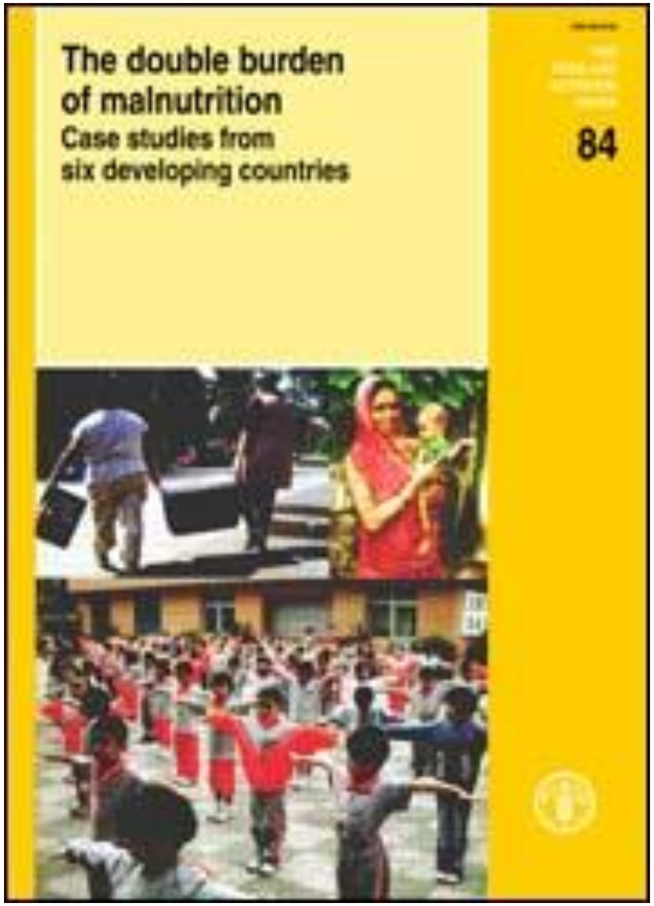
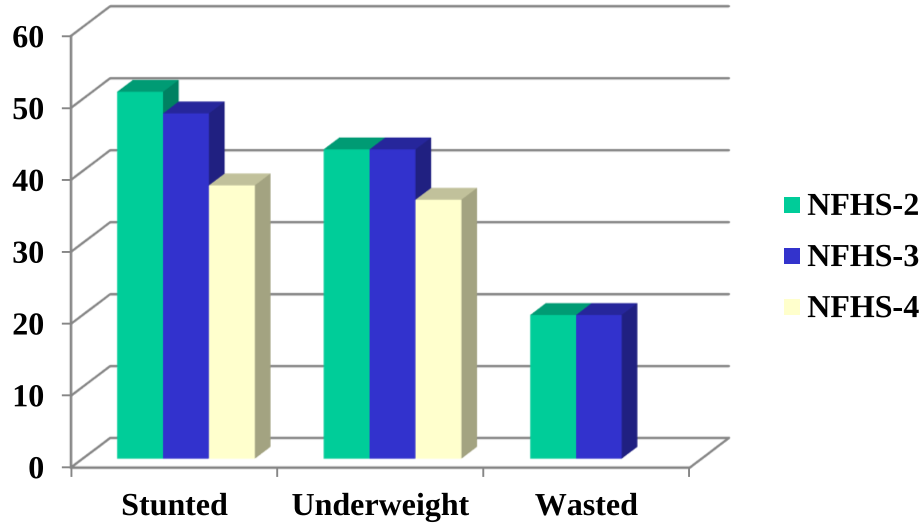
# Addressing the Double Burden of Malnutrition

