Key Anthropometry variables to clean and/or create

Prepared for the Micronutrient Manual and Toolkit by the CDC IMMPaCt team
January 2024

Notes: These steps may need to be altered (for example, these instructions defined the biologically plausible range for adult height as 81cm to 270cm. If your protocol wishes to use a different range, this will need to be adjusted).

Directly measured variables that must be cleaned:

  I. Length or height
      A. Length: children under 2 years
      B. Height: 2 years or older
 II. Weight
III. Waist circumference
 IV. Sagittal abdominal diameter
  V. Demographic/confounding variables
      A. Sex
      B. Pregnancy status

Steps for data cleaning

I. Clean or create the following variables:
    A. **Sex:**
        1. Ensure all entries have a sex assigned.
        2. If missing sex for individual between 15-49 years of age, determine the sex (if possible) by seeing whether they completed a women's or men's questionnaire. If no women's or men's questionnaire was completed, the data should be discarded. If there is a completed women's or men's questionnaire, assign as female or male, respectively.
    B. **Pregnancy status**:
        1. Ensure all those marked as pregnant are between 15-49 years and are female.
        2. Assume all women with "unknown" pregnancy status are not pregnant and change to "not pregnant."
        3. If missing pregnancy status value but weight was taken, assign as "not pregnant."
        4. Ensure that no pregnant women have data for weight, waist circumference, or sagittal abdominal diameter. These measures should not be assessed in pregnant women. If any pregnant women have these data, be sure to exclude them from analyses that should exclude pregnant women.
    C. **Weight:**
        1. Round to nearest 0.1 digit for analysis, per WHO guidelines (World Health Organization (WHO) & UNICEF, 2019)
    D. **Height/Length:**
        1. For individuals over 5 years, check for any with disability that prevented measurement standing up. Change from "length" to "height" if taken laying down and do not apply correction factor.

2. For children 0-59 months, per WHO guidelines (World Health Organization (WHO) & UNICEF, 2019):
   a. If children under 9 months are marked as having "standing height" set the height value to missing to avoid any errors in the following steps.
   b. For children 9-23 months with standing height measurements: change from "height" to "length" and add a correction value of 0.7cm.
   c. For children 24-59 months with recumbent length measurements: change from "length" to "height" and subtract a correction value of 0.7cm.
3. Create a new variable for the average length/height by taking the average of the two measurements.

E. **Oedema**
   1. Oedema is only recorded for children 0-59 months. Set any oedema values for anyone ≥5 years to missing.
   2. Children 0-59 months with oedema should not be included in certain weight-related anthropometric indices (see WHO guidelines 2019 and detailed analysis steps below). Create a flag variable for oedema (0=no oedema, 1 = oedema).

F. **BMI**
   1. Calculate BMI as BMI = weight (to 1 decimal place) / (height*height/100).
      a. Units should be kg/m^2

G. **Waist circumference** and **sagittal abdominal diameter**
   1. Calculate final value for each indicator by taking the average of the two measurements.

