PART 2: TECHNICAL NOTES

The technical notes are the second of four parts contained in this module. This module focuses on how acute malnutrition can be measured in individuals using anthropometry (body measurements) and clinical signs (e.g. visible wasting and bilateral oedema) in emergencies. The basic principles of anthropometric assessment are also applicable in non-emergency contexts and preventive programmes.[1] While the assessment of chronic undernutrition is generally not the focus during emergencies, its measurement and classification in children 6-60 months is discussed briefly at the end of the module.

Details on measurement of micronutrient malnutrition (Module 4), population assessment (Module 7 and Module 10), and the use of individual assessment information for admission and discharge into nutrition programmes (Modules 11, 12 and 13) are covered in other modules. The technical notes are intended for people involved in planning and implementation of nutrition programmes for the treatment of acute malnutrition. They provide technical details, highlight challenging areas and provide clear guidance on accepted current practices. Words in italics are defined in the glossary.

Summary

This module is about how acute malnutrition can be measured in individuals using anthropometry (body measurements) and clinical signs (e.g. visible wasting and bilateral oedema). Technical challenges associated with measuring malnutrition are outlined.

These technical notes are based on the following references and Sphere standard in the box below:

- *Anthropometric Indicators Measurement Guide*. (2003). Washington: FANTA.
- *Management of Acute Malnutrition in Infants (MAMI) Project: Technical Review: Current evidence, policies, practices & programme outcomes*. (2010) London: ENN, UCL-CIHD, ACF.
- *Adolescents: Assessment of Nutritional Status in Emergency-affected Populations*. (2000). Geneva: United Nations Standing Committee on Nutrition.
- *Adults: Assessment of Nutritional Status in Emergency-affected Populations*. (2000). Geneva: United Nations Standing Committee on Nutrition.
- *WHO Child Growth Standards: Training Course on Child Growth Assessment, Modules B & C*. (2008). Geneva: WHO.
- *Distance Learning Course: Nutritional Status – Assessment and Analysis*. (2007). Rome: Food and Agriculture Organization.
- *A Manual: Measuring and Interpreting Malnutrition and Mortality*. (2005). Rome: World Food Programme.

How do we assess nutritiona l status of an individua l?

There are four methods to assess an individual's nutritional status, though not all methods are suitable in emergencies. Since nutritional status cannot be observed directly, observable (proxy) indicators are used instead.[2]

[1] While obesity is acknowledged to be an issue of increasing importance globally, it is not addressed in this module because during an emergency, the focus is on acute malnutrition.

[2] Myatt, Mark, Tanya Khara, Steve Collins (2005). *A review of methods to detect cases of severely malnourished children in the community for their admission into community-based therapeutic care programs*. Food and Nutrition Bulletin, vol. 27, no. 3 (supplement)

Key messages

1. Anthropometry is the use of body measurements to assess and classify nutritional status in an individual.
2. Body measurements include: age, sex, weight, height (or length in children 6-23.9 months or under 87 cm in height) and mid-upper arm circumference (MUAC) for individuals 6 months and older.
3. Clinical signs of acute malnutrition include: visible wasting and bilateral oedema.
4. Acute malnutrition among infants less than 6 months of age is assessed using visible signs of wasting and bilateral oedema. Social criteria such as an absent mother or inadequacy of breastfeeding can indicate nutritional risk.
5. Acute malnutrition among children 6-60 months is assessed using the nutritional indices of weight-for-height or weight-for-length (WFH), MUAC, and signs of bilateral oedema.
6. Undernutrition among children and adolescents 5-19 years is assessed using the nutritional index of body mass index for age (BMI-for-age) and clinical signs.
7. Adult undernutrition is assessed through Body Mass Index (BMI) (either adjusted or unadjusted by Cormic index) or MUAC in addition to clinical signs. MUAC is the preferred nutritional index during pregnancy and up to 6 months postpartum.
8. There are numerous issues related to the assessment of undernutrition in the elderly, however BMI is recommended in addition to clinical signs.
9. The use of the 2006 WHO Growth Standards is now recommended over the use of the 1978 National Center for Health Statistics growth reference (NCHS GR) in the definition of acute malnutrition in children 6-60 months. The 2007 WHO Growth References is recommended for use in assessment of children and adolescents 5-19 years.
10. Nutrition indices should be presented as Z-scores as opposed to percentage of the median. Percentage of the median is no longer recommended for use in classification of individual nutrition status.
11. Methodologies and protocols for the anthropometric assessment of children 6-59 months of age are more developed than for other age groups, however additional research into best practice and relationship to functional outcomes is ongoing.

Anthropometry- can be defined as the measurement of physical dimensions and gross composition of the body (height, weight, mid-upper arm circumference, age, sex).[3] The degree of malnutrition is defined by *cut-off points*, in other words individuals falling below a specific cut-off point are classified with a specific degree of malnutrition. The method that is most widely used to assess nutritional status in an individual or population in emergencies is anthropometry.

Biochemical assessment- involves assessing specific components of blood and urine samples of an individual in order to measure specific aspects of an individual's metabolism, for example serum retinol levels to assess vitamin A status. This is generally expensive, time consuming, and not possible in an emergency.

Clinical assessment- involves assessing the physical presentation of signs and symptoms of acute malnutrition, such as *visible wasting* and *bilateral oedema* (fluid retention on both sides of the body). Bilateral oedema is verified when thumb pressure applied on top of both feet for three seconds leaves a pit (indentation) in the foot after the thumb is lifted. The *clinical sign* of bilateral oedema is critical complementary information to anthropometric information because it affects the weight measures. Signs of visible wasting include a thin "old man" face, loose skin around the buttocks that look like "baggy pants," and prominent ribs. Other clinical signs used in the assessment of acute malnutrition are found in Module 3.

Dietary intake- involves assessing the food intake of individuals over a specific period of time (e.g. 24 hours, 7 days) and comparison of overall intake to daily allowances, which is often not possible in emergencies. Proxy indicators of dietary quantity and quality have been developed for use in emergencies. Details of two examples of these can be found in Box 1.