**Bharati Kulkarni**

**National Institute of Nutrition, Hyderabad, India**

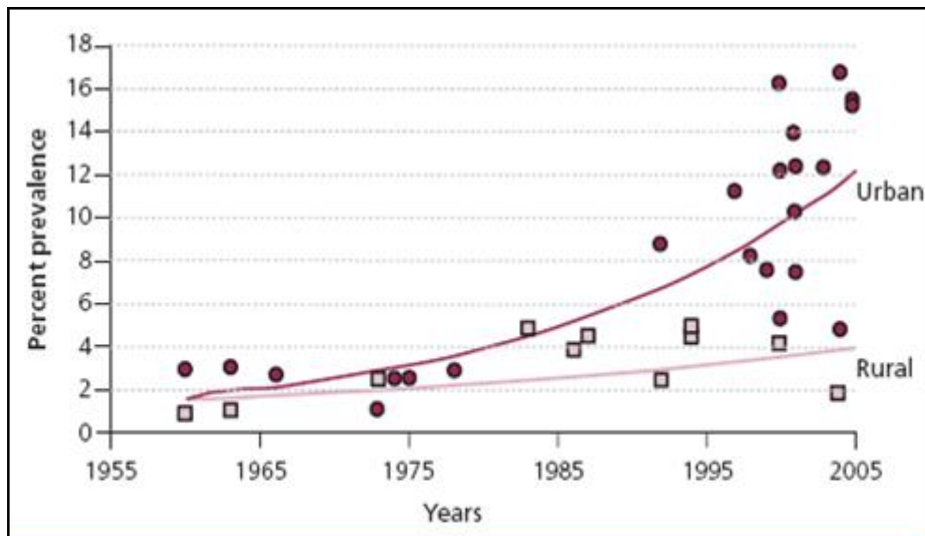



# Undernutrition in Children U-5 in India



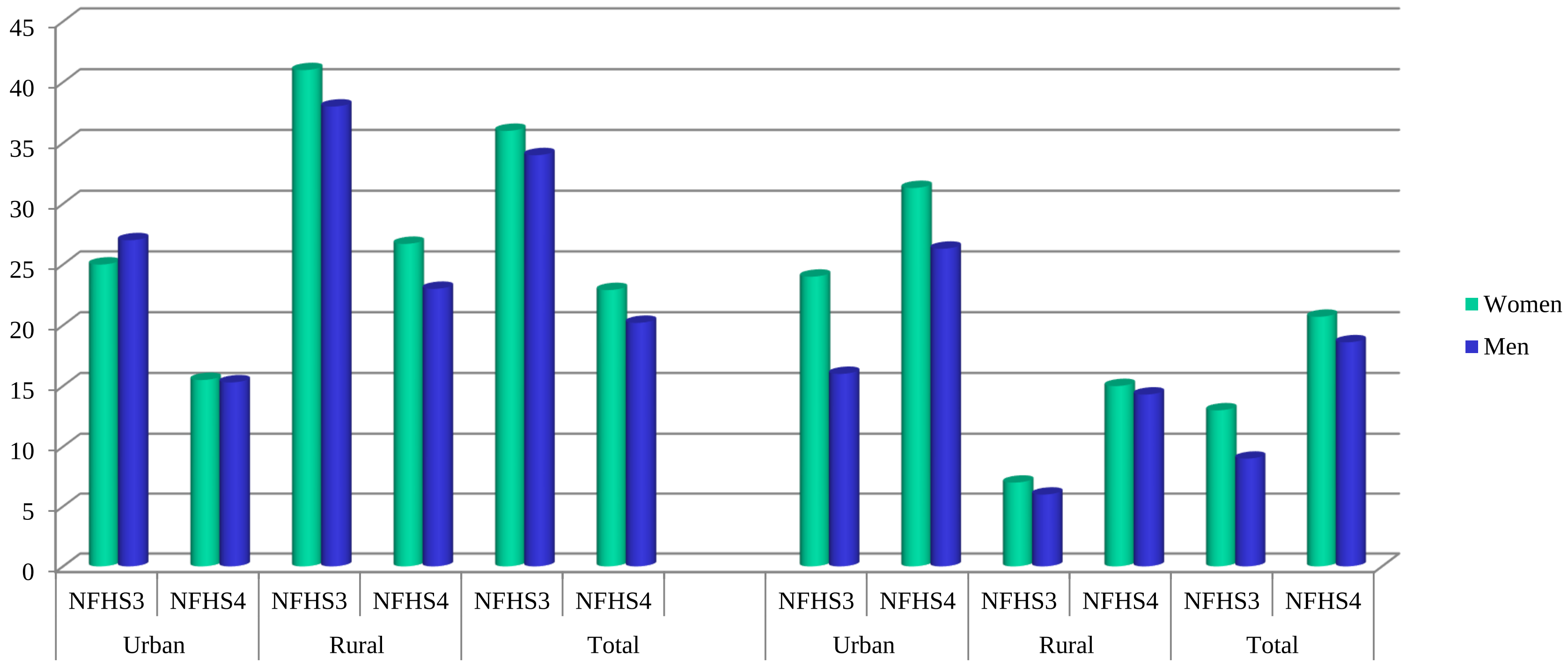

* NFHS-2 – children under 3 years

# Rising prevalence of diabetes in India




**(V Mohan, Diabetologia 2006; 49: 1175-78)**

# Prevalence of Undernutrition & Overweight/Obesity among Indian Adults



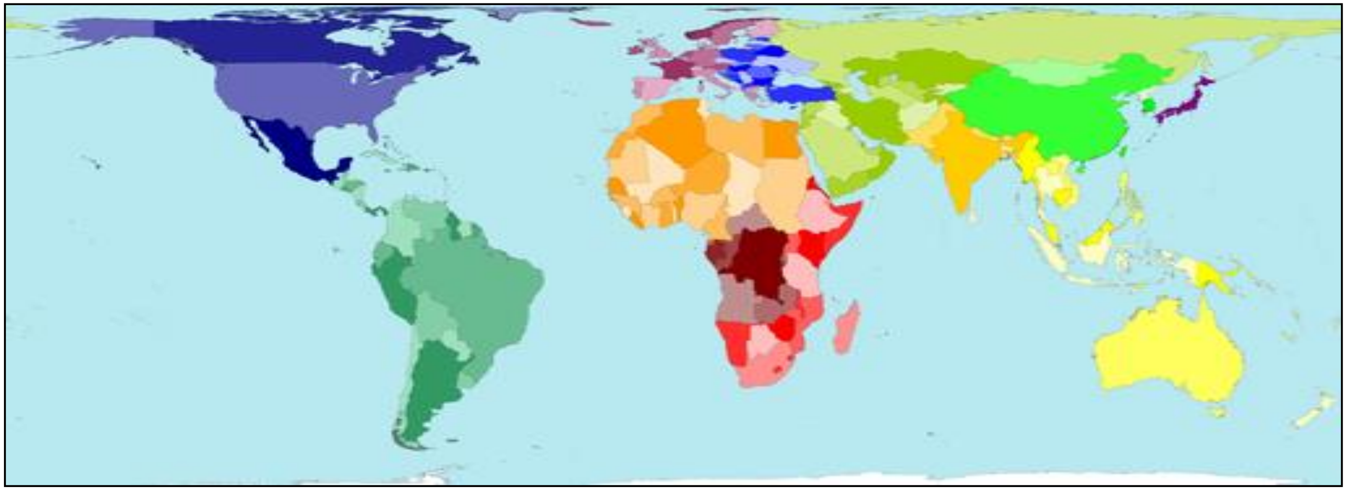

**Under nutrition (BMI < 18.5)**

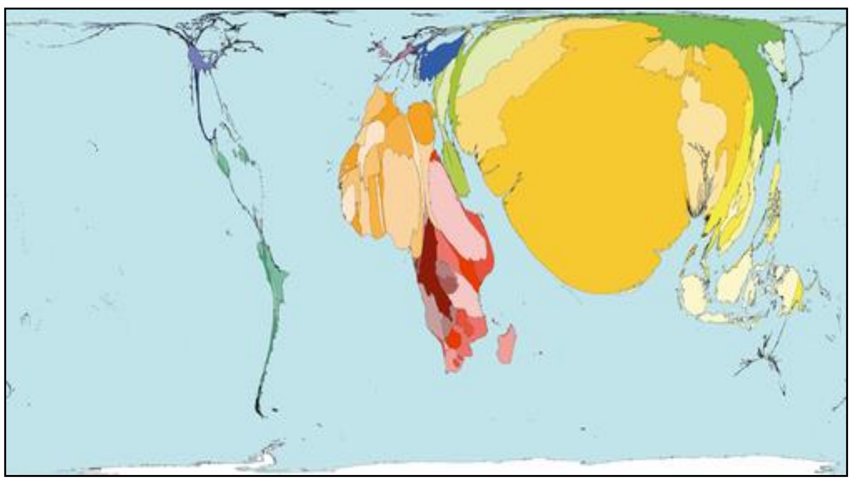
**% Overweight/ obese (BMI > 25)**

**NFHS-3, 2005-06**

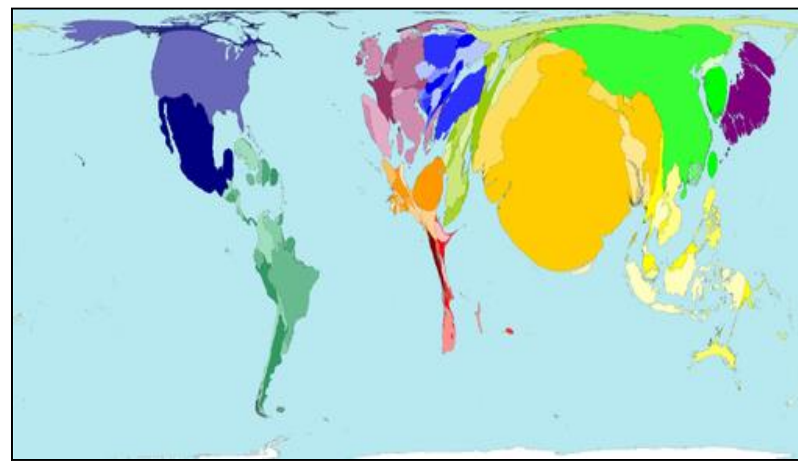
**NFHS-4, 2015-16**

WORLDMAPPER The world as you've never seen it before





**Low birth weight**



**Diabetes prevalence**

APPLIED NUTRITIONAL INVESTIGATION

# Non-Obese (Body Mass Index < 25 kg/m$^2$) Asian Indians With Normal Waist Circumference Have High Cardiovascular Risk

Naval K. Vikram, MD, Ravindra Mohan Pandey, MSc, PhD, Anoop Misra, MD, Rekha Sharma, MS, RD, J. Rama Devi, MBBS, and Nidhi Khanna, BSc, MA

*From the Department of Medicine, the Department of Dietetics, and the Department of Biostatistics, All India Institute of Medical Sciences, New Delhi, India*

## Cardio-metabolic risk in non-obese adults -high fat phenotype

International Journal of Obesity (2003) 27, 173–180

0307-0565/03 $25.00
www.nature.com/ijo

PAPER

### Neonatal anthropometry: the thin–fat Indian baby. The Pune Maternal Nutrition Study

CS Yajnik[1]*, CHD Fall[2], KJ Coyaji[1], SS Hirve[1], S Rao[3], DJP Barker[2], C Joglekar[1] and S Kellingray[2]

- **Reduced muscle mass , visceral mass**
- **Preserved subcutaneous & abdominal fat**

Original Paper

Annals of Nutrition & Metabolism

Ann Nutr Metab 2010;56:182–189
DOI: 10.1159/000276597

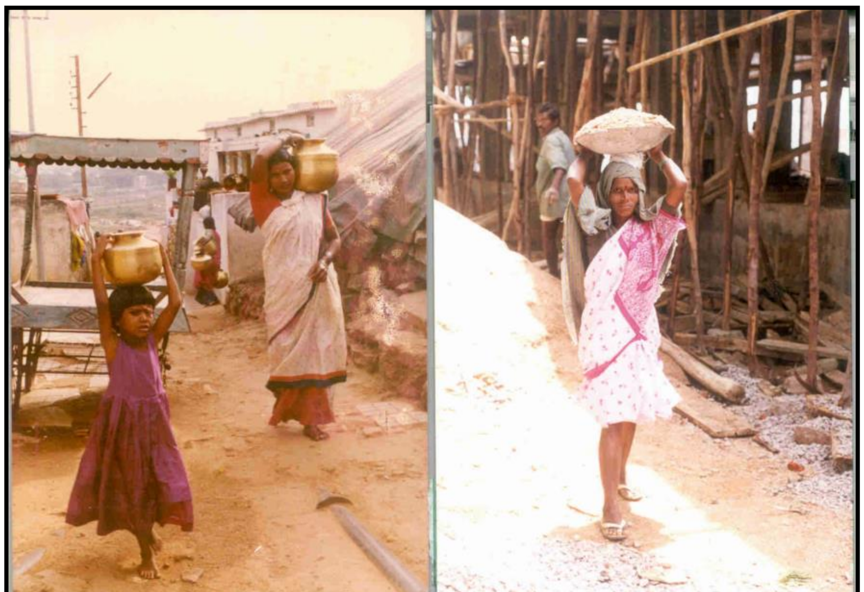
Received: May 25, 2009
Accepted after revision: January 11, 2010
Published online: February 25, 2010

# Regional Body Composition of Indian Women from a Low-Income Group and Its Association with Anthropometric Indices and Reproductive Events

Bharati Kulkarni   Veena Shatrugna   Balakrishna Nagalla   K. Usha Rani

National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India

(N = 278)

