Energy requirements of Indians

Anura V Kurpad, MD, PhD, FRCP, FAMS

Professor, Department of Physiology,

St John's Medical College, Bengaluru

Key points to discuss

- The recent ICMR-NIN 2020 energy norms for adults and children
- Implications of the Energy Norm
  - Poverty
  - Hunger
  - Supplementary nutrition for children
  - Energy requirement of catch-up growth in SAM

The energy requirement: method

- Only based on expenditure measurements – not intake
- Factorial method – most common, as you only need to measure weight and age; and get a physical activity questionnaire
  - BMR x PAL
- Measure Total Energy Expenditure
  - DLW

BMR: for populations (or individuals)

- BMR is predicted from age- and sex-specific equations
- Most used –WHO equation or Schofield
  - Clinical equations - Harris-Benedict, Owen, Mifflin
- The equation depends on the population it was derived from
  - Muscular, active young men (army recruits) would probably have a higher BMR

The Indian BMR

- Careful measurements by Shetty & Soares (1980's-90's) documented that Indian subjects' BMR was lower than what was predicted by the WHO/FAO/UNU equation

- This has been repeated in many countries in Asia- but methods vary (RMR vs BMR) – this is a critical problem.

- A lower BMR will lower the total Energy requirement

And if you do not have the measured weight?

- Take an aspirational height: 95th percentile of population values
- Find the weight for this height that would correspond to a BMI of 21 kg/M^2
- 65 Kg for men and 55 for women
- Predict BMR

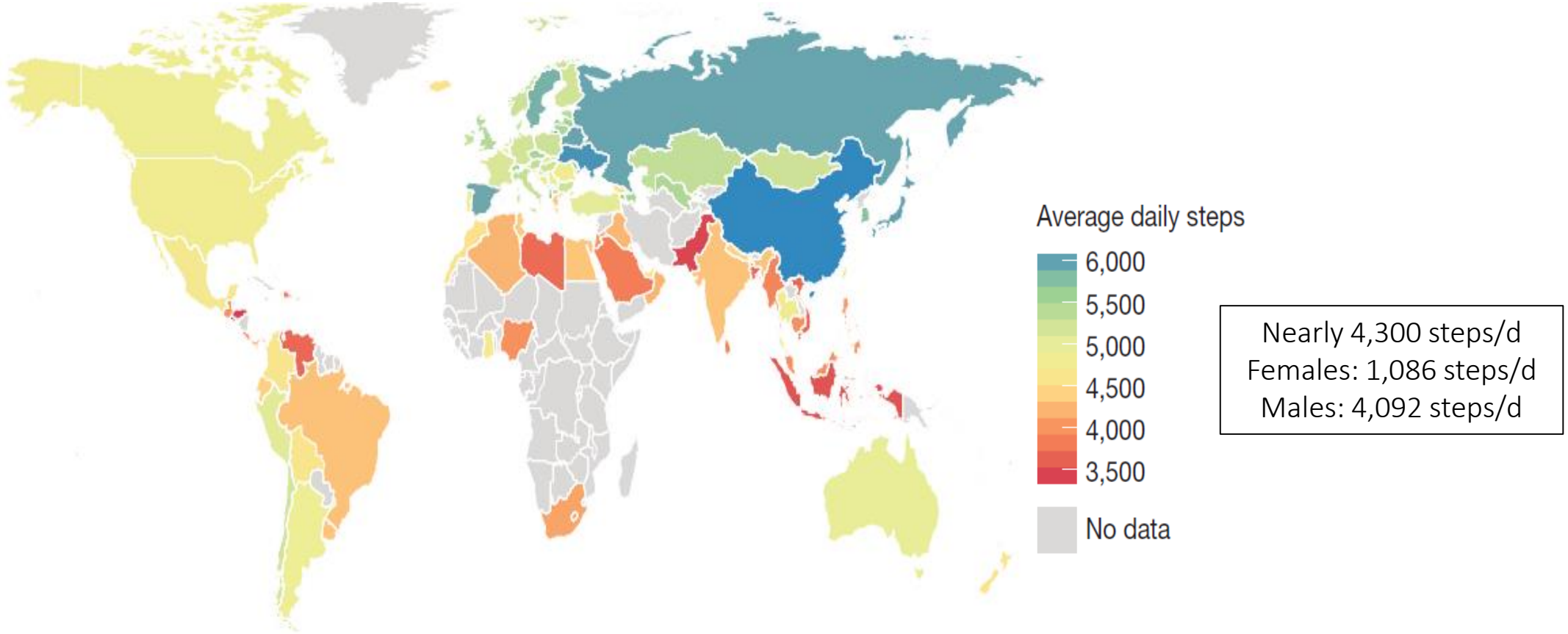
Is PAL lower in Indians?

doi:10.1038/nature23018

Large-scale physical activity data reveal worldwide activity inequality

Tim Althoff[1], Rok Sosič[1], Jennifer L. Hicks[2], Abby C. King[3,4], Scott L. Delp[2,5] & Jure Leskovec[1,6]

App-based step counts from smartphones and self reported BMI (n=717,527)