[3] Jelliffe, DB (1966). *The assessment of the nutritional status of the community*. WHO Monograph No. 53. Geneva. WHO.

Sphere standard

Food security and nutrition, Assessment Standard 2: nutrition[4]

Where people are at increased risk of undernutrition, assessments are conducted using internationally accepted methods to understand the type, degree and extent of undernutrition and identify those most affected, those most at risk, and the most appropriate response.

Key actions

- Compile existing information from pre-disaster and initial assessments to highlight the nature and severity of the nutrition situation.
- Identify groups with the greatest nutritional support needs and the underlying factors that potentially affect nutritional status.
- Determine if population level qualitative or quantitative assessments are needed to better measure and understand anthropometric status, micronutrient status, infant and young child feeding, maternal care practices, and associated potential determinants of undernutrition.
- Consider the opinions of the community and other local stakeholders on the potential determinants of undernutrition.
- Include an assessment of national and local capacity to lead and/or support response.
- Use nutrition assessment information to determine if the situation is stable or declining.

Source: The Sphere Project (2011). *Humanitarian Charter and Minimum Standards in Humanitarian Response, Chapter 3: Minimum Standards in Food Security and Nutrition*. Geneva: The Sphere Project.

Box 1: Dietary intake methods in emergencies

For the World Food Programme's (WFP) Emergency Food Security Assessments, calculation of a food consumption score for households is recommended as part of minimum information requirements. The household's food consumption score is based on dietary diversity (the number of food groups eaten in the recall period), food frequency (the number of times that food is consumed in the recall period) and the relative nutritional importance of those foods. The food consumption score is calculated from the types of foods and the frequencies with which they are consumed during a seven day period.[5]

The 2008 Indicators for assessing infant and young child feeding practices also use dietary recall to produce standard estimates of adequate infant and young child feeding practices. These indicators have been successfully collected and used in emergency contexts. One example is minimum dietary diversity for children 6-23 months of age. It is based on 24 hours recall of dietary diversity (the number of food groups eaten). It is then defined as proportion of children 6-23 months of age who receive foods from 4 or more food groups in that period, since this is correlated with better quality diets for both breastfed and non-breastfed children.[6]

There are some limitations to these examples: they do not indicate quantity of the food intake, and are primarily used for population level rather than individual level assessment. Additionally, recent dietary intake may or may not reflect the " normal" intake. This information can however help in understanding the food security aspects underlying malnutrition.

4 While the Key actions outlined here refer primarily to population level assessment, individual assessment forms the basis for understanding of nutrition status at population level. Population level assessment is covered in more detail in Module 7.

5 WFP (2009). *Emergency Food Security Assessment Handbook. Second edition*. Rome. WFP.

6 WHO (2008). *Indicators for assessing infant and young child feeding practices: conclusions of a consensus meeting held 6-8 November 2007 in Washington D.C.*, USA. Rome. WHO.

In the context of emergencies, anthropometric status is commonly referred to as *nutritional status*. Of particular interest in emergencies is the anthropometric status of children 6-59 months, given that they are often the most nutritionally vulnerable in the population.

Anthropometric assessment has its limitations. Anthropometry cannot identify micronutrient malnutrition and does not indicate the driving factors underlying malnutrition. Analysis of the underlying causes at the individual and population level is critical to complement anthropometric information.

Three forms of growth failure (undernutrition) in children 0-60 months can be assessed through anthropometry: *wasting* (acute malnutrition); *stunting* (chronic undernutrition); and *underweight* (acute malnutrition and/or chronic undernutrition) (Table 1).

Table 1: Types of undernutrition in children 0-60 months

Acute malnutrition	• Acute malnutrition is indicated by wasting and/or bilateral oedema. • Wasted children are extremely thin (low *weight-for-height* (WFH)[7]. • Wasting is measured by the nutritional index of WFH or *mid upper arm circumference* (MUAC). • Bilateral oedema, found in cases of *kwashiorkor* and *marasmic-kwashiorkor*, is an abnormal infiltration and excess accumulation of serous fluid in connective tissue or in a serous cavity. • Acute malnutrition is the result of recent rapid weight loss or a failure to gain weight due to acute infection and/or inadequate dietary intake. • Acute malnutrition is readily reversible once conditions improve.
Chronic undernutrition	• Chronic undernutrition is indicated by stunting. • Stunted children are short for their age (low *height-for-age* (HFA). • Stunting is measured by the nutritional index of HFA. • Stunted children may have normal body proportions but look younger than their actual age. • Stunting is a slow, cumulative process that develops over a long period as a result of inadequate nutrition or repeated infections, or both. • The presence of stunting does not necessarily mean that current dietary intake or health is inadequate – the growth failure may have occurred at some time in the past. • By two years of age, stunting may be irreversible.
Underweight (acute and/ or chronic)	• Underweight children weigh less than the average weight for children of the same age and sex. • Underweight is measured by the nutritional index of *weight-for-age* (WFA). • Underweight is due to either wasting or stunting or a combination of both.

Each form of growth failure reflects a different condition. It is important to note that one individual can be classified with more than one form of growth failure at the same time. A child that is suffering from *severe acute malnutrition* (SAM) may be both wasted and stunted.

Infants, adolescents, adults and older people can also be malnourished. Assessment tools and methods for identifying malnutrition, as well as understanding of the longer term health and well-being (functional outcomes) based on type and level of malnutrition, are less well defined in these other age groups. Terminology differs as well: acute malnutrition is referred to as “thinness” rather than “wasting” in individuals 5 years and older.

How can we use anthropometric data in emergencies?

Acute malnutrition is the form of growth failure that is of most concern in emergencies. It is often associated with an increased risk of *morbidity* (illness) and *mortality* (death). Wasted children can rapidly deteriorate but will also improve rapidly if treated appropriately, so identifying, preventing and addressing moderate and SAM malnutrition can save lives.