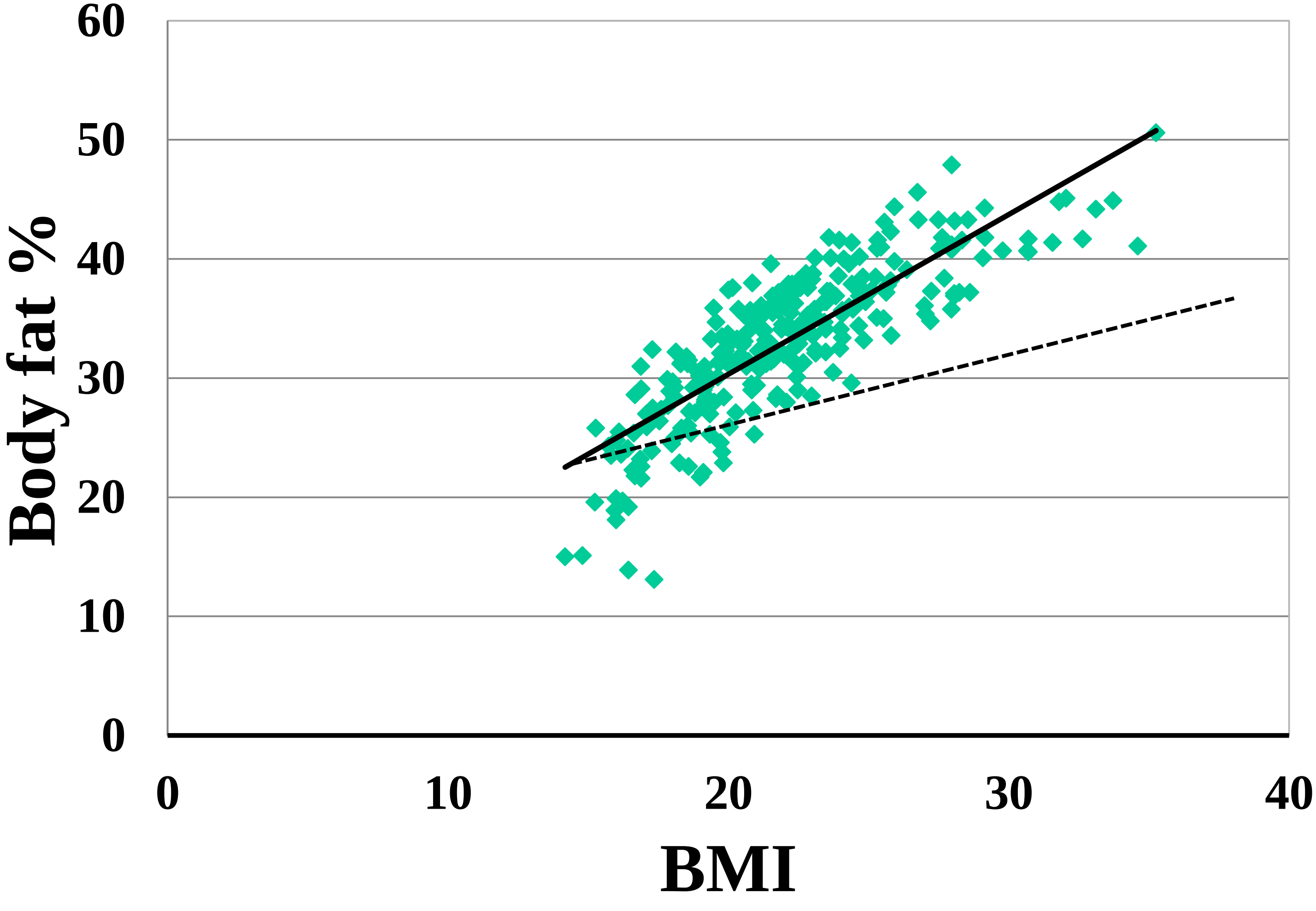


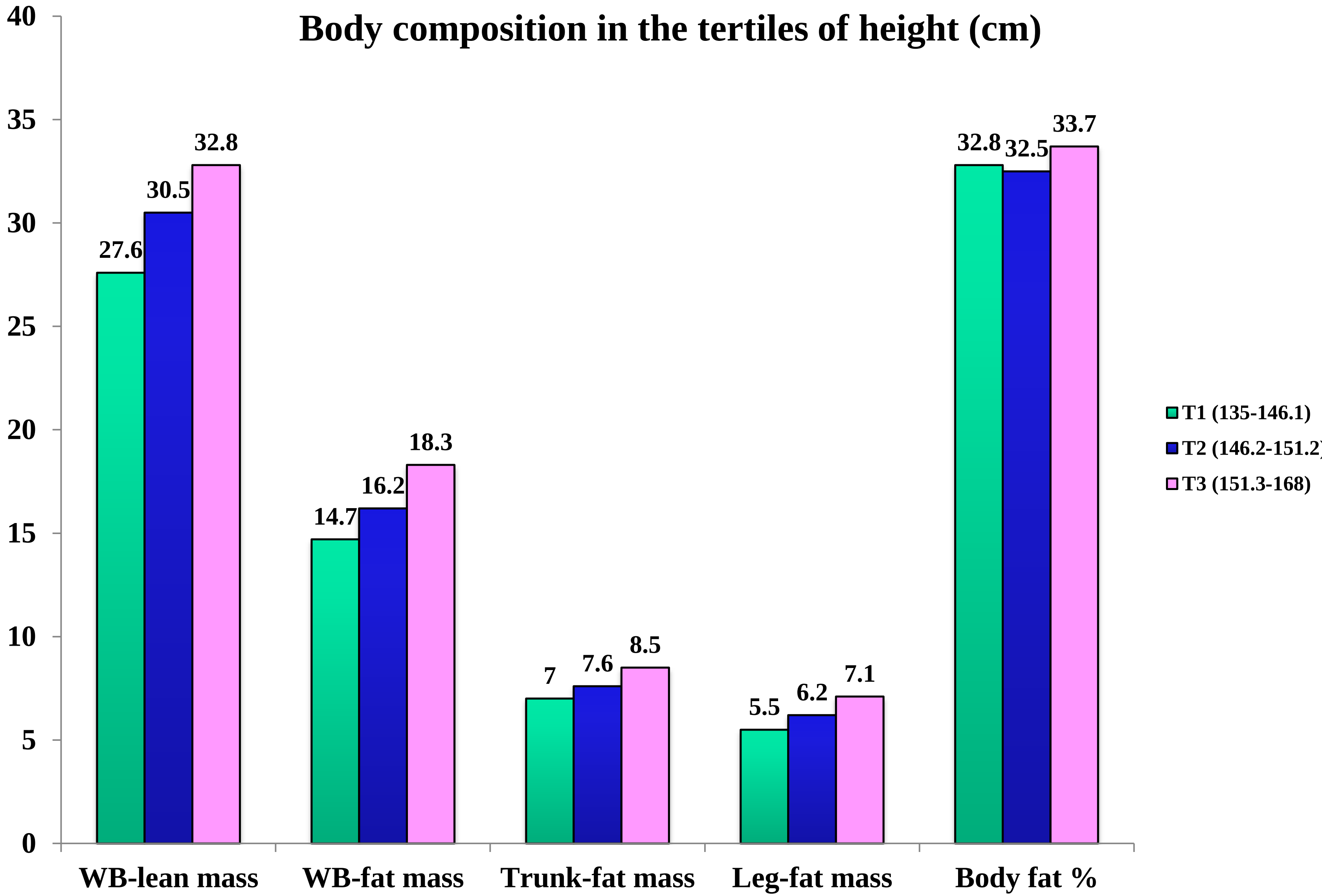

Mean age: 40 y;  BMI: 22 kg/m$^2$;   Body fat %: 33

Table: Sensitivity and specificity of different levels of BMI for identifying subjects with high body fat cutoffs of 30 and 35%, using ROC analysis

| BMI cutoff points | Sensitivity | Specificity | Correct classification |
|---|---|---|---|
| BF% of >30% | | | |
| 19 | 94.4% | 61.2% | 84.9% |
| 20 | 85.9% | 82.5% | 84.9% |
| 21 | 76.3% | 90.0% | 80.2% |
| 22 | 61.6% | 95.0% | 71.2% |
| 23 | 46.5% | 98.7% | 61.5% |
| 24 | 35.9% | 98.7% | 54.0% |
| 25 | 26.8% | 100% | 47.8% |
| BF% of >35% | | | |
| 19 | 100% | 31.8% | 61.9% |
| 20 | 99.1% | 56.4% | 73.7% |
| 21 | 92.9% | 67.3% | 77.7% |
| 22 | 82.3% | 80% | 80.9% |
| 23 | 69.0% | 90.9% | 82.0% |
| 24 | 57.5% | 95.8% | 80.2% |
| 25 | 46.0% | 98.8% | 77.3% |