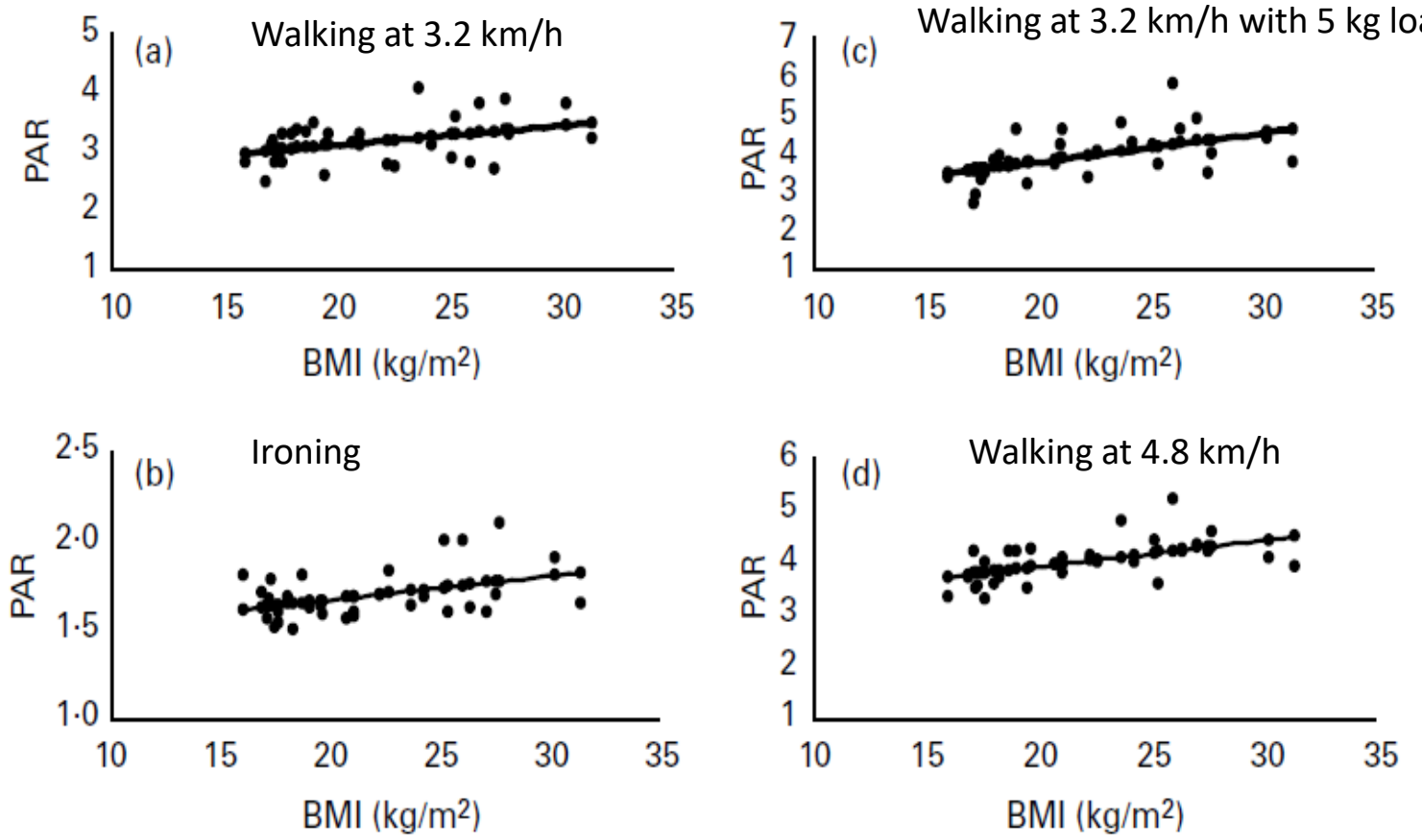


Nearly 4,300 steps/d
Females: 1,086 steps/d
Males: 4,092 steps/d

- Indian ranked low in physical activity with large gender gap;
- A careful attention is required in defining energy requirement for sedentary population

Other reasons for a lower PAL in Indians?

- PAR (energy expended in each activity) could also be lower
- Take a daily history of activities
- PAL = Daily sum of (activity PAR x its duration)/total minutes
- The PAR is lower at lower BMI – would lead to a lower PAL



British Journal of Nutrition (2006), **96**, 71–79
DOI: 10.1079/BJN20051672

Physical activity ratio of selected activities in Indian male and female subjects and its relationship with body mass index

Rebecca Kuriyan[1]*, Parvathi P. Easwaran[2] and Anura V. Kurpad[1]

A recent study in Bengaluru

- TEE of millennials (in their 20's to 30's), measured by DLW.
- Measure BMR to get PAL (TEE/BMR)
- Also validate BMR equation

- TEE was 13% lower than predicted using FAO/WHO/UNU 2004
- Measured BMR: 7% lower than predicted
- Measured PAL = 1.35

- PAL by questionnaire: 1.53

Srishti Sinha, A Kurpad, Rebecca Kuriyan-Raj, EJCN, 2020

Present PAL recommendations for the requirement

Activity	Sedentary	Moderate	Heavy
FAO/WHO/UNU 2005			
• Males and females	1.40-1.69	1.70-1.99	2.0-2.40
ICMR 2010			
• Males and females	1.53	1.80	2.30
ICMR 2020			
• Males and females	1.40	1.80	2.30

A philosophical aside: do you reduce the PAL value or keep it high, *hoping* that population will become more active?

The energy norm

Age group	Category	ICMR 2020	ICMR 2010	Difference
		kcal/d		
Adult Men (65 Kg)	Sedentary work	2110	2320	-210
	Moderate work	2710	2730	-20
	Heavy work	3470	3490	-20
Adult Women (55 Kg)	Sedentary work	1660	1900	-240
	Moderate work	2130	2230	-100
	Heavy work	2720	2850	-130

- Not much difference for moderate and heavy work
- The difference is due to lower BMR
- Larger difference in women because the normative weight in men increased

Implications - poverty

- Rangarajan Committee
- Energy is part of poverty estimation: Nutrient intake compared to nutritional norms for energy, protein and fat per capita per day

- Earlier Norm for energy
  - Rural: 2155 kcal/capita/d
  - Urban: 2090 kcal/capita/d

- With new energy requirements, energy norms come down marginally
  - Rural: 2063 kcal/capita/d
  - Urban: 1959 kcal/capita/d

