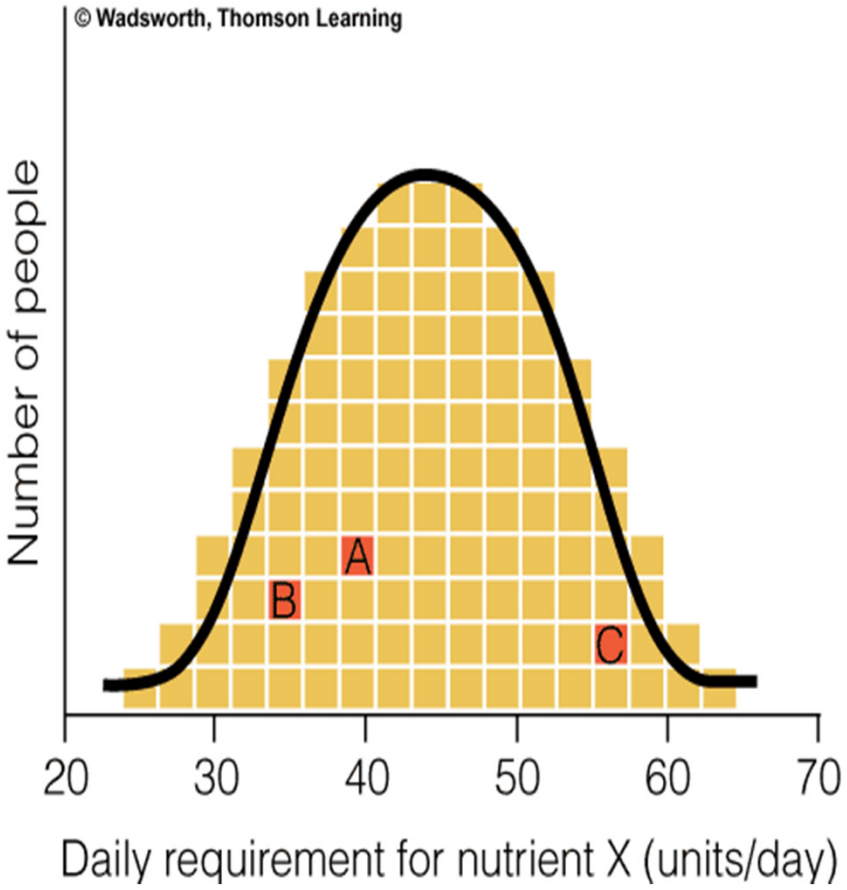
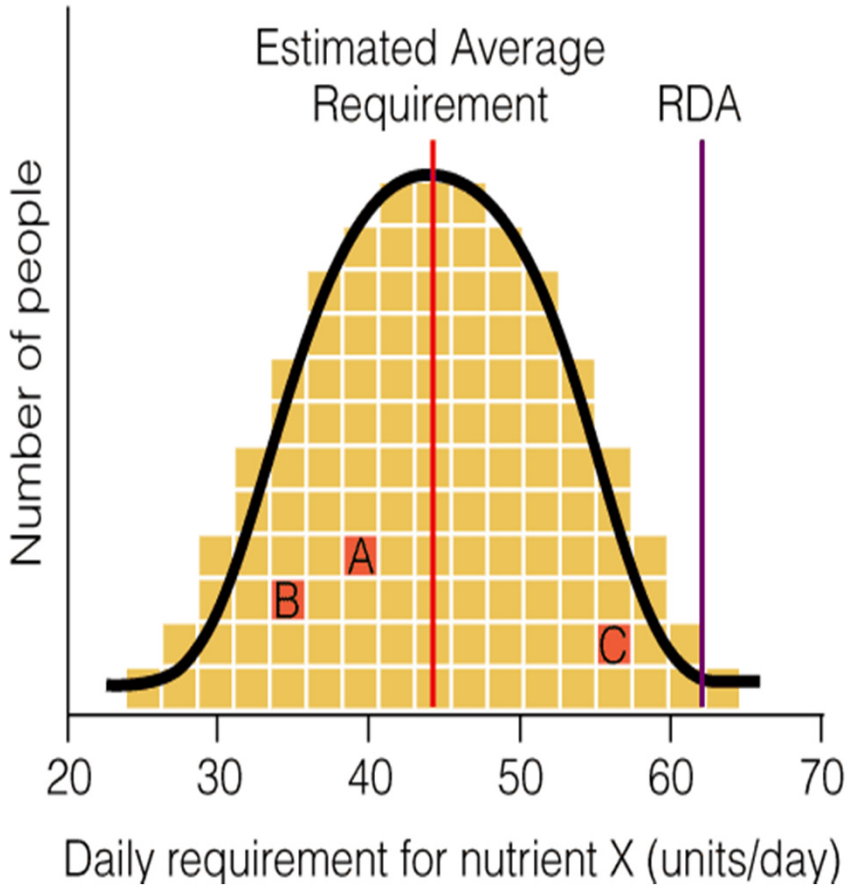
Basic Principles of coming to a requirement