# BMI Body Fat Relationship

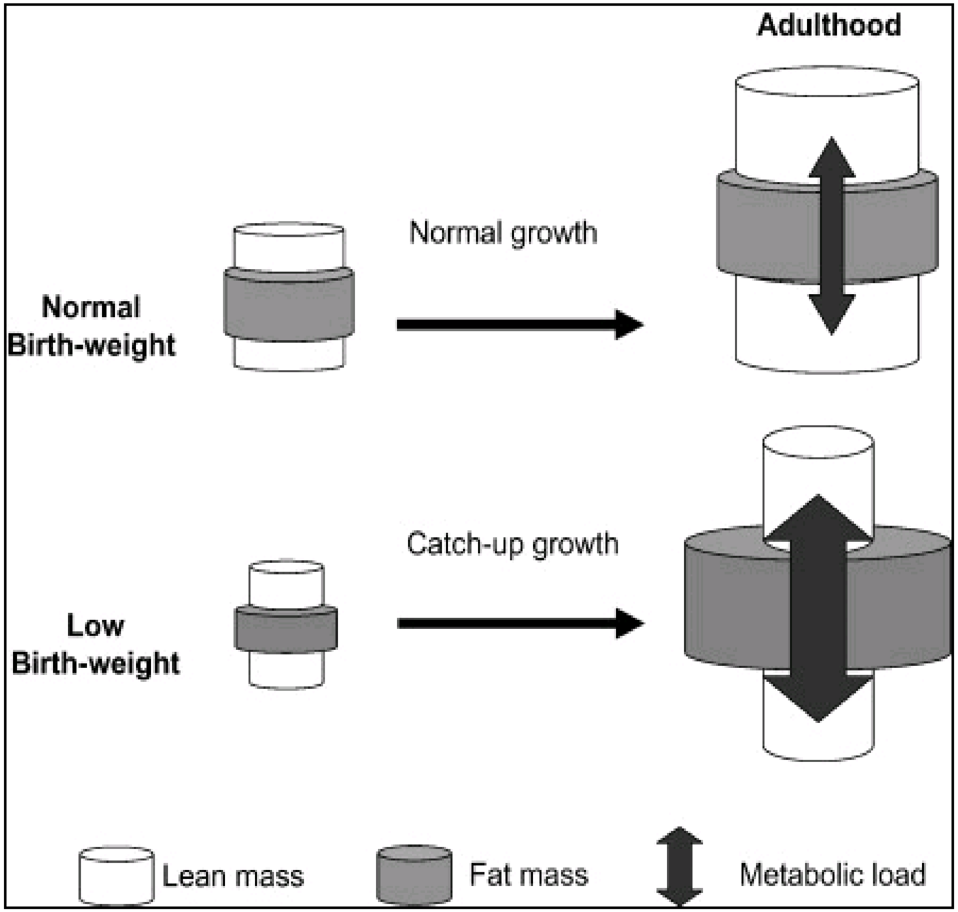





**Mean Body weights**

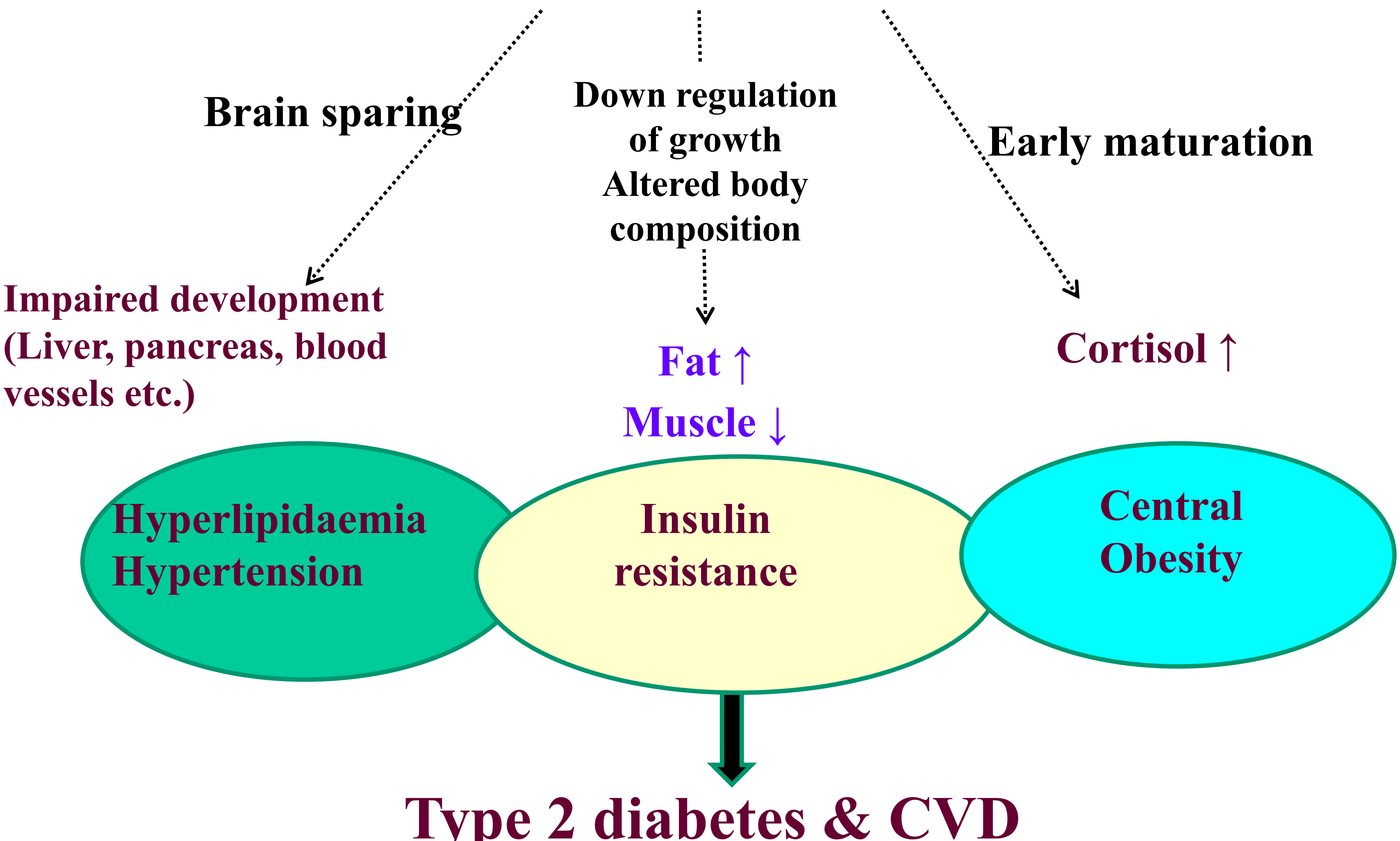
**T1 - 44.4 kg , T2 – 49.0 kg, T3 – 53.6 kg**

# Childhood Growth & Optimal Body Composition




JCK Wells (2007) Early Human Development

# Foetal Undernutrition




*Fall CHD Indian Pediatr 2003; 40:480-502*

# New Delhi Birth Cohort (born 1969-1972)

- Measured every year to age 21 y
- Body comp assessment at age 30 y
- *n* = 1526

BMI & BMI gain in infancy & early childhood

↓

Related to adult LBM

BMI & BMI gain in late childhood

↓

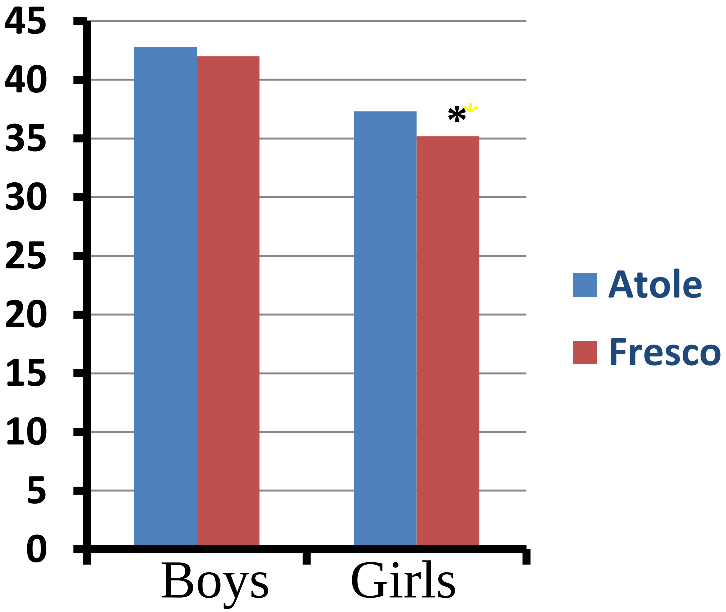
Related to adult fat mass & central adiposity.