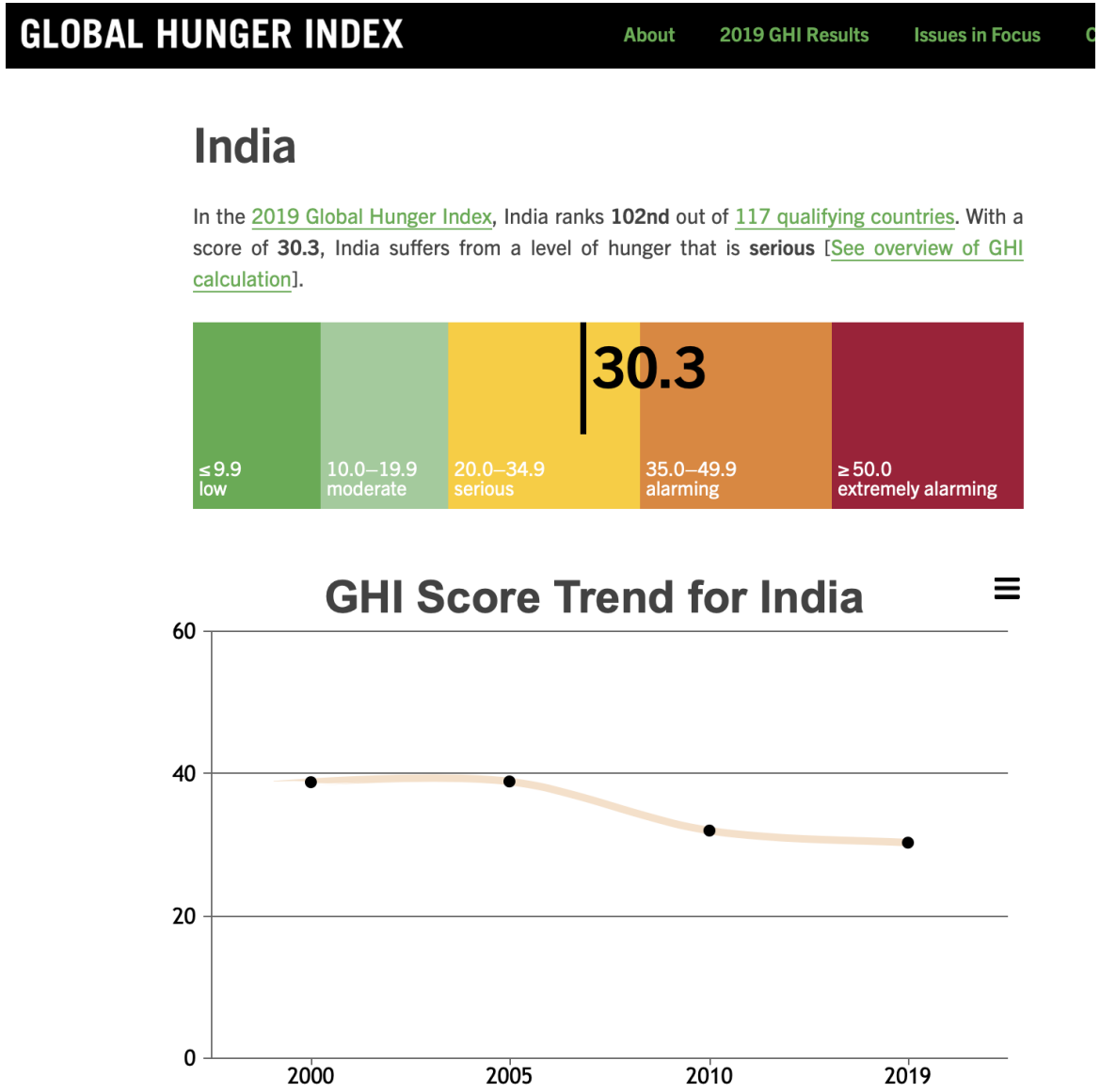
Reduces poverty line by Rs 1; reduces proportion BPL by 2%

Implications: Global Hunger Index

https://www.globalhungerindex.org/results.html

A contentious index

Uncertain metrics



How is the GHI calculated?

4 Indicators are assessed

1. **UNDERNOURISHMENT:** the share of the population that is undernourished (that is, whose caloric intake is insufficient) (Below the minimum dietary energy requirement for survival)

2. **CHILD WASTING:** the share of children under the age of five who are wasted (that is, who have low weight for their height, reflecting acute undernutrition);

3. **CHILD STUNTING:** the share of children under the age of five who are stunted (that is, who have low height for their age, reflecting chronic undernutrition); and

4. **CHILD MORTALITY:** the mortality rate of children under the age of five (in part, a reflection of the fatal mix of inadequate nutrition and unhealthy environments). [2]

The minimum dietary energy requirement (MDER) (FAO 2016)

- The intake that is adequate to maintain the minimum acceptable BMI of adult men and women engaged in low physical activity

- Where did the **minimum acceptable BMI come from?**
- Based on lowest (5^{th} percentile) weight – from WHO 1995 – from NHANES
  - Use weight to predict BMR
  - Use PAL of 1.55 for males and 1.56 for females