AV Kurpad

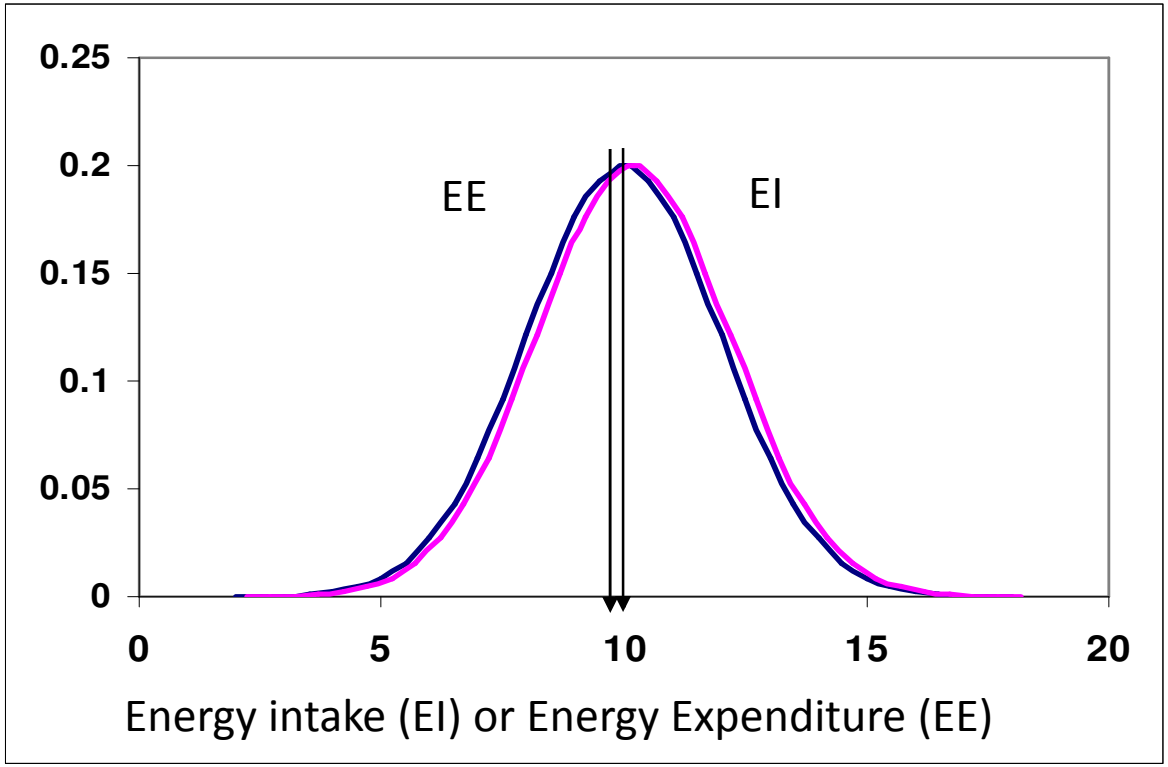
EAR vs RDA

Remember, we are talking of a distribution of <u>requirements</u>





Energy expenditure and intake overlap



Body weight stable in population

Use of DRIs: Assessing Intakes

- **For an Individual**
- EAR: Use to examine the probability that usual intake is inadequate
- RDA: Usual intake at/above this level has low probability of inadequacy
- AI: Usual intake at/above this level has low probability of inadequacy
- UL: Usual intake above this level may place individual at risk of adverse effects from excessive nutrient intake

- **For a Group**
- EAR: Use to examine the prevalence of inadequate intakes within a group
- RDA: Do not use to assess intakes of groups
- AI: Mean usual intake at/above this level implies a low prevalence of inadequate intakes
- UL: Use to estimate % population at potential risk of adverse effects from excessive nutrient intake

RDA is inappropriate for assessing groups

- RDA: intake levels that exceed requirements of 97–98 % of all individuals when requirements in the group have a normal distribution

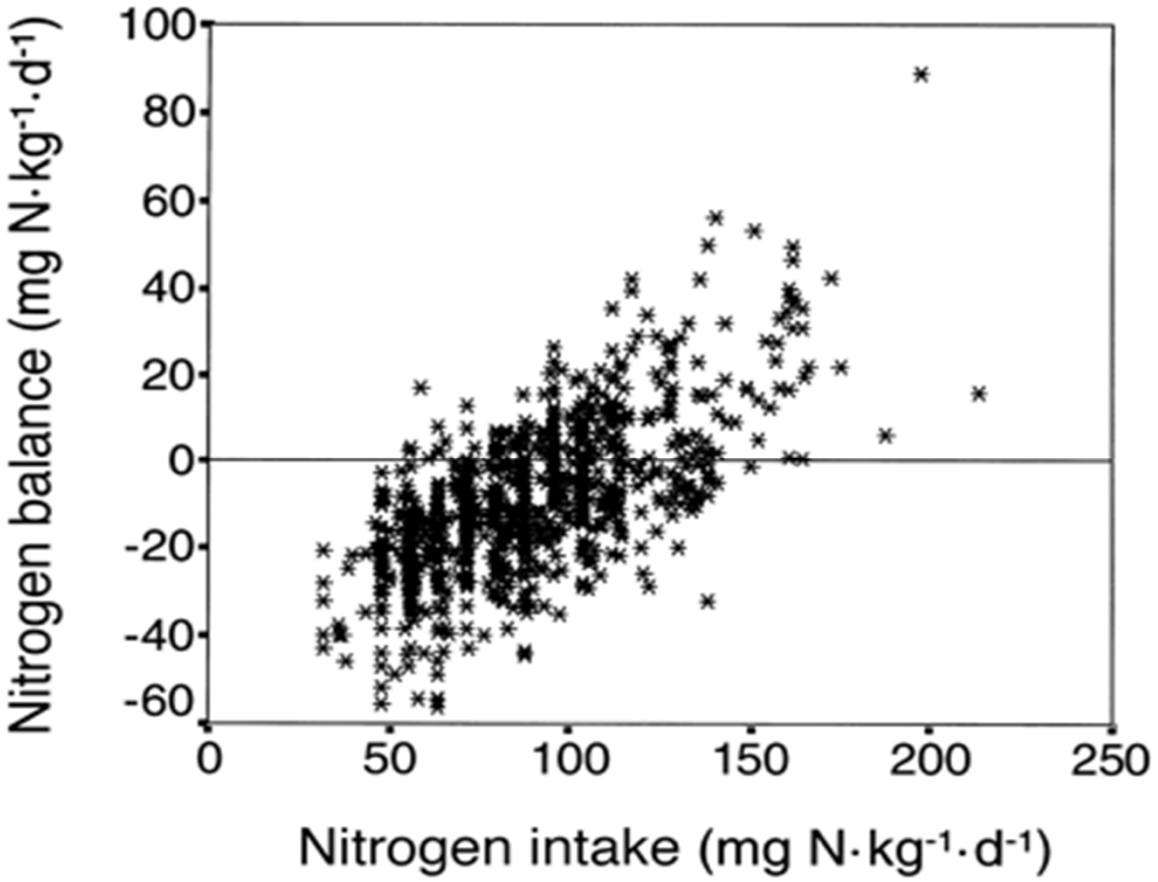
- Thus, RDA: not a cut-point for assessing nutrient intakes of groups-- serious overestimation of the proportion of the group at risk of inadequacy would result