At the individual level, anthropometric data can be used in:

[7] The abbreviation WFH refers to both weight-for-height and weight-for-length.

Individual assessment

1. *Growth monitoring and promotion* which can be part of a mother and child health (MCH) programme where the growth (weight gain) of infants and young children is monitored over time. The indicator most commonly used is WFA (e.g. underweight, which reflects acute malnutrition and/or chronic undernutrition). This information is often some of the only information available at the onset of emergencies.
2. Community level or programme level *nutritional screening*, where each child is assessed for acute malnutrition in order to refer individuals for further medical check-ups or to services such as targeted supplementary programmes (for moderate acute malnutrition (MAM) or therapeutic feeding (for SAM). This activity is common in emergencies where it is critical to identify cases of acute malnutrition in a timely manner. The indicator of choice is MUAC.
3. *Admission and discharge criteria* into targeted supplementary feeding programmes and therapeutic feeding programmes are generally based on anthropometry, as well as identification of bilateral oedema. The anthropometric indicators of choice are MUAC and WFH for children 6-59 months, and among specific age groups, *Body Mass Index* (BMI) or *BMI-for-age*.

At the population level, anthropometric information can be used in:

Population assessment[8]

- *Nutritional surveillance*[9] for famine early warning systems and food security monitoring. Anthropometry can be used to measure changes in nutritional status of populations over time. The indicators used are usually WFH (as a reflection of acute malnutrition) and MUAC (as a reflection of mortality), though HFA (stunting) and WFA (underweight) can also be included as indicators of underlying vulnerability.
- *Rapid Assessments* are generally conducted in the initial stages of an emergency, in order to quickly establish whether there is a major nutrition problem or not and to identify immediate needs. The indicator of choice is MUAC.
- *Anthropometric surveys* can be used during an emergency in order to assess the extent and severity of malnutrition or to estimate the numbers of children who might require supplementary and therapeutic feeding. The main indicator collected is WFH (with collection of MUAC as additional information, generally used for programme planning).

Measuring acute malnutrition of children aged 6-59 months through a representative sample in anthropometric surveys has become one of the most commonly used proxy indicators of population level nutrition status in emergency situations. Acute malnutrition reflects recent conditions, and young children are generally the most nutritionally vulnerable group. The *prevalence* (rate) of acute malnutrition (defined by WFH and bilateral oedema) among children 6-59 months is a sensitive and objective indicator and can be used to reflect the nutritional status of a broader emergency-affected population. The concern, however, is not just for the children who are classified with MAM or SAM, but for the entire population whose nutritional status is sub-optimal.

In some situations, however, other age groups may be nutritionally vulnerable. For example, in Eastern European countries, where the percentage of young children is relatively low compared to adults and older people, older age groups may be at risk of acute malnutrition. Where breastfeeding is disrupted due to the death of, or separation from, the mother, or where exclusive breastfeeding is not being practised, infants under six months may also be at risk of acute malnutrition.

How do we identify and classify degree of acute malnutrition with anthropometry?

Changes in the anthropometric measures of weight and height may not be due to changes in nutritional status, but due to normal growth with age. From birth until the end of adolescence, growth rates can impact weight and height measurements substantially. Growth patterns also differ between males and females. In order to take these differences in growth patterns into account, anthropometric measurements are transformed into *nutritional indices* (e.g. WFH, WFA, HFA, Body Mass Index (BMI), BMI-for-age).

When an individual has bilateral oedema, a clinical sign for SAM, body weight increases because of the fluid retention. As a result, nutritional indices involving weight (WFH, WFA, BMI, BMI-for-age) cannot be interpreted in the same way in oedematous individuals. Generally WFH is not calculated for an individual with oedema in the assessment of acute malnutrition, but can be used in differentiating between cases of kwashiorkor and marasmic kwashiorkor.

[8] For more information on population assessment, see Module 7.
[9] Nutritional surveillance is covered in detail in Module 10

Nutritional indices are compared to expected anthropometric values for an individual of the same sex and age, e.g. a *growth standard or growth reference*. A **standard** is based on prescriptive criteria and involves value or normative judgments. In contrast, a **reference** reflects the expected values in a reference population. The comparison is used to classify the nutritional status of the individual, e.g. whether they have or do not have MAM or SAM, according to specific cut-off points. Other nutritional indices for acute malnutrition, (e.g. MUAC and BMI), are interpreted directly with cut-off points, without comparison to a growth standard or reference.

Prior to 2006, the internationally accepted reference population for calculating nutrition indices among children 0-59 months was the 1978 National Center for Health Statistics (NCHS GR) international reference. In 2006, the World Health Organisation (WHO) introduced a new growth standard (WHO GS) for children 0-60 months of age. Further details are found in Box 2: The new 2006 WHO Growth Standards.

Box 2: The new 2006 WHO Growth Standards

There has been a long-running debate about whether different ethnic groups grow differently, e.g., whether some ethnic groups are 'naturally' shorter or smaller than others. Data used to develop the new 2006 WHO GS show that young children from all over the world under optimal circumstances will grow in a broadly similar pattern and to within the same height and weight range given the same optimal nutritional, environmental, and care conditions.

The 1978 NCHS GR international references were based on the growth patterns of a limited group of American children, most of whom were formula-fed (and thus have different growth patterns from breastfed babies). The mode of infant feeding and other undesirable features of this reference dataset led to calls for the development of an international growth standard.

The 2006 WHO GS are based on the growth patterns of over 8,000 children 0-60 months from Brazil, Ghana, India, Norway, Oman, and the United States. All the children were deemed to have optimal conditions for good growth, including being breastfed exclusively for the first four to six months, having good medical care, and living in smoke-free households.

