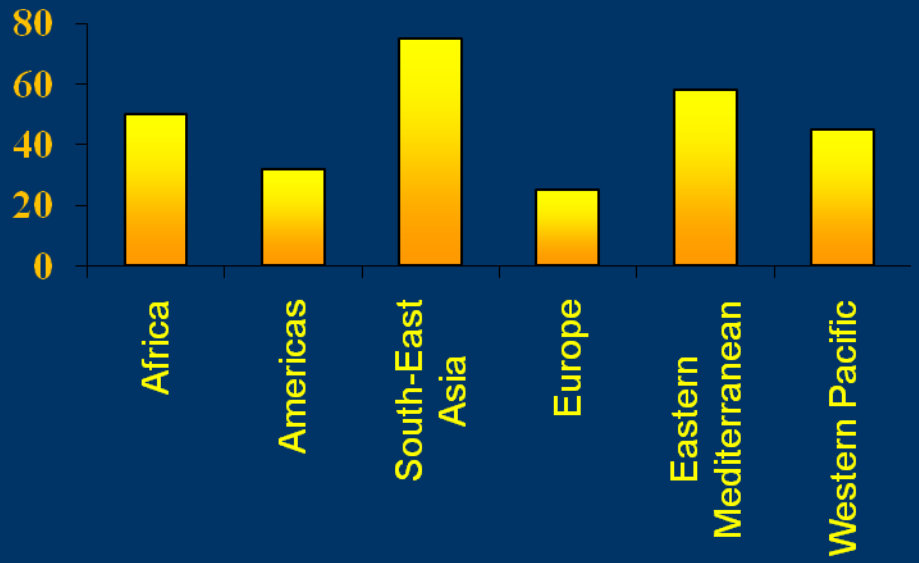
Population at Risk - Global



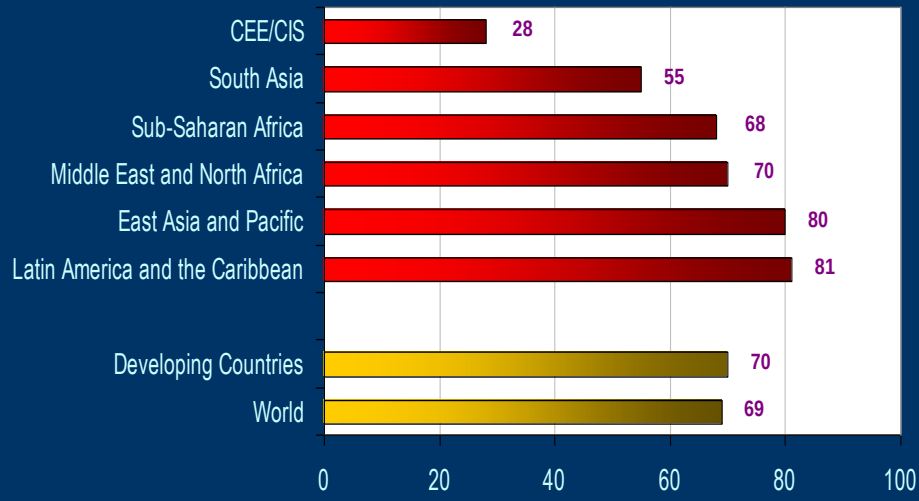
Vitamin A Coverage - Global



Anemia prevalence - Global

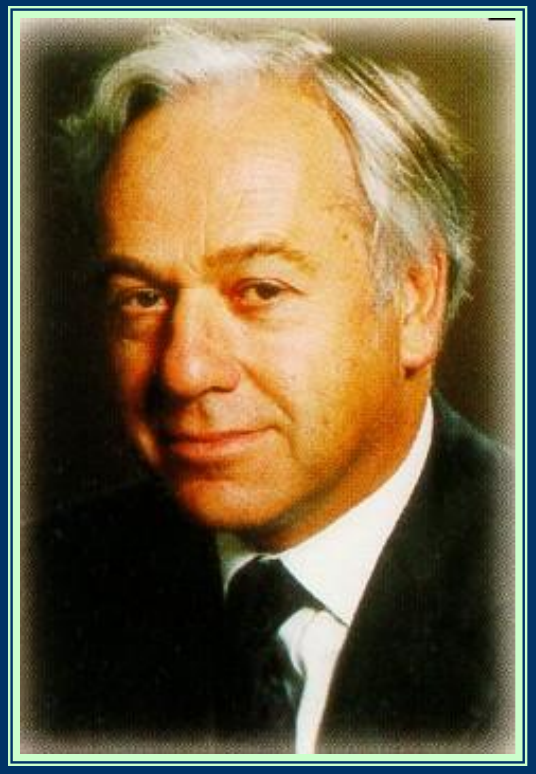


Iodized Salt coverage - Global

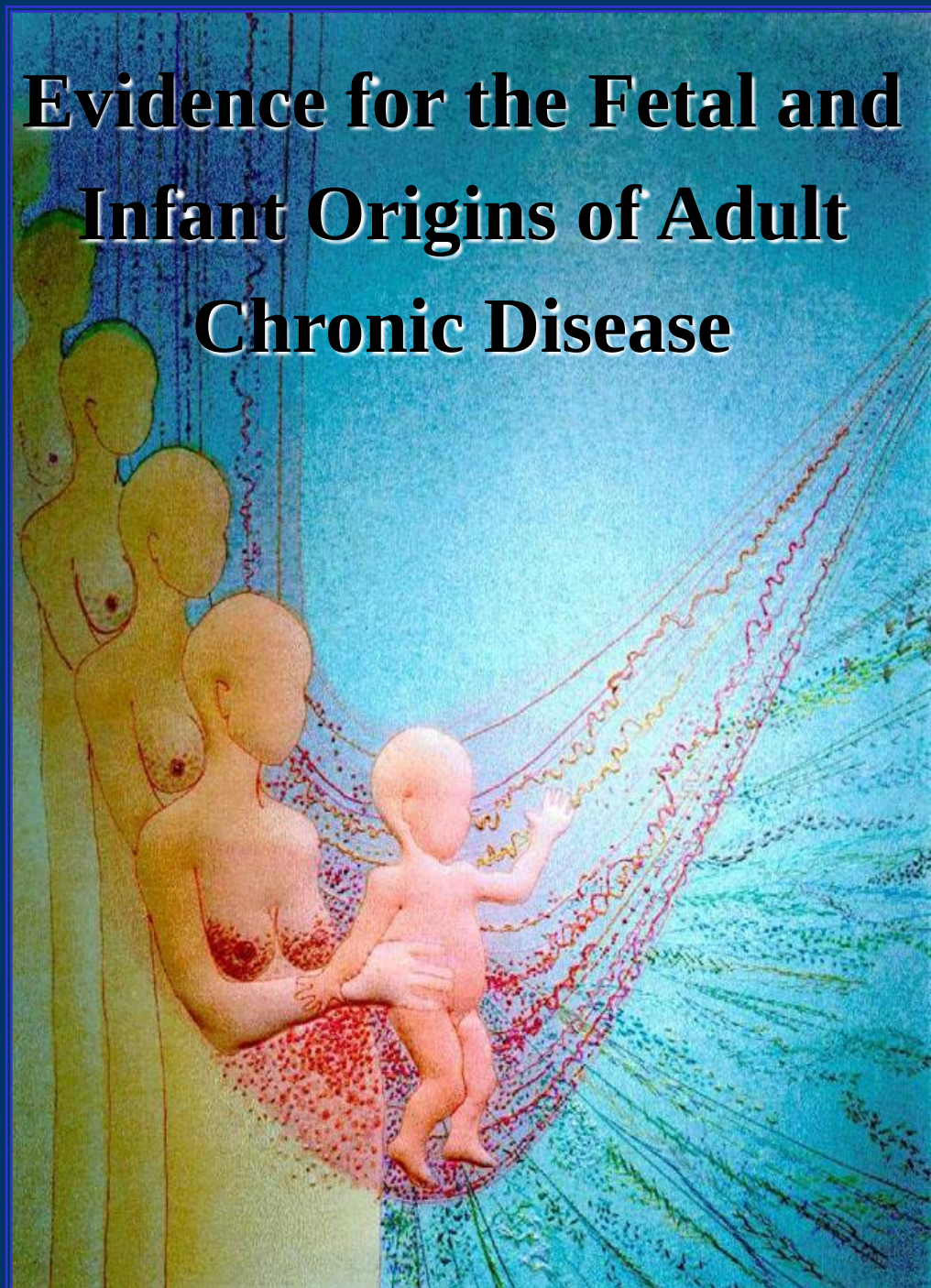


Persistent undernutrition in India

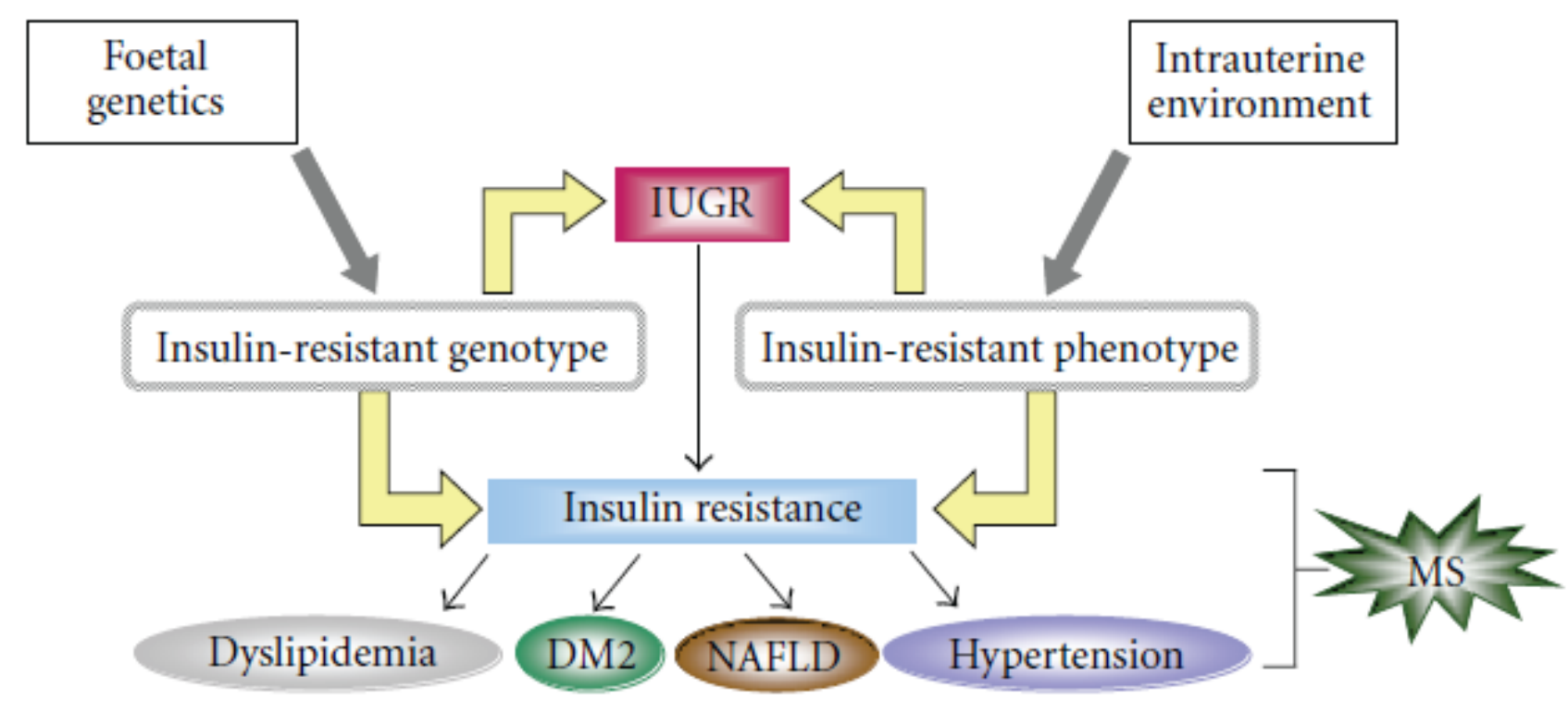
Country	*Percentage of infants with low birth weight*				
	1980-88	*1990*	*1990-94*	*1994-96*	*2010*
Bangladesh	47	50	50	50	32
Indonesia	14	14	14	11	8
Maldives	….	….	20	20	11
Myanmar	16	16	16	….	8
Sri Lanka	25	25	25	18	12
Thailand	12	13	13	7	5
India	30	33	33	30	24



Evidence for the Fetal and Infant Origins of Adult Chronic Disease



Possible hypotheses to explain the association between IUGR and METABOLIC SYNDROME



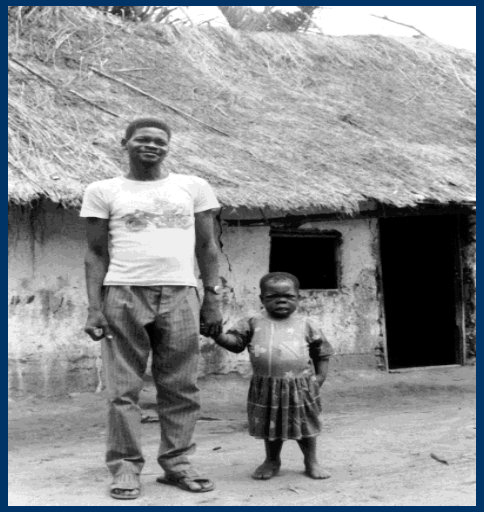
Alisi A et al, Int J Endocrino, 2011

The Ugly Face of "Hidden Hunger"

Iron Deficiency

Folic Acid Deficiency

Vitamin A Deficiency



Iodine Deficiency

Zinc Deficiency

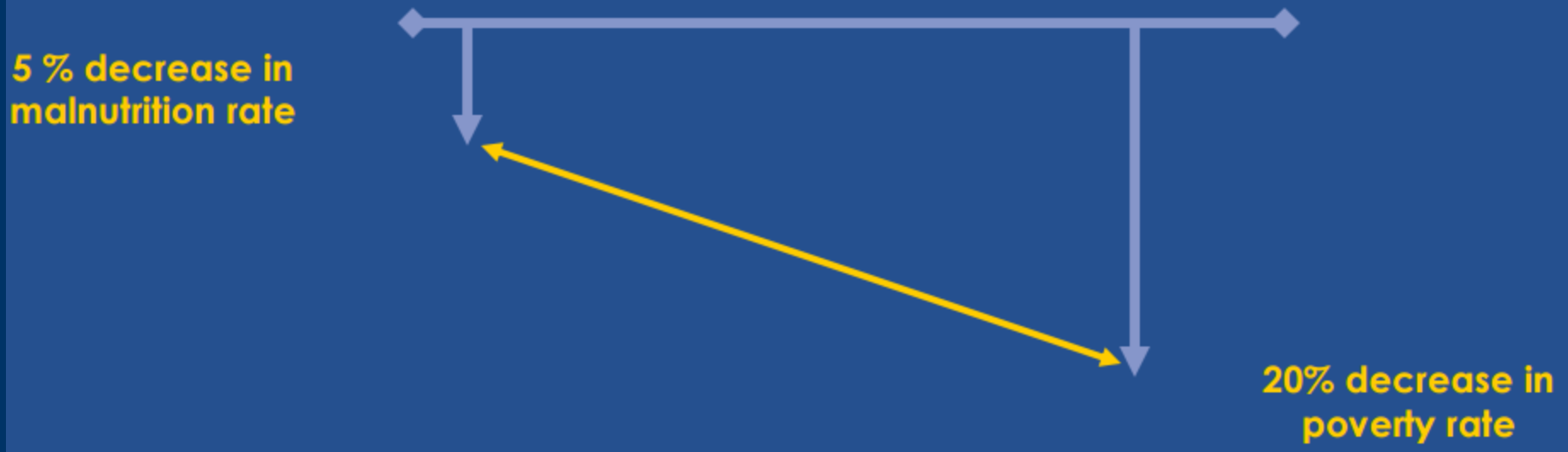
Micronutrients (vitamins and minerals) are essential for many functions and health

They cannot be produced by the body and have to come from the diet

Nutrition is the centre for over all development of the country

A decrease of 1% in malnutrition rate achieves a 4% decrease in poverty

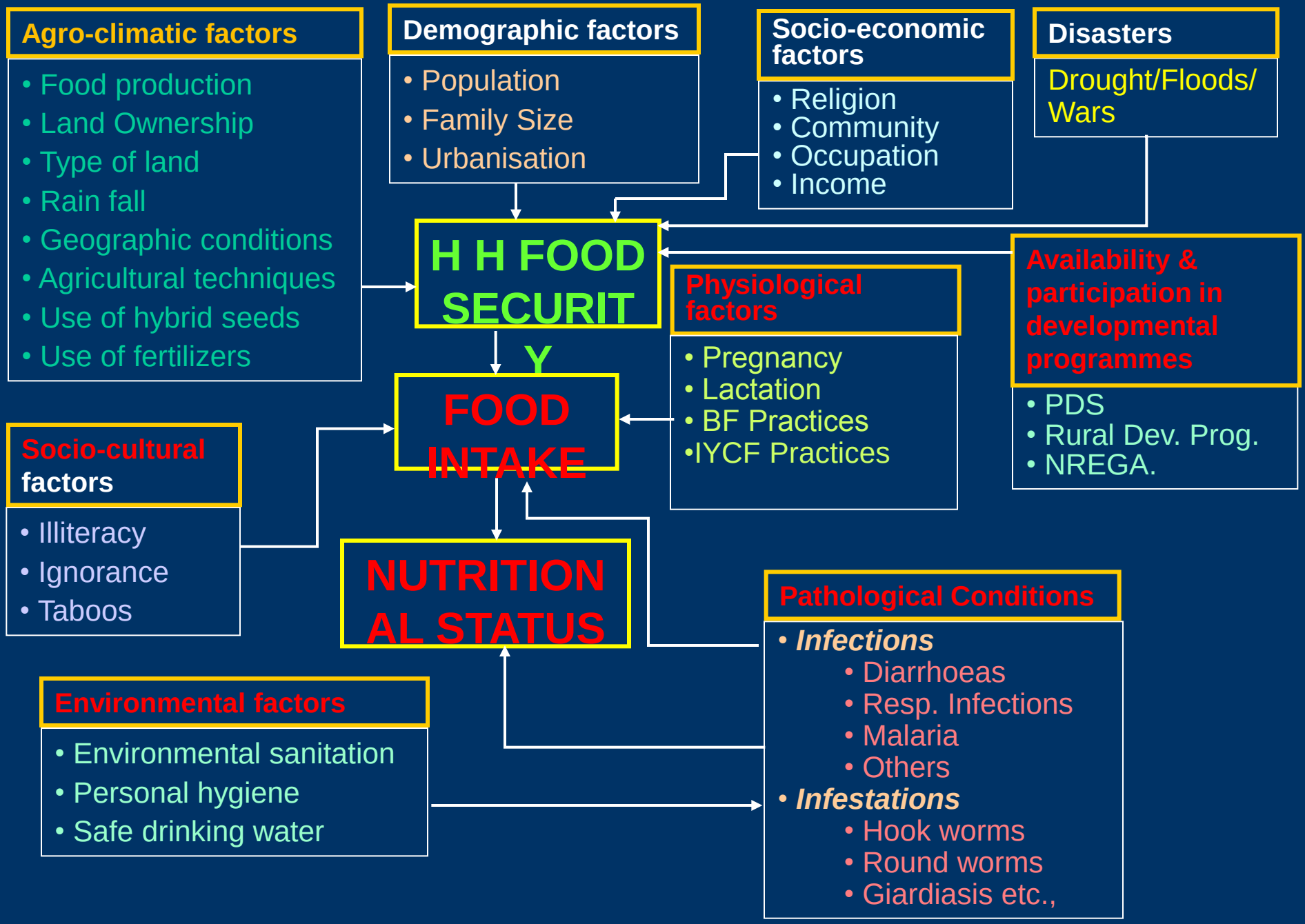
A decrease of 1% in poverty rate achieves a 0.25% decrease in malnutrition rate



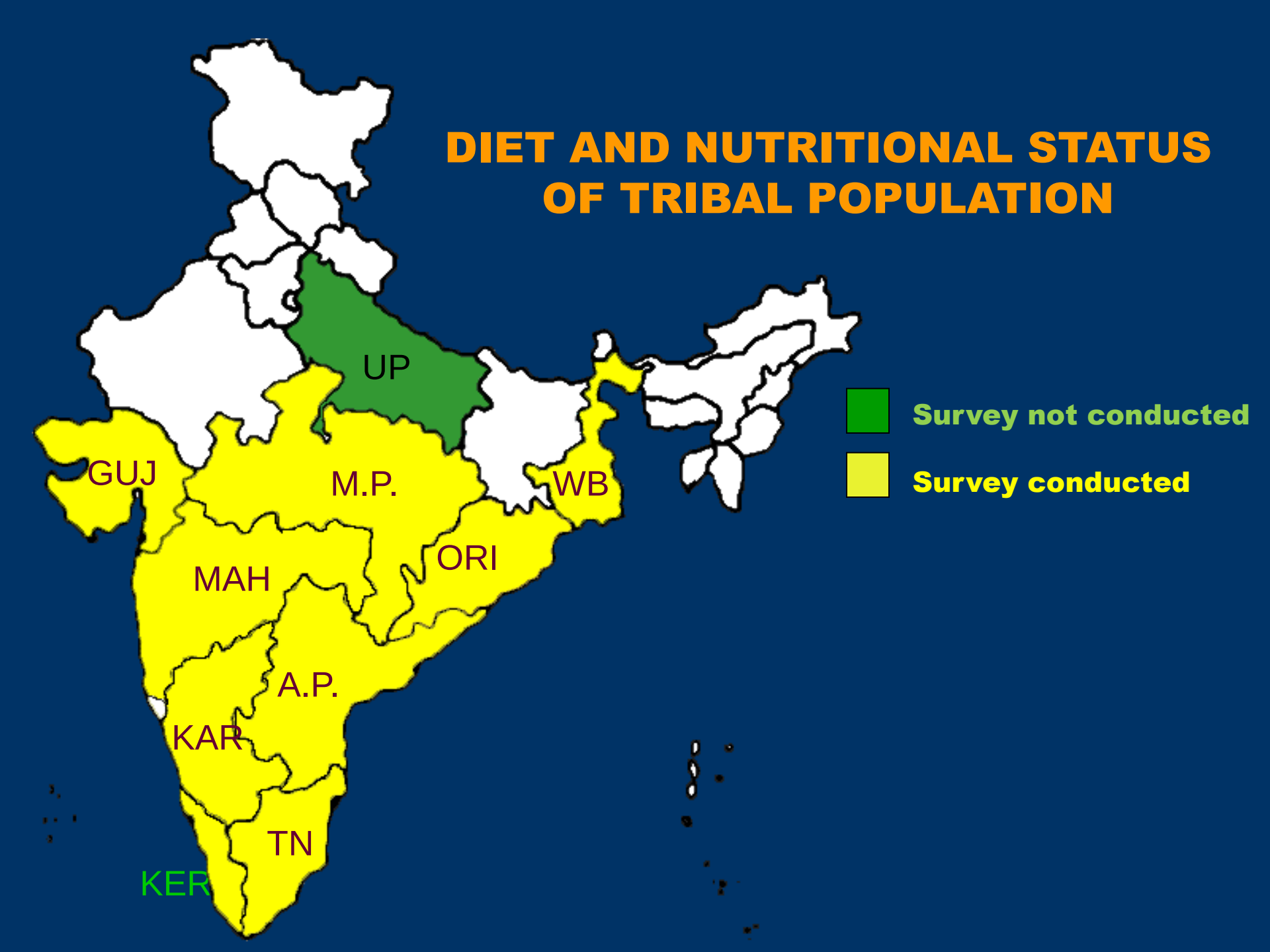
An efficient way of fighting poverty is to address hunger – especially child chronic undernutrition

Source: Alderman, Harold (2004). Linkages Between Poverty Reduction Strategies and Child Nutrition.