Requirement

- g/kg/day or mg/kg/day – physiological construct
- Mg/g protein – a food or protein quality construct
- Ratio of protein to energy: PE ratio

- Digestibility
- PDCAAS
- Ileal digestibility
- Corrections for PDCAAS

Data from all studies



- Is balance equal to optimal growth?

Infections?

Kurpad IJMR 2006

Requirements for protein in different acute and chronic bacterial infections

Condition	Allowance (As a percentage of protein requirements)
Untreated Tuberculosis	25
Partly treated melioidosis	15
Mixed intestinal parasites	10
Acute bacterial infection (including convalescence)	20
Acute diarrhea (including convalescence)	30
Mild febrile illness	15
Sepsis	30

PE ratios

- Protein: Energy ratio
- Protein quality (Amino Acid Score)
- The higher the energy requirement, the lower the PE requirement of the diet

  - 1500 cal + 60 g protein = PE ratio of 0.16
  - 2000 cal + 60 g protein = PE ratio of 0.12

Protein quality is important in addressing PE ratios

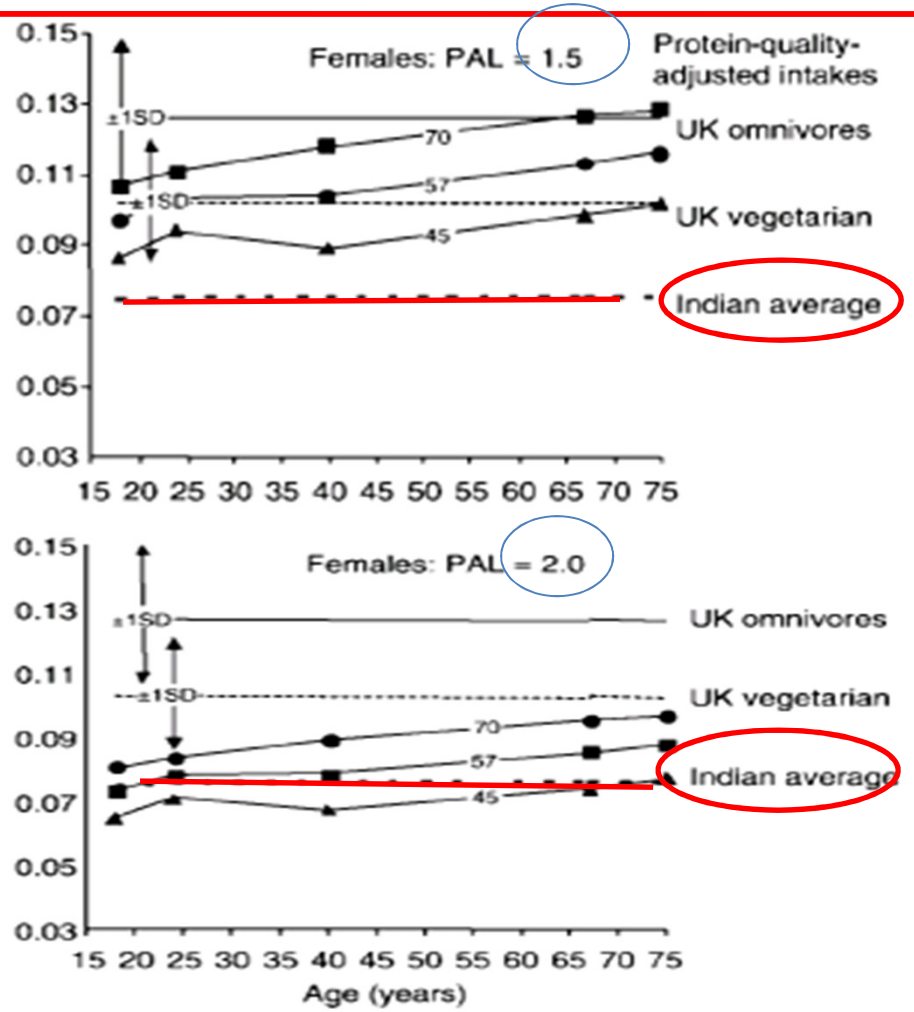
- Protein: Energy ratio
- Protein quality (Amino Acid Score)
- Lysine limiting
- Req of lysine = 30 mg/kg/d ; req of protein = 0.66 g/kg/d
- Lysine score of requirement = 30 / 0.66 = 45 mg/g
- Diet lysine score = 30 mg/g
- Amino Acid Score = Diet score / reference score = 30 / 30 = 1
- Digestibility = 85%
- PDCAAS = 0.85 x 1 = 0.85

- PE Ratio corrected for protein quality: PDCAAS PE
- If PE ratio = 10%, then PDCAAS corrected PE ratio = 10 * 0.85 = 8.5%