When the two sets of charts are compared it can be seen that the median rate of growth during the first six months or so of life is expected to be faster when using the new WHO GS. Later in infancy the expected growth rate decreases relative to the NCHS GR. These differences have important implications for the classification of malnutrition, meaning that the classification of anthropometric status in a child will vary based on which comparison population is used, e.g. NCHS GR or WHO GS. The switch from the NCHS GR to the WHO GS has implications for prevalence estimates and numbers of children admitted into selective feeding programmes. Studies indicate that the overall prevalence of *global acute malnutrition* (GAM) (wasting and/or oedema) changes relatively little, but there is a significant increase in the prevalence of SAM. In turn, this means an increase in the number of children eligible for admission into therapeutic feeding programmes.

Currently, the WHO 2006 GS should be used to calculate nutritional indices for children 6-59 months during an emergency.

Source: Seal, Andrew and Marco Kerac (2007). *Operational implications of using 2006 World Health Organization growth standards in nutrition programmes: secondary data analysis*. BMJ, 334, February.

In 2009, WHO and UNICEF endorsed the use of the new WHO GS to identify SAM in children 6-59 months.[10] In 2009, WHO and UNICEF also endorsed MUAC less than 115 mm/11.5cm (previously the cut-off was 110 mm/11.0cm) as an independent admission criterion for the treatment of SAM. The introduction of the WHO GS and the revision of the MUAC cut-off to identify children with SAM will tend to increase the caseload for therapeutic feeding programmes, however at the same time the duration of treatment will decrease since more children will be detected earlier and in a less severe state.

It is important to note that when WFH (WHO GS) and MUAC are both used, only about 40% selected by the one criterion are also selected by the other. This is explained further in the Case example 1: Classification of acute malnutrition: WFH and MUAC in Nepal.

[10] WHO and UNICEF. (2009). *WHO child growth standards and the identification of severe acute malnutrition in infants and children A Joint Statement by the World Health Organization and the United Nations Children's Fund*. Geneva: WHO and UNICEF.

Case example 1: Classification of acute malnutrition: WFH and MUAC in Nepal

WFH and MUAC are anthropometric indicators that are used independently to identify acute malnutrition. On average, only 40% of children will be identified with SAM by both WFH and MUAC.[11] Community outreach and screening to identify children with acute malnutrition often involves two stages, e.g. screening of children with MUAC in the community, followed by assessment based on WFH upon arrival at the programme facility. Based on WFH, some children would not be classified with SAM. These "rejected referrals" would often undermine the relationship between the programme and the community, decreasing coverage of programmes, and failure to treat all acutely malnourished individuals.

Community based management of acute malnutrition (CMAM) was piloted in the Bardiya district of Nepal by Concern Worldwide from November 2008 to December 2009 based on a clear and demonstrated understanding of the nutrition situation. Between May and December, 1,123 children were admitted into 11 outpatient therapeutic feeding programme sites. Analysis of the monthly statistics over that period of 8 months showed that 34.7% of admissions were classified with SAM based on MUAC (<115mm) alone, 22.1% were classified with SAM based on WFH (<-3 standard deviations (SD)) alone, while 43.2% of those admitted were classified with SAM by both MUAC and WFH. Children were admitted based on WFH or MUAC, so rejected referrals were not an issue in this case.

A critical challenge remains in that MUAC has been endorsed as an independent admission criterion for the treatment of SAM, however the evidence base for MUAC-only admissions in the treatment of MAM is less well developed. For this reason, many programmes admit children based on WFH or MUAC.

Source: Guerrero, Saul. (2010). *Final Evaluation of Concern Worldwide/MoHP Community-based Management of Acute Malnutrition (CMAM) Pilot Programme, Bardiya District, Nepal*. Oxford. Valid International.

And M Myatt, A Duffield, A Seal, F Pasteur (2009). *The effect of body shape on weight-for-height and mid-upper arm circumference based case definitions of acute malnutrition in Ethiopian children*. Annals of Human Biology, vol 36, No.1, pp 5-20.

In 2007, WHO introduced the WHO Growth Reference (WHO GR) for children and adolescents 5 to 19 years of age[12]. Previously, there was no single growth reference for the screening, surveillance and monitoring of acute malnutrition in school-aged children and adolescents.[13] The 2007 WHO GR is a reconstruction of the 1978 NCHS GR data, supplemented with data from the 2006 WHO GS sample.[14] The limitation of the 2007 WHO GR for 5-19 years of age is that it does not describe optimal growth under ideal conditions, and is therefore a reference, rather than a standard. In terms of other forms of undernutrition, the 2007 WHO GR contains WFA data for 5-10 years of age, and HFA as well as BMI-for-age data for 5-19 years of age.

There are no global standard or reference populations for adults or older people at this time.

Some countries have their own national growth reference population data. These are not appropriate to use in emergencies. The 2006 WHO GS should be used for the assessment of children 0-60 months, and the 2007 WHO GR should be used in the assessment of children 5-19 years. If these two have not been formally adopted at country level, the benefits of their use versus the NCHS GR and national references should be discussed with relevant stakeholders.

How do we measure acute malnutrition in infants less than 6 months?

Infants less than 6 months are usually not measured anthropometrically in emergencies, with the exception of assessment of birthweight (Box 3) which is not a reflection of acute malnutrition. While WFH can be used as part of the assessment of acute malnutrition in infants less than 6 months, there are no globally agreed anthropometric cut-off points for classification of anthropometric status. In practice, most protocols that include anthropometric assessment of infants less than 6 months use the same WFH cut-off points as those used for children 6-59 months.[15] MUAC is not currently recommended for use in infants less than 6 months.[16] Visible wasting and bilateral oedema are clinical signs of acute malnutrition in this age group.

11 WHO and UNICEF. (2009). *WHO child growth standards and the identification of severe acute malnutrition in infants and children A Joint Statement by the World Health Organization and the United Nations Children's Fund*. Geneva: WHO and UNICEF.

12 Technically the 2007 Growth Reference covers from 5 years and one month (61 months) upwards to 19 years.

13 The BMI-for-age reference was developed in 1991, but only started at 9 years of age and had several drawbacks for use.