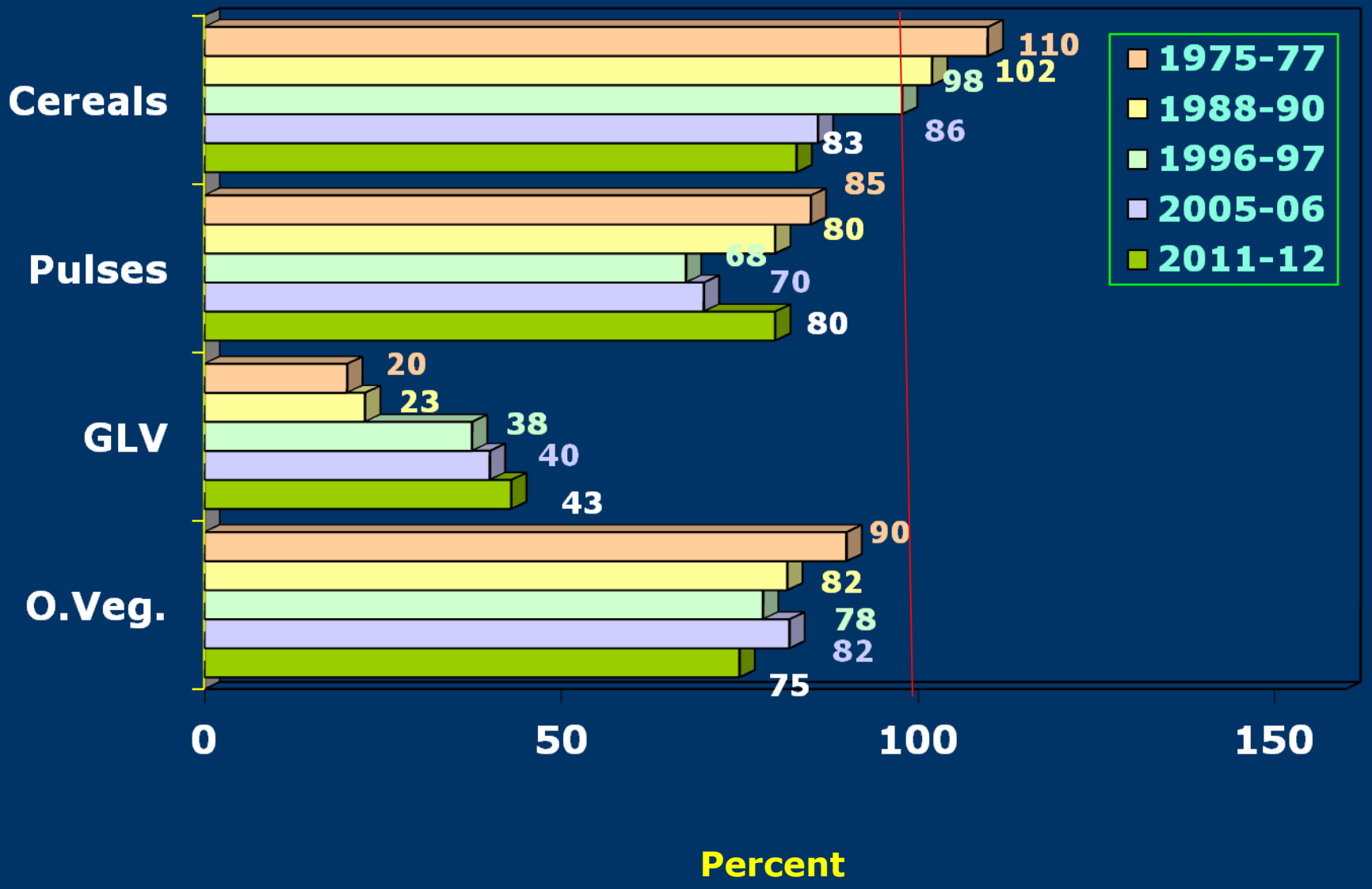
DETERMINANTS OF NUTRITIONAL STATUS



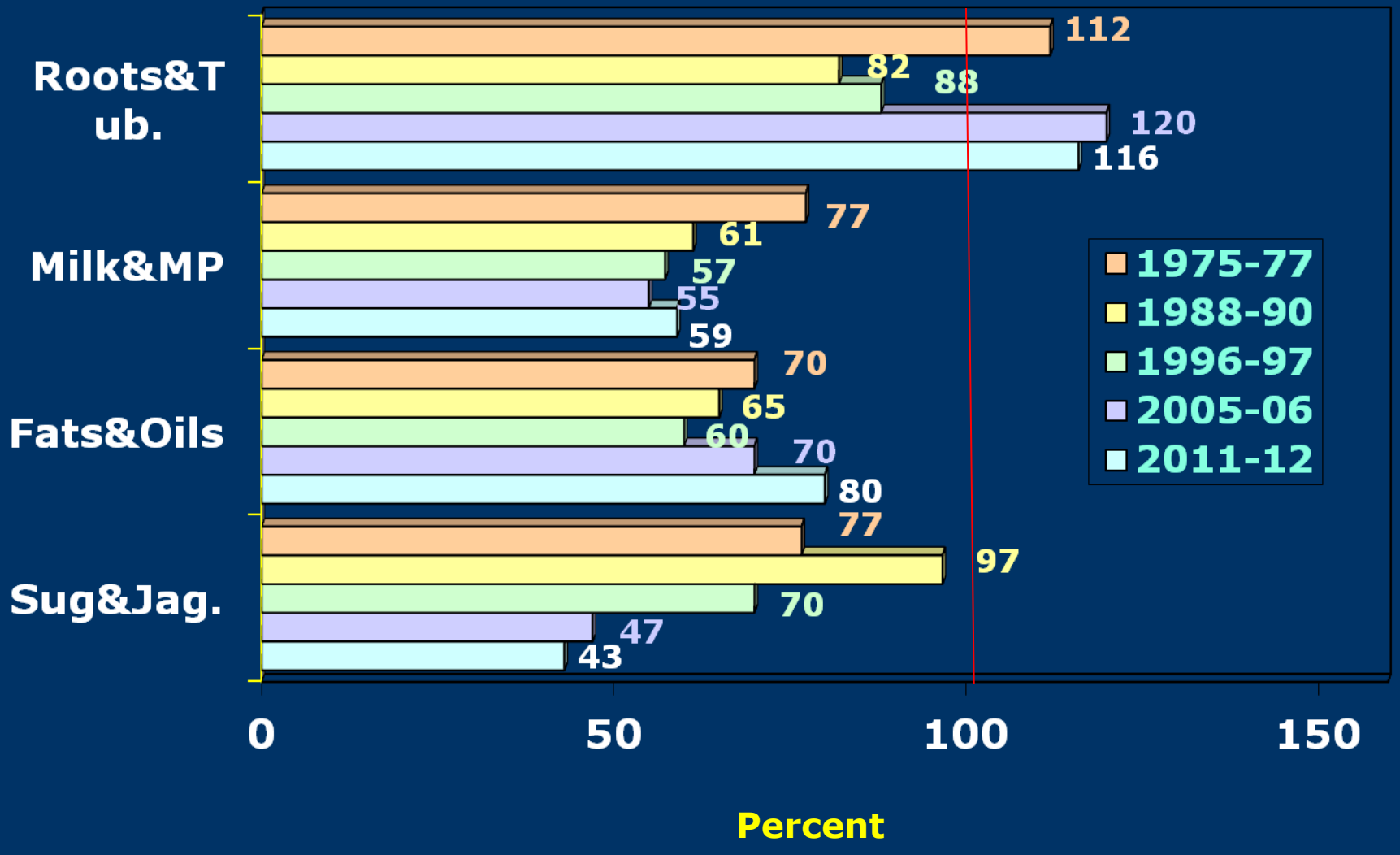
DIET AND NUTRITIONAL STATUS OF TRIBAL POPULATION



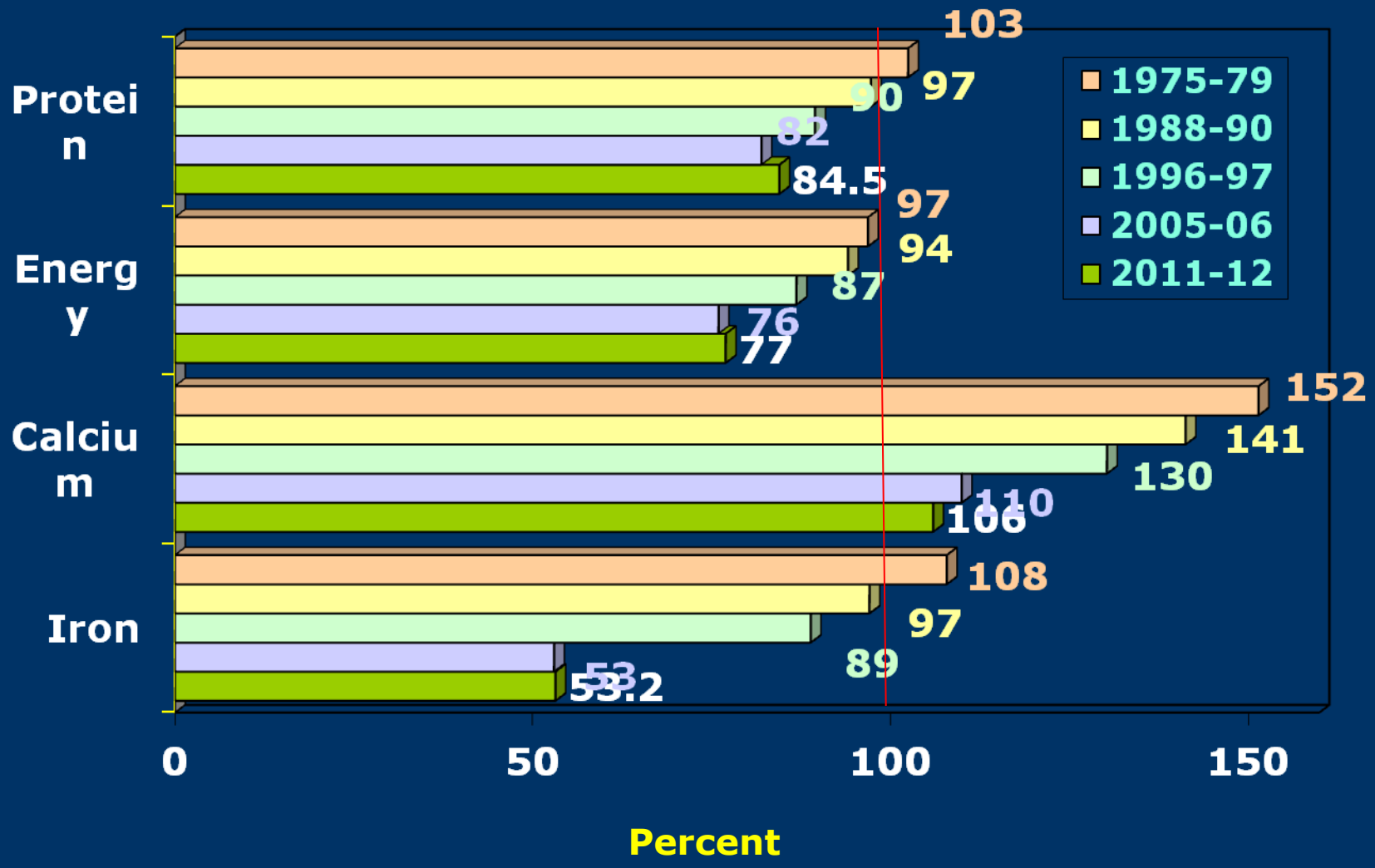
Average Intake of Foodstuffs (per CU/day) as % of RDI by Period of Survey



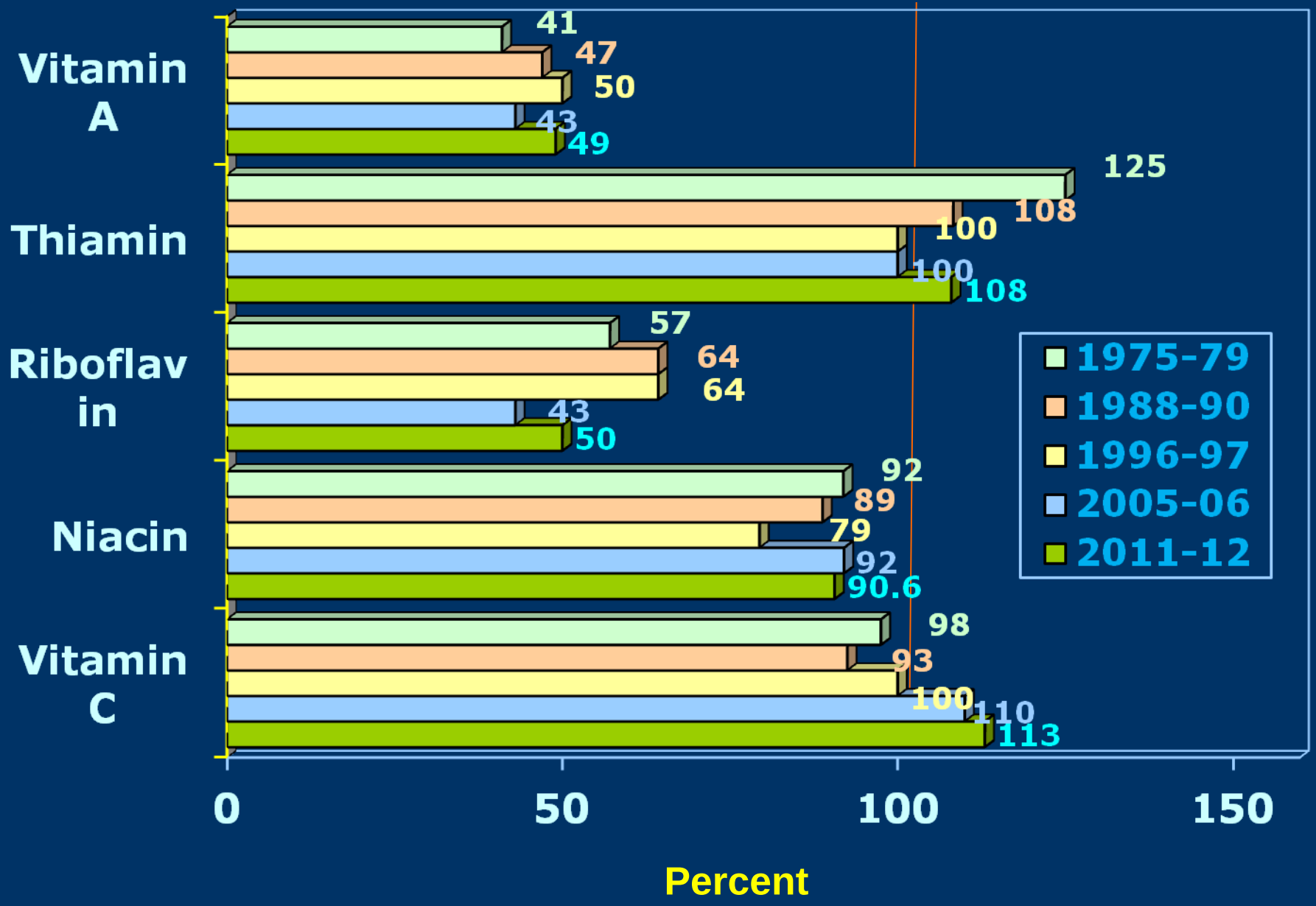
Average Intake of Foodstuffs (per CU/day) as % of RDI by Period of Survey (contd.)



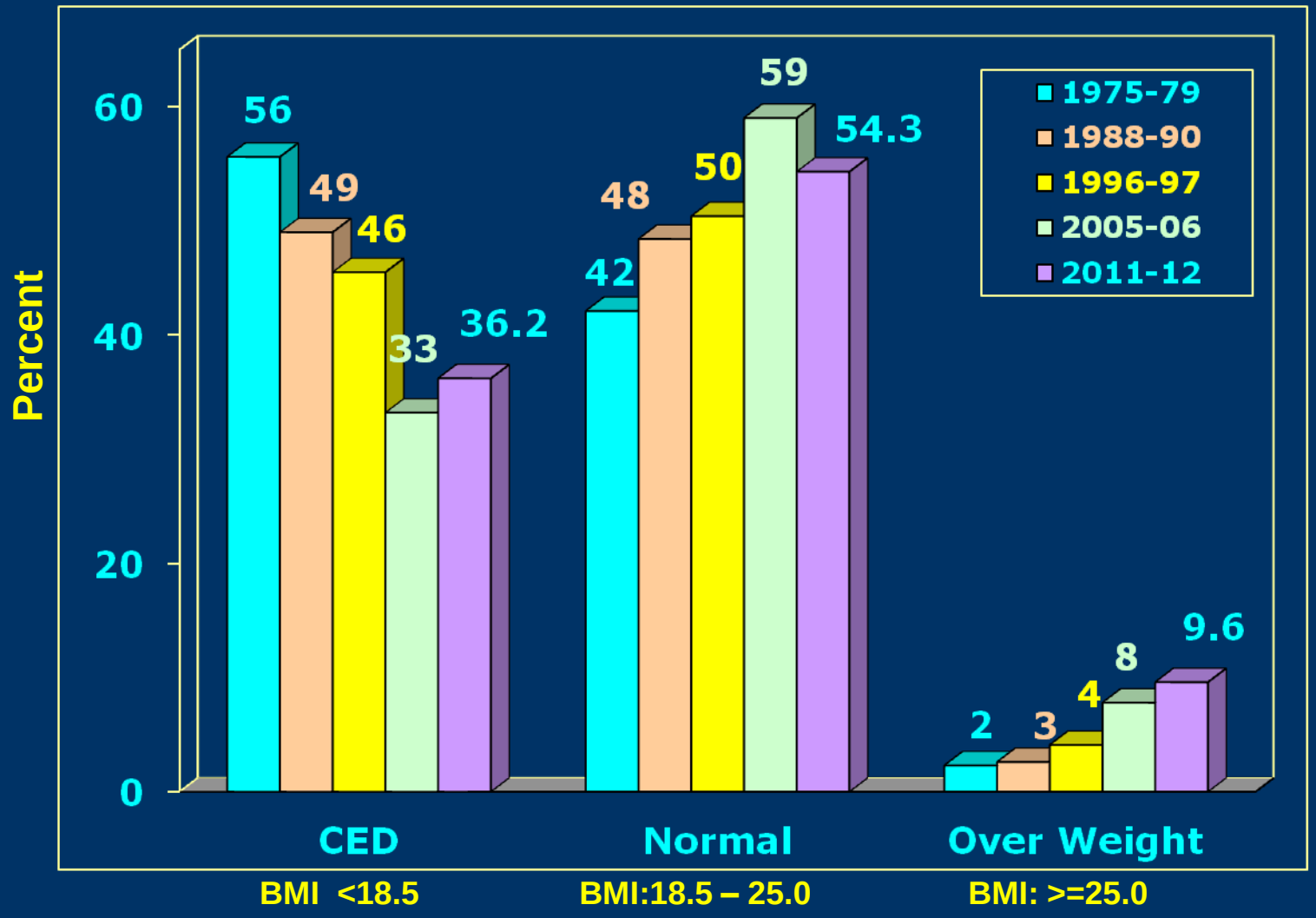
Average Intake of Nutrients (per CU/day) as % of RDI by Period of Survey



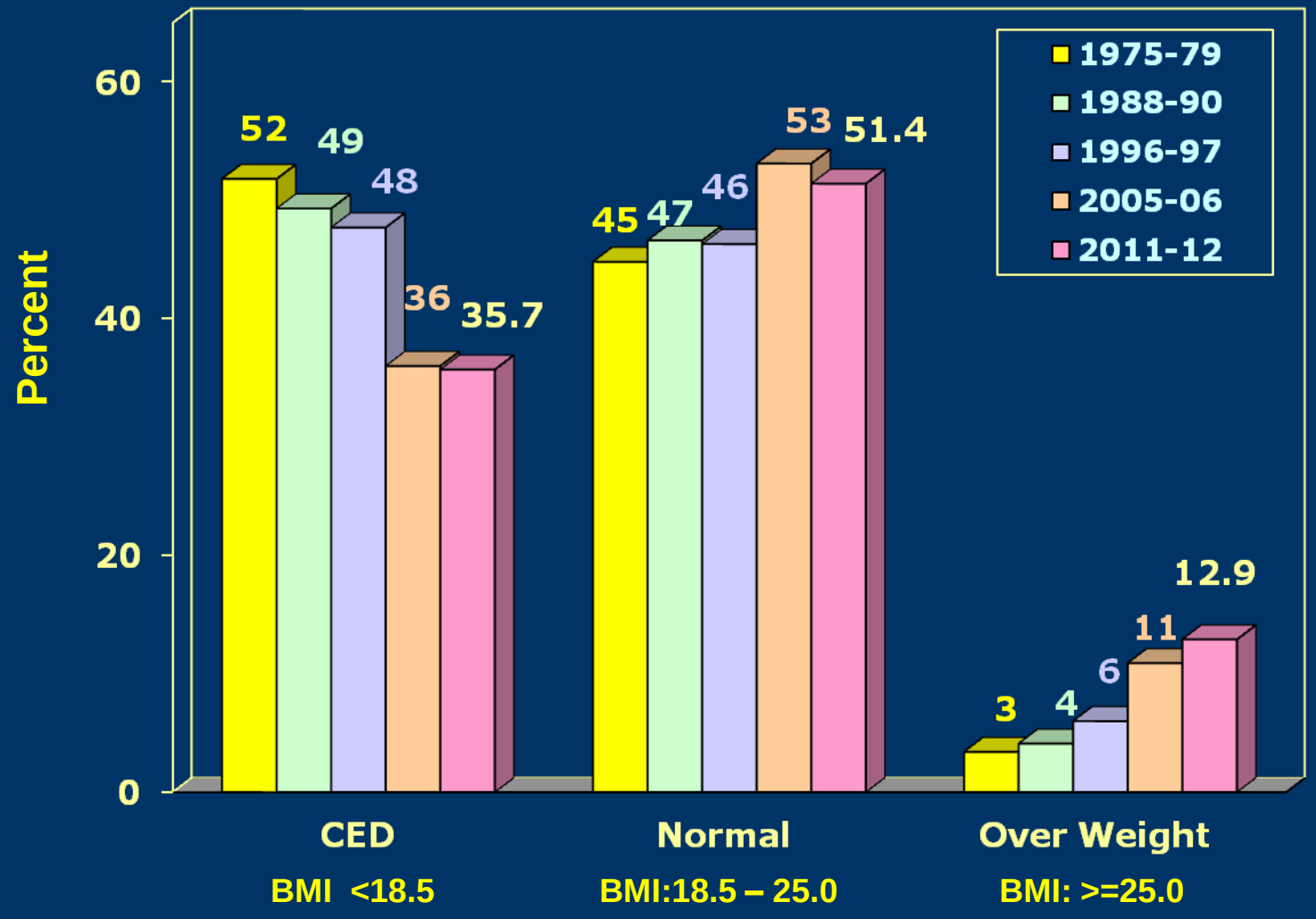
Average Intake of Nutrients (per CU/day) as % of RDI by Period of Survey (Contd.)