(Sachdev et al. Am J Clin Nutr 2005;82:456-66)

# Follow-Up Studies of Nutrition Supplementation Trials
## INCAP study - Guatemala (1969-77)

- Assessed impact of nutrition supplementation in pregnancy & early childhood on growth & development
- Follow-up study 1988-89 (age 14-20 y)
- Body composition by anthropometry

Lean Body Mass; N=460



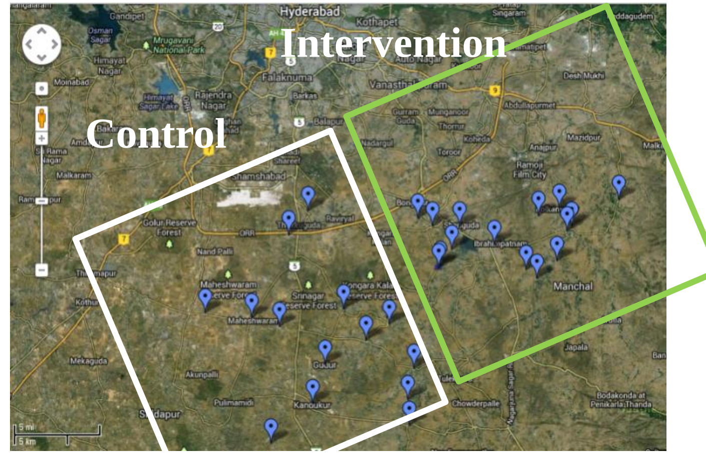

* *P* <0.01

*(Martorell R. J Nutr 1995; 125: 1127S-1138S)*

APCaPS Andhra Pradesh Children and Parents Study

# Follow up study of Hyderabad Nutrition trial, 1987-90

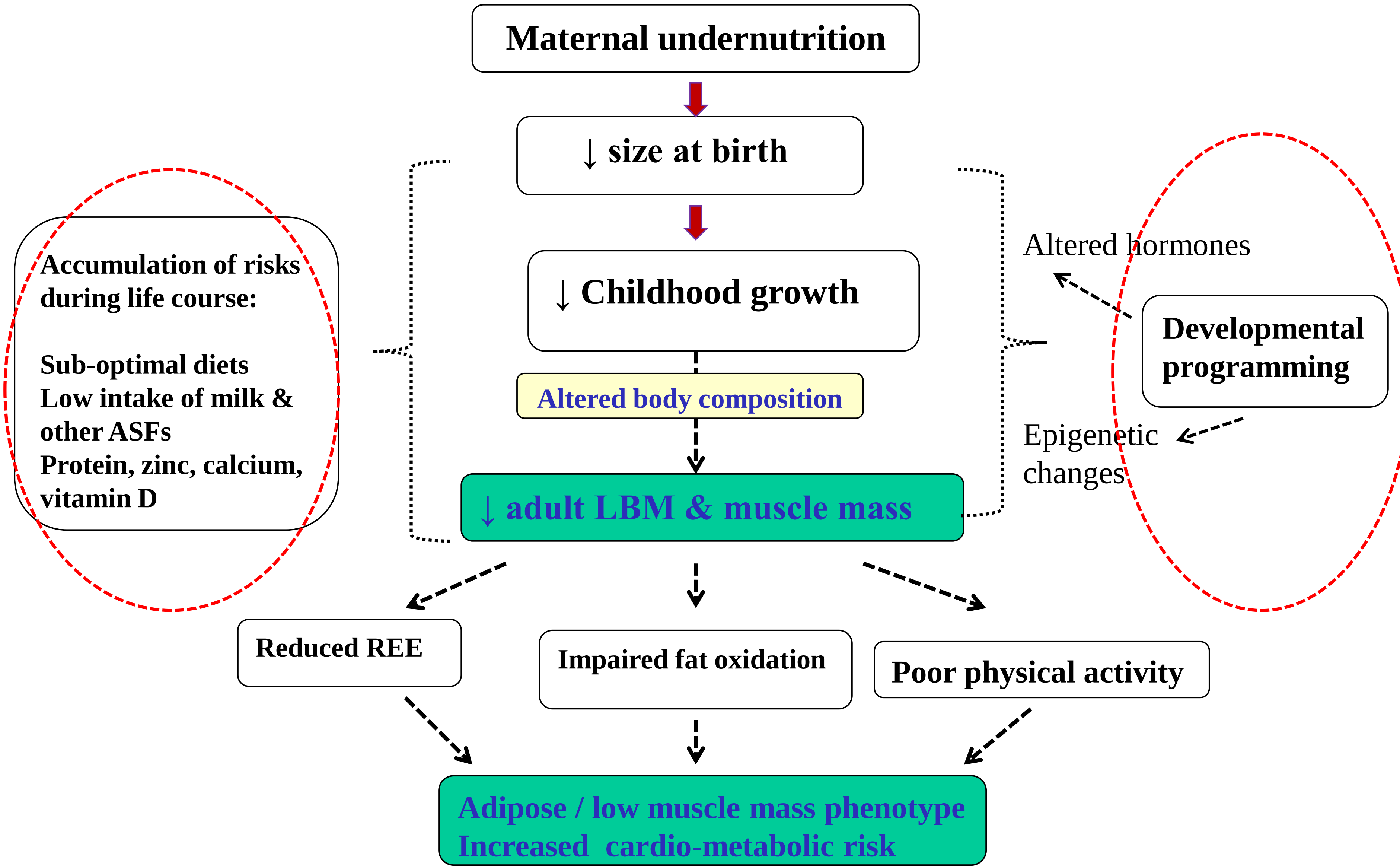
To assess the long term impact of early life food supplementation & other environmental risk factors on cardio-metabolic disease risk.




Higher birth weight: I *vs* C
**F1**: Adolescence: Intervention group taller by 14 mm
**F2**: Age: 18-21y
Current diet / PA : more important determinant of LBM

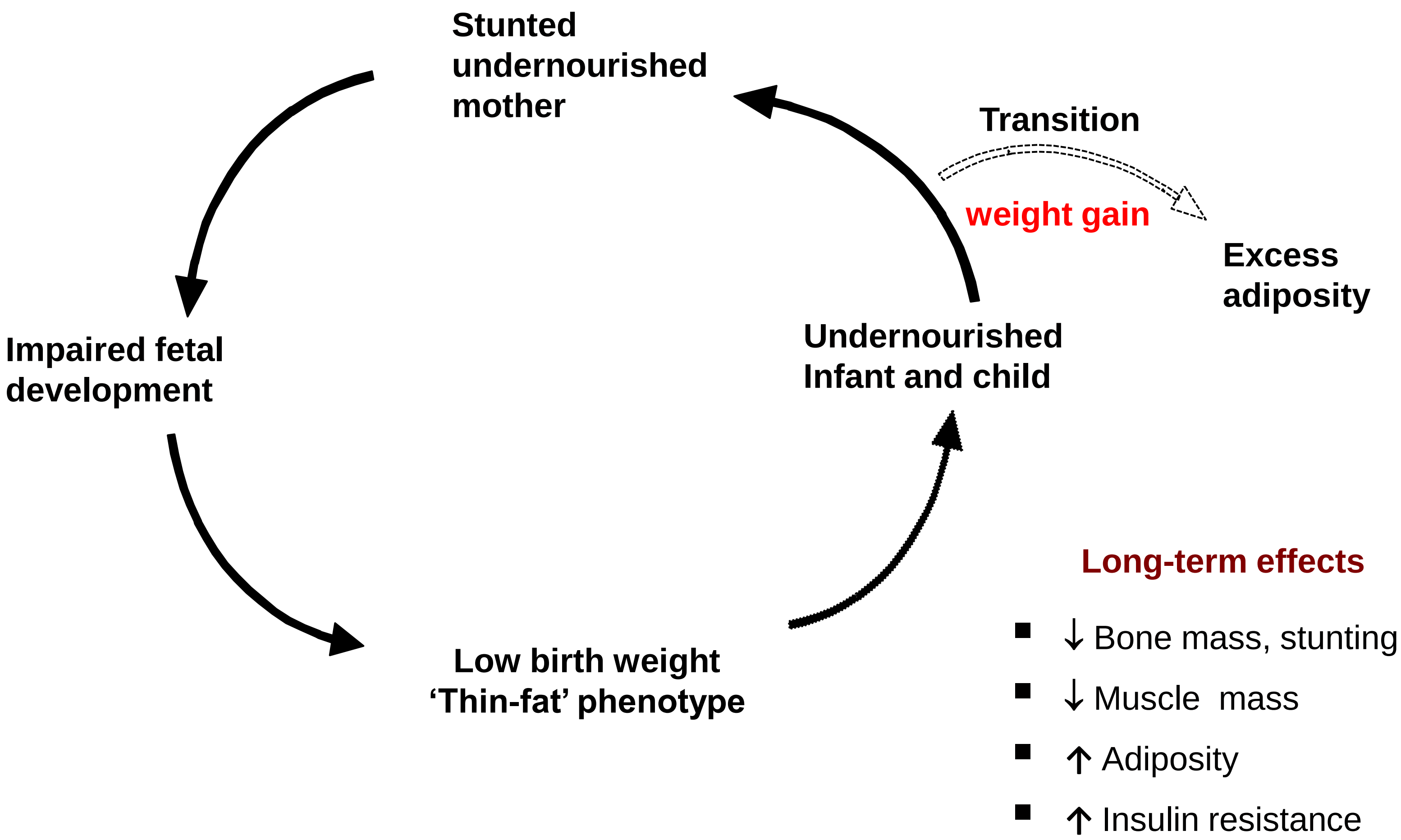
*(S Kinra, BMJ 2008; 337: a605 ; B Kulkarni, Am J of Epidemiol* 2014;179:700-9)