14 http://www.who.int/growthref/en/

15 The Sphere Project (2011). *Humanitarian Charter and Minimum Standards in Humanitarian Response, Chapter 3: Minimum Standards in Food Security and Nutrition*. Geneva: The Sphere Project.

16 ENN, UCL-CIHD, ACF (2010) *Management of Acute Malnutrition in Infants (MAMI) Project: Technical Review: Current evidence, policies, practices & programme outcomes*. London. ENN.

Assessment of nutritional status of infants less than 6 months of age for admission into selective feeding programmes has relied primarily on clinical signs (e.g. oedema, visible wasting, too weak to suckle, not gaining weight despite feeding) and risk factors (e.g. insufficient breastmilk, absence of mother). Assessment should include infant feeding practices, particularly access to breastmilk, and any medical conditions in order to determine whether acute malnutrition in this age group may be a problem.

Due to the assumption that infants less than 6 months are breastfeeding and therefore not at nutritional risk, limited progress has been made in further developing anthropometric tools for this age group for the assessment of acute malnutrition in emergencies.[17] Based on data on exclusive breastfeeding rates from different countries, this assumption is not often met. Further work to define tools and methodologies to assess acute malnutrition in emergencies, such as the use of existing tools for breastfeeding assessment, and growth monitoring rather than one off measurements, are being explored (see Challenge 1). Further definition of measurement of acute malnutrition in infants less than 6 months will need to address several operational issues, such as identification of the most appropriate weighing scales[18] and review of cut-off points for classification of acute malnutrition in relation to functional outcomes in this age group.

Challenge 1: Use of the 2006 WHO Growth Standards and the assessment of acute malnutrition in infants less than 6 months

While the evidence base for infants less than 6 months is limited, a secondary analysis was carried out in 2009 as part of the Management of Acute Malnutrition in Infants (MAMI) project. Data from 21 Demographic Health Surveys were analysed using both the NCHS GR and WHO GS. The analysis found that acute malnutrition based on WFH Z-score in infants less than 6 months is a prevalent public health problem. The degree of the problem was found to be larger when based on the WHO GS as opposed to the NCHS GR. Prevalence of SAM increased over three fold and moderate wasting 1.4 fold when transitioning from NCHS GR to the WHO GS (Z-score).[19] At the individual level, this means that more infants less than 6 months will be classified with acute malnutrition when using the WHO GS rather than the NCHS GR.

While the use of Z-scores (see description of Z-scores and percentage of the median in section on children 6-59 months) is recommended over percentage of the median, in practice many selective feeding programmes still admit infants less than 6 months based on percentage of the median. The implication on caseloads for admission with the transition from percentage of the median NCHS GR to Z-scores based on WHO GS is being defined through further research.

How do we measure acute malnutrition in children aged 6-60 months?

The basic information and body measurements needed to assess acute malnutrition in children 6-60 months are: age, sex, weight, height/length, MUAC, and clinical signs of visible wasting and bilateral oedema. The nutritional indices used are WFH and MUAC.

The decision to measure height or length depends on age and physical condition. Height is measured for children more than or equal to 24 months and length for children under 24 months (e.g. 23.9 months and below). If the age of the child is not known, then height should be measured for children more than or equal to 87 cm, and length measured for children under 87 cm. If a child is too sick to stand, length should be measured.

Guidelines for measuring height, length, weight and arm circumference, estimating age, and for diagnosing bilateral oedema can be found in **Annex 1**. Small errors in individual measurements can result in improper classification of nutrition status. Common errors in measurement are included in **Annex 2**.

WFH

The WFH index is used to assess child wasting. It shows how a child's weight compares to the weight of a child of the same length/height and sex in the WHO GS. The recommended method for comparing an individual's measurement with the WHO GS is using Z-score.

[17] WHO has developed Child Growth Standards: Growth Velocity based on Weight, Length and Head Circumference which provide a set of tools for monitoring the rapid and changing rate of growth in early childhood. These have not however been used extensively in emergencies.

[18] Hanging scales are often used in measuring weight of children 6-59 months but are not considered to be suitable for taking weight of infants less than 6 months. Balance beam scales may be the most suitable for both clinical and community work, however there are other types of scales that have not yet been rigorously compared. Digital UNISCALEs measure infant weight by taking the weight of the mother and child, and subtracting the weight of the mother, which has the benefit of ensuring that the child is calmer than when weighed alone.

[19] Ibid.

Box 3: Low Birth weight and assessment of acute malnutrition in infants less than 6 months

The birthweight of a baby is an indicator of the child's future health and nutritional status as well as an indicator of the mother's nutritional and health status. As such, birthweight is an important indicator for programmes aimed at pregnant and lactating women and young children. A child born with a birthweight below 2.5 kg is defined as *low birthweight* (LBW).

Reliable birthweight data are often scarce, particularly during an emergency. Interpretation of available birthweight data needs to be done with caution. For example, data collected at hospitals may be skewed towards better-nourished mothers, who are more likely to give birth in institutions. Fewer women may be able to access hospitals when there is an emergency, so records at the facility level may be incomplete. Variation in the amount of time between birth and the baby being weighed can also introduce measurement bias in birthweight data.

Children with LBW may not necessarily be acutely malnourished. There has been some concern that LBW infants may be artificially classified with a higher degree of wasting when compared to a non LBW infant. The reanalysis of 21 Demographic Health Surveys by the MAMI project reported that the majority of infants less than 6 months were not LBW infants, however there was an elevated risk of subsequently developing both severe and moderate wasting in LBW infants when compared to normal birth weight infants.[20]

The WHO GS are relevant in anthropometric assessment of LBW infants because LBW infants born at greater than or equal to 37 weeks and less than 42 weeks are included in the data set. Research is on-going in order to define the standard rate of catch up growth in LBW infants and the use of the WHO GS in LBW and non LBW infants.