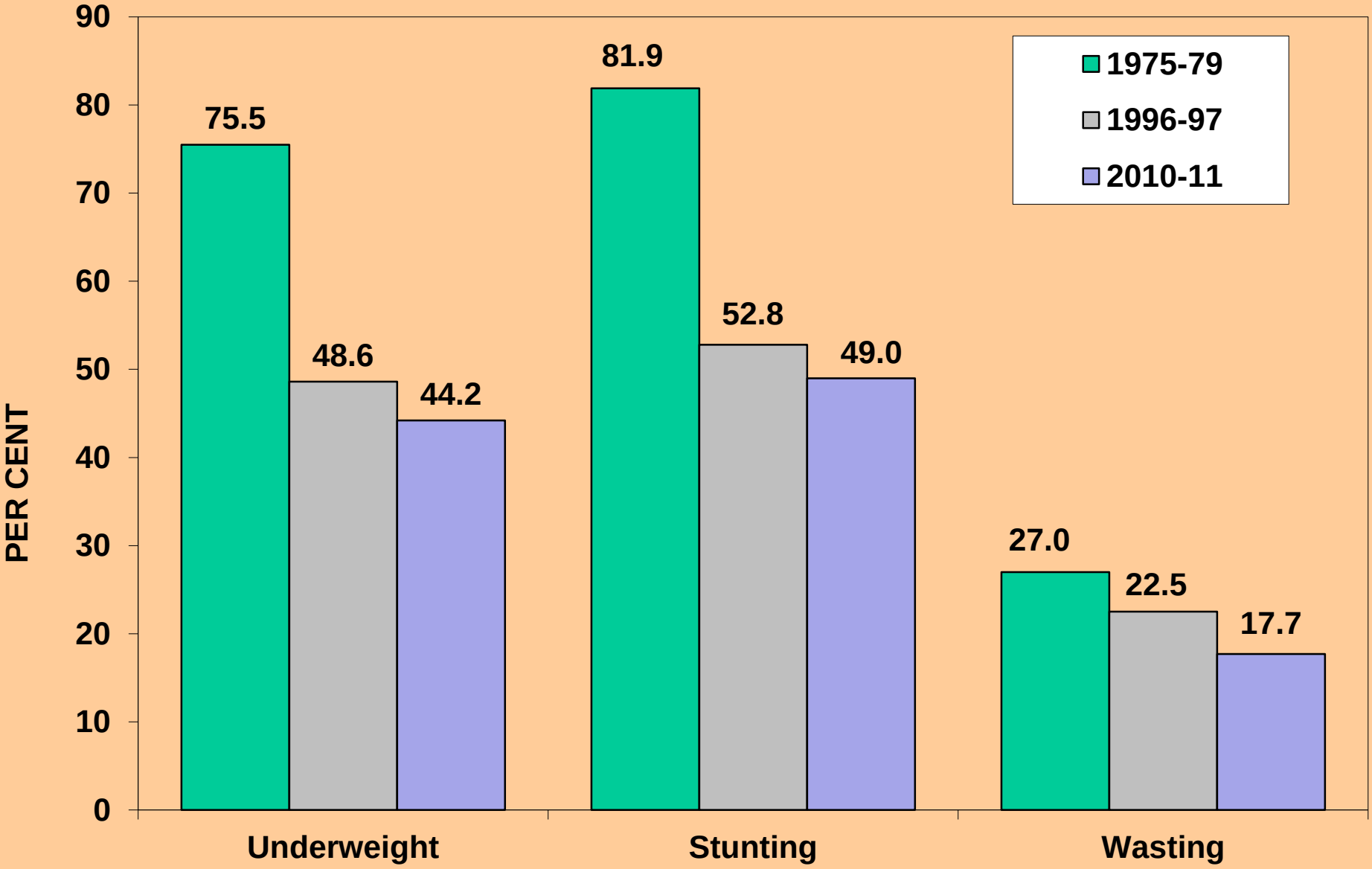
Distribution (%) of Adult Men according to BMI Grades by Period of Survey



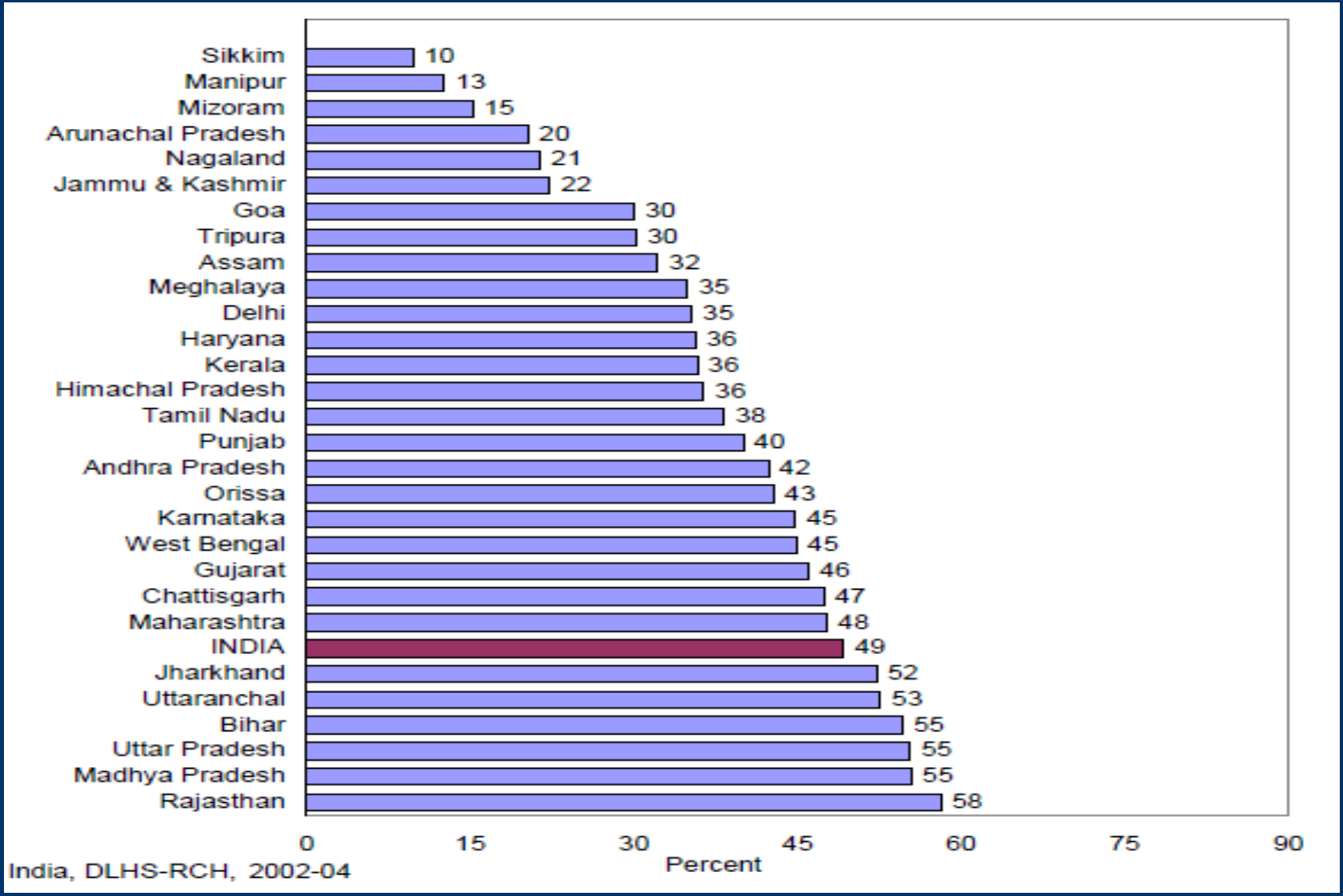
Distribution (%) of Adult Women according to BMI Grades by Period of Survey



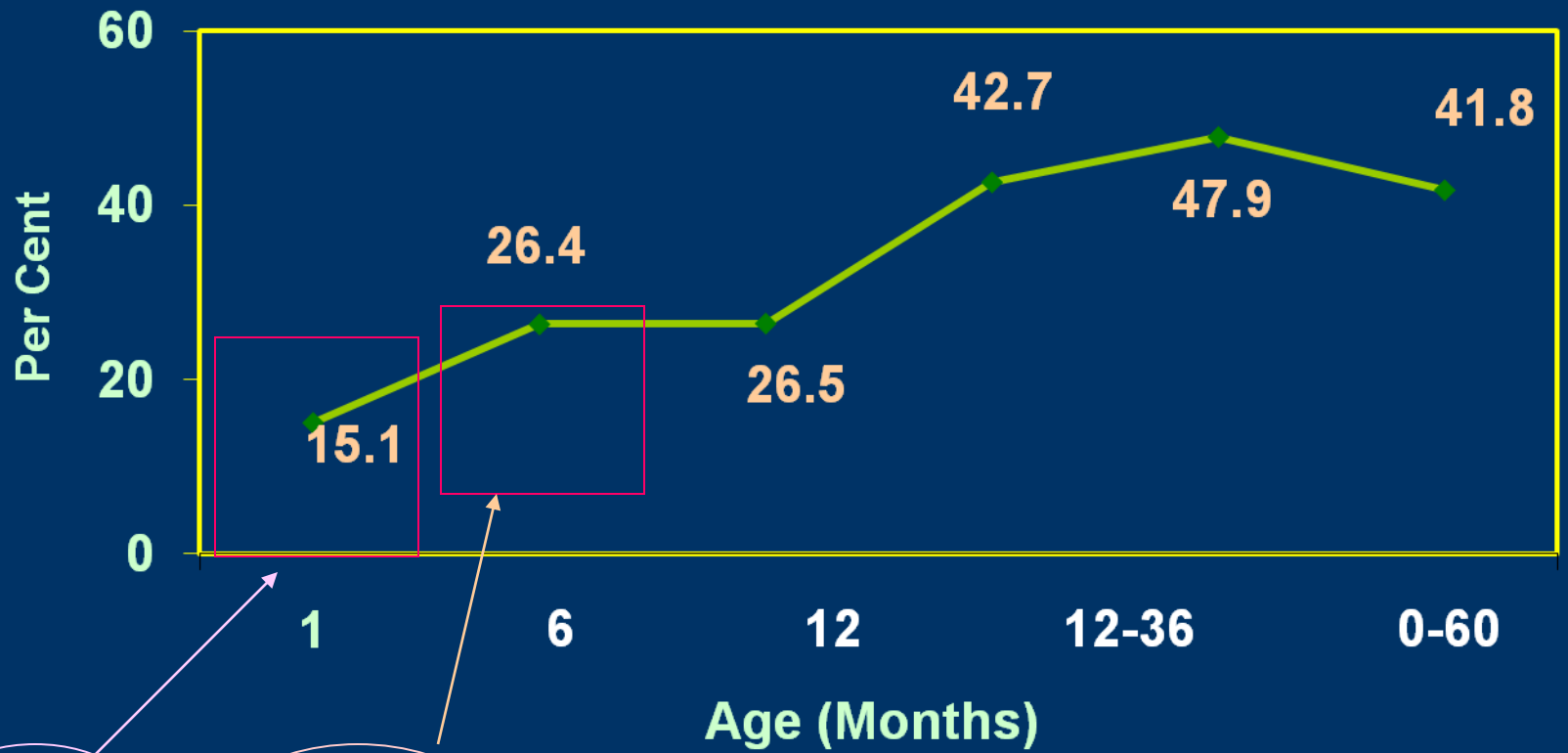
Prevalence (%) undernutrition among rural Preschool children in 10 NNMB States in India (2011-12)



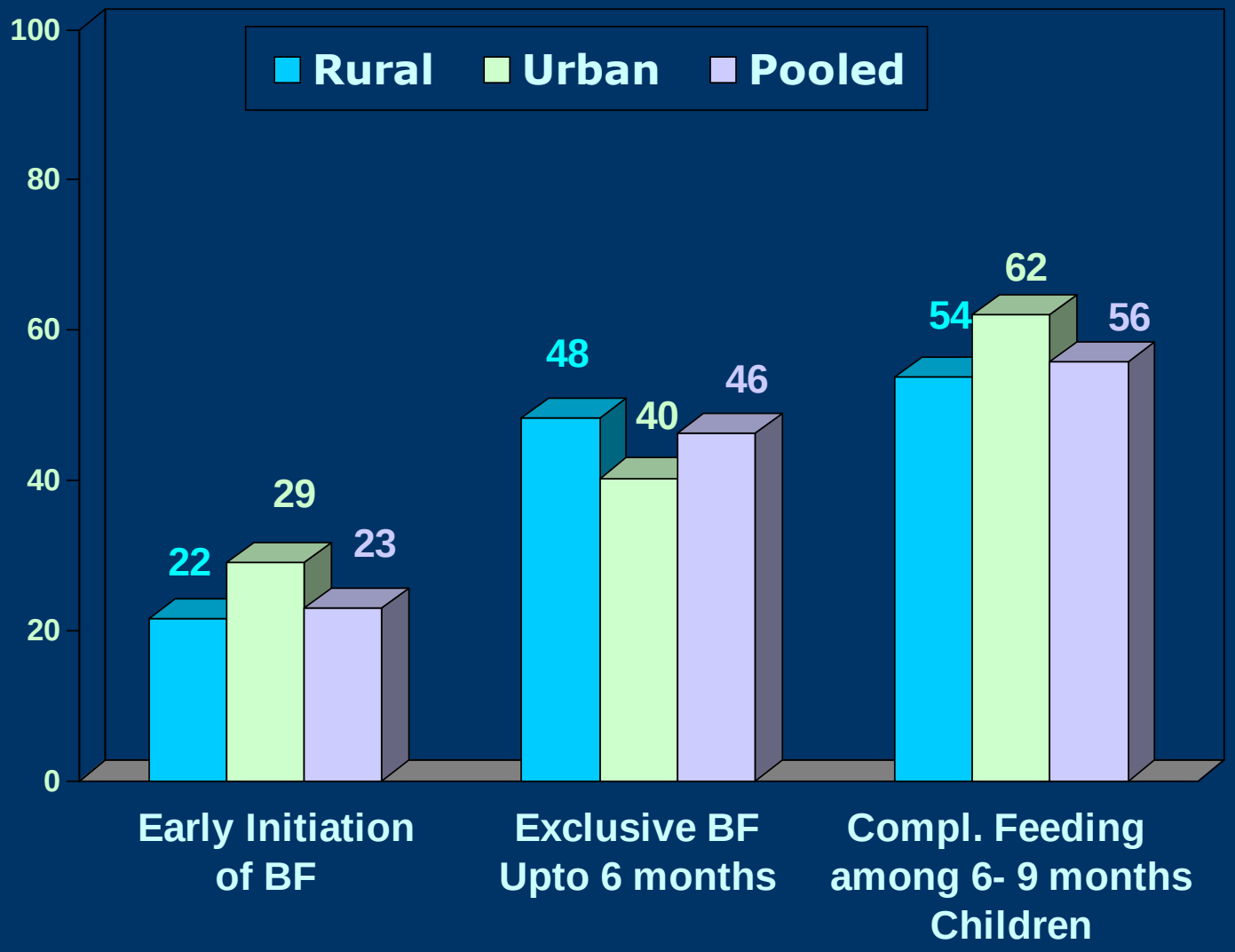
Percentage of Under weight Children by State (<6 years)



Prevalence of Undernutrition among <5 years children according to Weight for Age

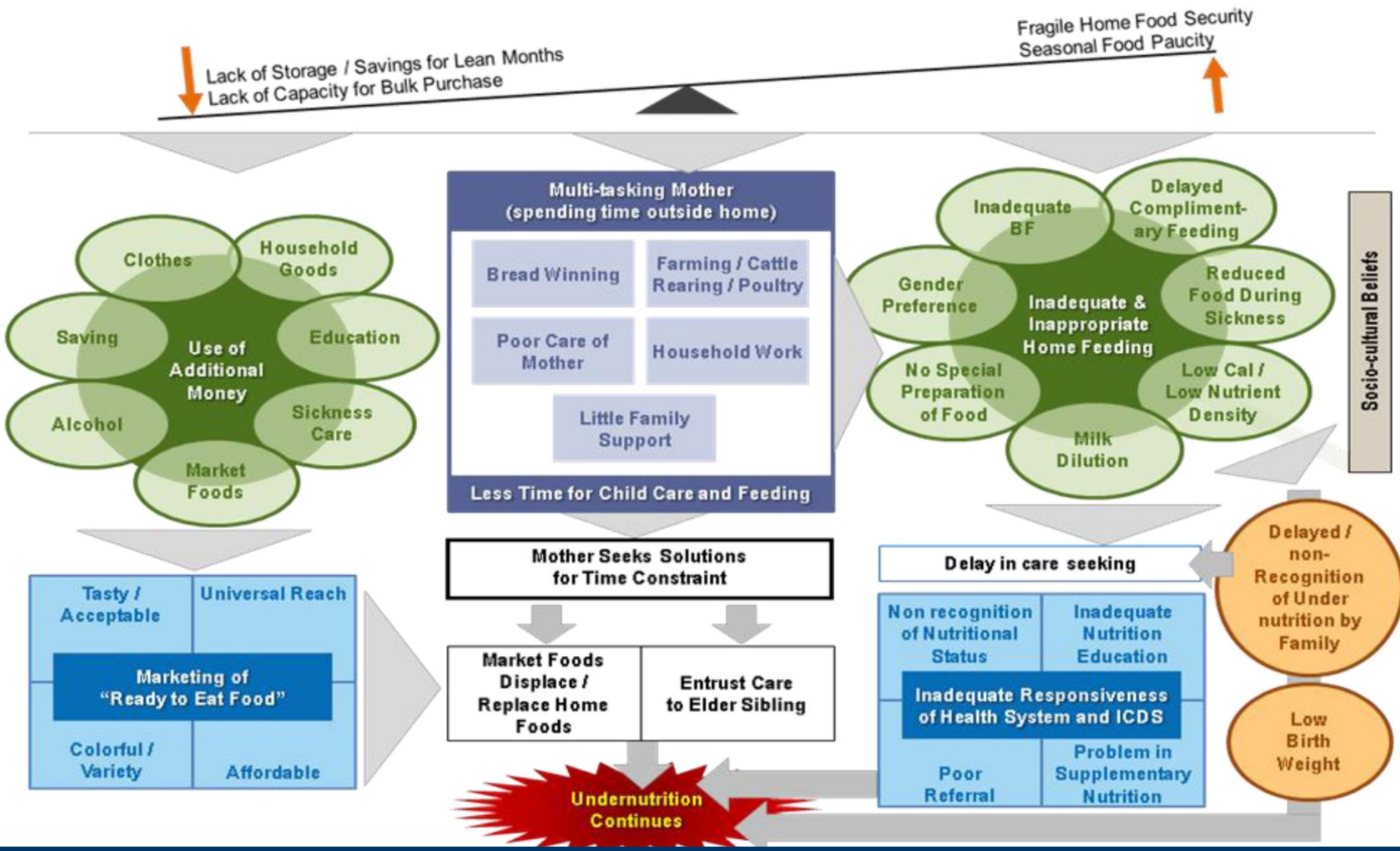


INFANT AND YOUNG CHILD FEEDING PRACTICES
(Low levels of IYCF Practices)