# Nutritional influences affecting LBM during life course




*(Kulkarni B et al. Nutr Rev 2014;72:190–204)*

# Inter-generational cycle of malnutrition




***Intervening at each point in the life cycle will help positive change***

# Optimizing nutrition during life cycle

- **Pre-conception**
- **During pregnancy**
- **Infancy**
- **Early childhood**
- **Adolescence**
- **Adult**

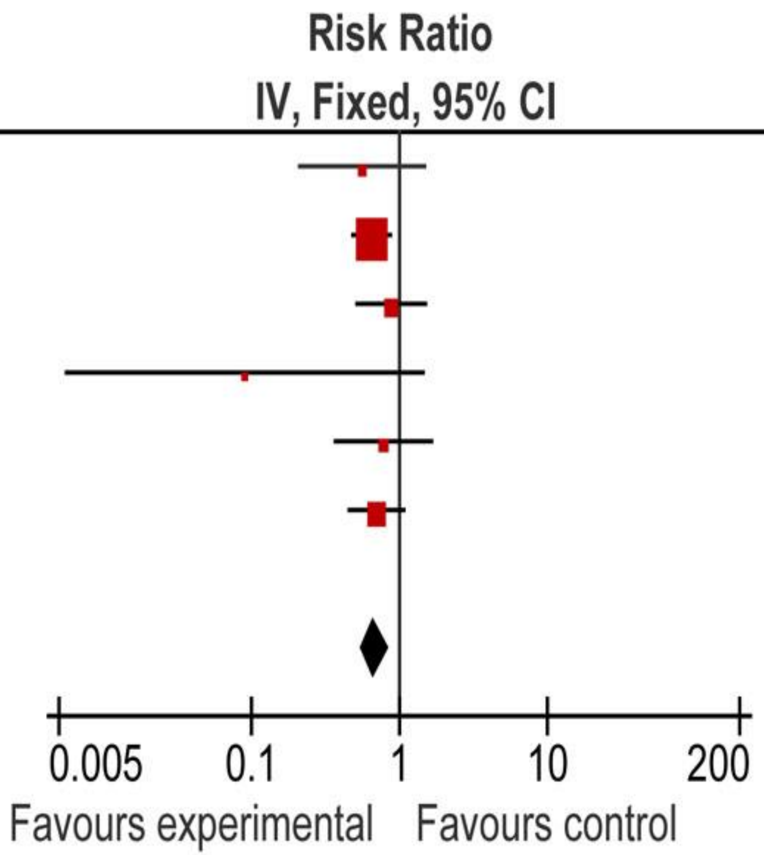
a. Diet diversification by adding MN rich foods
b. Fortification of staple foods with MN
c. Balanced protein energy suppl /multiple MNs
d. For children & pregnant women: Specially formulated fortified food supplements : both micro & macronutrients (EFAs & protein)
e. For young children: increasing the energy density of foods

**Nutrition education & counseling:** limited impact when provided without food suppl

# Balanced protein energy supplementation during pregnancy & risk of SGA births

| Study or Subgroup | Weight | Risk Ratio IV, Fixed, 95% CI |
|---|---|---|
| Blackwell 1973 | 4.4% | 0.56 [0.21, 1.48] |
| Ceesay 1997 | 49.4% | 0.65 [0.49, 0.87] |
| Elwood 1981 | 14.8% | 0.88 [0.52, 1.50] |
| Girija 1984 | 0.5% | 0.09 [0.01, 1.45] |
| Mora 1978 | 7.5% | 0.78 [0.37, 1.65] |
| Rush 1980 | 23.3% | 0.70 [0.46, 1.07] |
| **Total (95% CI)** | **100.0%** | **0.69 [0.56, 0.85]** |

Heterogeneity: Chi² = 3.31, df = 5 (P = 0.65); I² = 0%
Test for overall effect: Z = 3.56 (P = 0.0004)




*Imdad & Bhutta BMC Public Health 2011, 11(S 3):S17*
*Kramer , Cochrane Database Syst Rev. 2003*

# Meta-analysis of the effects of antenatal MMN vs IFA suppl on birth outcomes in 12 RCTs in developing countries

*(Christian P. Ann Rev Nutr 2010, 30:83-104)*

| Birth outcome | Pooled effect size (95% CI) |
|---|---|
| Birth weight, g | 22.4 (8.3, 36.4) |
| **Low birth weight (<2500 g)** | **0.89 (0.81, 0.97)** |
| Small for gestational age | 0.90 (0.82, 0.99) |
| **Large for gestational age** | **1.13 (1.00, 1.28)** |
| Gestational age, days | 0.17 (−0.35, 0.70) |
| Preterm delivery (<37 weeks) | 1.00 (0.93, 1.09) |
| Stillbirths | 1.01 (0.88, 1.16) |
| Perinatal mortality | 1.11 (0.93, 1.33) |
| Early neonatal mortality | 1.23 (0.96, 1.59) |
| Late neonatal mortality | 0.94 (0.73, 1.23) |

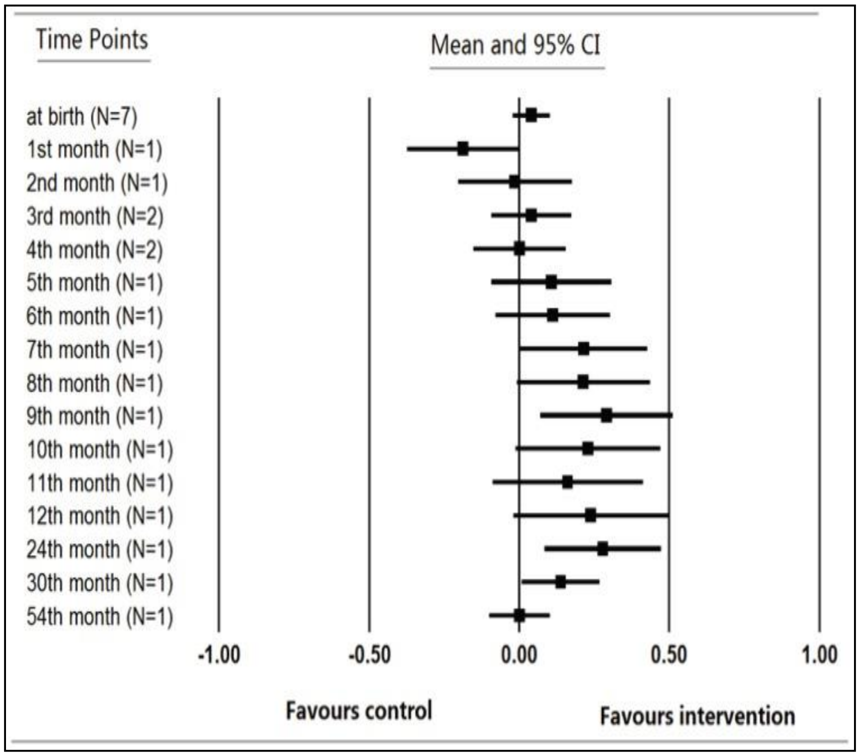
**Limited impact of MMN supplementation in pregnancy**
**Estimated reduction in LBW- 11%**