The Z-score is used to describe how far a measurement is from the median, or average.[21] A WFH Z-score calculated for an individual tells exactly how many standard deviation units an individual's weight value is away from of an individual of the same height in the WHO GS. A positive WFH Z-score means that the individual's measurement is higher than the median weight value of an individual of the same height in the WHO GS, while a negative WFH Z-score means that the measurement is lower than the median weight value of an individual of the same height in the WHO GS.

Ninety-five per cent of the WHO GS population has anthropometric Z-scores between -2 and +2, which is within the normal range. If a child's Z-score falls outside the normal range, this signals a deviation from the norm in his or her nutritional status.

Because the distribution of weight-for-height is skewed in the WHO GS, the formula required to calculate the Z-scores based on the WHO GS uses three parameters, and is thus not practical for hand calculation in the field.[22, 23] Sex specific look up tables have been developed to enable classification of nutrition status in relation to cut-off points[24], and freely downloadable software (WHO Anthro[25]) can automatically generate the specific Z-score value. Box 4 outlines the use of look up tables (sample found in Annex 3), and calculation of exact Z-score by hand or computer.

Percentage of the median, on the other hand, also compares to the weight of a child of the same length/height and sex. The measured weight is divided by the median weight of a child of the same length/height, multiplied by 100.

While percentage of the median has been commonly used in the field as the basis for admission criteria into selective feeding programmes, global recommendations issued in May 2009 recommend the use of Z-score instead of percentage of the median for admission and discharge criteria for programmes that treat acute malnutrition.[26] Because of this global recommendation, calculation of percentage of the median is not covered further here, but can be found in Annex 4. There are however some technical issues related to the shift from use of percentage of the median NCHS GR to the use of WHO GS Z-scores (see Box 5).

[20] Management of Acute Malnutrition in Infants (MAMI) Project (2010): Technical Review: Current evidence, policies, practices & programme outcomes. London: ENN, UCL-CIHD, ACF.

[21] The method for calculating Z score is different between normally distributed (e.g. height) versus non-normally distributed measurements (e.g. weight).

[22] This is in contrast to the NCHS GR where calculation of Z score by hand was easily done in the field. The complexity of the calculation in the WHO GS is due to the methodology in the construction of the WHO GS.

[23] Hand calculation is also only possible for children whose Z score falls between -3 and +3 Z score. A separate equation is required for values beyond those parameters, which is not possible by hand.

[24] Simplified sex-combined tables for the NCHS GR were often used in the field in situations where it is important to simplify systems as much as possible.

[25] www.who.int/childgrowth/software/

[26] WHO and UNICEF. (2009). WHO child growth standards and the identification of severe acute malnutrition in infants and children A Joint Statement by the World Health Organization and the United Nations Children's Fund

Box 4: Calculation of weight for height Z-score

A. Using look up tables to identify Z-score range

Separate tables are used for boys and for girls. They come in two forms- full (which include L, M, and S values which are related to the way that the WHO GS were calculated) and simplified field tables. Both can be used for estimation of the category of malnutrition and have similar layout. The sex and age range are clearly noted on the top (eg. Weight-for-height boys 2-5 years, weigh-for-length girls birth to 2 years). The left-most column displays length or height increasing with an interval of 0.5 cm, and subsequent columns have values for weight in kg under columns of -3SD, -2SD, -1SD, median, +1SD, +2SD, +3SD.

Using the table for the correct sex and age group, one looks down the left-most column of length/height until the value of the individual child is found. Then one moves horizontally in the same line to find where the individual's weight is listed, or if not listed, then the two columns between which the value would fall. This will allow determination of the range of values, eg greater than -3 SD and less than -2 SD.

For example, a boy is 3 years old, is 90.6 cm and 10.8 kg.

Using the WFH table for boys 2-5 years, one finds the nearest height value in cm to 90.6. In this case, it is 90.5cm. Moving horizontally and to the right, the value of 10.6 kg falls between 10.3 kg (or -3SD) and 11.1kgs (or -2SD). The Z-score is greater than -3 SD and less than -2 SD.

Weigh-for-height BOYS
2 to 5 years (z-scores)

				Z-scores (weight in kg)			
Heigh (cm)	L	M	S	-3 SD	-2 SD	-1 SD	Median
89.0	-0.3521	12.6495	0.08045	10.0	10.8	11.7	12.6
89.5	-0.3521	12.7683	0.08038	10.1	10.9	11.8	12.8
90.0	-0.3521	12.8864	0.08032	10.2	11.0	11.9	12.9
90.5	-0.3521	13.0038	0.08028	10.3	11.1	12.0	13.0
91.0	-0.3521	13.1209	0.08025	10.4	11.2	12.1	13.1
91.5	-0.3521	13.2376	0.08024	10.5	11.3	12.2	13.2

Given that the tables only show length/height in 0.5 cm increments, it is necessary to round the values.

If length/height ends in 0.1 or 0.2, then you round down to 0.0.

If length/height ends in 0.3 or 0.4, you round up to 0.5

If length/height ends in 0.6 or 0.7, you round down to 0.5.

If length/height ends in 0.8 or 0.9, you round up to the next highest 0.0.

Box 4: Calculation of weight for height Z-score (continued)

B. calculating the Z-score by hand

The full tables, which include values for L, M, and S, have to be used, along with a complicated formula. This formula will also only apply if the child has a Z-score between -3SD and +3 SD. It is not possible to calculate by hand when the Z-score is below -3 SD or above +3SD. It isn't possible to know whether this is the case, so making the calculation by hand can result in wasted time in the field.

The formula for calculation of Z-score (if it falls between -3 and +3 SD) is

$$\text{Z-score} = \frac{(\text{observed value}/M)^{L} - 1}{L \times S}$$

Let's take an example of a girl who is 3 years and 1 month old. Her height is 91.1cm, with a weight of 10.5 kg. Using the lookup tables, the values for L, M, and S for someone with a height of 91.0cm (e.g. 91.1 was rounded down to 91.0) are:

M = 12.8939
L = -0.3833
S = 0.08920

$$\text{Z-score} = \frac{(10.5/12.8939)\ -0.3833 - 1}{(-0.3833 \times 0.08920)}$$

$$= \mathbf{-2.26}\ \text{Z-score}$$

C. Calculating the Z-score by computer

The WHO Anthro software has an anthropometric calculator module. It requires the user to enter the date of birth, weight, length or height, to specify how the measurement was made (standing up or lying down), sex, and presence or absence of oedema. The Z-scores (with 2 decimal places) for WFH, HFA, WFA, and BMI for age are generated and can be graphically displayed against the standard curves.