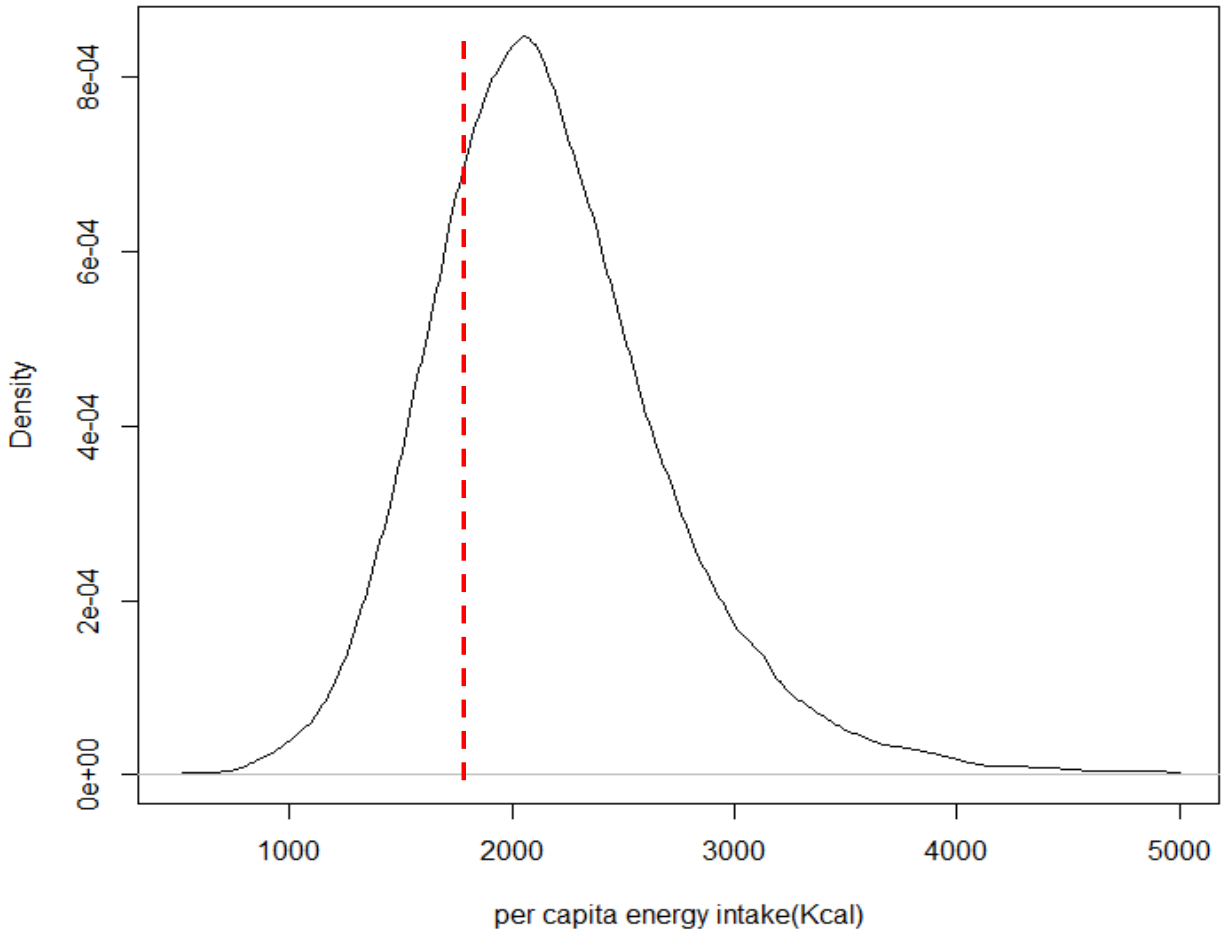
- MDER: 1802 Kcal/capita/day

WHO Physical status: The use and interpretation of anthropometry, 1995 → NHANES1, 1991; Must et al, 1991 AJCN

What proportion of energy intakes fall below the MDER?

- EI based on NSSO (2011-12)[1]
- Average for men and women
- Mean intake = 2060 kcal/capita/d