II. Create flags for biologically implausible values (BIVs)
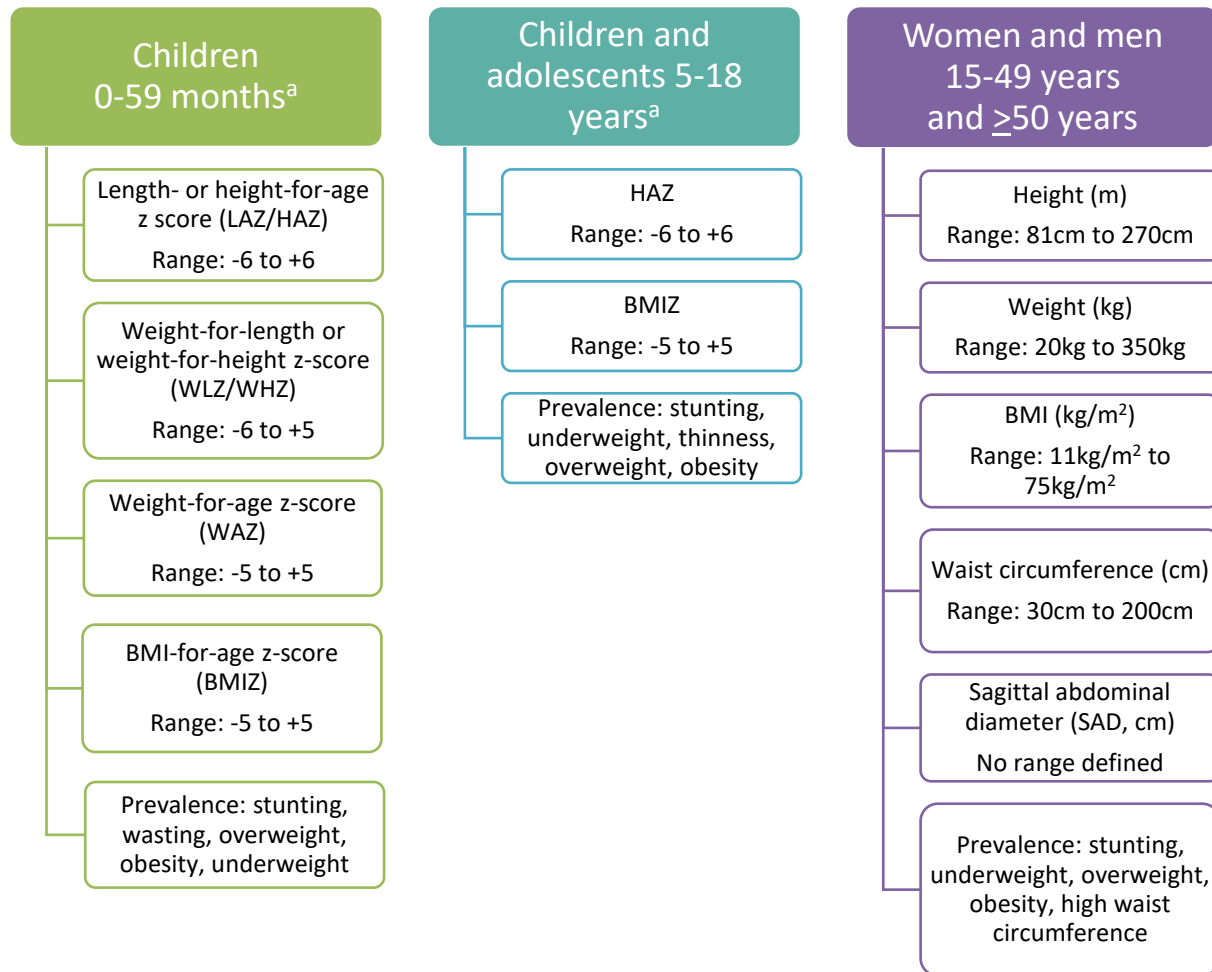   A. For **anthropometry:** BIVs are defined based on the ranges shown in *Figure 1* below.
      1. Example, if a woman 15-49 years has a waist circumference <30cm, that value would be flagged. The flag should be a 0/1 binary variable (0= no flag, 1= flag). These flags will be used in analyses below to exclude those with biologically implausible values from the analyses.

III. Create flags for unreliable measurements due to large differences between repeated measurements
   A. **Length / height / waist circumference**: flag observations with >1 cm difference between repeated measurements. Drop these observations from analyses.
   B. **Sagittal abdominal diameter**: flag observations with >0.5 cm between repeated measurements

Figure 1 Indicators assessed and biologically plausible ranges, by population group

Children 0-59 months[a]	Children and adolescents 5-18 years[a]	Women and men 15-49 years and $\geq$50 years
Length- or height-for-age z score (LAZ/HAZ) Range: -6 to +6	HAZ Range: -6 to +6	Height (m) Range: 81cm to 270cm
Weight-for-length or weight-for-height z-score (WLZ/WHZ) Range: -6 to +5	BMIZ Range: -5 to +5	Weight (kg) Range: 20kg to 350kg
Weight-for-age z-score (WAZ) Range: -5 to +5	Prevalence: stunting, underweight, thinness, overweight, obesity	BMI (kg/m^2) Range: 11kg/m^2 to 75kg/m^2
BMI-for-age z-score (BMIZ) Range: -5 to +5		Waist circumference (cm) Range: 30cm to 200cm
Prevalence: stunting, wasting, overweight, obesity, underweight		Sagittal abdominal diameter (SAD, cm) No range defined
		Prevalence: stunting, underweight, overweight, obesity, high waist circumference