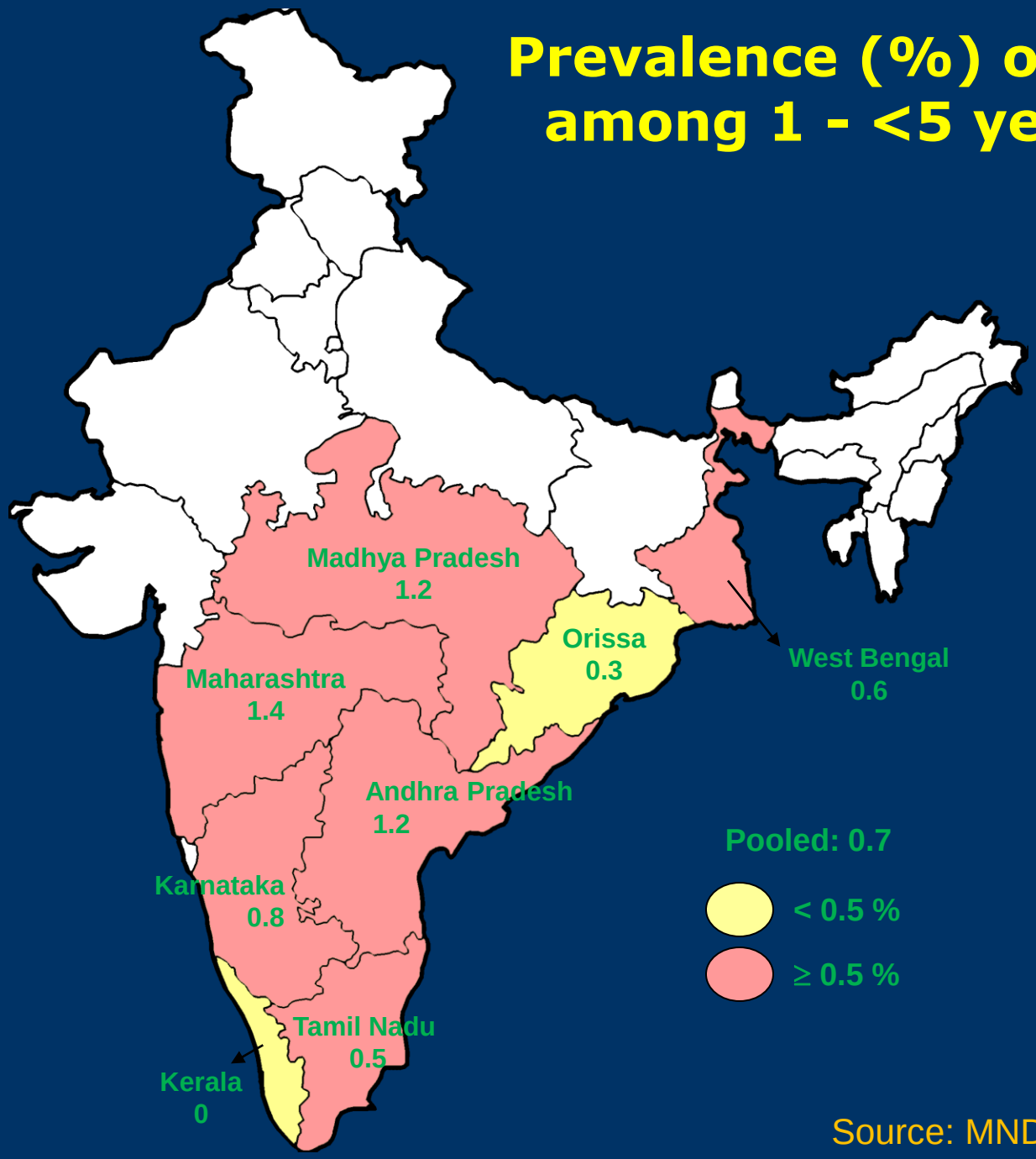
Low coverage for National nutrition programmes by the target beneficiaries

Persisting undernutrition: Social, cultural and environmental determinants



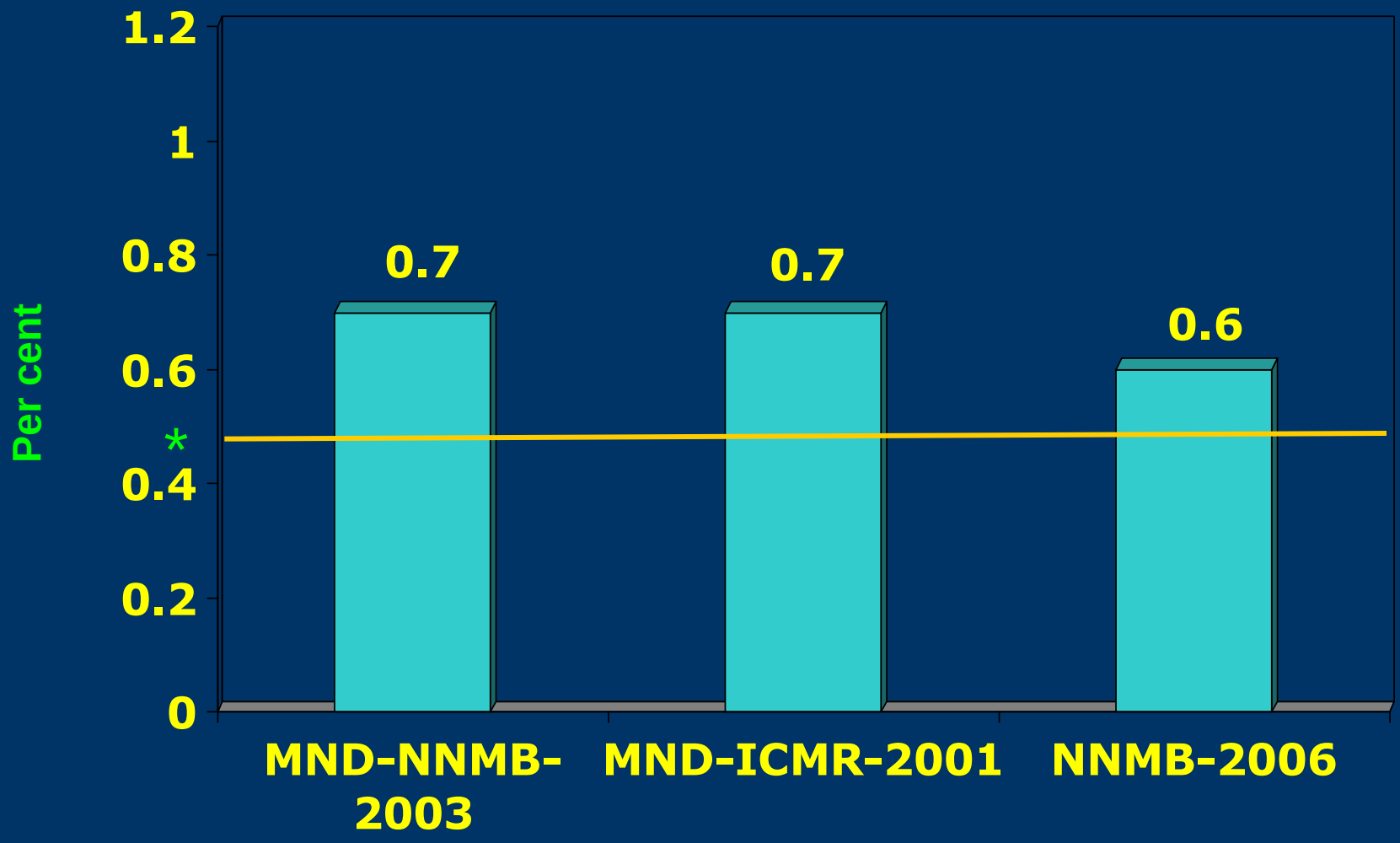
INCLEN Study

Prevalence (%) of Bitot spots among 1 - <5 year children



Source: MND-NNMB, Tech Rep 22, 2003

Prevalence (%) of Bitot Spots among 1 - <5 yrs. Children



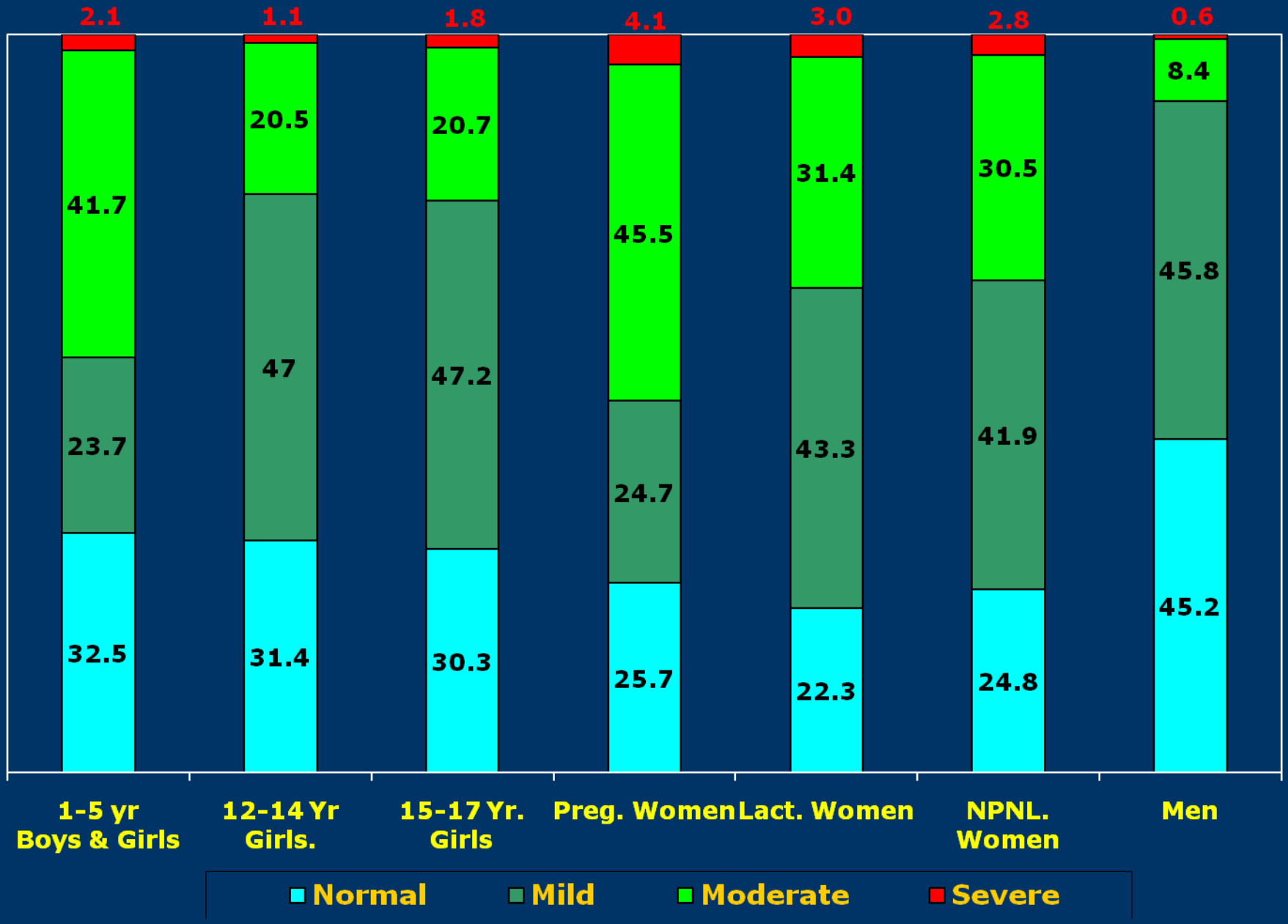
* WHO cut-off level (0.5%) of Public Health significance

Definition of Anemia

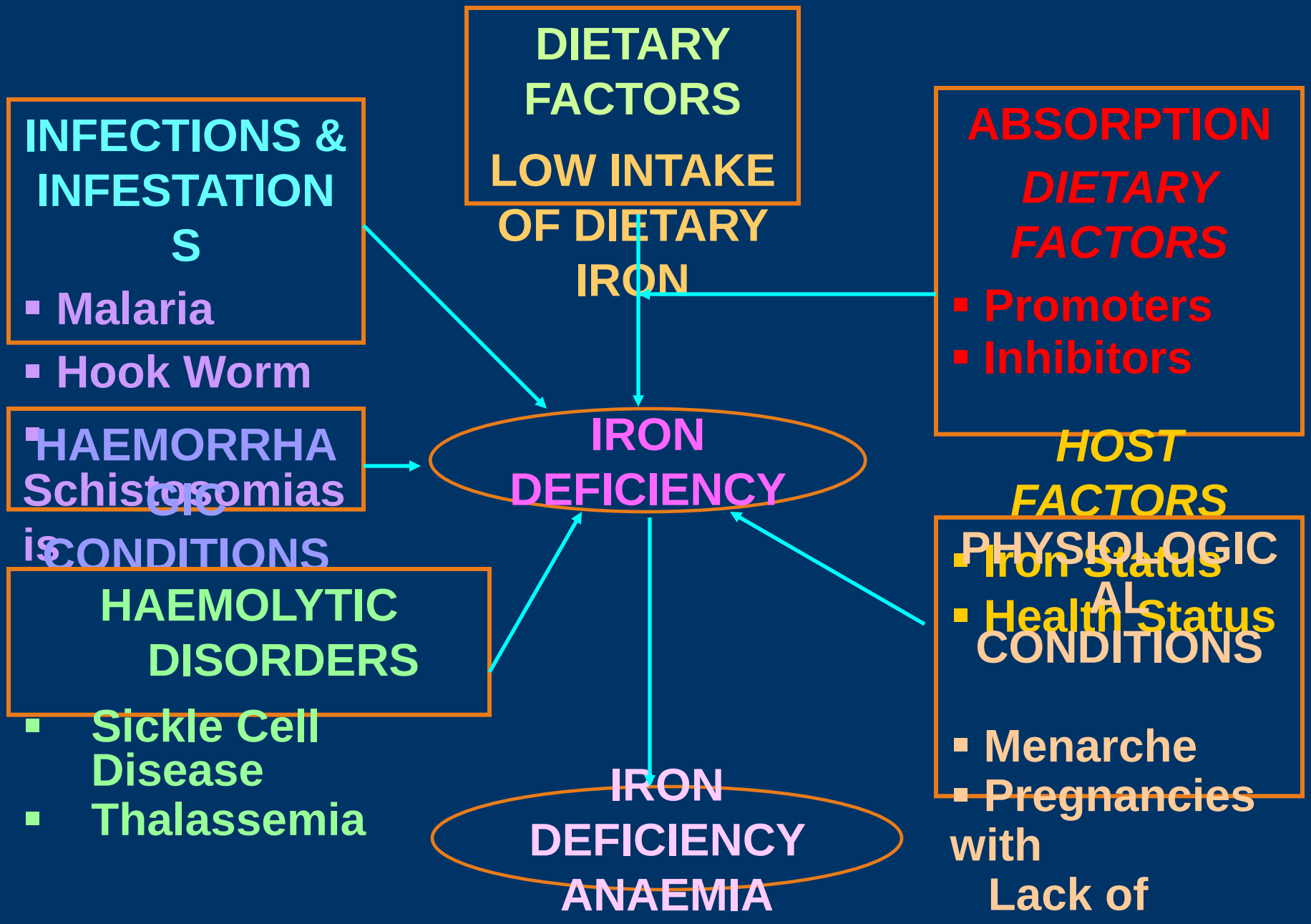
AGE / PHYSIOLOGICAL GROUP	Gender	Hb (g/dl)
6 months – 6 Years	Boys & Girls	<11
6 – 14 Years	Boys & Girls	<12
≥ 14 Years	Men	<13
	Women	<12
Pregnant Women		<11

WHO, Nutritional Anemia - TRS No. 405, Geneva 1968.