- Proportion <1800 = 14.3%
  - This is the value used in the GHI



NSSO 68th round consumer expenditure survey, 2011-12

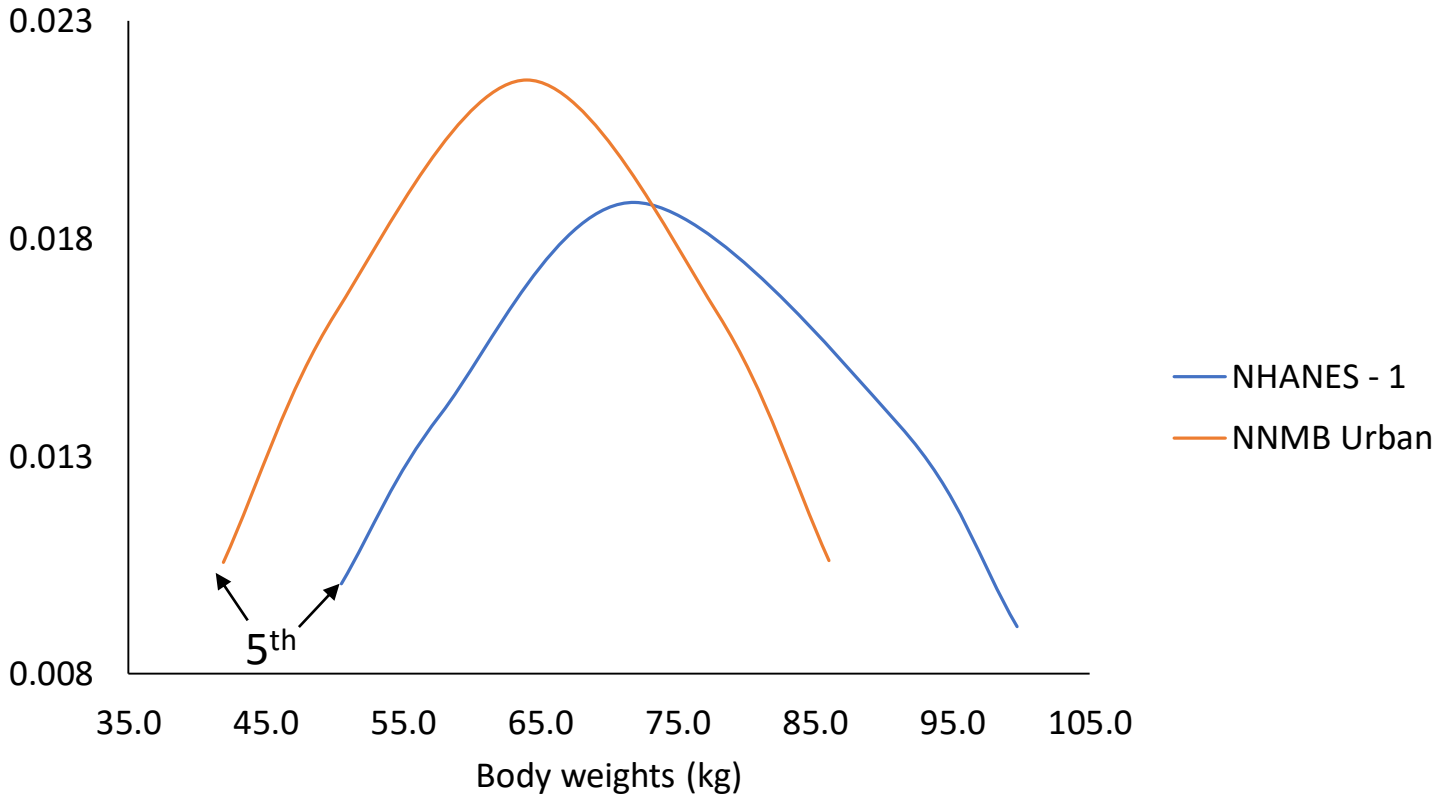
Re-thinking the MDER in India

- ICMR-NIN 2020
  - Sedentary Men = 2110 kcal/d
  - Sedentary Women = 1660 kcal/d
  - Average = 1885 kcal/d
  - FAO, MDER = 1800 kcal/d

FAO/WHO/UNU, Human Energy Requirement, 2004

Body weight matters! NHANES Vs NNMB

- Weights are different:
- NHANES – 1 & NNMB urban survey – For men
- 5th percentile for American men = 20th percentile for Indian men
- Also: lower BMR and PAL



Possible MDER for India

Data	Body weight (kg)	BMR	PAL	MDER (kcal/d)	MDER adjusted for demographics (kcal/capita/d)*
FAO 2016 (5th percentile BMI)[1]	45.5	1260	1.55	1950	1802
NNMB 5th percentile BW & 10% lower BMR[3]	40.7#	1085	1.55	1691	1563

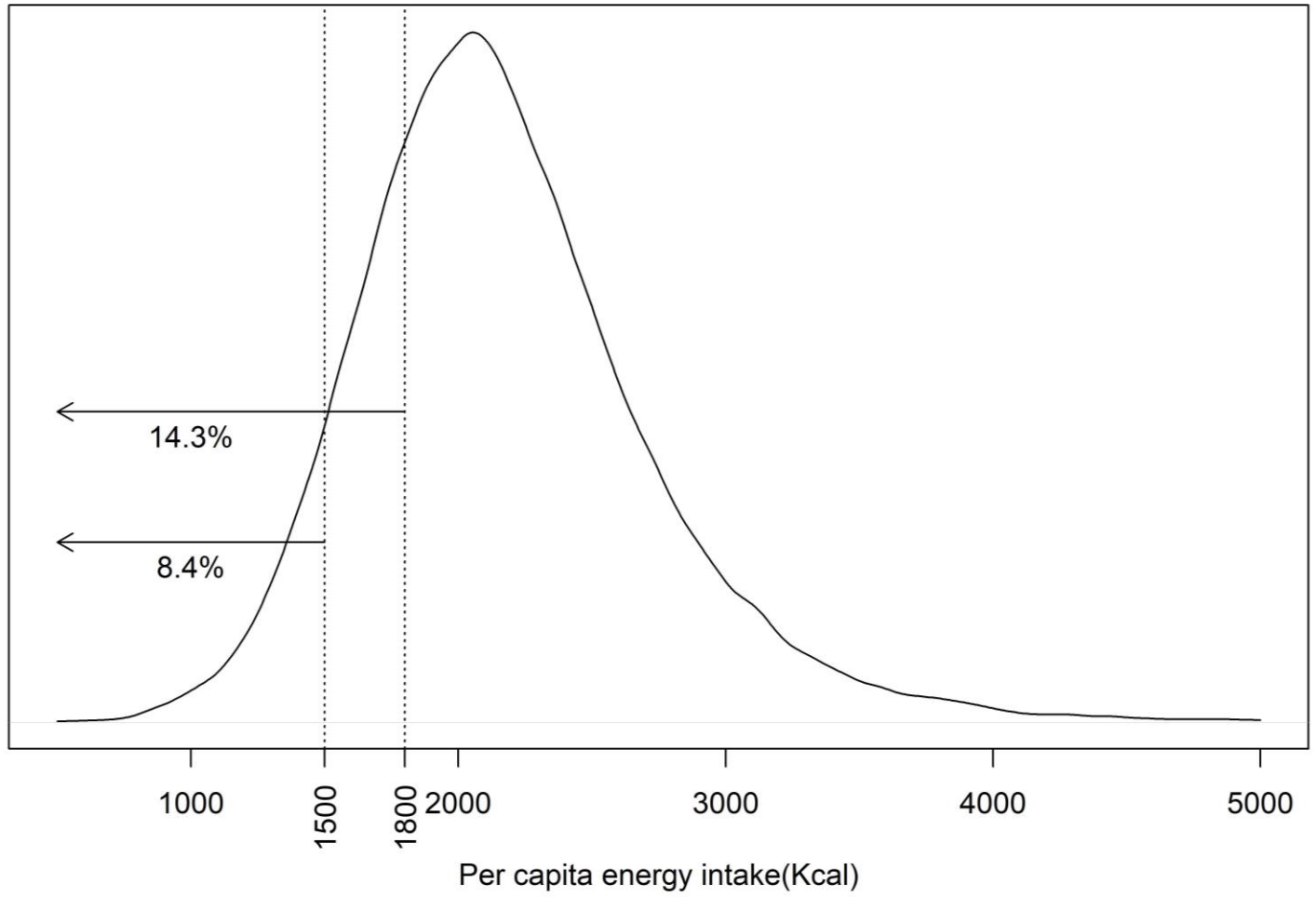
*Requirement is weighed according to population structure - 23% children population and 77% adult population – Census, 2011
Calculated with BMI of 18.5 kg/m^2 and 5th percentile height (NNMB, 2012 & 2016)

[1]http://www.fao.org/faostat/en/#data/FS/metadata; [2]Must et al, 2005 AJCN; [3]NNMB – rural and urban surveys, 2012, 2016

What proportion of undernourishment when using different MDER cutoffs (1800 vs 1500 kcal/d)?