Box 5: NCHS GR percentage of the median and WHO GS Z-scores

The shift from using NCHS GR percentage of the median for admission to programmes to WHO GS Z-scores is recommended. In making the transition, some things to keep in mind are:

Classification: The WHO GS appear to classify children who were previously identified as moderately malnourished by NCHS GR as severely malnourished. When weight is plotted against height, the cut-off of 80% of the median NCHS GR is close to the cut-off of – 3 Z-score WHO GS, while the cut-off of 70% of the median NCHS GR is close to the cut-off – 4 Z-score WHO GS.[27] This difference has been estimated to translate into a 2 to 5 fold increase in admissions. While the WHO GS and the revision of the MUAC cut-off to identify SAM children will increase the caseload for therapeutic feeding programmes, the duration of treatment will decrease since more children will be detected earlier and in a less severe state.

Ease of use: The concept of Z-scores is more complicated than that of percentage of the median. Field workers may find it difficult to adequately calculate and use Z-score information without sufficient training, understanding, and supportive supervision. Since Z-scores using the WHO GS will tend to identify more children with acute malnutrition, field workers may notice that the children that are being admitted (often earlier in terms of level of deterioration) may not look the same in terms of condition as those admitted under NCHS GR percentage of the median, leading them to doubt their classification.

Community understanding: With the shift, many children who were not eligible before will become eligible for admission into programmes to treat acute malnutrition. Without adequate engagement with the community members in terms of explaining the changes, the reasons for the changes and the implications, relationships between the programmes and the community can become strained, putting field level workers in a potentially uncomfortable position.

[27] WHO, UNICEF, WFP and UNHCR (2010). Consultation on the Programmatic Aspects of the Management of Moderate Acute Malnutrition in Children under five years of age: 24-26 February. Geneva: WHO.

MUAC

MUAC is an indicator of wasting and in particular lean body mass.[28] It is a proxy measure of nutrient reserves in muscle and fat. Measurement is not time consuming, and has been documented as an effective predictor of risk of death in children aged 6 to 59 months.[29] MUAC has been endorsed as an independent admission criterion for nutrition programmes addressing SAM.[30] The cut-off was recently modified from less than 110mm (11cm) to less than 115mm (11.5 cm) for classification of SAM.[31] Appropriateness of this shift in terms of identifying severely malnourished children has been documented from the field.[32] MUAC does not respond rapidly when malnourished children are treated. It is less helpful in measuring recovery or improvement of nutritional status over a short period of time.[33]

MUAC does have a bias towards selecting younger rather than older children, who naturally have a smaller arm circumference measurement. This bias is considered acceptable in terms of identifying individuals at risk of mortality and classifying acute malnutrition. MUAC can be adjusted for age and height in order to compensate for this bias towards younger children – WHO GS tables are available for MUAC-for-age – however use of MUAC-for-age and MUAC-for-height is not widespread.

Some operational issues in the use of MUAC persist, as described in **Challenge 2** below. Cut-off points for MUAC are found in Table 2.

Challenge 2: The use of MUAC

MUAC has been successfully used with low-skilled staff given training and supervisory support, and is especially suitable for use in the community. The method is based on a single measurement, as opposed to two measurements (for example weight and height). It does not require heavy material and can be used with a single cut-off for boys and girls.[34] It is increasingly being incorporated into guidelines for the treatment of severe and moderate malnutrition.[35] However, there are drawbacks to using MUAC in emergencies. The chance of inaccurate measurement is high due to differing techniques, and there is limited evidence documenting ethnic differences in MUAC measurements.

At the individual level, MUAC can be used to initially screen individuals for admission to selective feeding programmes. It is an independent admission criterion for treatment of SAM, however it is not currently recommended as a discharge criterion.

At the population level, it is recommended that MUAC information is collected in nutrition surveys for use in programme planning, but that MUAC should not be used as the single measure in anthropometric surveys. Research is underway to determine appropriateness of using MUAC to estimate population level nutrition status.

Classification of acute malnutrition in children (6-60 months)

Cut-off points are used to classify the severity of malnutrition measured through anthropometric indices. The cut-offs for different nutritional indices for children are shown in Table 2.

A child with bilateral oedema is always classified with SAM, however bilateral oedema is a clinical sign of both kwashiorkor (bilateral oedema), as well as marasmic kwashiorkor (severe wasting and bilateral oedema). In order to differentiate between kwashiorkor and marasmic kwashiorkor, there is a need to include explicit identification of wasting. This has previously been defined as:[36]

[28] Young, Helen and Susanne Jaspars (2009). *Review of Nutrition and Mortality Indicators for the IPC: Reference Levels and Decision-making*. Geneva: UNSCN.

[29] IASC Global Nutrition Cluster, and Standing Committee on Nutrition (SCN) Task Force on Assessment, Monitoring, and Evaluation. (2009). Fact sheet on MUAC. Geneva: UNSCN.

[30] WHO, WFP, IASC, UNICEF. (2007). *Community-Based Management of Severe Acute Malnutrition*. Geneva: WHO.

[31] WHO and UNICEF. (2009). *WHO child growth standards and the identification of severe acute malnutrition in infants and children A Joint Statement by the World Health Organization and the United Nations Children's Fund*. Geneva: WHO and UNICEF.

[32] Fernandez, MA, Delchevalerie P, Van Herp M. (2010) *Accuracy of MUAC in the detection of severe wasting with the new WHO growth standards*. Pediatrics July; 126 (1) e195-201.