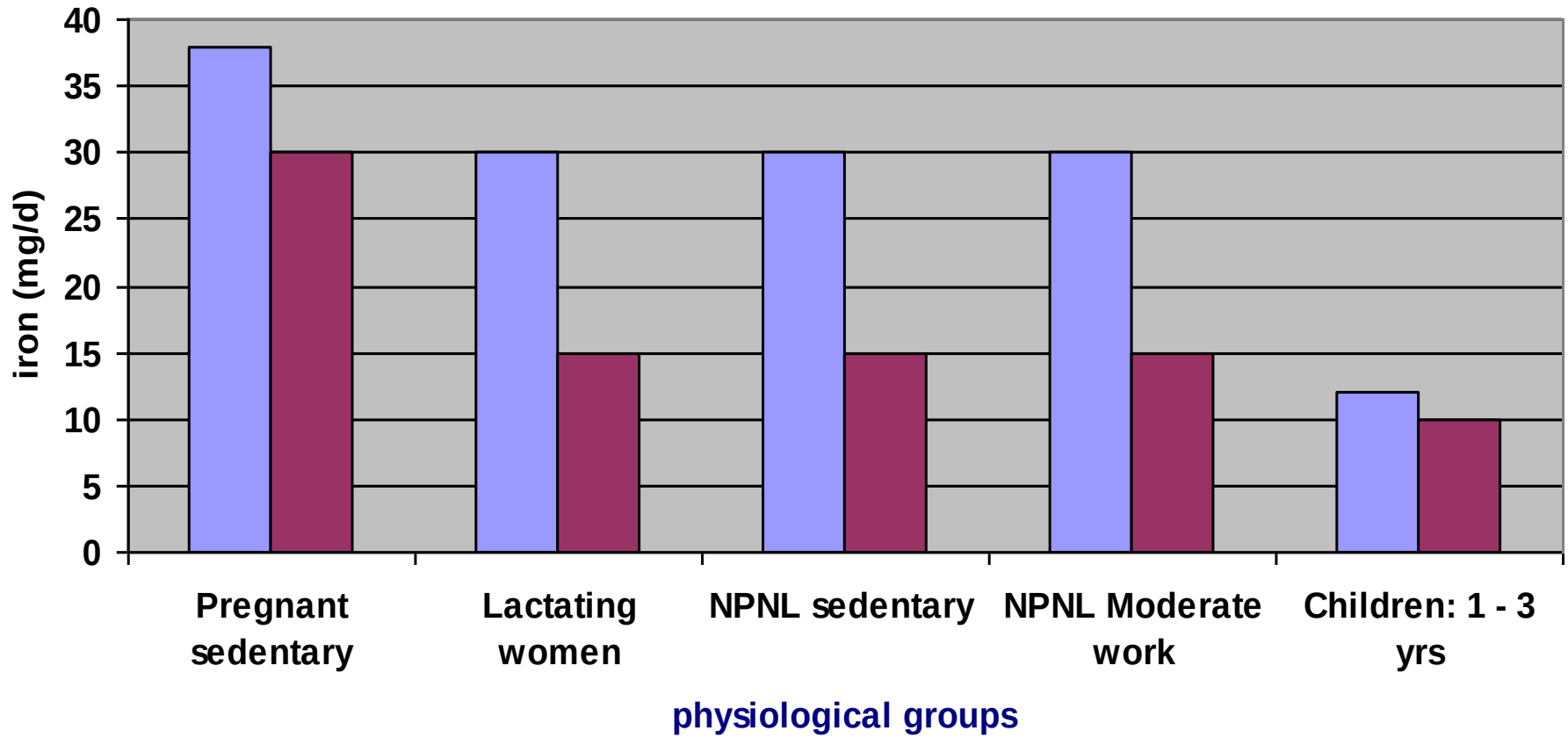
PREVALENCE (%) OF ANEMIA AMONG DIFFERENT PHYSIOLOGICAL GROUPS



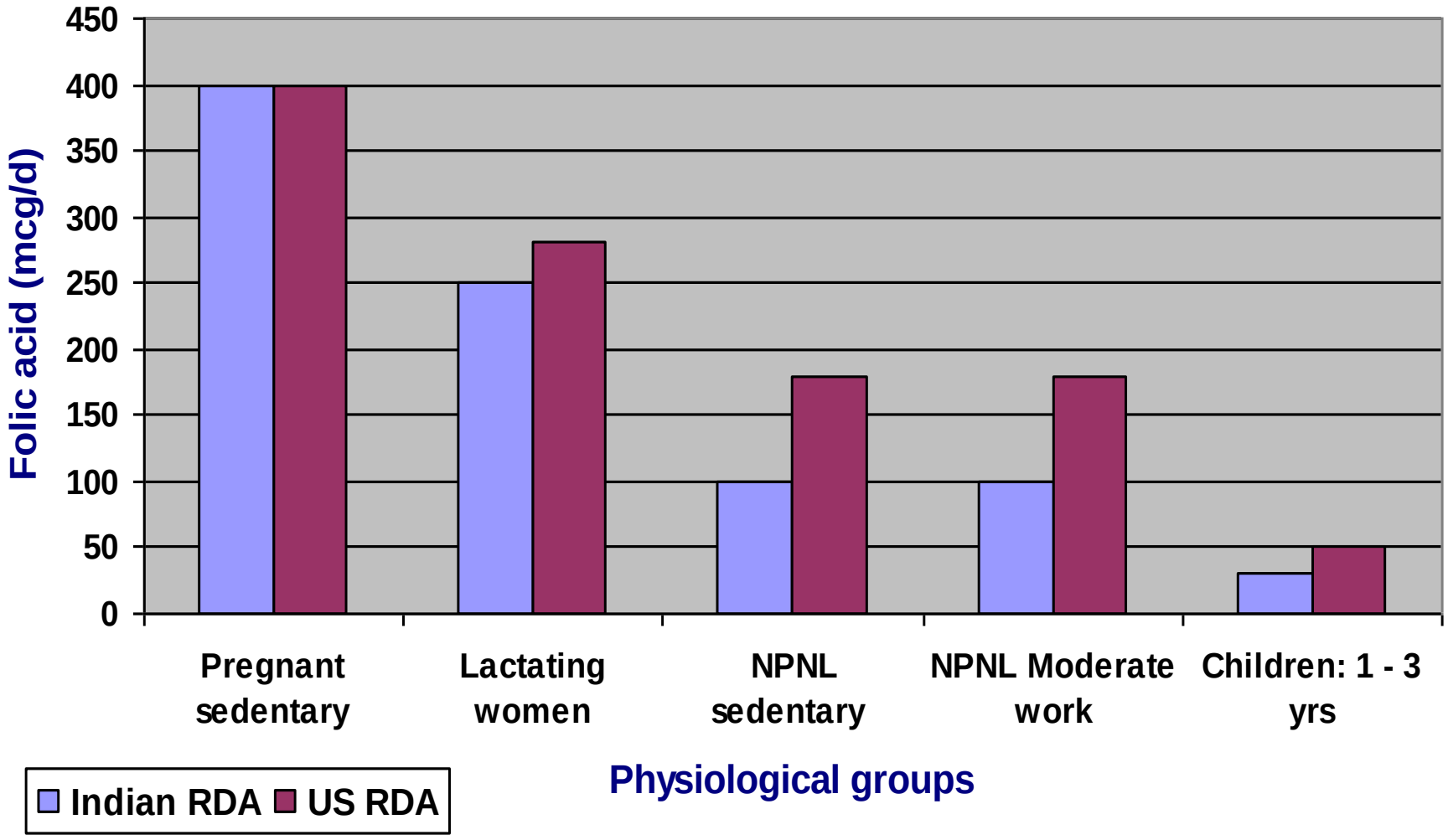
AETIOLOGY OF IDA



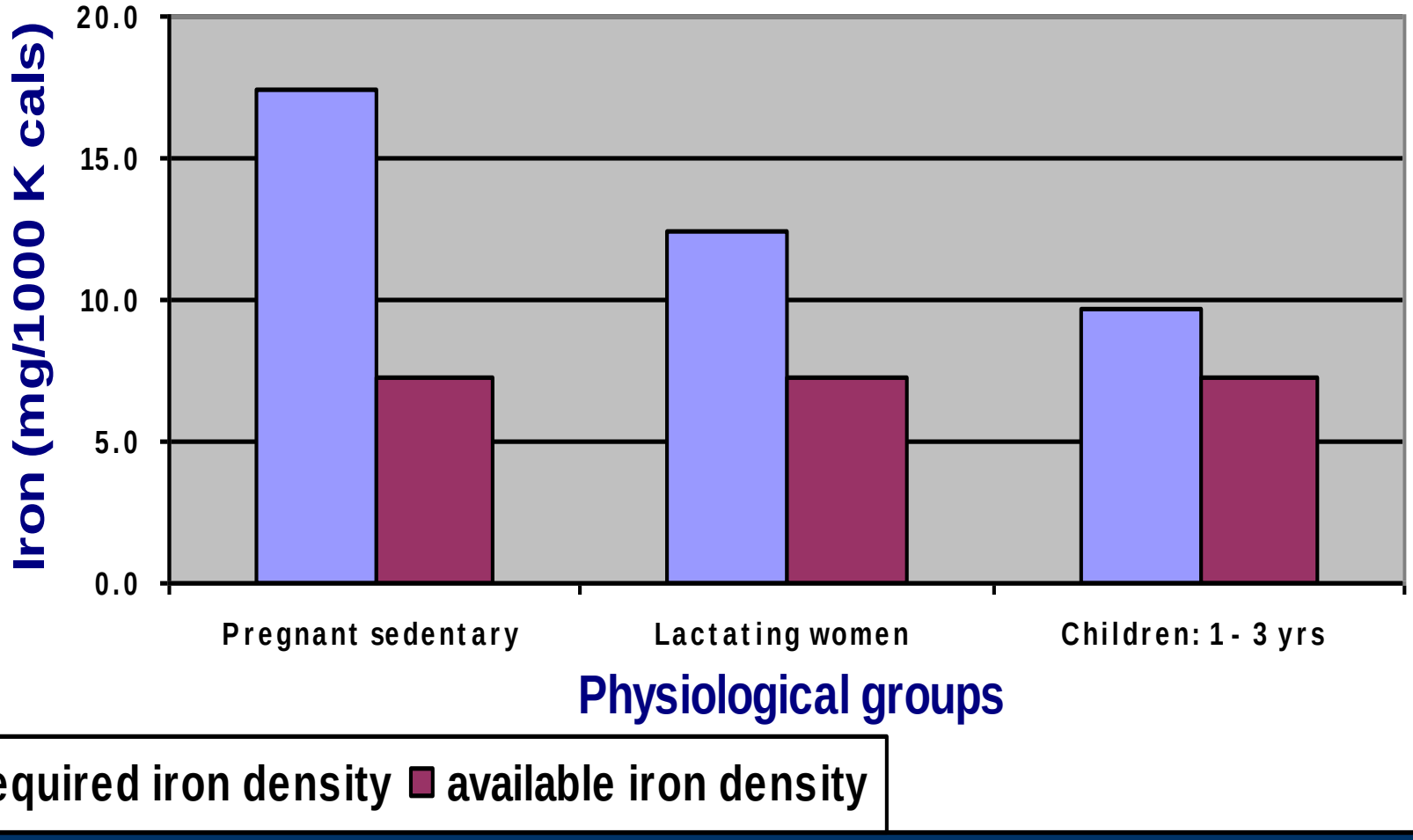
ESTABLISHMENT OF RDA FOR INDIANS



ESTABLISHMENT OF RDA FOR INDIANS

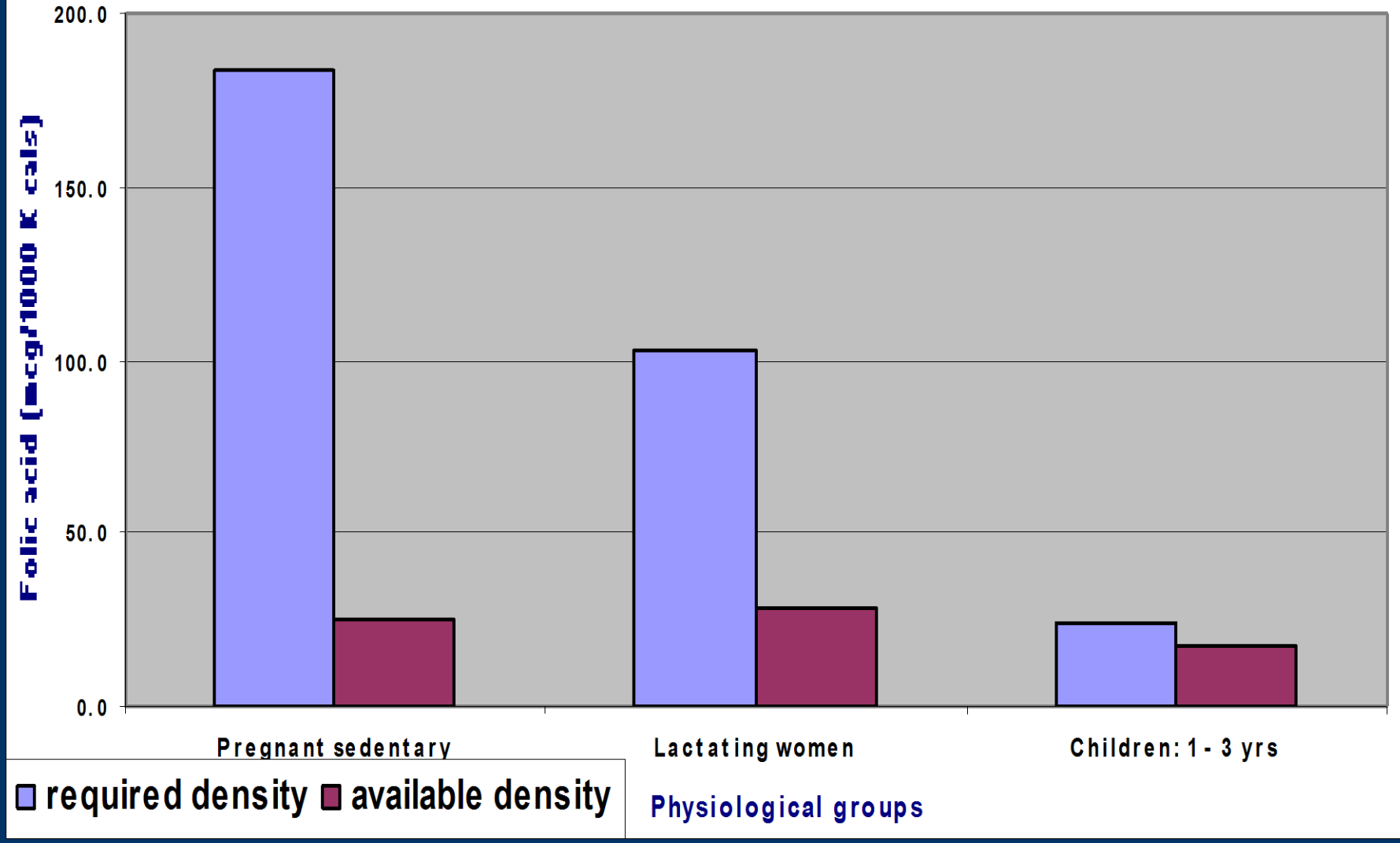


IRON DENSITY TO MEET RDA



Computed from NNMB data, rural survey, 2001

FOLIC ACID DENSITY TO MEET RDA

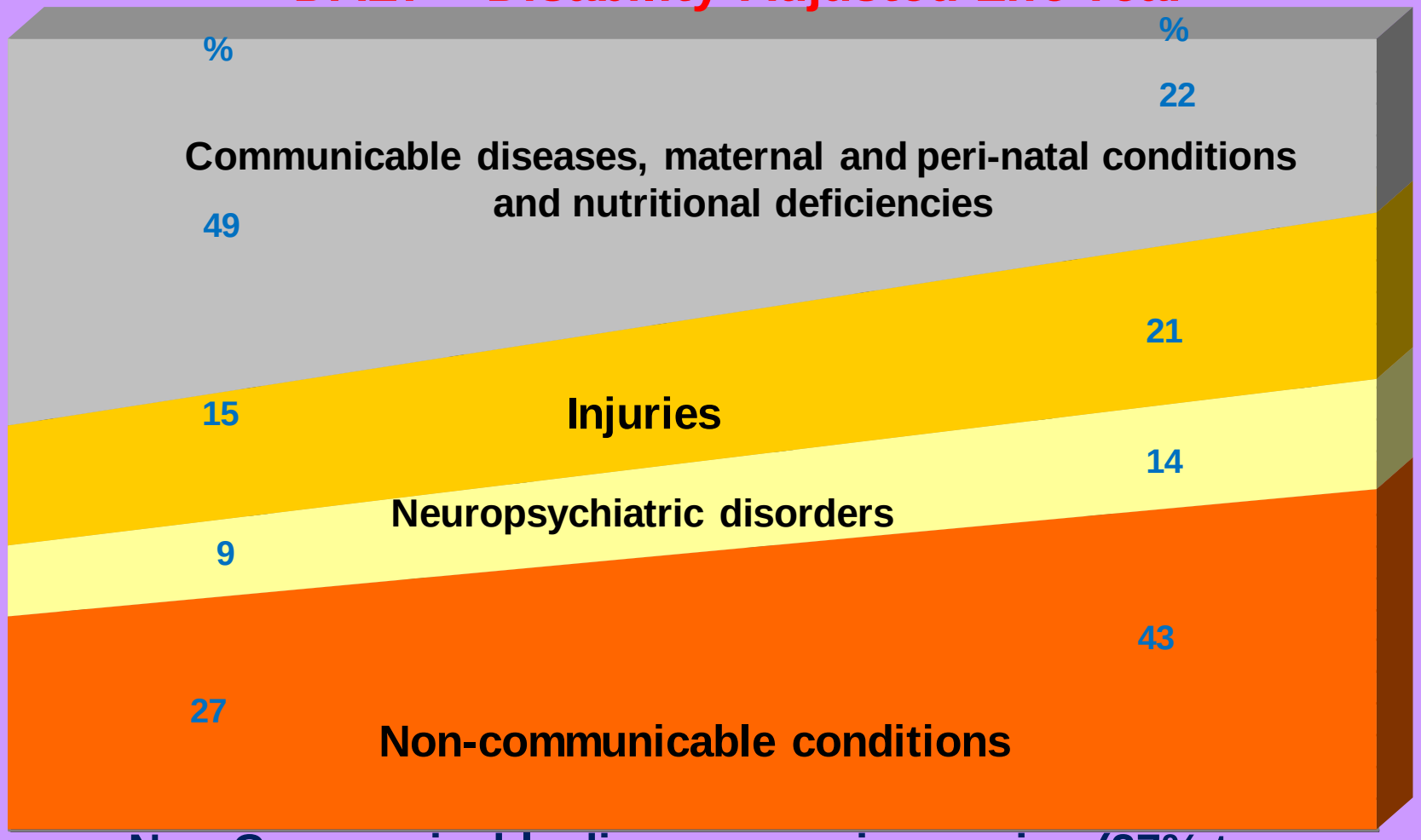


Computed from NNMB data, rural survey, 2001

OVERNUTRITION: DIET RELATED NCDs

DALYs, by broad cause group 1990 - 2020 in developing countries (baseline scenario)

DALY = Disability-Adjusted Life Year



1990

Non-Communicable diseases are increasing (27% to 43%) while communicable diseases are decreasing (49% to 22%)

2020

Determinants → Risk Factors → NCD disease outcomes

Socio-economic determinants

Common Risk Factors

Modifiable

- Unhealthy diet
  - Obesity,
  - Dyslipidemia
- Physical inactivity
- Tobacco/alcohol consumption

Non-modifiable

- Age
- Gende
- Genetic

Promotion

Intermediate Risk Factors

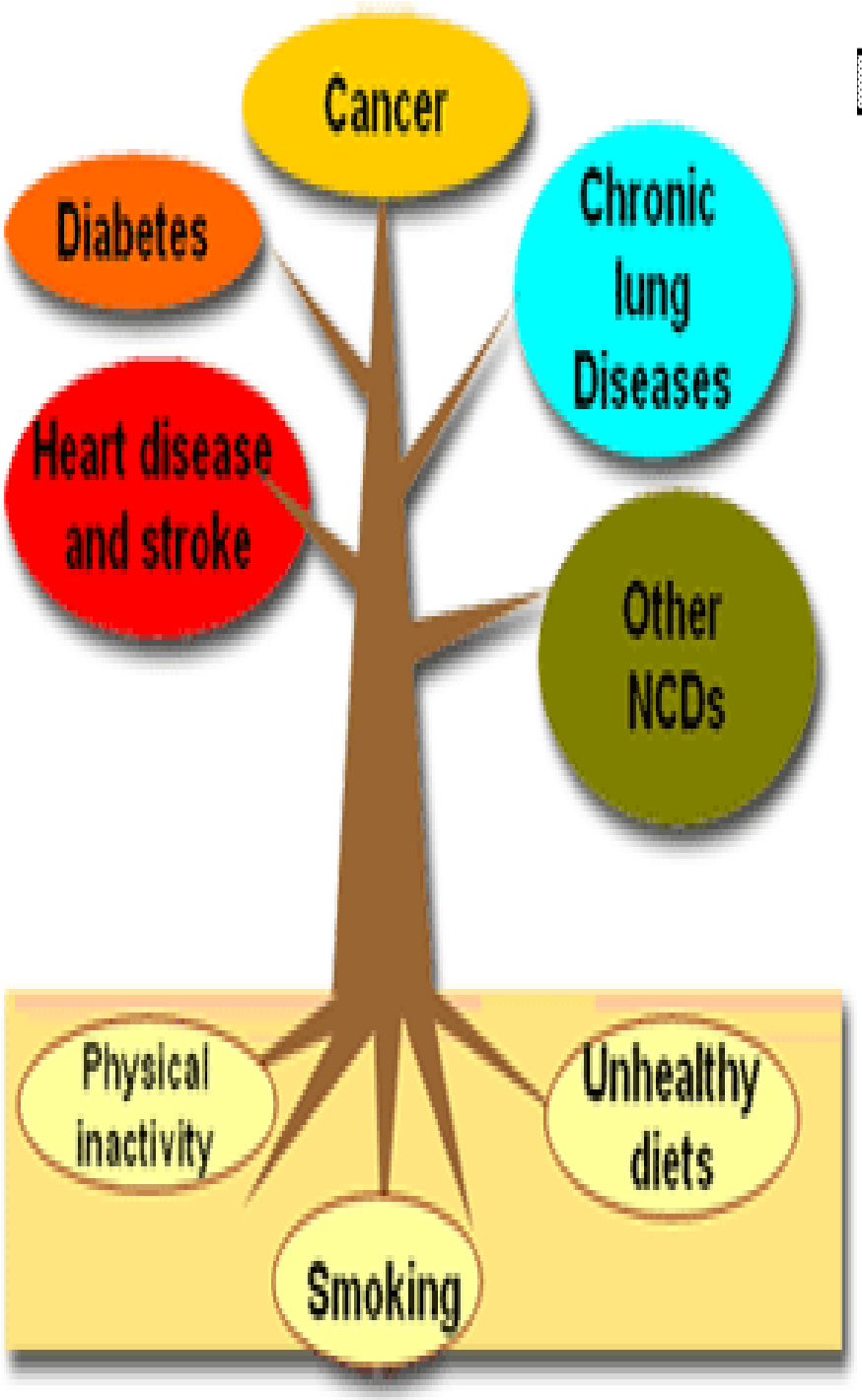
- High lipids
- High Bld Pressure
- High Bld Gluco
- Overweight/Obesity

Prevention

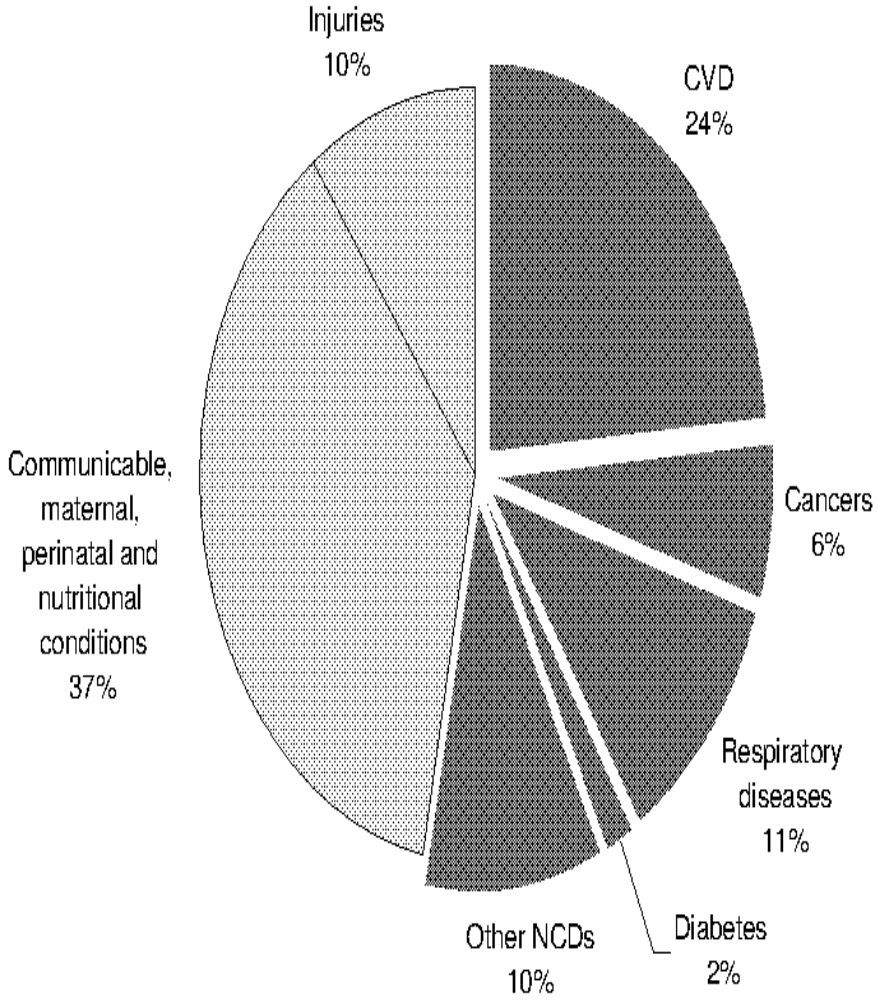
NCD disease outcomes

- CVD/Stroke
- Diabetes
- Chronic Resp. Dis.
- Canc rs

Early Treatment

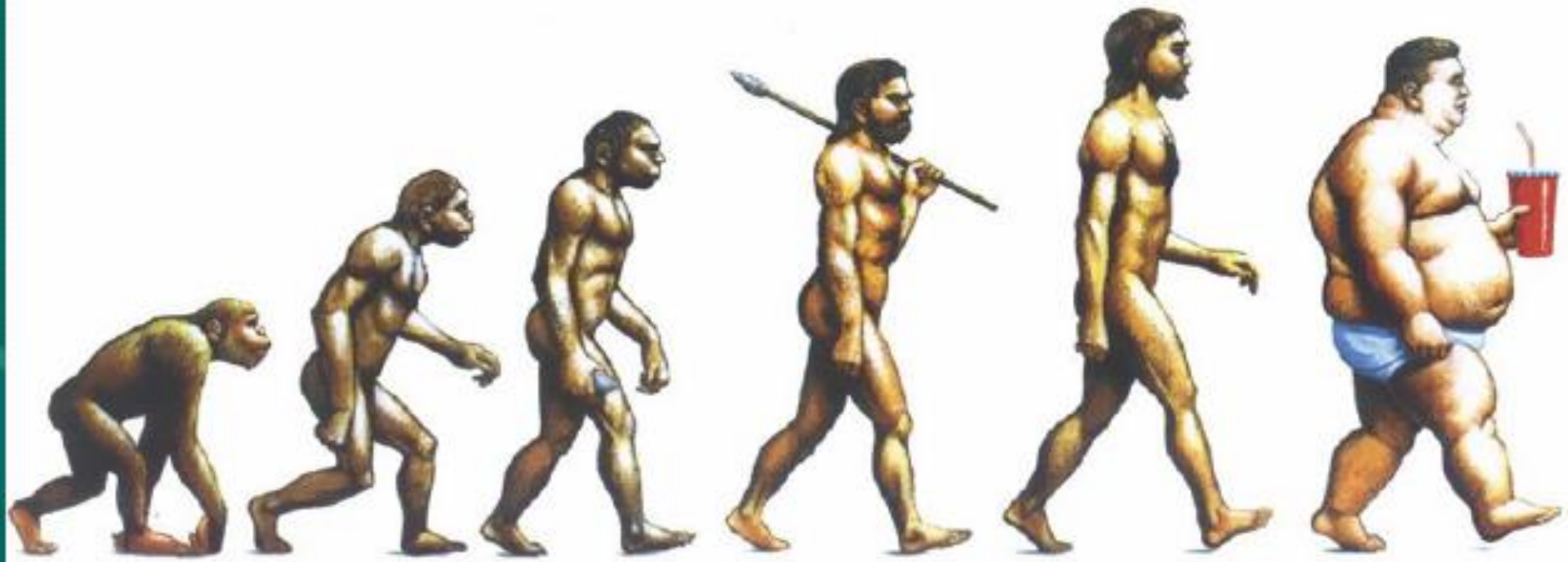


Proportional mortality (% of total deaths, all ages)