PDCAAS corrected PE ratio

PDCAAS PE Ratio

of the requirement



PDCAAS PE Ratio of the intake

Millward & Jackson, PHN, 2003

PDCAAS

- Digestibility is prime
- Cannot have a PDCAAS > 100
- Generally- with Indian diets- always at 0.8.
- Meat/milk- 0.95

Insights on digestibility

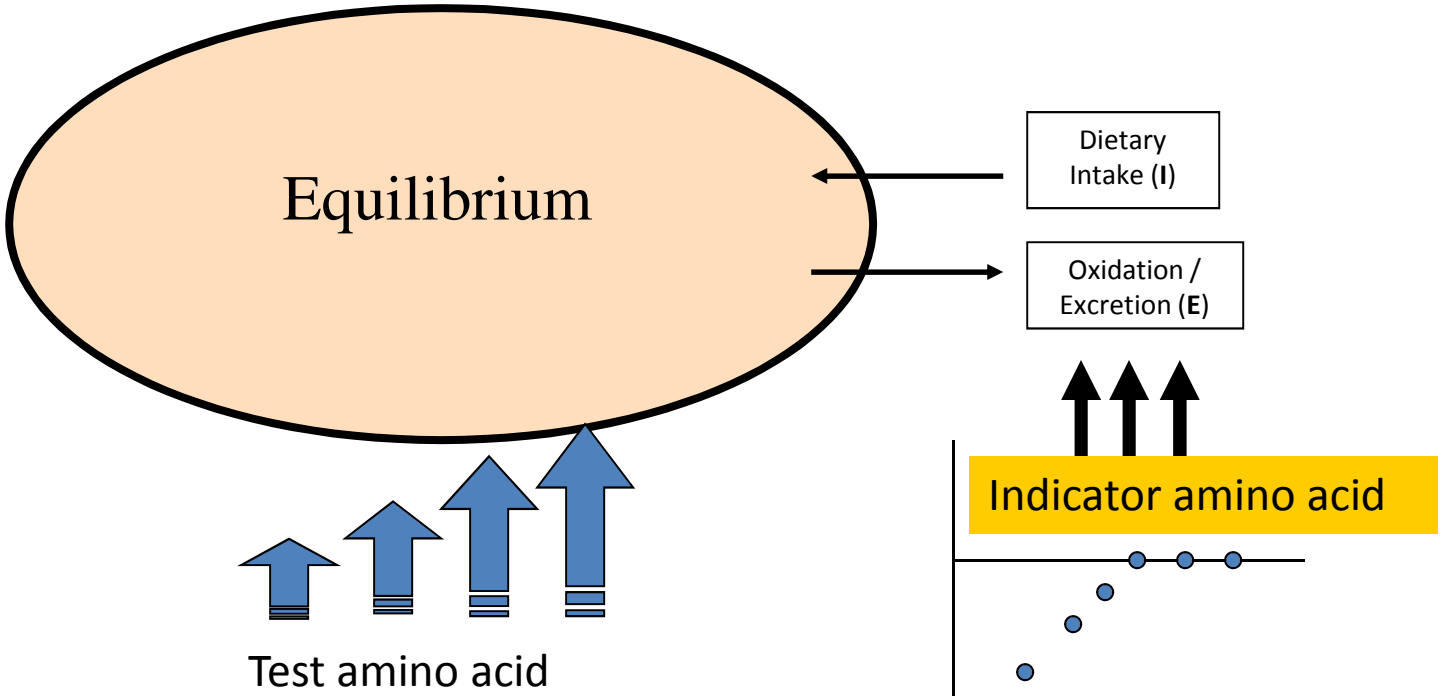
- Fecal digestibility
- Ileal digestibility - DIAAS
- AA digestibility – specific for each AA
- Cooking and digestibility

