**Map to measure energy/nutrient inadequacy for individuals and inequality:**

Blue path is starting from household survey

Adjustments for pregnancy, lactation, activity

Orange path is starting from individual survey

Gray boxes are inputs

Reported household consumption of the nutrient

Reported individual consumption of the nutrient

Calculated individual consumption of the nutrient

Individual inadequacy measure for calculated nutrient consumption

Individual inadequacy measure for reported nutrient consumption

**Household Survey Data**

* Household Expenditure
* Household Consumption Diary or Recall

**Individual Survey Data**

* Individual Consumption Diary or Recall
* Observed Food Weight Record

**Food Composition Table**

* USDA Database
* Regional Survey
* Private data

Adjustments for bioavailability and retention factors

**Individual nutrient requirements**

* IOM (US/Canada)
* WHO/FAO
* Regional

**Adult Equivalents**

* Ratio of individual energy or nutrient requirements to requirements for base individual
* Pre-generated AE
* Per capita

START

END

Inequality measure

**IOM Nutrient Requirement Definitions:**

* Estimated Average Requirement (EAR): The average daily nutrient intake level that is estimated to meet the requirements of half of the healthy individuals in a particular life stage and gender group. It is actually a median. Although it can also be used to examine the probability that usual intake is inadequate for individuals (in conjunction with information on the variability of requirements), it is not meant to be used as a goal for daily intake by individuals.
  + Estimated Energy Requirement (EER): Average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, height, and level of physical activity consistent with good health. Adjustments for needs of children, pregnant and lactating women
* Recommended Daily Allowance (RDA): The average daily nutrient intake level that is estimated to meet the requirement of nearly all (97-98 %) of the healthy individuals in a particular life stage and gender group. It is the EAR + 2SD. The RDA thus exceeds the requirements of nearly all members of the group. It can be used as a guide for daily intake by individuals, and because it falls above the requirements of most people, intakes below the RDA cannot be assessed as being inadequate. Usual intake at the RDA should have a low probability of inadequacy.
* Adequate Intake (AI): The recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate; used when an RDA cannot be determined.
* Tolerable Upper Limit (UL): The highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase.
* Acceptable Macronutrient Distribution Range (AMDR): The range of intakes of an energy source that is associated with a reduced risk of chronic disease, yet can provide adequate amounts of essential nutrients. The AMDR is expressed as a percentage of total energy intake. The key feature of each AMDR is that it has a lower and upper boundary. Intakes that fall below or above this range increase the potential for an elevated risk of chronic diseases and raise the risk of inadequate consumption of essential nutrients.
* Requirement distribution is the variability in requirement across individuals. Intake distribution is the reported variability in nutrient intake within an individual

**RDA / EER**

* IOM does not recommend use

**AMDR**

* AI (UL) gives confidence that intake is above (below) the lower (upper) bound of AMDR

**AMDR**

* Gives proportion of group that is inside/outside range

**RDA**

* IOM does not recommend use

**BMI**

* Proportion of group with BMI below, within, and above the range reflect proportions with inadequate, adequate, and excessive energy intakes

**Nutrients with an AI**

* Groups with mean/ median intake above AI assumed to have low prevalence of inadequacy

**Nutrients with UL**

* Proportion of group with intake above UL is at risk of adverse effects

**Nutrients with an EAR**

* Probability method averages probabilities (from z-scores) across individuals to estimate group’s prevalence of inadequacy. Intakes and requirements independent
* Cut-point method assumes proportion of group with intakes below the EAR will be similar to proportion of group that does not meet requirement. Intakes and requirements independent, symmetrical (not true for iron), distribution of intakes more variables than distribution of requirements

**BMI**

* BMI between 18.5-25 kg/m^2 for adults indicates that energy intake is adequate relative to expenditure

**Group Intake Inadequacy**

**Individual Intake Inadequacy**

**Nutrients with an AI**

* Intake at or above AI has low probability of inadequacy

**Nutrients with UL**

* Usual intake below UL indicates low risk of adverse effects

**Nutrients with an EAR**

* Z-score correlates with probability of adequacy
* Intake below the EAR likely needs to be improved