Proportion <MDER:

- <1800 kcal/capita/d = 14.3%
- <1500 kcal/capita/d = 8.4%



NSSO 68th round consumer expenditure survey, 2011-12

ER for Children and Adolescents

Age Group	Category	Body weights	Requirement	
			(kcal/d)[a]	(kcal/kg/day)
Infants	0-6 m	5.8	550	95
	6-12m	8.5	670	80
Children[d]	1-3y 4-6y 7-9 y	11.7 18.3 25.3	1010 1360 1700	86 74 67
Boys	10-12y	34.9	2220	64
Girls	10-12y	36.4	2060	57
Boys	13-15y	50.5	2860	57
Girls	13-15y	49.6	2400	49
Boys	16-18y	64.4	3320	52
Girls	16-18y	55.7	2500	45

80

ICMR, 2020

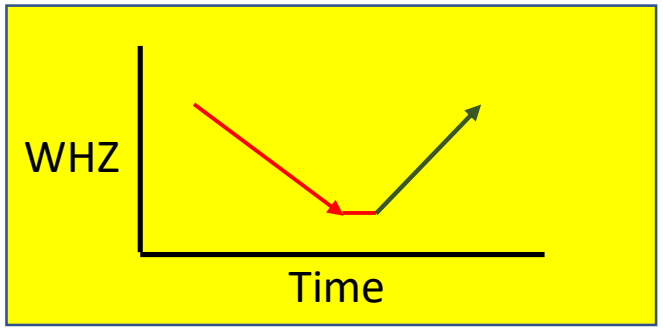
Energy norms for Supplementary Nutrition

- Present norm: **500 kCal/day** for 0.5 to 6y old child; **800 kCal/day** for malnourished
- But what is the real energy gap, and what foods are needed?
- Using NNMB rural intake data, cleaned, and only for those children with WAZ ≥-2
  - Calculate gap against ICMR NIN 2020 requirement
- The gap is ~**250 kCal/day**; risk of protein inadequacy is low at 6% (mainly cereal)
- The macronutrient with most deficit: **fat** (10-20g/day)

- We are overfeeding with the wrong foods; too much volume
- Legumes, fruits & vegetables, milk intake is low

Energy norms for Catch-up growth in SAM

- How much energy do you feed a malnourished child (SAM)?
- The aim is to have the child to catch up: from <-3WHZ to > -2 WHZ in a short time (10-20 days) – **in a hurry**.