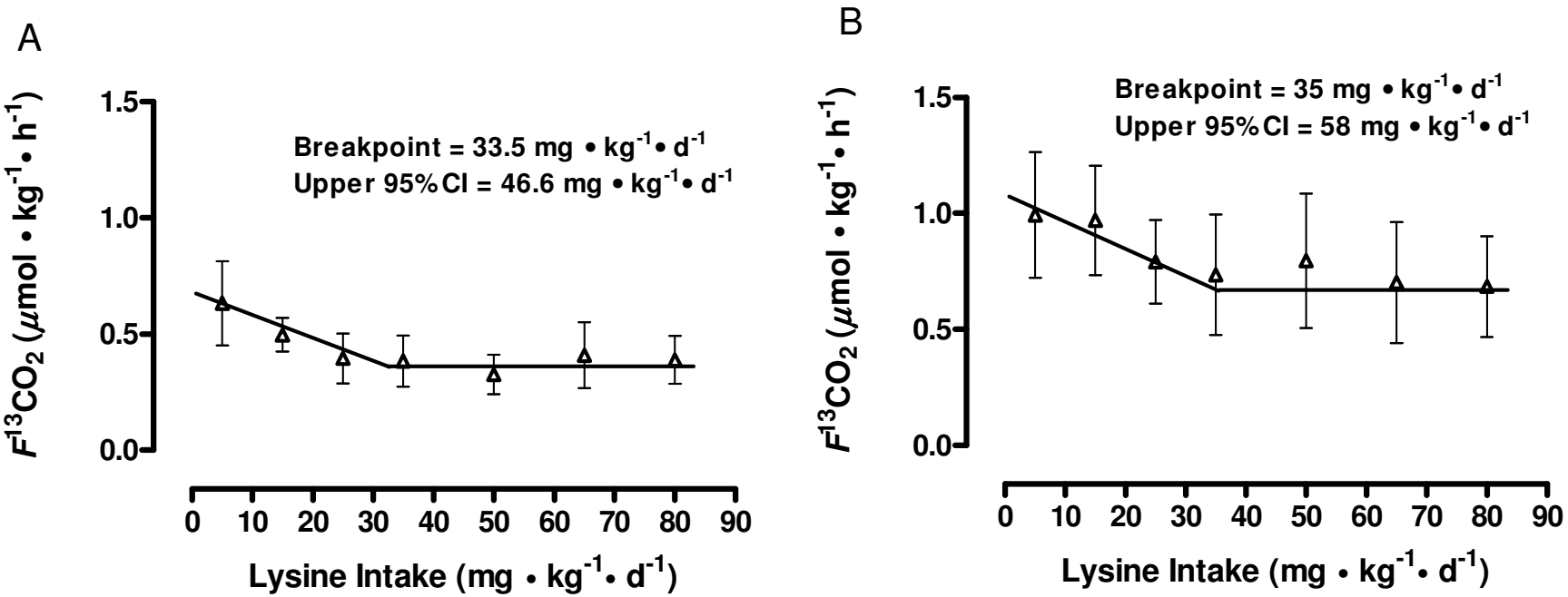
Amino Acid requirement

N balance

- Unreliable for a variety of reasons
- Protein sparing effect of energy

The indicator method developed in St John's




A
B
$F^{13}CO_2$ (μmol • kg^{-1}• h^{-1})
1.5
1.0
0.5
0.0
Breakpoint = 33.5 mg • kg^{-1}• d^{-1}
Upper 95%CI = 46.6 mg • kg^{-1}• d^{-1}
0 10 20 30 40 50 60 70 80 90
Lysine Intake (mg • kg^{-1}• d^{-1})
Breakpoint = 35 mg • kg^{-1}• d^{-1}
Upper 95%CI = 58 mg • kg^{-1}• d^{-1}

Amino Acid Scoring Patterns for Different Food Products

		Amino Acid Score based on	
Protein Source	**Lysine Content mg/g protein**	**FAO/WHO/UNU 1985 (16 mg/g protein)**	**New Requirement Value (45 mg/g protein)**
Wheat	27	>100	60
Rice	35	>100	78
Sorghum	24	>100	53
Millet	22	>100	50
Nuts / Seeds	35	>100	77
Vegetables	43	>100	96
Legumes	73	>100	>100
Animal Protein	82	>100	>100

What can be done?

Complementary foods

Mix high and low lysine foods

Rice and dal (60: 40 or thereabouts!)
Chapatti and dal

Fish, meat, milk
Groundnut
Soy: limiting AA is sulfur containing AA

Public initiative: Increase pulse availability

Children: Needs for maintenance and growth

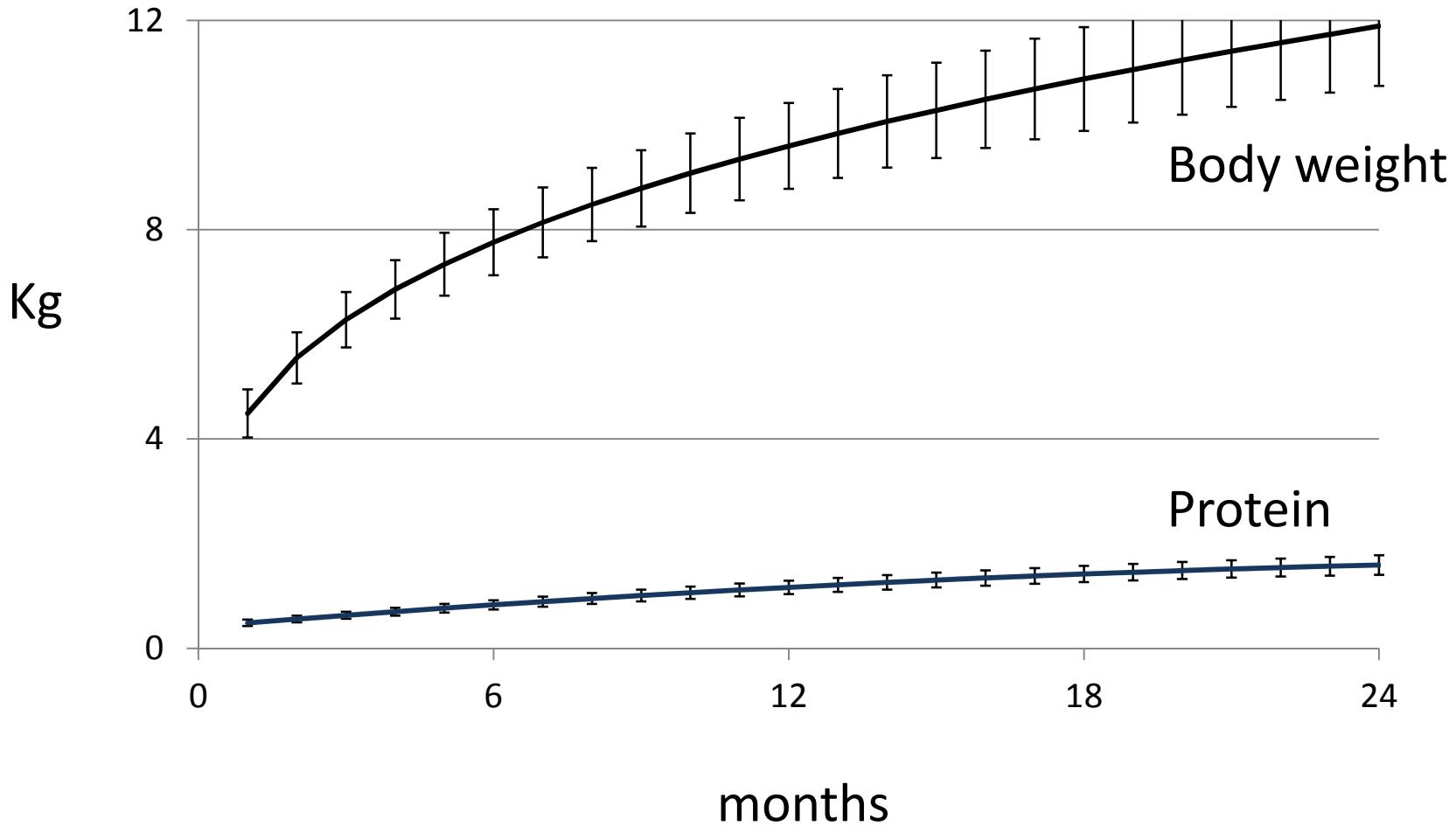
- For 0-6 months: breast milk
- For older children
  - From the factorial method
  - Direct experimental evidence