**IOM Requirements**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Life Stage Group** | **Age** | **Ref Weight (kg, M/F)** | **Ref Height (cm, M/F)** | **Estimated Energy Requirement[[1]](#footnote-1) (kcal/day)** | **AMDR Fat (% energy)** | **AMDR Carb (% energy)** | **AMDR Protein (% energy)** | **Calcium[[2]](#footnote-2) (mg, EAR, M/F)** |
| Infancy | 0-6, 6-12m | 6 , 9 | 62, 71 | See Table 1 |  |  |  | 200 , 260 (AI) |
| Toddler | 1-3 | 12 | 86 | (89 x weight [kg] –100) + 20 | 30-40 | 45-65 | 5-20 | 500 |
| Early Childhood | 4-8 | 20 | 115 | Boys: 88.5 – (61.9 x age [y]) + PAb x [(26.7 x weight [kg]) + (903 x height [m])] + 20  Girls: 135.3 – (30.8 x age [y]) + PA x [(10.0 x weight [kg]) + (934 x height [m])] + 20 | 25-35 | 10-30 | 800 |
| Puberty | 9-13 | 36 / 37 | 144 / 144 | Boys: 88.5 – (61.9 x age [y]) + PA x [(26.7 x weight [kg]) + (903 x height [m])] + 25  Girls: 135.3 – (30.8 x age [y]) + PA x [(10.0 x weight [kg]) + (934 x height [m])] + 25 | 1100 |
| Adolescence | 14-18 | 61 / 51 | 174 / 163 | 1100 |
| Young Adult | 19-30 | 70 / 57 | 177 / 163 | Men: 662 – (9.53 x age [y]) + PA x [(15.91 x weight [kg]) + (539.6 x height [m])]  Women: 354 – (6.91 x age [y]) + PA x [(9.36 x weight [kg]) + (726 x height [m])] | 20-35 | 10-35 | 800 |
| Middle Age | 31-50 | 70 / 57 | 177 / 163 | 800 |
| Adulthood | 51-70 | 70 / 57 | 177 / 163 | 800 /1000 |
| Older Adults | 70+ | 70 / 57 | 177 / 163 | 1000 |

**FAO/WHO requirements**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Life Stage Group** | **Age** | **Ref Weight[[3]](#footnote-3) (kg, M/F)** | **Ref Height (cm, M/F)** | **TEE[[4]](#footnote-4)** | **AMDR Fat[[5]](#footnote-5) (% energy)** | **Carb ?** | **Protein (EAR)[[6]](#footnote-6)** | **Calcium** ? |
| Infants | 0-1 | 5.6, 8.4 | 59.1, 70.35 | See Table 3.3 | 40-60 |  |  |  |
| Child | 1-3 | 15.25 / 14.90 | 99.55 / 98.70 | Boys: 310.2 + 65.3 x weight – 0.263 x weight^2  Girls: 263.4 + 65.3 x weight – 0.454 x weight^2 | 25-35 |  |  |  |
| Child | 4-8 | 21.55 / 21.23 | 86 |  |  |  |  |
| Child | 9-13 | 37.32 / 38.46 | 145.74 / 147.92 |  |  |  |  |
| Adolescent | 14-18 | 63/29 / 55.25 | 174.13 / 162.70 |  |  |  |  |
| Adults | 19-30 | 66.78 / 57.04 | 176.54 / 163.16 | Men: 15.057 x weight +692.2  Women: 14.818 x weight + 486.6 | 20-35 |  | 105 mg/kg |  |
| Adults | 31-60 | 66.78 / 57.04 | 176.54 / 163.16 | Men: 11.472 x weight + 873.1  Women: 8.126 x weight + 845.6 |  |  |
| Older Adults | 60+ | 66.78 / 57.04 | 176.54 / 163.16 | Men: 11.711 x weight + 587.7  Women: 9.082 x weight + 658.5 |  |  |

1. Dietary Reference Intakes (2006) IOM: Add 340/452 kcal for second/third trimesters of pregnancy and 330/400 kcal for 0-6 / 7-12 months postpartum, PA coeff Table 2 [↑](#footnote-ref-1)
2. Dietary Reference Intake for Calcium and Vitamin D (2011) IOM: Pregnant/lactating 14-18y requires 1100mg, Pregnant/lactating 19-50y requires 800mg [↑](#footnote-ref-2)
3. Adjustments made for Pregnancy and Lactation [↑](#footnote-ref-3)
4. Human Energy Requirements (2001) FAO/WHO/UNU: For children 1-18: adjust TEE by 85% for light activity and 115% for heavy activity, for adults 19+ multiply TEE by PAL [↑](#footnote-ref-4)
5. FAO Fats and Fatty Acids in Human Nutrition (2011) [↑](#footnote-ref-5)
6. Protein and Amino Acid Requirements in Human Nutrition (2002) RDA is also provided for all ages in Table 46 [↑](#footnote-ref-6)