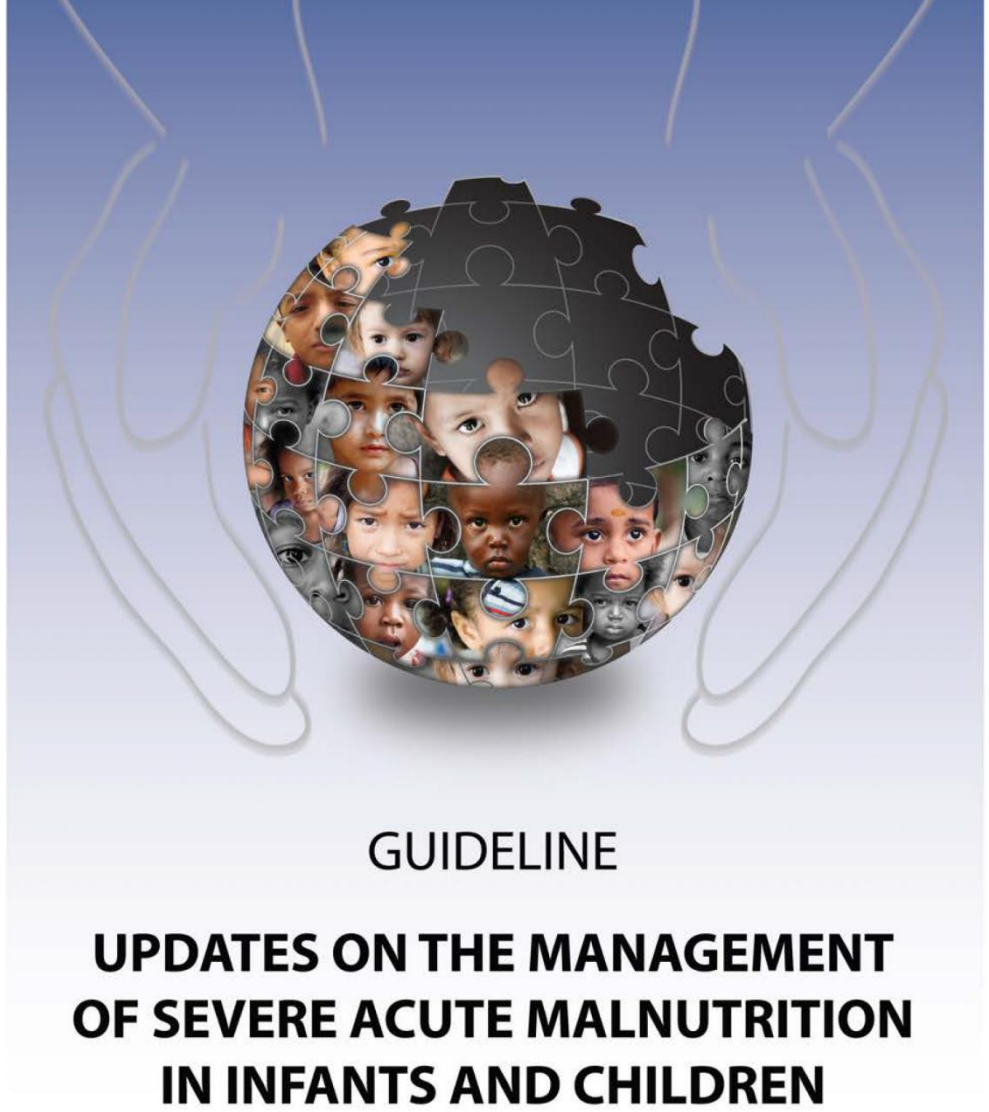


Led to the concept of 'therapeutic' feeding

A form of hyperalimentation

- Feeding Norm in India is **200 kCal/kg/day***

*: Niti Ayog, NTBN



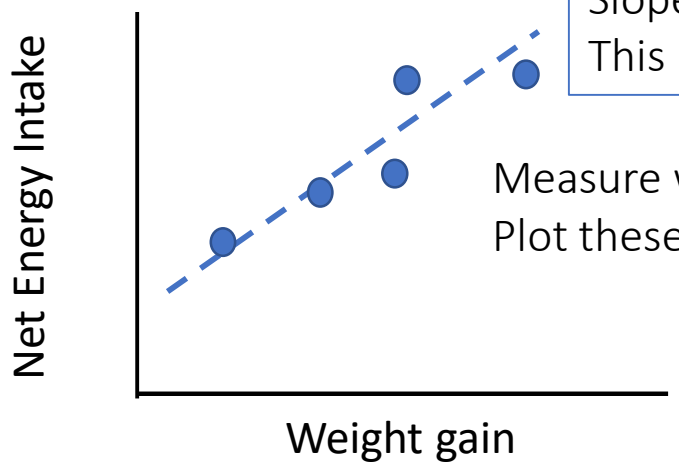
What is the WHO guideline?

- The WHO norm is **100-135** kCal/kg/day

- How was this calculated?

Calculating the energetic cost of growth (more lean mass)

Total cost



Slope= 4.3 kCal/ 1 g tissue
This is the total cost of material + labor

Measure weight gain and energy intake in growing children
Plot these data, draw a trend line

Labor =
~ 1.0 kCal/g tissue

Materials

1 g weight

30% Fat 0.3 — 85% fat, 15% cytoplasm — 0.255 g — Gross energy 9.37 kCal/g — 0.8 kCal

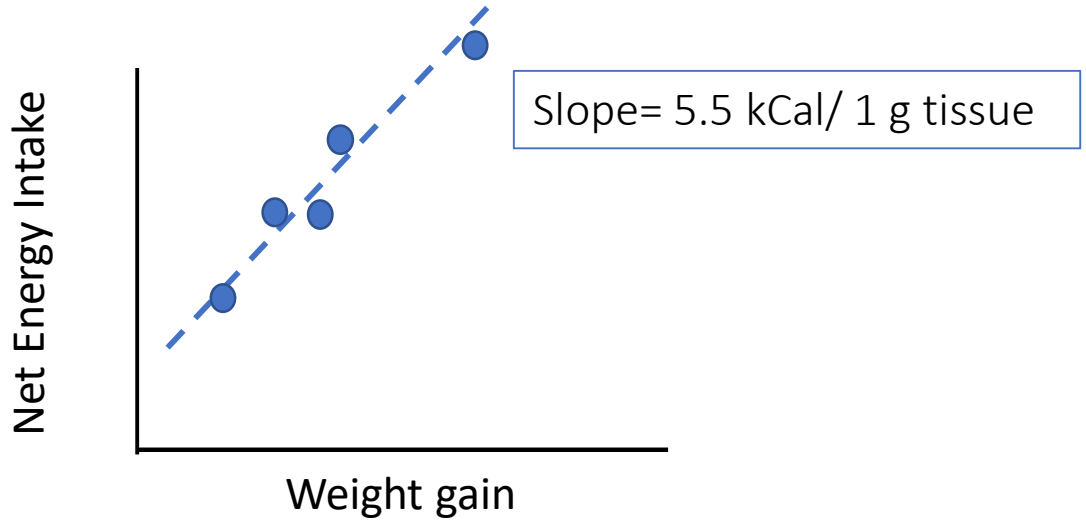
70% Lean 0.7 — 20% protein, 80% other — 0.14 g — Gross energy 5.67 kCal/g — 2.37 kCal

0.8 + 2.37 = 3.2 kCal/g

FAO/WHO/UNU, 2004 and Spady et al, 1976

Calculating the energetic cost of growth (more fat)

Total cost



Cost

5.5 kCal/g Vs 4.3 kCal/g

Materials

1 g weight

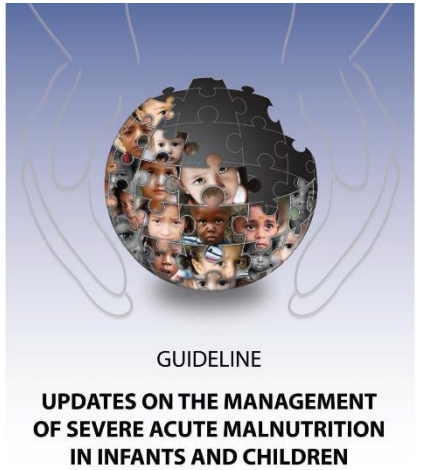
50%	Fat 0.5	85% fat 15% cytoplasm	0.425 g	Gross energy 9.37 kCal/g	3.98 kCal
50%	Lean 0.5	20% protein 80% other	0.1 g	Gross energy 5.67 kCal/g	0.56 kCal

3.98 + 0.56 = 4.5 kCal/g

FAO/WHO/UNU, 2004 and Spady et al, 1976

So: the total energy cost of 5 – 10 g/kg weight gain/day

	70:30 (Lean: Fat)		50:50 (Lean: Fat)	
Growth rate	Cost (4.3 kCal/g)	Total required (kCal/kg/day)	Cost (5.5 Kcal/g)	Total required (kCal/kg/day)
5g/kg/day	= 5 x 4.3 = 21.5 kCal	= 80 + 21.5 = **101.5** kCal	= 5 x 5.5 = 27.5 kCal	= 80 + 27.5 = 107.5 kCal
10g/kg/day	= 10 x 4.3 = 43 kCal	= 80 + 43 = 123 kCal	= 10 x 5.5 = 55 kCal	= 80 + 55 = **135** kCal



100 – 135 kCal/kg/d

In perspective

What is the normal growth rate of a child (1-2y old)?