Children – the factorial method

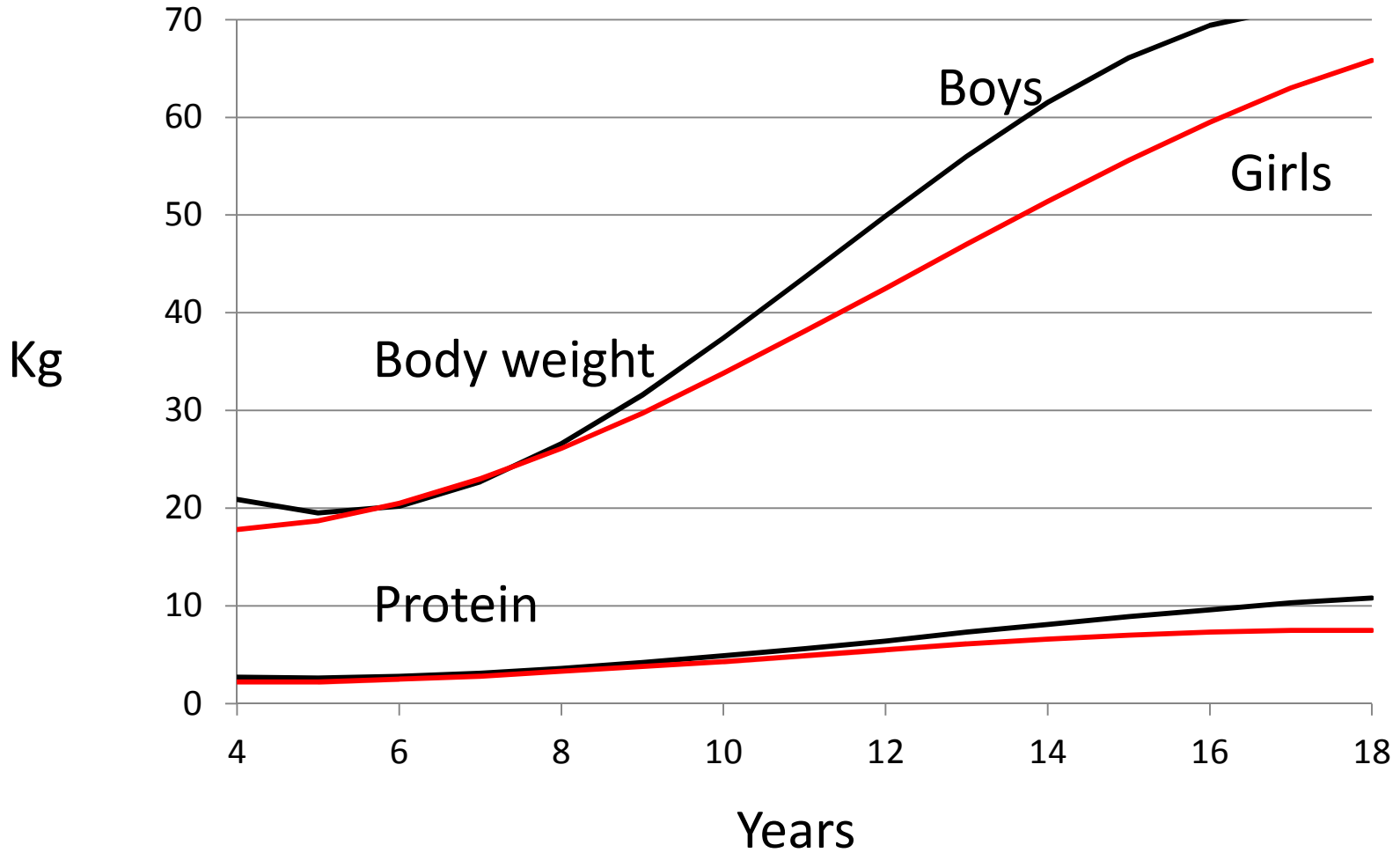
- Start with the protein requirement

- Obtain estimates of
  - maintenance requirement
  - growth-protein deposition data
  - efficiency of utilization of protein
  - the variability of growth