[a] World Health Organization growth standards (de Onis et al., 2007; WHO Multicentre Growth Reference Study Group, 2006).
BMI= Body mass index

Variables to create from the measured variables, by age group

I. **Children, 0-59 months.**
   A. Calculate the following variables in children 0-59 months.
      1. Length- or height-for-age Z-score (LAZ/HAZ):
         a. Stunting: LAZ/HAZ < -2z
         b. Severe stunting: LAZ/HAZ <-3z
      2. Weight-for-length or weight-for-height z-score
         a. Wasting: WLZ/WHZ < -2z
         b. Severe wasting: WLZ/WHZ < -3z
         c. Overweight: WLZ/WHZ > +2z
         d. Obesity: WLZ/WHZ > +3z
         e. Note: Analyses of wasting, severe wasting, overweight, or obesity should exclude all children with oedema as well as any children with BIVs

3. Weight-for-age Z-score (WAZ)
   a. Underweight: WAZ <-2z
   b. Severe underweight: WAZ< -3z
   c. Note: Analyses of underweight and severe underweight should exclude all children with oedema as well as any children with BIVs
4. Optional variables to create:
   a. Wasting, severe wasting, overweight, and obesity based on BMI-for-age (BMIZ), used in addition to reporting using WLZ/WHZ. Note that WHO recommends WLZ/WHZ Z-score based assessment of these variables. These would also exclude children with BIVs and oedema.

B. When analyzing, these variables, be sure to exclude anyone with a flagged biologically implausible value according to the "range" listed in Table 1 and those with large differences between repeated measurements.

II. Children and Adolescents, 5-18 years
A. Calculate the following variables:
   1. Height-for-age Z-score
      a. Stunting: HAZ <-2z
      b. Severe stunting: HAZ <-3z
   2. BMI-for-age Z-score
      a. Thinness: BMIZ <-2z
      b. Severe thinness BMIZ<-3z
      c. Overweight BMIZ >+1z
      d. Obesity BMIZ>+2z
B. When analyzing, these variables, be sure to exclude anyone with a flagged biologically implausible value according to the "range" listed in Table 1 and those with large differences between repeated measurements.
C. Exclude pregnant adolescents from BMI-for-age variables. Can leave pregnant adolescents in analysis for height-for-age variables.

III. Men and non-pregnant women ≥15 years
A. Calculate the following variables:
   1. (WOMEN ONLY) Short stature (<145 cm).
      a. There is currently no universally agreed upon cutoff for short stature in adult men.
   2. BMI classifications (in kg/m^2)
      a. Underweight: BMI <18.5 kg/m^2
      b. Normal weight: BMI 18.5-24.9 kg/m^2
      c. Overweight: BMI 25.0-29.9 kg/m^2
      d. Obesity: BMI>30 kg/m^2
   3. High waist circumference (>80cm women, >94cm men)
   4. Sagittal abdominal diameter (SAD) provides an estimate of visceral adipose tissue, a predictor of cardiovascular and metabolic risk. There are currently no established cut off values to define risk based on SAD in women or men. Report means and standard errors.
B. When analyzing these variables, be sure to exclude anyone with a flagged biologically implausible value according to the "range" listed in Table 1 and those with large differences between repeated measurements.

C. Exclude pregnant women 15-49 years from weight, BMI, SAD, and waist circumference. Can leave pregnant women 15-49 years in analysis for height-related variables (short stature).

NOTE: Prior to conducting any analyses, apply appropriate household- and individual-level weights.

Key References:

de Onis, M., Onyango, A. W., Borghi, E., Siyam, A., Nishida, C., & Siekmann, J. (2007). Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization*, *85*(9), 660-667. http://dx.doi.org/10.2471/BLT.07.043497

WHO Multicentre Growth Reference Study Group. (2006). *WHO child growth standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for height and body mass index-for-age: Methods and development.* World Health Organization. https://www.who.int/childgrowth/en/

World Health Organization (WHO), & UNICEF. (2019). *Recommendations for data collection, analysis and reporting on anthropometric indicators in children under 5 years old*. Geneva: World Health Organization and the United Nations Children's Fund (UNICEF) Retrieved from https://apps.who.int/iris/bitstream/handle/10665/324791/9789241515559-eng.pdf?sequence=1&isAllowed=y