<<< 1 g/kg/day

Reduces even more with age

The clinical reality:

- Growth rate of >5 g/kg/day is rare
- Usually about 3 g/kg/day

<u>The downside of 200 kCal @ a density of 5 kCal/g</u>:

- Re-feeding syndrome
- Oily and sweet: sets taste preference
- Adverse composition of growth
- High K content

Overfeeding and fatty liver

PLOS ONE

Long-term metabolic effects of malnutrition: Liver steatosis and insulin resistance following early-life protein restriction

Prasad S. Dalvi[1,2], Steven Yang[1], Nathan Swain[1], Junsoo Kim[1], Senjuti Saha[1], Celine Bourdon[1], Ling Zhang[1], Rose Chami[3,4], Robert H. J. Bandsma[1,5]*

- Either 'undernourished' or 'normal' litter
- With 16 weeks of recovery feeding – Normal vs 'High Energy, Fat' (5.5 kCal/g; 58% fat)

- Liver fat increased ~3 fold (~9 vs 27%) in both groups

Why this hurry? Why give so much?

Mortality of children with severe acute malnutrition observed in longitudinal studies

Country	Mortality rate
Congo, Democratic Republic of the	21%
Bangladesh	20%
Senegal	20%
Uganda	12%
Yemen	10%

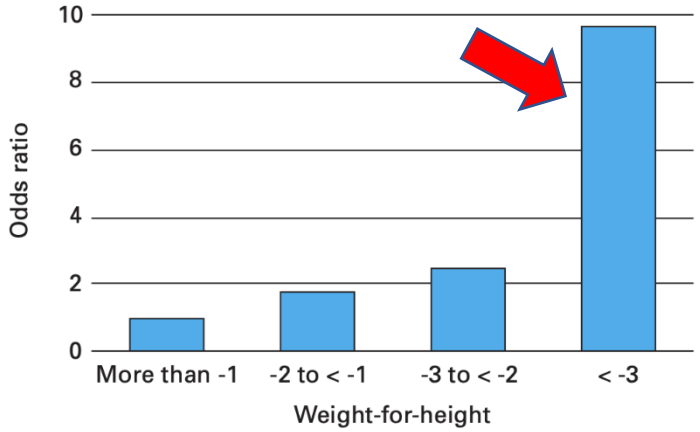
Note: For studies of less than 12 months, rate was adjusted for duration of follow-up.

A high mortality

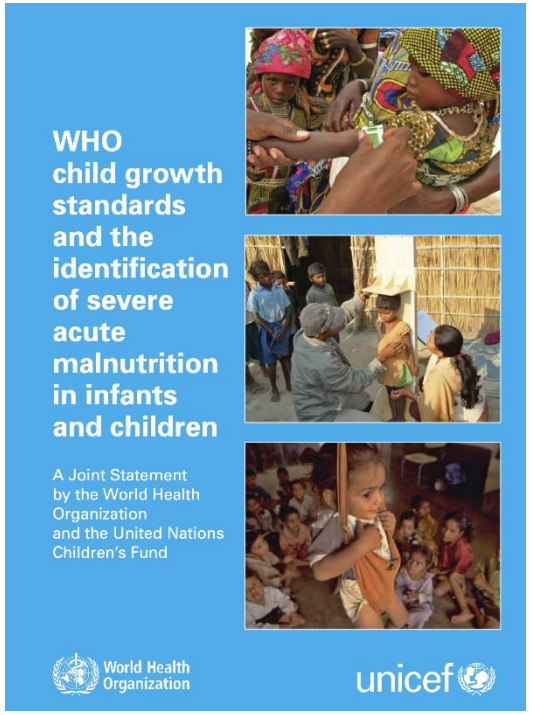
A dramatic increase in mortality risk (10-fold)

FIGURE 1

Odds ratio for mortality by weight-for-height. Adapted from reference 9



Note: reference category: children with a weight-for-height > -1 SD.



One peculiarity in Severe Acute Malnutrition (SAM)

- The word '**Acute**' implies sudden and recent weight loss
- Yet- when we diagnose SAM in public health- no history is obtained
  - This is OK during an infectious epidemic or disasters
- Sudden (acute and unintended) weight loss is always a concern
- However, is SAM in India different? Is the severe malnutrition chronic or persistent?
- Then, could mortality differ?

Some studies of mortality in India

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RESEARCH ARTICLE

Mortality and recovery following moderate and severe acute malnutrition in children aged 6–18 months in rural Jharkhand and Odisha, eastern India: A cohort study

Audrey Prost, Nirmala Nair, Andrew Copas, Hemanta Pradhan, Naomi Saville, Prasanta Tripathy, Rajkumar Gope, Shibanand Rath, Suchitra Rath, Jolene Skordis, Sanghita Bhattacharyya, Anthony Costello, Harshpal S. Sachdev

Published: October 15, 2019 • https://doi.org/10.1371/journal.pmed.1002934

We found that SAM carried a lower case fatality rate **(1.2%)** than expected from WHO estimates (10%–20%), echoing results from three other Indian studies, which found case fatality rates ranging from **2.7% to 5.2%** among children older than 6 months.

- If mortality is low in India, is there a need for such a fast rate of catch-up?
- Could severe acute 'overnutrition' occur?

Final thoughts

- New norms: mindful of extra energy at all ages: the risk of overweight is real
- Has implications for assessing “hunger”, small effect on poverty
- Energy norm for supplemental nutrition and feeding children with SAM:
  - Too much cereal calories at present
  - In SAM: aim for steady restitution with the best possible body composition
  - No need for 200 kCal/kg/day: 100 is enough
  - Distinguish undersized from undernourished