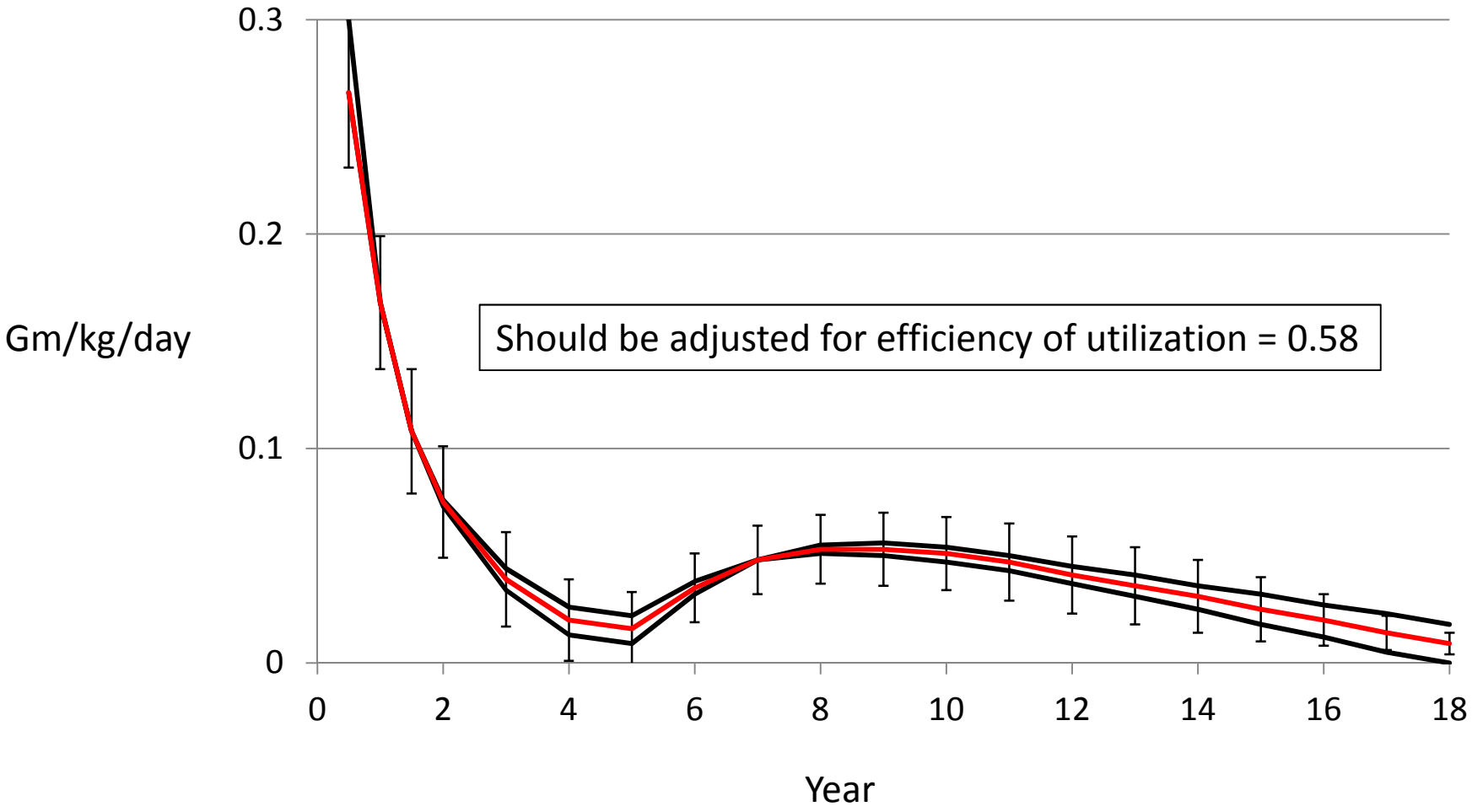
Growth and protein deposition curves for 0-2 years (Butte et al, 2000)



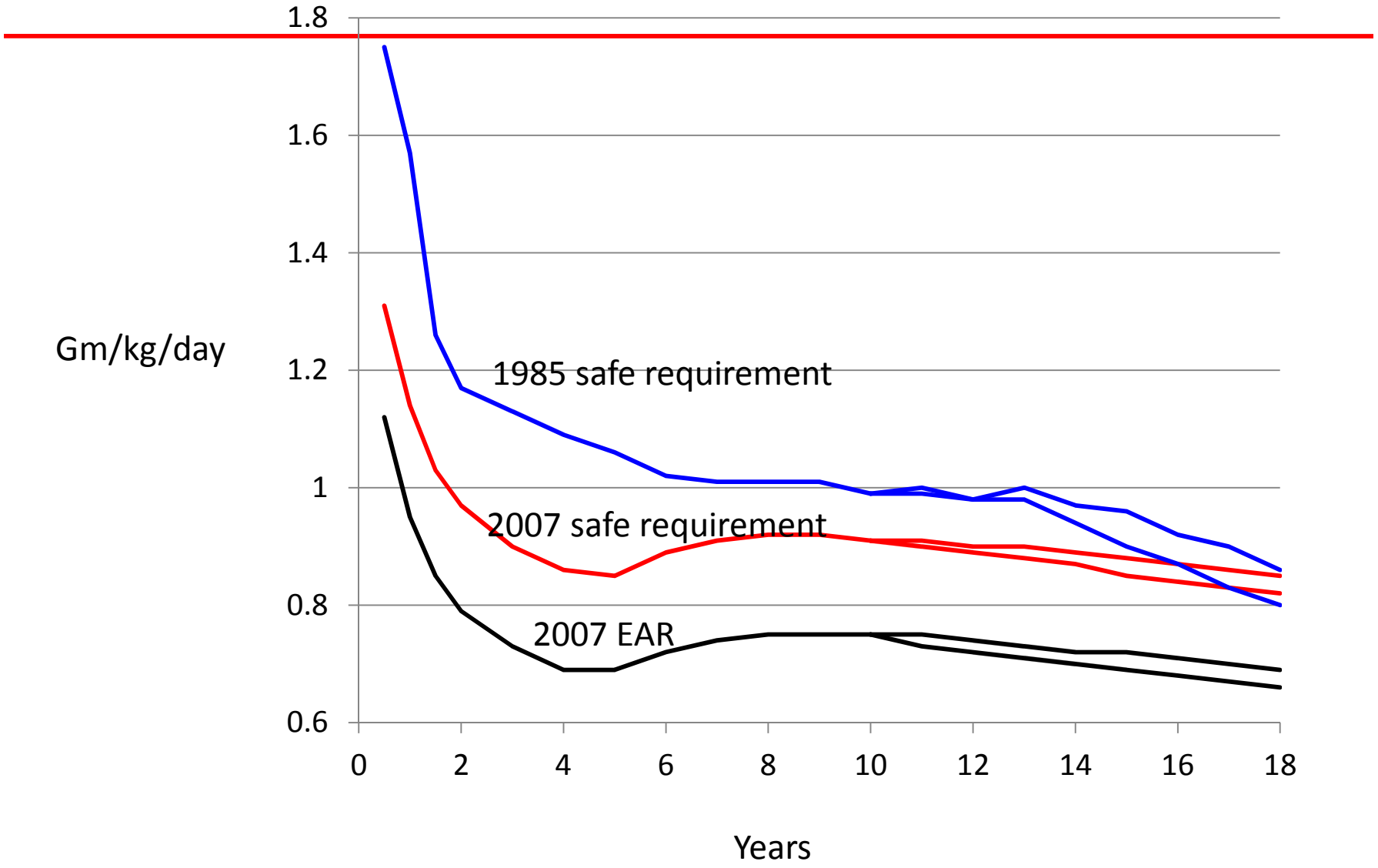
Growth and protein deposition curves for 4-18 years, boys & girls (Ellis et al, 2000)