# MMN Suppl in Pregnancy & Postnatal Growth of Children U5

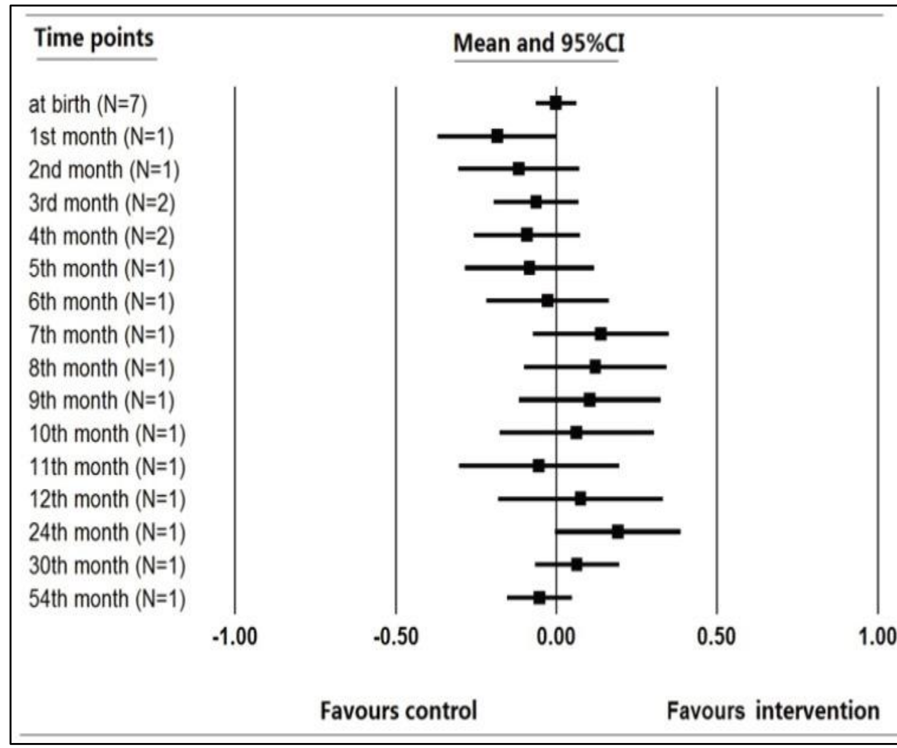
*(Wei-Ping Luo et al. PLOS One 2014; 9: e88496)*

Meta-analysis: 9 trials from different countries

**Mean diff in weight over time**




**Mean diff in height over time**




No impact on weight, height & WHZ of children

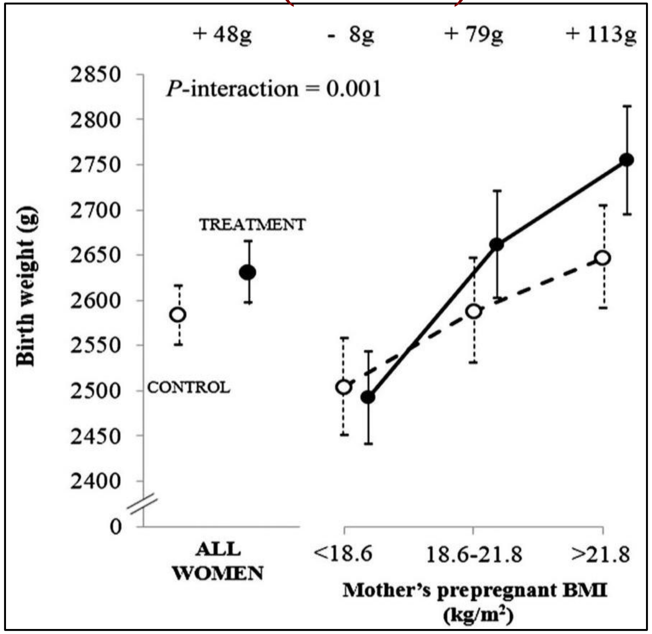
# Mumbai Maternal Nutrition Project

MN-rich food supplement pre-conceptionally & throughout pregnancy ; ~ 6,700 women from Mumbai slums

(*Potdar R et al. Am J Clin Nutr 2014; 100: 1257-68*)

**Ingredients of a snack (samosa):**
**Dry GLV powder**
**Milk powder**
**Fruit powder**
**Fresh GLV**
**Dried fruit**
**Chick peas**
**Sesame seeds**

(N=1094)




**Birth weight effect:**

+48 g in women who started suppl ≥ 3 mo before pregnancy

LBW – 34% vs 41%

Impact higher in women with higher BMI at baseline

Macro + Micro N supplementation may be needed in undernourished women.

# Intergenerational impact of low LBM

European Journal of Clinical Nutrition (2006) 60, 1341–1344

0954-3007/06 $30.00
www.nature.com/ejcn

SHORT COMMUNICATION

## Maternal lean body mass may be the major determinant of birth weight: a study from India

B Kulkarni, V Shatrugna and N Balakrishna

*National Institute of Nutrition (Indian Council of Medical Research), Clinical Division, Jamai Osmania, Hyderabad, Andhra Pradesh, India*

**Maternal body composition assessed by DXA within 1 mo after delivery ( N = 76)**

**Maternal lean mass – strongest correlation with birth weight of the baby.**

# Dietary intakes of rural women & children in India: low Diet Diversity (NNMB 2012)

| | Cereals Millets | Legumes | Green leafy veg. | Other veg | Roots Tubers | Nuts Oil seeds | Fruits | Meat poultry | Milk Milk products | Fats Oils |
|---|---|---|---|---|---|---|---|---|---|---|
| NPNL women (n=9519) | 341 | 28 | 19 | 49 | 70 | 8 | 24 | 21 | 82 | 15 |
| Pregnant (n=322) | 354 | 34 | 18 | 47 | 60 | 7 | 32 | 21 | 79 | 16 |
| Lactating (n=693) | 395 | 34 | 19 | 48 | 70 | 6 | 24 | 16 | 66 | 17 |
| 1-3 y children (n=2895) | 131 | 15 | 7 | 13 | 21 | 2 | 12 | 6 | 86 | 6 |

**Children (6-23 mo) receiving minimum adequate diet (NFHS 4)**

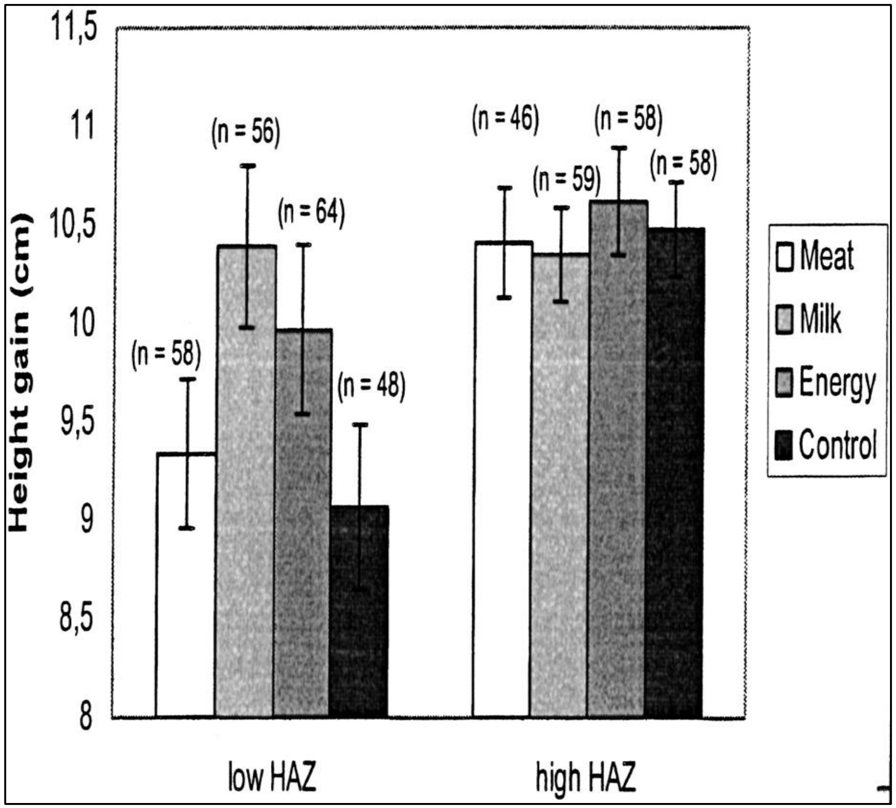
Breastfeeding children : 9%

Non- Breastfeeding children : 14%

# ASF supplements increase LBM in Kenyan school children

(544 children; median age 7 y, supplemented for 23 months)

Height gain




Children with low baseline HAZ:

• Milk-supplemented children gained 1.3 cm ↑ height than controls ($p$ = 0.05) &

•1 cm ↑ height than Meat group

Arm muscle area -

Meat group -

•80% more ↑ than controls

•Milk and Energy groups- 40% more ↑ than control group.