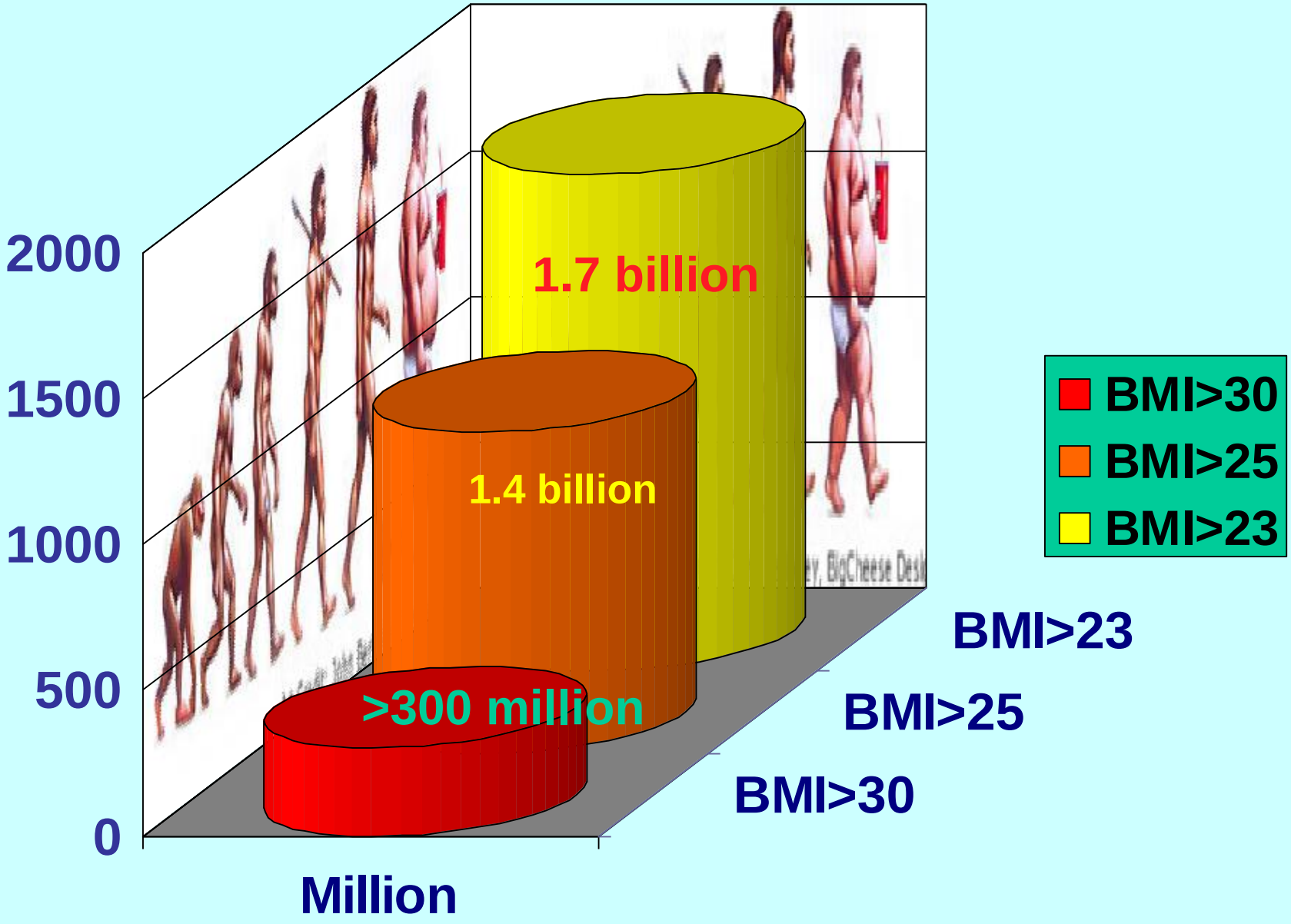
NCDs are estimated to account for 53% of all deaths.

The shape of things to come

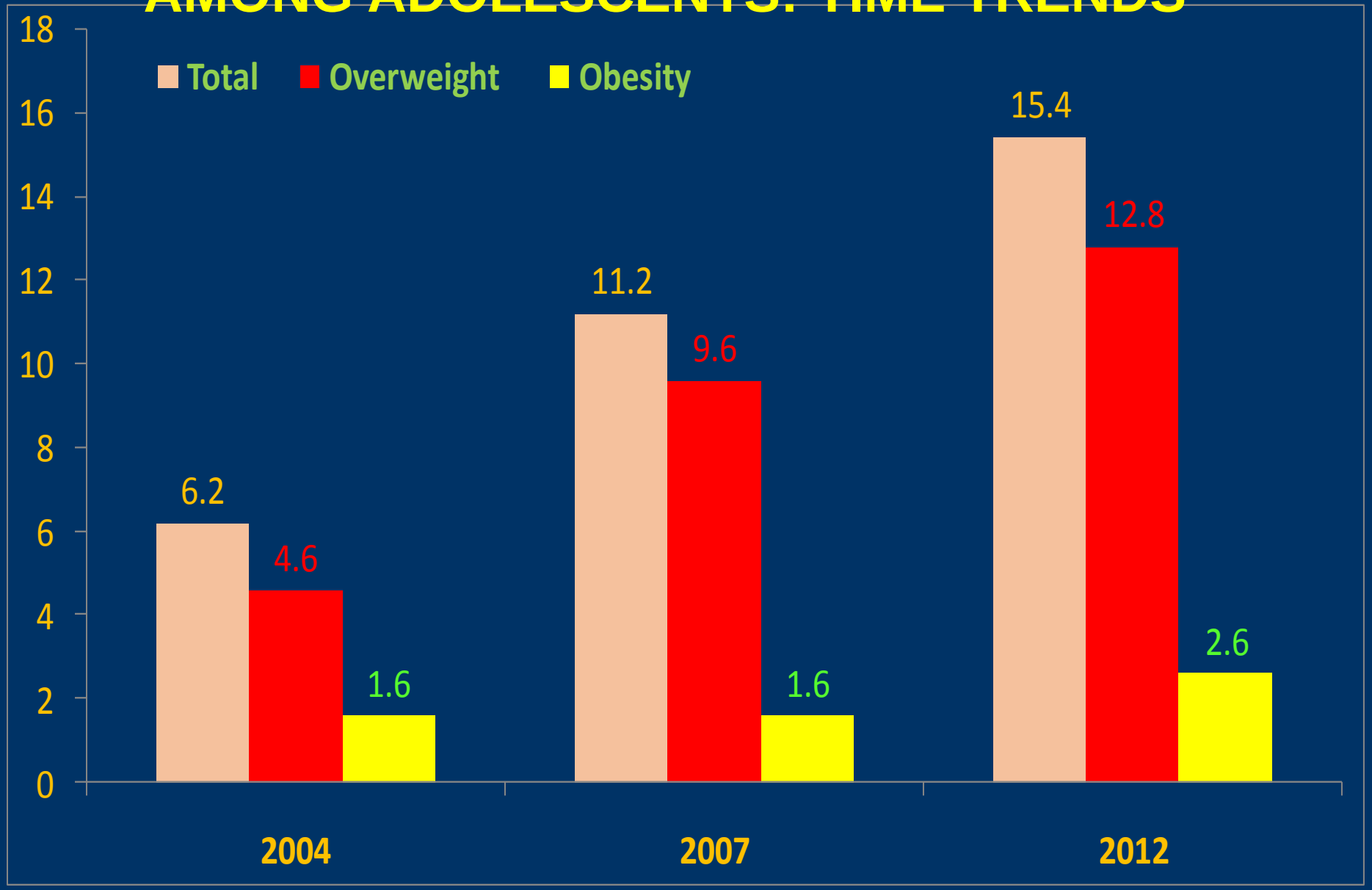


The cover of "The Economist", Dec. 13-19, 2003.

ADULT OBESITY: GLOBAL EPIDEMIC

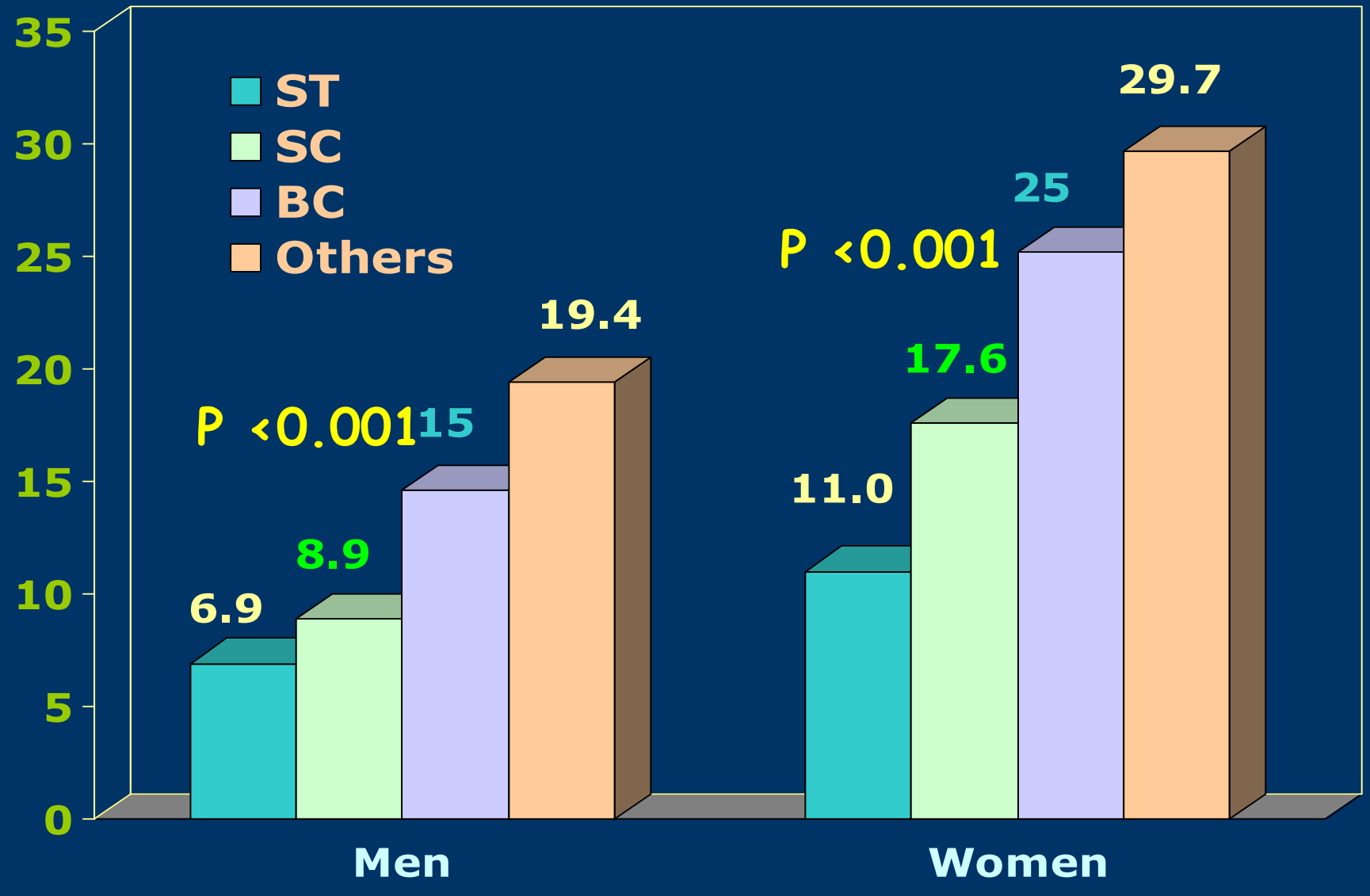


PREVALENCE OF OVERWEIGHT AND OBESITY AMONG ADOLESCENTS: TIME TRENDS

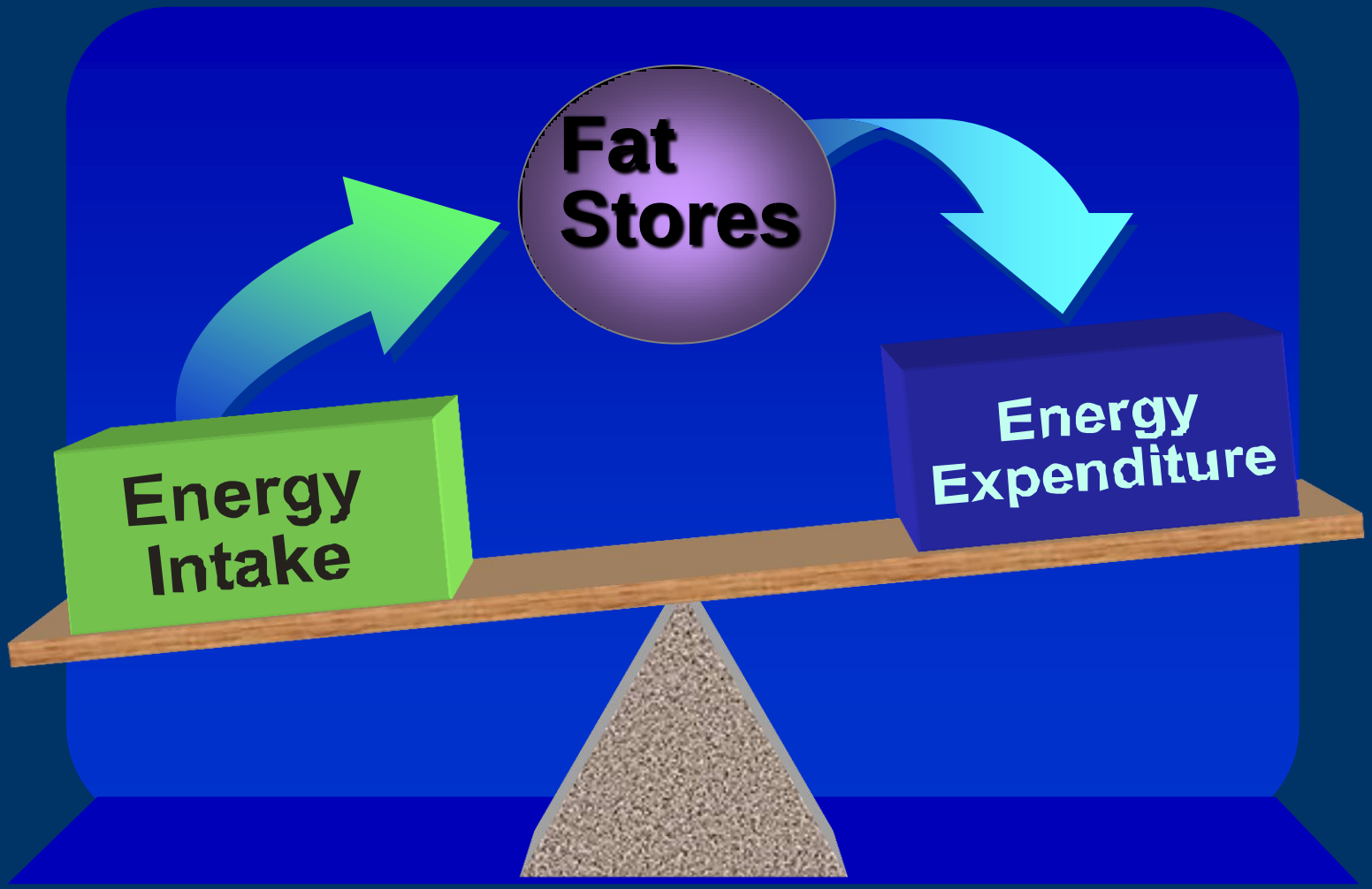


Laxmaiah et al. 2014

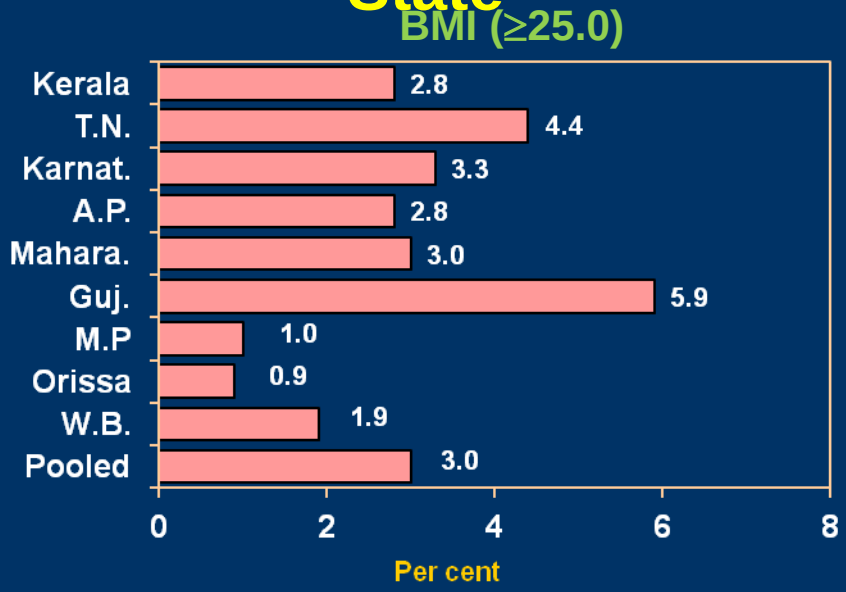
Prevalence (%) of Abdominal obesity among Adults by Community: NNMB Technical Repeat 26 (2012): 10 States (m=22,066; w=27,235)

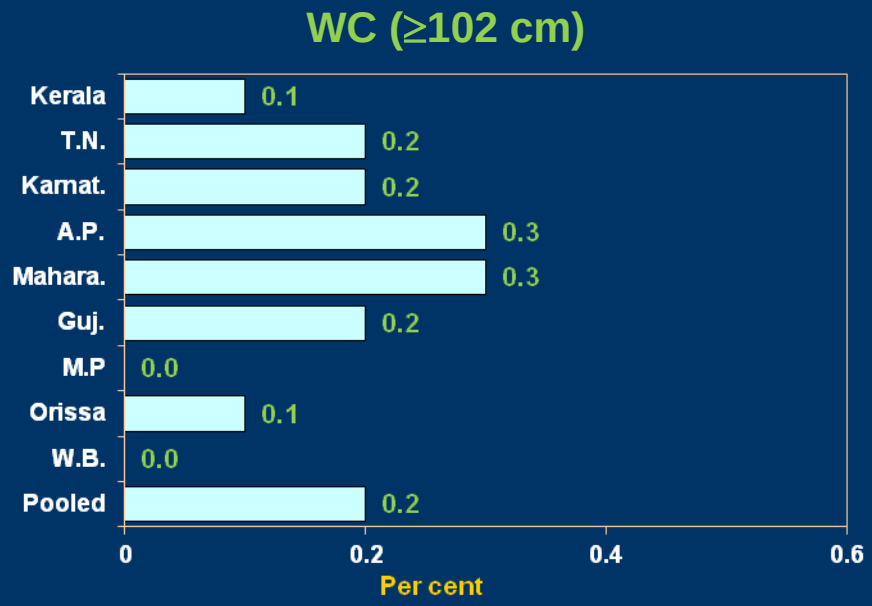


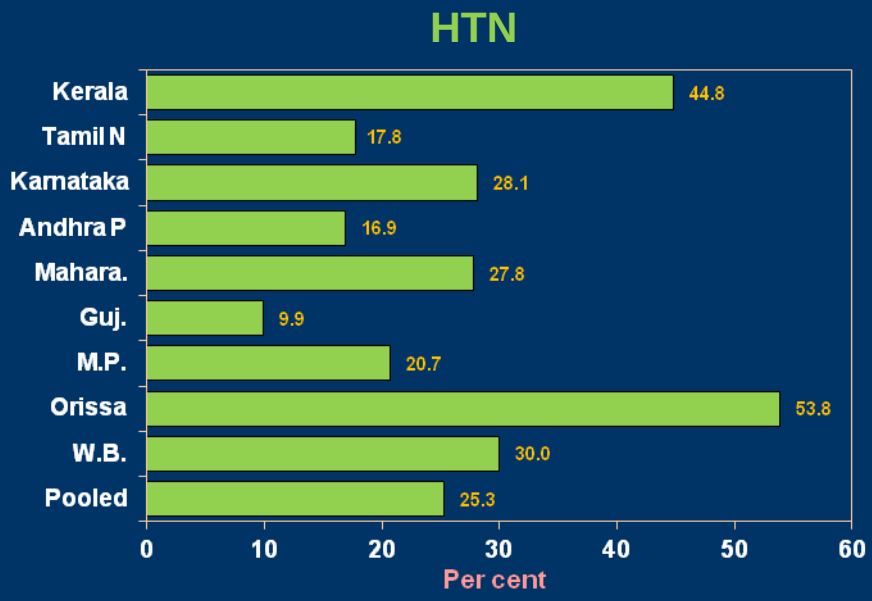
Obesity Is Caused by Long-Term Positive Energy Balance