Growth- Protein deposition rates



Protein requirements: 0.5 -18 years



Children – measuring AA requirement

- After obtaining protein requirement for
  - Maintenance
  - Growth

- Need amino acid composition of these two factorial estimates
  - Use adult maintenance AA pattern for maintenance
  - Use mixed tissue AA pattern for growth

Amino Acid requirement

- Maintenance requirement x maintenance pattern
- $\left\{ \frac{\text{Growth requirement}}{\text{Efficiency of deposition}} \right\}$ x tissue amino acid pattern
- SD of maintenance and growth

Preschool children: 2007 comparison with 1985

AA requirements (mg/kg/day)	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
1985 report preschool	31	73	64	27	69	37	13	38
2007 report preschool	27	54	45	22	40	23	6.4	36
New/Old ratio	0.87	0.74	0.70	0.81	0.58	0.62	0.49	0.95
Requirement pattern (mg/gm protein)	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
1985 report preschool	28	66	58	25	63	34	11	35
2007 report preschool	31	63	52	26	46	27	7.4	42
New/Old ratio	1.11	0.95	0.90	1.04	0.73	0.79	0.67	1.20

Catch up growth - acute

Depends on

- When- after stabilization on a low PE diet
- Composition of weight gain
- Efficiency of utilization for catch up growth
- Energy density

Requirement of catch up growth

Weight Gain rate (g/kg)	Protein required (gm/kg/day)	Energy required (kcal/kg/day)	PE ratio
1	1.02	89	4.6
2	1.22	93	5.2
5	1.82	105	6.9
10	2.82	126	8.9
20	4.82	167	11.5

Assuming 73% lean and 27% fat in composition of growth
Assuming 70% efficiency of deposition
Lysine scoring pattern would be similar as before

Requirements beyond tissue needs

- …how much of the different materials must be fed to maintain the body in condition?
- AAA required for acute phase protein synthesis
- Tyrosine/ SAA requirements in children recovering from SCU
- Anabolic drive for growth

ICDS

- Started in 1975. Program included growth monitoring, immunization, health check up and supplementary feeding for children under 6 years through anganwadi centers all over India.

- Recommendations: 500 kcal + 12-15 gm protein/day for 0.5 – 6 years
- Cost available: Rs 4 per day
- Mostly vegetarian- few states have eggs/milk
- No meat

- Cost per 100 g cooked, Rs 2 – 6 depending on subsidy;
  - depending on adding adequate lentils
  - Oil
  - Vegetables

Age group	1-3 years	
Weight (kg)	13	
EER (kcal/kg/day) (kcal/day)	82 (1066)	
EAR Protein (g/kg/day) (gm/day)	0.85 (11)	
PE Ratio of requirement	0.041	
Ratio of lentil:rice (500 kcal)	0:1	1:5
Protein (g)	8	12
Lysine (mg/g protein)	31	46
PDCAAS	0.600	0.708
PDCAAS adjusted protein	4.8	8.5
PE Ratio	0.060	0.092
PDCAAS Adjusted PE ratio	0.036	0.065

PDCAAS calculated using lysine score of 52 for 1-3 years; digestibility 80%

Age group	4-6 years	
Weight (kg)	18	
EER (kcal/kg/day) (kcal/day)	75 (1350)	
EAR Protein (g/kg/day) (gm/day)	0.73 (13)	
PE Ratio of requirement	0.038	
Ratio of lentil:rice (500 kcal)	0:1	1:5
Protein (g) obtained	8	12
Lysine (mg/g protein)	31	46
PDCAAS	0.645	0.767
PDCAAS adjusted protein	5.2	9.2
PE Ratio	0.060	0.092
PDCAAS Adjusted PE ratio	0.039	0.071

PDCAAS calculated using lysine score of 48 for 4-6 years; digestibility 80%

Summary

- Needs are for maintenance and growth
- Saltatory growth?
- Needs for catch up in chronic undernutrion?

What are the dimensions

- Protein requirement: g/day
- Amino Acid requirement – mg/kg/day
- Amino Acid Score – mg/g protein
- Digestibility
- PDCAAS
- PE ratio
- PDCAAS adjusted PE Ratio