Grillenberger M et al. J. Nutr. 2003;133:3957S-3964S

# Secular trends in height in different states of India in relation to socioeconomic characteristics and dietary intakes

Raja Sriswan Mamidi, Bharati Kulkarni, and Abhishek Singh Food Nutr Bull. 2011 ;32:23-34

## Positive relation between milk intakes & height of adults (NFHS 3)

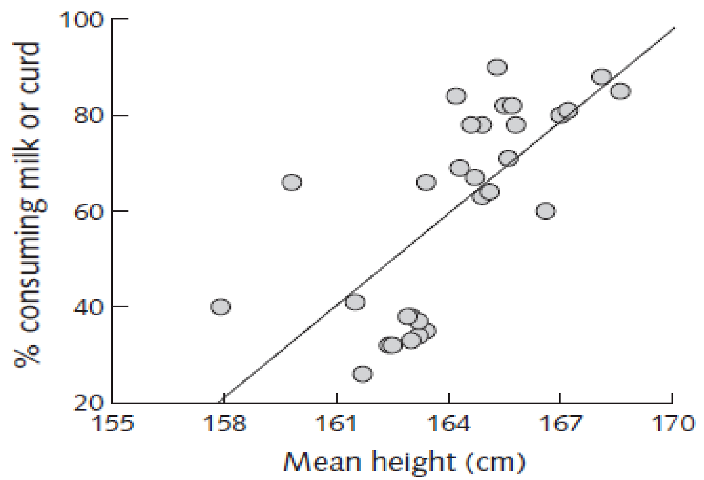



FIG. 3. Scatter diagram showing the percentage of men 20 to 49 years of age in different states consuming milk or curd at least once a week in relation to mean height ($r = 0.69$)

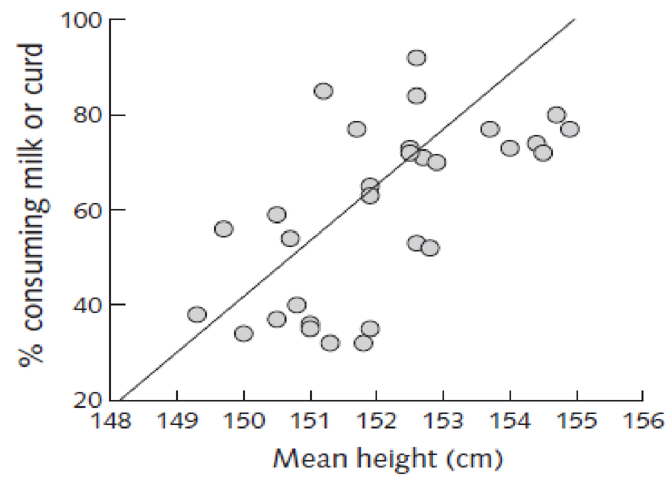
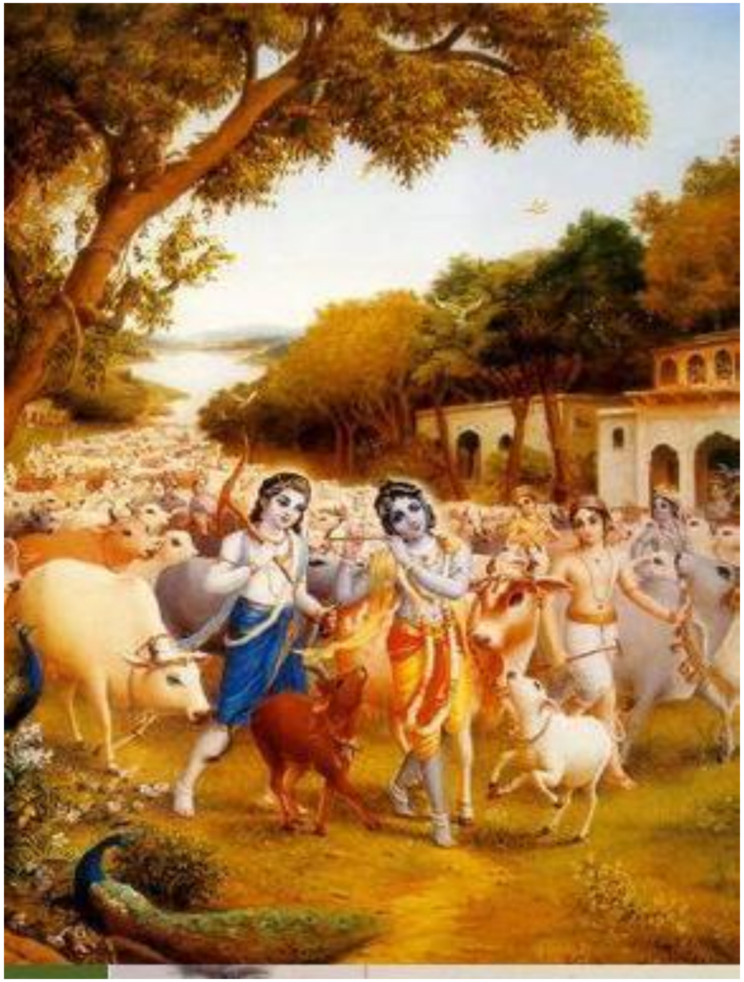


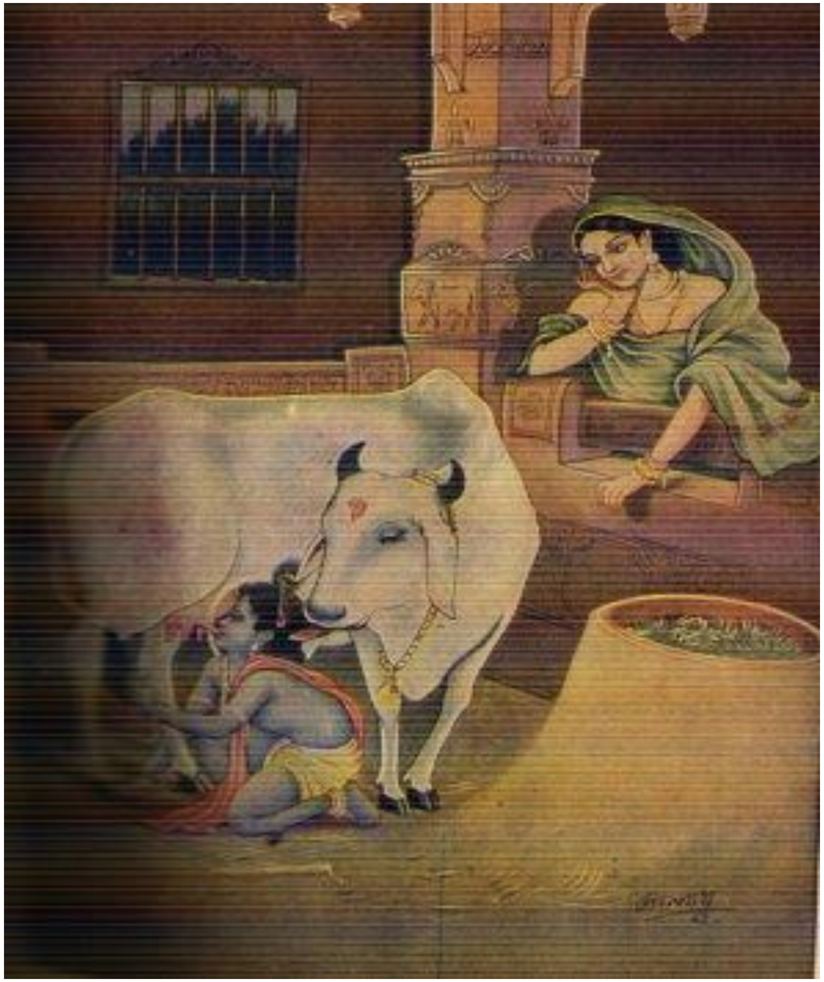

FIG. 4. Scatter diagram showing the percentage of women 20 to 49 years of age in different states consuming milk or curd at least once a week in relation to mean height ($r = 0.63$)

**Milk consumption ≥ once/week *vs* < once/week: difference in height +0.65 cm (men) & 0.40 cm (women) (both p<0.001); adjusted for confounders**

**Intake of other ASFs not associated with height**

# Cultural importance of milk in India goes beyond nutritive value





# SUMMARY

• Double burden of childhood undernutrition & adult-onset adiposity in transitioning societies: public health challenge.

• Sub-optimal LBM- link between these 2 forms of malnutrition

• Positive association of early nutritional status with LBM in later life.

• Nutritional influences throughout the life course impact LBM

• Improving intake of diverse foods especially milk & animal source foods is necessary for optimal body composition

• Interventions focusing on child nutrition should aim at increase in LBM to address the double burden of malnutrition

# THANK YOU