Prevalence (%) of Obesity according to BMI/WC and HTN among Adult men – By State



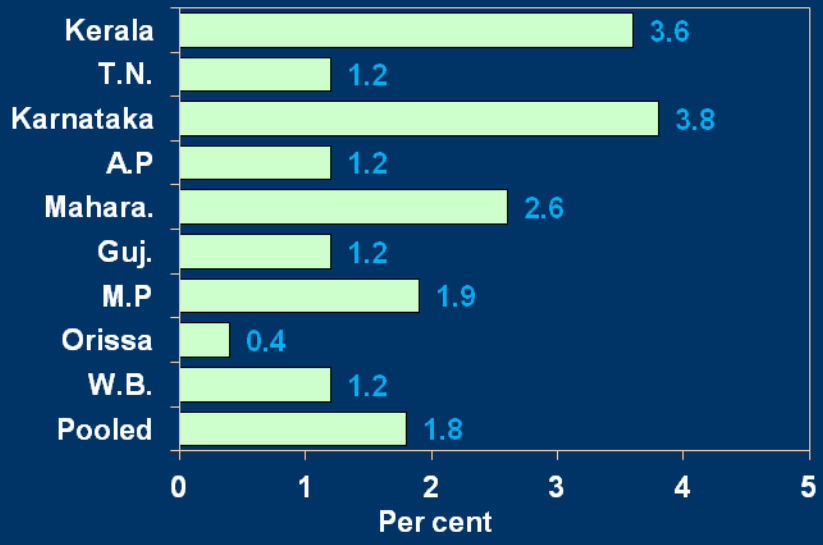




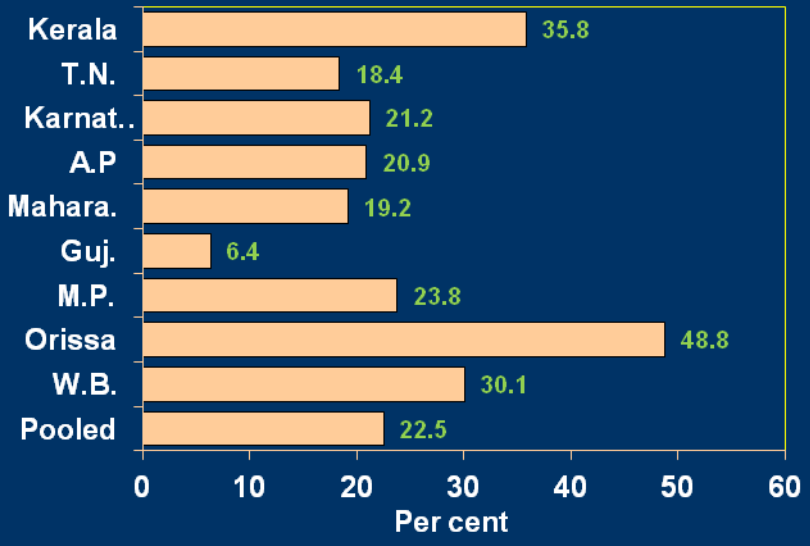
Prevalence (%) of Obesity according to BMI/WC and HTN among Adult women – By State

BMI (≥25.0)

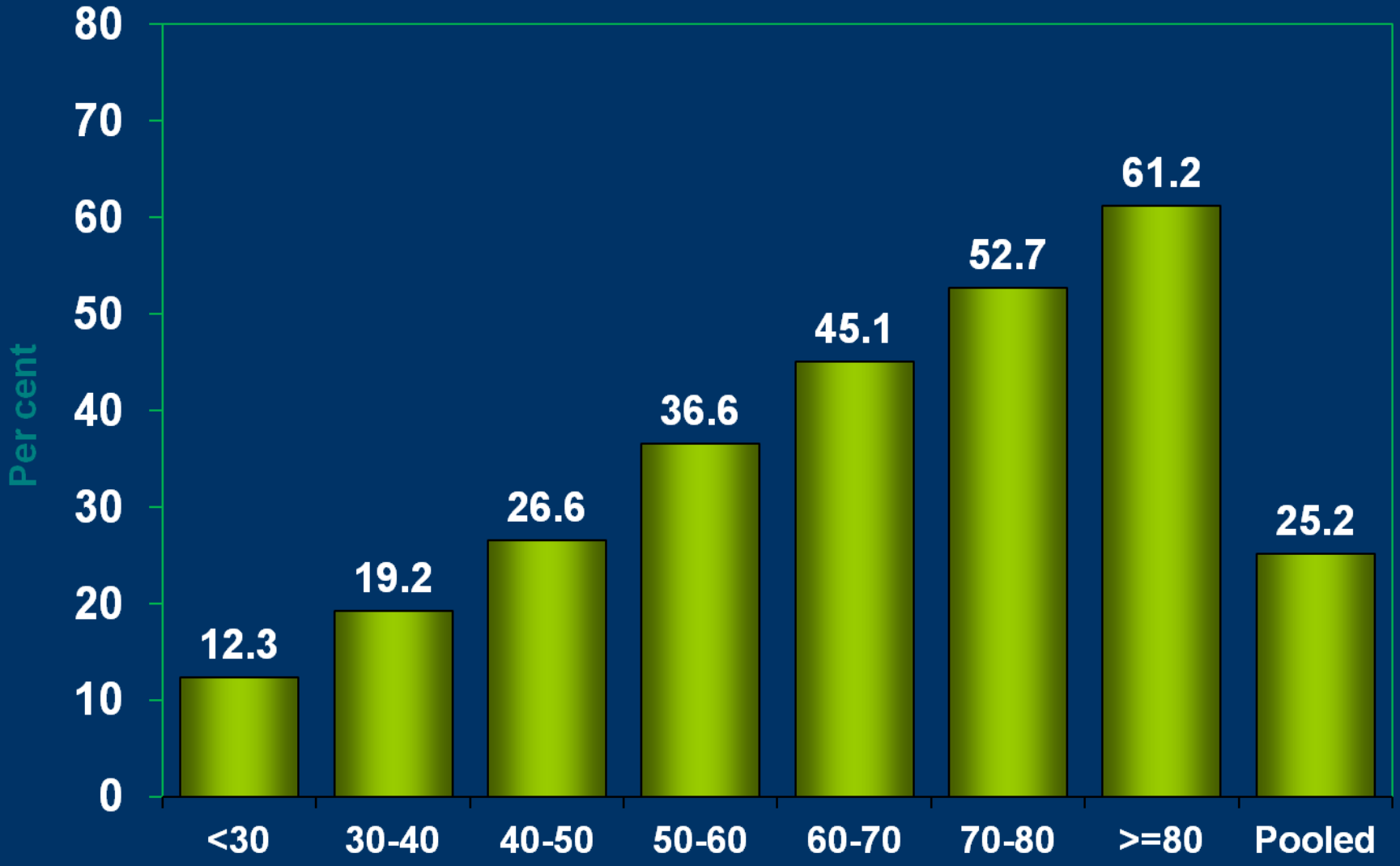
WC (≥88 cm)



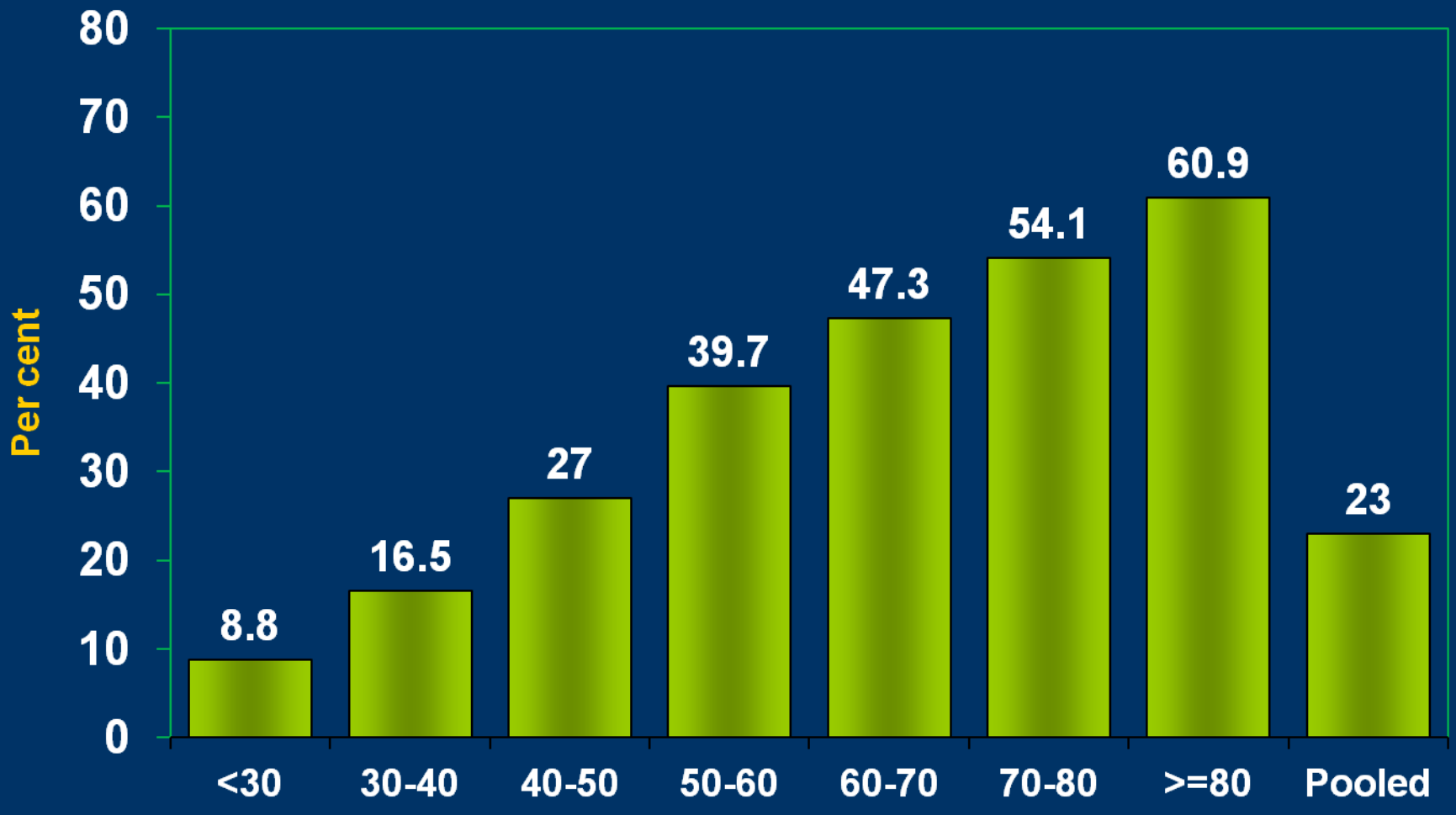
HTN



Prevalence (%) of hypertension among Adult men By Age group



Prevalence (%) of hypertension among Adult Women By Age group



Association of Hypertension with Obesity and personal habits

Variables		Men	χ^2	Women	χ^2
BMI (kg/m^2)	<23	24.4	P<0.001	21.7	P<0.001
	>23	35.4		36.2	
Salt intake (g)	<5	23.1	NS	20.2	NS
	≥5	24.1		21.1	
Activity	Sed	39.1	P<0.001	31.1	P<0.001
	Mod & heavy	23.8		19.8	
Consume Tobacco	Yes	28.3	P<0.001	31.1	P<0.001
	No	19.2		18.7	
Consume alcohol	Yes	28.4	P<0.001	35.8	P<0.001
	No	21.3		20.8	

Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

Summary

Background Underweight and severe and morbid obesity are associated with highly elevated risks of adverse health outcomes. We estimated trends in mean body-mass index (BMI), which characterises its population distribution, and in the prevalences of a complete set of BMI categories for adults in all countries.

Methods We analysed, with use of a consistent protocol, population-based studies that had measured height and weight in adults aged 18 years and older. We applied a Bayesian hierarchical model to these data to estimate trends from 1975 to 2014 in mean BMI and in the prevalences of BMI categories (<18·5 kg/m² [underweight], 18·5 kg/m² to <20 kg/m², 20 kg/m² to <25 kg/m², 25 kg/m² to <30 kg/m², 30 kg/m² to <35 kg/m², 35 kg/m² to <40 kg/m², ≥40 kg/m² [morbid obesity]), by sex in 200 countries and territories, organised in 21 regions. We calculated the posterior probability of meeting the target of halting by 2025 the rise in obesity at its 2010 levels, if post-2000 trends continue.

Findings We used 1698 population-based data sources, with more than 19·2 million adult participants (9·9 million men and 9·3 million women) in 186 of 200 countries for which estimates were made. Global age-standardised mean BMI increased from 21·7 kg/m² (95% credible interval 21·3–22·1) in 1975 to 24·2 kg/m² (24·0–24·4) in 2014 in men, and from 22·1 kg/m² (21·7–22·5) in 1975 to 24·4 kg/m² (24·2–24·6) in 2014 in women. Regional mean BMIs in 2014 for men ranged from 21·4 kg/m² in central Africa and south Asia to 29·2 kg/m² (28·6–29·8) in Polynesia and Micronesia; for women the range was from 21·8 kg/m² (21·4–22·3) in south Asia to 32·2 kg/m² (31·5–32·8) in Polynesia and Micronesia. Over these four decades, age-standardised global prevalence of underweight decreased from 13·8% (10·5–17·4) to 8·8% (7·4–10·3) in men and from 14·6% (11·6–17·9) to 9·7% (8·3–11·1) in women. South Asia had the highest prevalence of underweight in 2014, 23·4% (17·8–29·2) in men and 24·0% (18·9–29·3) in women. Age-standardised prevalence of obesity increased from 3·2% (2·4–4·1) in 1975 to 10·8% (9·7–12·0) in 2014 in men, and from 6·4% (5·1–7·8) to 14·9% (13·6–16·1) in women. 2·3% (2·0–2·7) of the world's men and 5·0% (4·4–5·6) of women were severely obese (ie, have BMI ≥35 kg/m²). Globally, prevalence of morbid obesity was 0·64% (0·46–0·86) in men and 1·6% (1·3–1·9) in women.

Lancet 2016; 387: 1377–96

See Comment page 1349

*NCD Risk Factor Collaboration members are listed at the end of the paper

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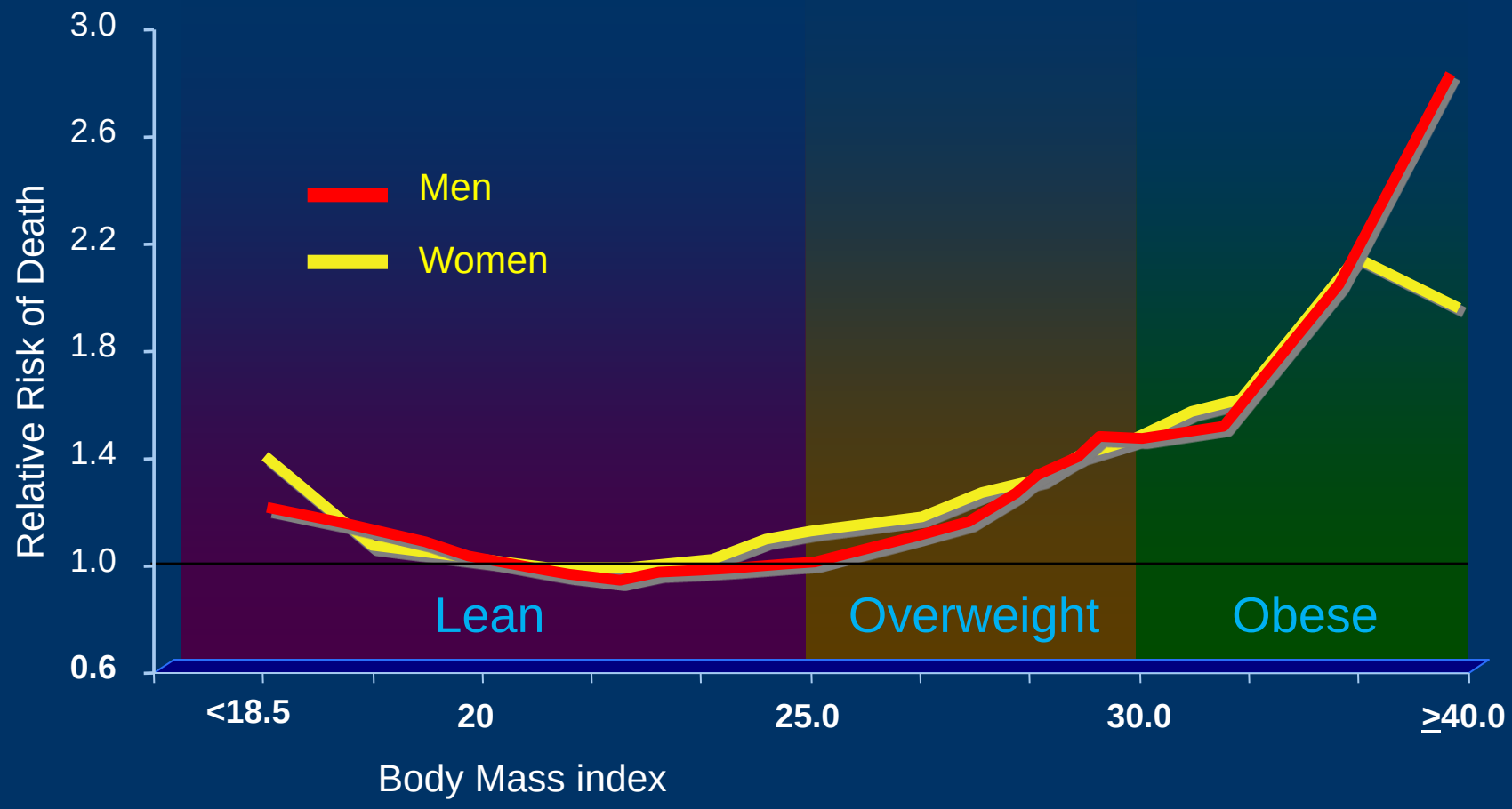
3.2% in 1975 to 10.8% in 2014 in men

In case of women, it increased from 6.4% to 14.9%

Consequences of 0verweight/obesity

- Diabetes
- Stroke
- Heart Disease / Hypertension
- Gall Bladder Disease
- Osteoarthritis
- Sleep Apnoea
- Cancers
  - Breast/Colon

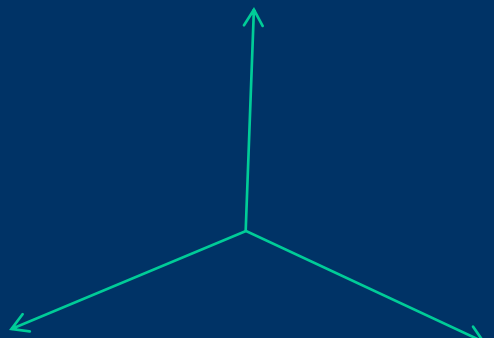
Relationship Between BMI and Cardiovascular Disease Mortality



Source: Calle et al. *N Engl J Med* 1999;341:1097.

Lifestyle modification

Diet



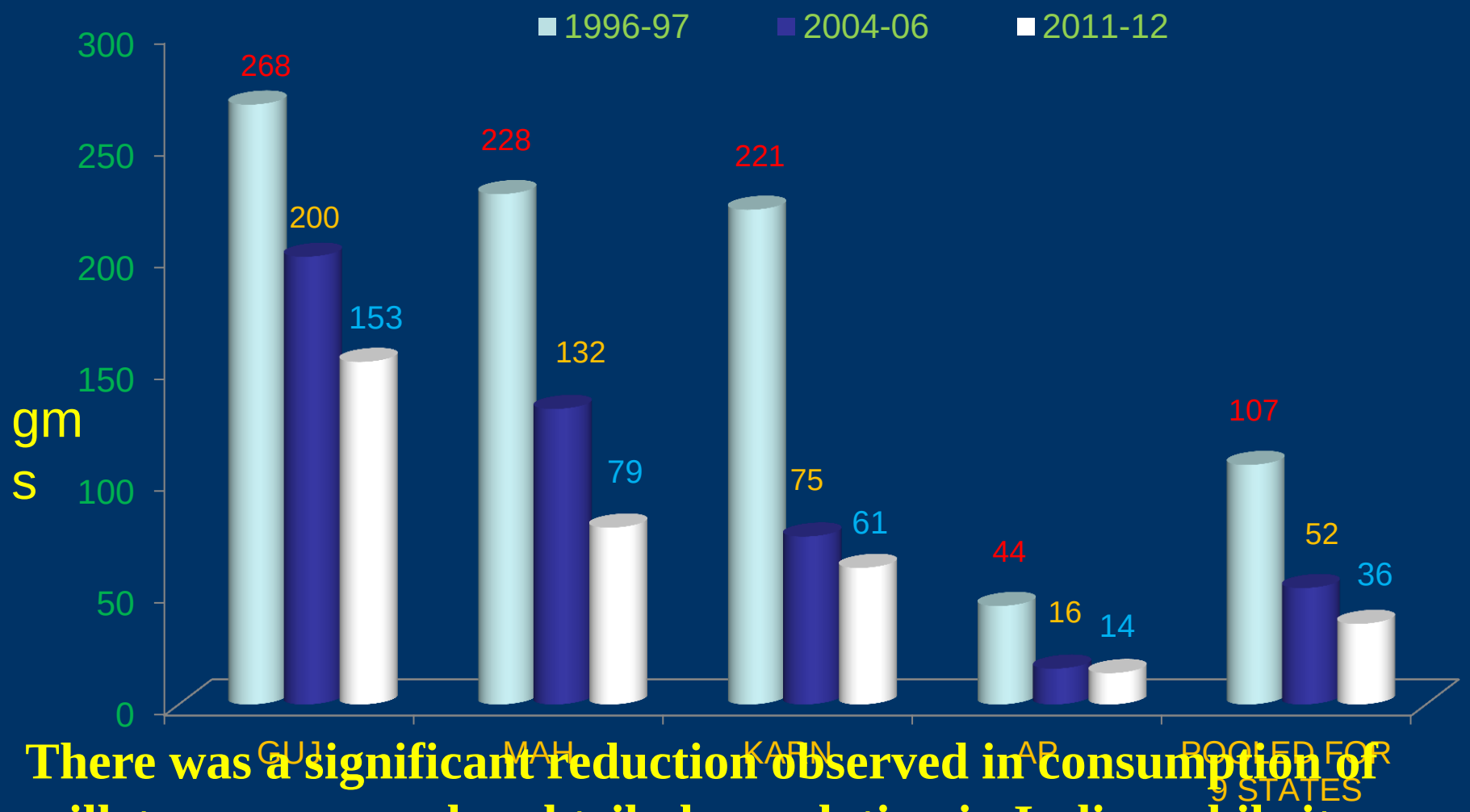
Physical activity

Behaviour therapy

Factors affecting Lifestyles

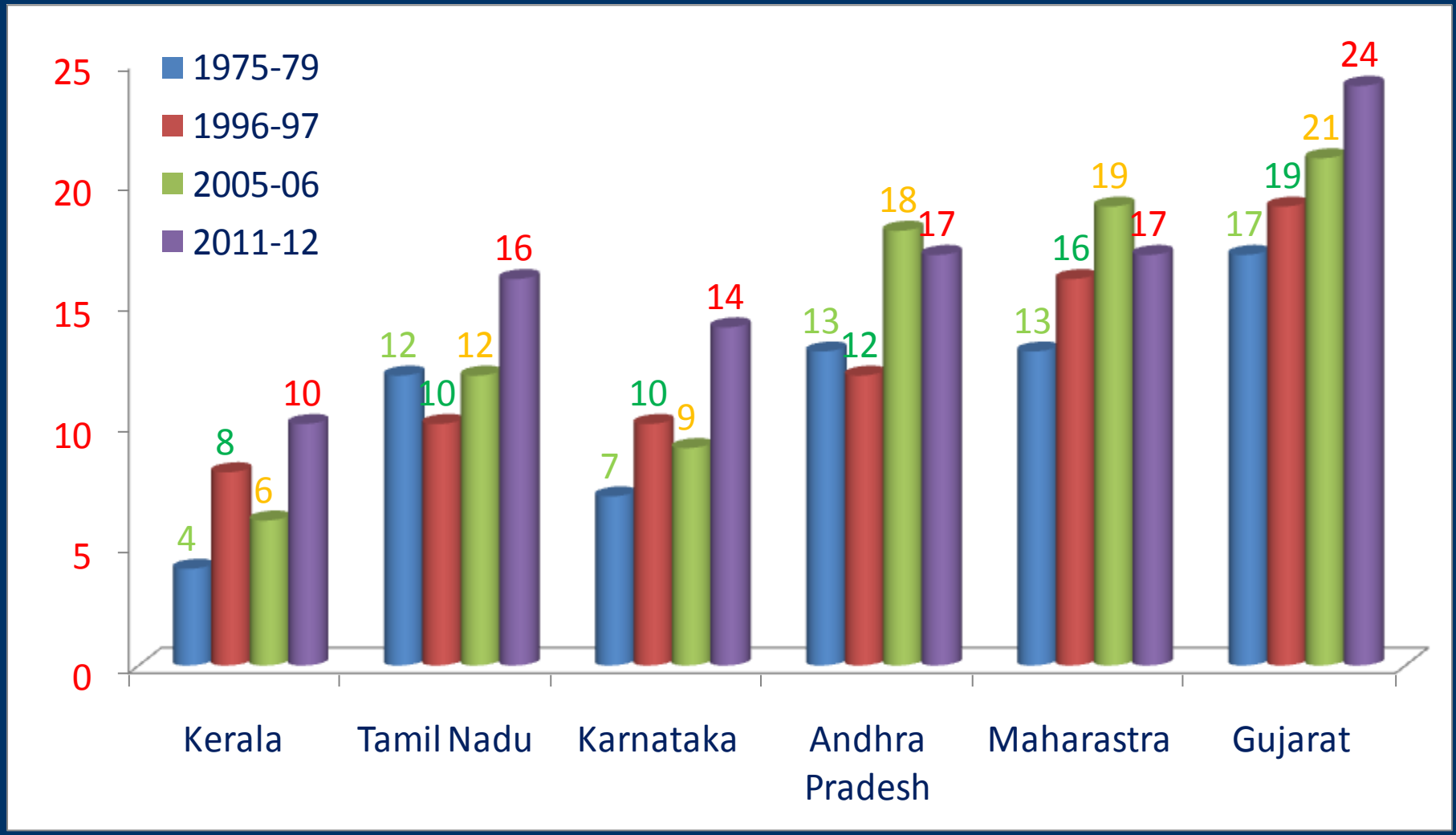
- The way we are born
- The way we grow up
- The food we eat
- The fluids we drink
- The way we live
- The way we play
- The way we move around
- The work we do
- The social habits
- The way we conduct our personal lives

TIME TRENDS IN THE CONSUMPTION OF MILLETS (g/CU/day) AMONG RURAL POPULATION



There was a significant reduction observed in consumption of millets among rural and tribal population in India , while it was increased in urban population over a period of two decades–

TIME TRENDS IN THE CONSUMPTION OF *VISIBLE FATS* (g/CU/day) AMONG RURAL POPULATION



A significant increase observed in consumption of visible fats (fats & oils) among rural population in India over a period of four decades– NNMB Surveys

TEMPTATIONS TOWARDS UNHEALTHY FOODS

10 Challenges

30 Solutions

Ranking list

4 solutions related to Malnutrition in first 10 priorities

1. Micronutrient supplements for children (vitamin A and zinc)
3. Micronutrient fortification (iron and salt iodization)
5. Bio-fortification
9. Community-based nutrition promotion

FAO/WHO International Conference on Nutrition (ICN) : World Declaration on Nutrition

"Overcoming micronutrient malnutrition is a precondition for ensuring rapid and appropriate national development"

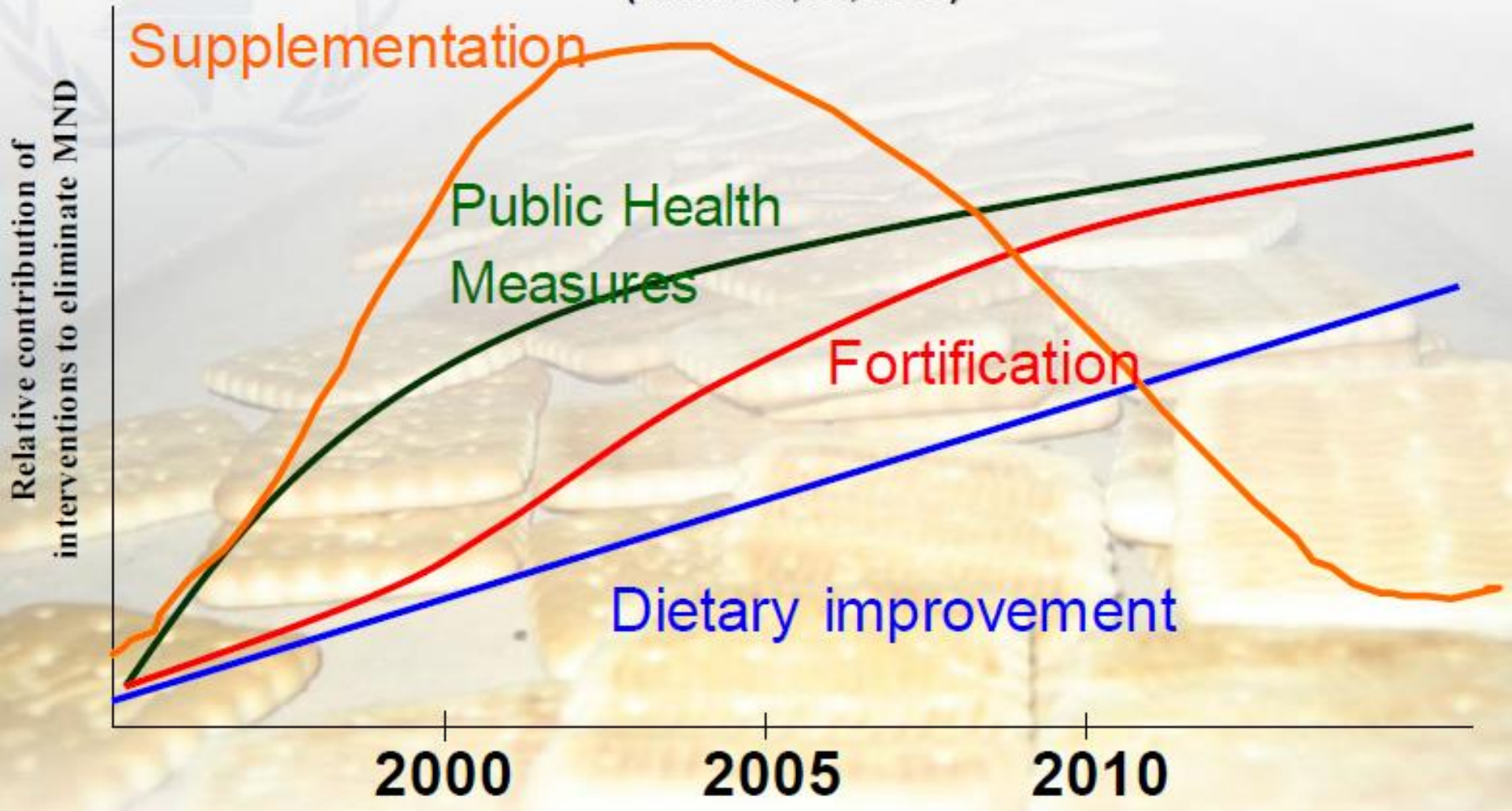
The *World Health Report 2000 identified iodine, iron, vitamin A and* zinc deficiencies as among the world's most serious health risk factors

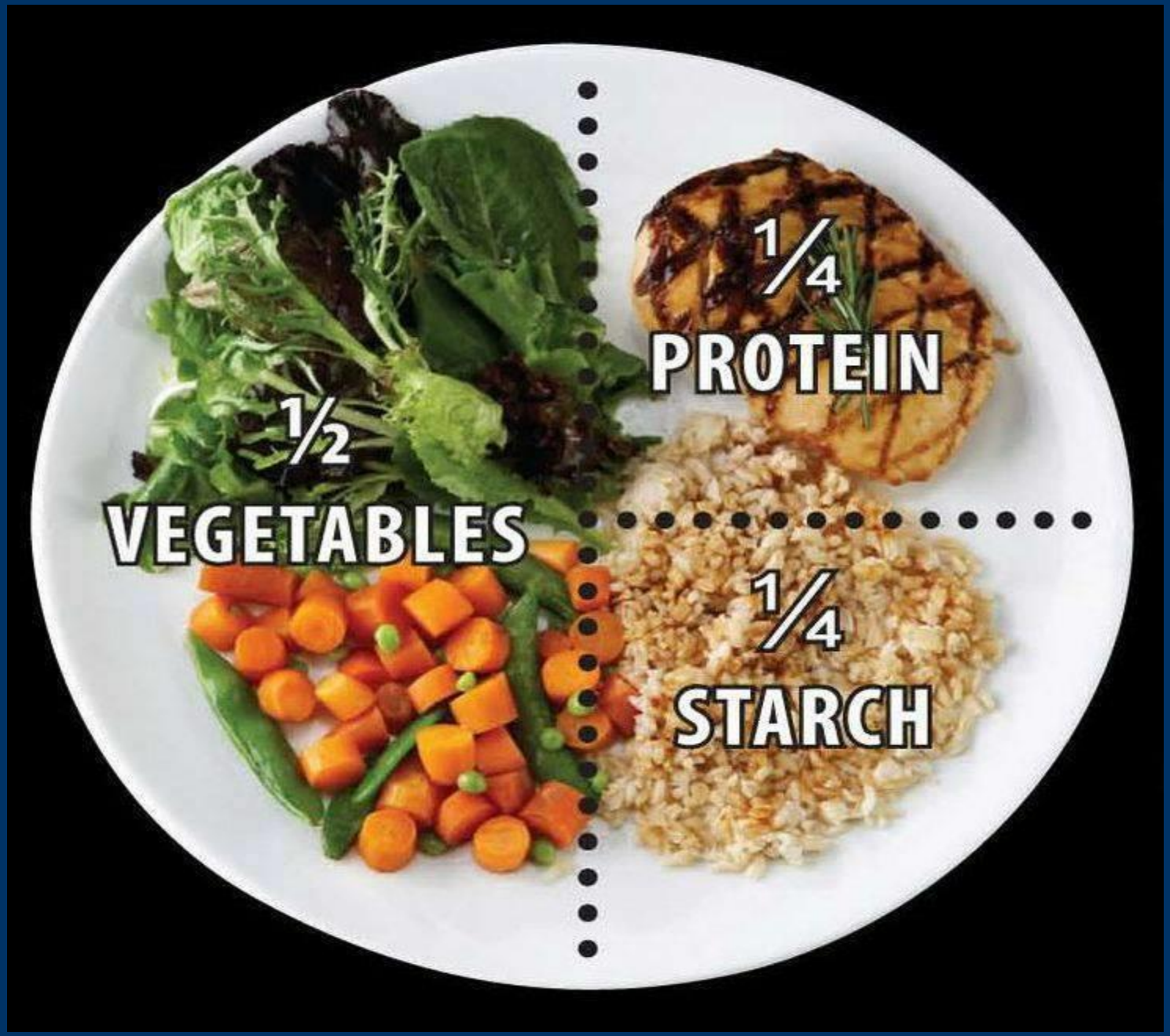
FAO and WHO have adopted five main strategies:

- **Improving dietary intakes through increased production, preservation and marketing of micronutrient-rich foods**
- **Nutrition education**
- **Food fortification**
- **Supplementation**
- **Global public health and disease control measures**

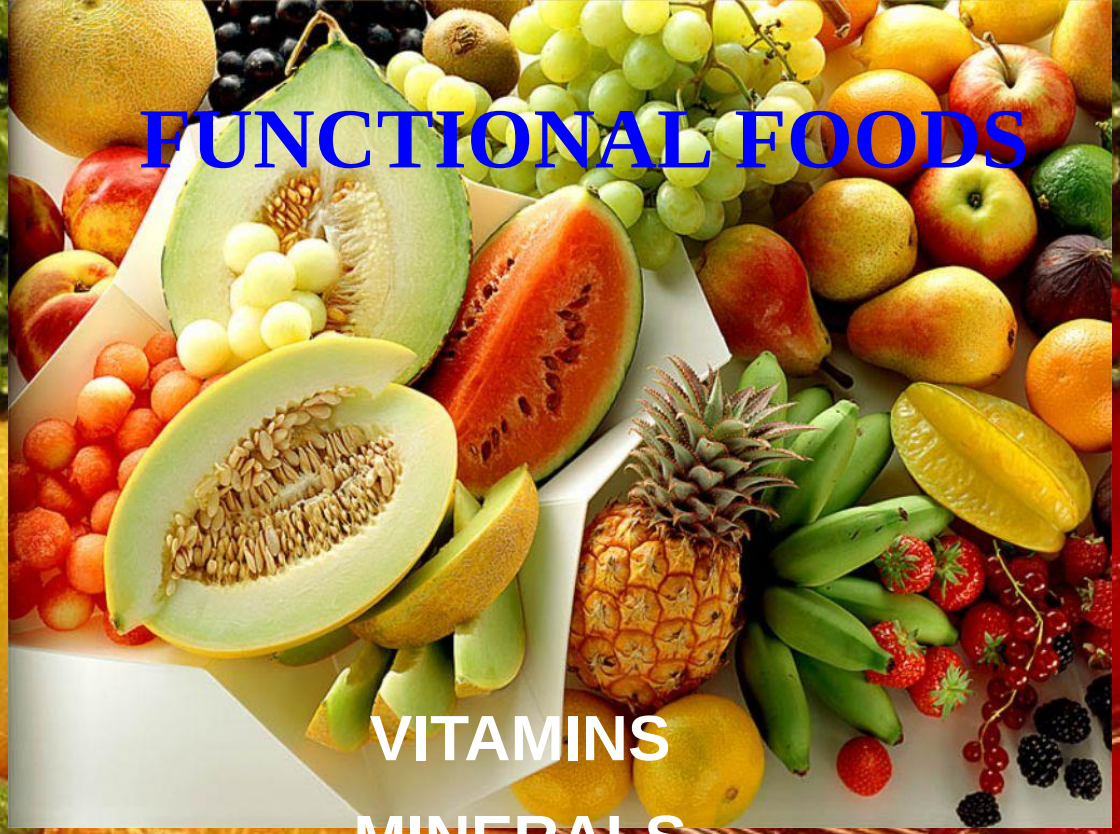
Integrated Approaches to eliminate Micronutrient Deficiencies

(V.Mannar, MI, 2003)




1/4
PROTEIN
1/2
VEGETABLES
1/4
STARCH

FUNCTIONAL FOODS



VITAMINS

MINERALS

ANTIOXIDANTS

PHYTONUTRIENTS

HORMONES

N-3 FATTY ACIDS

FIBER

Rice Fortification with Iron in India

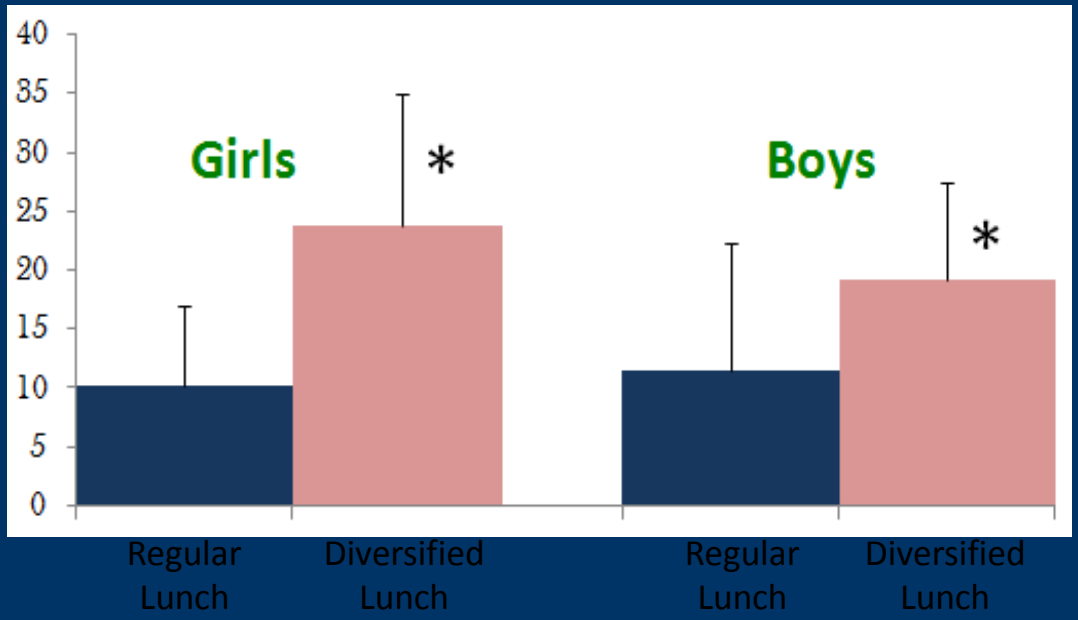
Micronized ferric pyrophosphate supplied through extruded rice kernels

Design	Duration	Source of iron and dose	Impact	
			Change in prevalence	Ferritin μg/L
RCT, Bangalore School lunch Iron depleted children N= 184	7 months Dewormed at Baseline and at 3.5 months	Extruded rice fortified with Micronized ferric pyrophosphate / 20 mg	Control	+ 2.3
			Fortified	+ 9.5
RCT NIN Hyderabad MDM Anemic children N= 164	8 months Dewormed at baseline	Extruded Ultra rice fortified with ferric pyrophosphate/18 mg	Control	- 3.0
			Fortiifed	+ 8.2

Radhika et al. 2011; AJCN, 94:1– 9, Moretti et al. 2006; AJCN 84: 822 – 29

IRON BIOAVAILABILITY

Regular meal was diversified with 100g guava among adolescent girls-boys and iron absorption was estimated for both the meals using stable isotope technique.



Diversified meal found to increase iron absorption by 2 times among both the girls and boys.

Nair et. al 2013, J Nutr; 143: 852-858

ROLE OF ANALYTICAL LABORATORIES IN CONTROL AND PREVENTION OF MNDs

AS YOU ARE AWARE, MNDs ESTIMATED MOSTLY ON SUBCLINICAL BASIS AND MONITORING FORTIFICATION AND SUPPLEMENTARY PROGRAMMES

THEREFORE, WE NEED POINT OF CARE DIAGOSTIC KITS

FOR FORTIFICATION OF IODINE – MONITORING TESTING KITS

ARE REQUIRED (IODISED SALTS/DFS)

FOR EXAMPLE HEMO CUE IS AVAILABLE FOR Hb TESTING IN THE FIELD

- **DBS METHOD FOR SMAPLE COLLECTION, TRANSPORTATION AND STORAGE AND ANALYSIS OF MANY MICRONUTRIENTS**
- **NON INVSIVE METHODS TO BE DEVELOPED FOR ANALYSIS OF BIOMARKERS FROM URINE, SALIVA, HAIR, FEACAL SAMPLES**

- **IRON STORAGE - FERRITN AND VITAIN A CAN BE MEASURED IN FINGER PRICK BLOOD SAMPLES COLLECTED EITHER BY CAPILLARY /DBS**
- **ALL THESE METHODS REQUIRE EXTENSIVE VALIDATION AND QUALITY CONTROL AND TRAINING**
- **WE SHOULD RECALL OURSELVES ABOUT IODINE SUCCESS STORY ON ACCOUNT OF ITS SIMPLE MEEASUREMNET TECHNIQUES AVAILABLE**
- **LATEST TECHNIQUES INCLUDES LIQUID CHROMATOGRAPHY AND MASS SPECTORMETRY AT GC MS-MS AND ALSO SENSITIVE METHODS OF RIA AND ELISA EXPLORED FOR DETECTION OF MANY MNDs TO ENABLE US TO PREVENT AND CONTROL THESE PROBLEMS.**

LABORATORY BASED METHODS

Micronutrients: Vitamins

VITAMIN C: By Spectro-photometric method

VITAMINS B1, B2, B6: By HPLC kits

VITAMIN B12: By RIA METHOD

FOLIC AICD: By RIA METHD

VITAMIN B12 AND FOLIC AICD: By DUAL ASSAY METHOD

VITAMIN D: By HPLC/LCMS

Micronutrients: Minerals

IODINE STATUS: T3 AND T4-DBS RIA/ELISA METHOD

PLASMA/SERUM MINERALS:

Fe/Zn/Se and other trace Elements can be estimated by Atomic Absorption Spectrometry or ICP-MS inductively coupled plasma emission mass spectrometry

Laboratory /Infrastructure

- BARC clearance for procurement and use and disposal of radioisotopes for RIA kits
- ELISA –require plate reader and washer and Manpower
- Quality control: Both internal and external
- Developing strategies Bioavailability of micronutrients
  - Radiosiotopic methods
  - stable isotopic methods
- Biomarkers of micronutrients for impact assessment of supplementation/food fortilfcation

Take Home Messages

Micronutrient deficiencies

- Public Health Problem
- Burden is heavy
- Health consequences
  - Serious & irreversible
- Productivity loss – Significant

Conclusions

- **Evidence-based strategies are available to control multiple micronutrient deficiencies.**
- **For achieving micronutrient security, optimum mix of supplementation, dietary diversification, fortification, bio-fortification, and health services should be defined depending on local context.**
- **Ensure consumption of fortified food in adequate amounts by target population**
- **Multi-stakeholders strategies -Government and food industry, laboratory/diagnostics partnership could eliminate the MND problem in India.**

THANK YOU

FOR PATIENT HEARING