[33] WHO. *Guidelines for an integrated approach to the nutritional care of HIV-infected children (6 months -14 years)*. 2009. Geneva, WHO.

[34] IASC Global Nutrition Cluster, and Standing Committee on Nutrition (SCN) Task Force on Assessment, Monitoring, and Evaluation. (2009). *Fact sheet on MUAC*. Geneva: UNSCN.

[35] ENN, UCL-CIHD, ACF (2010). Management of Acute Malnutrition in Infants (MAMI) Project: *Technical Review: Current evidence, policies, practices & programme outcomes*. London. ENN.

[36] Action Contre La Faim/Prudhon, Claudine (2002). *Assessment and Treatment of Malnutrition in Emergency Situations: Manual of Therapeutic Care and Planning for a Nutritional Programme*. Paris: ACF.

Table 2: Classification of acute malnutrition in children 6-60 months

Nutrition Indicator	Moderate Acute Malnutrition (MAM)	Severe Acute Malnutrition (SAM)
WFH (wasting)	≥ -3 SD & < -2 SD	< -3 SD
MUAC	≥ 115mm & < 125mm (≥ 11.5cm & < 12.5cm)	<115mm (<11.5cm)
MUAC for age/height		< -3 SD
Bilateral Oedema	No	Yes

	Criteria
Kwashiorkor	Bilateral pitting oedema And WFH ≥ -2 Z-scores
Marasmic-kwashiorkor	Bilateral pitting oedema And WFH < -2 Z-scores

As mentioned in Case Example 1 (Nepal), the nutritional indices of WFH and MUAC may not always identify the same children with SAM. Recent research suggests that these differences may be related in part to body shape of population groups (see Challenge 3). For the time being, and until the evidence base is developed, the cut-off points in Table 2 are recommended for classification of acute malnutrition in children 6-59 months.

Challenge 3: Body shape and the use of MUAC and WFH in children 6-59 months

Body shape, in terms of the proportion of the trunk to legs, has been documented to vary among adults. This proportion is measured through the sitting height to standing height ratio (SH/S or SSR). Smaller values of SSR translate into longer limbs and/or shorter trunks, while larger SSR values translate into longer trunks and/or shorter limbs. Correction of WFH for SSR is not currently practiced for children 6-59 months. Recent research has however documented differences in the classification of acute malnutrition in children 6-59 months within the same ethnic group, specifically between livelihood groups, in relation to SSR.

In 2005, an anthropometric survey was conducted in the Belete Weyne district of Somalia by Save the Children – UK. It reported that prevalence estimates for GAM were different when based on WFH Z-score and MUAC in pastoralist and agro-pastoralist livelihood zones. In the riverine-agrarian livelihood zone, however, the estimated prevalence was similar, whether based on WFH Z-score or MUAC. Further research identified that children in the pastoralist and agro-pastoralist livelihood zones had longer limbs and lower SSR than children from the riverine-agrarian livelihood zone.

A more formal study on the relationship between each nutritional index and body shape was carried out among children 24-59 months (as opposed to 6-59 months commonly used in anthropometric surveys). Based on current case definitions and cut-off points, standard WFH Z-score tended to overestimate the prevalence of acute malnutrition in populations with lower SSR body shapes in comparison to MUAC. MUAC was also found to be associated with body shape, though the relationship was weak. Further research is ongoing to define the potential implications of body shape on classification of nutrition status in relation to body shape.

Source: M Myatt, A Duffield, A Seal, F Pasteur (2009).The effect of body shape on weight-for-height and mid-upper arm circumference based case definitions of acute malnutrition in Ethiopian children. Annals of Human Biology: Vol 36, No.1, pp 5-20.

Measuring malnutrition in older children, adults and older people

Increasing attention is being paid to assessing malnutrition in older children, adults and older people, however the tools and protocols to make the assessment are not as well developed as they are for children 6-59 months of age. Women, especially during pregnancy and lactation, have long been considered a nutritionally vulnerable group. In some emergencies, high rates of wasting in adults and older people have been noted. Inclusion of women of reproductive age in anthropometric surveys are increasingly common, but less so in emergencies. Inclusion of older children and adolescents remain relatively rare unless part of a research study.

Children and Adolescents 5-19 years of age

The basic information and body measurements needed to assess acute malnutrition in children 5-19 years of age are: age, sex, weight, and height, in addition to the clinical signs of visible wasting and bilateral oedema. Adolescence, which occurs from around 10 to 18 years of age, is a period of rapid growth and sexual maturation. Rates of change in height and weight are not constant. There are, however, no field-friendly and accurate methodologies for adjusting for sexual maturation in adolescents.

WHO recommends that acute malnutrition among children and adolescents 5-19 years be assessed by calculating BMI, and then adjusting for age to generate BMI-for-age. BMI is calculated based on the weight (in kg) divided by the square of the height (in m) of the individual. (See Box 6 for an example).[37] BMI-for-age should be presented in Z-scores based on the 2007 WHO GR for children 5-19 years.

Recommended cut-off points for BMI-for-age are found in Table 3. Bilateral oedema and visible wasting are also clinical signs of SAM in this age group. Anthropometric measurements should not be used as the sole indicator of malnutrition in adolescents.

Sex specific tables and charts exist, and a sample can be seen in Annex 5. Look up tables are used in the same way as they are in Box 4 (calculation of Z-scores).

Classification of children and adolescents 5-19 years of age

	BMI-for-age Z-score
Severe thinness:	<-3SD
Thinness:	≥ -3 SD & < -2 SD
Overweight:	>+1SD & ≤+2 SD (equivalent to BMI 25 kg/m^2 at 19 years)
Obesity:	>+2SD (equivalent to BMI 30 kg/m^2 at 19 years)

There are no internationally agreed upon cut-offs for MUAC for children 5-19 years; however recent guidelines for the nutritional care of HIV-Infected Children have proposed the following values for screening (pending formal validation):

- In children 5-9 years of age, a MUAC less than 129 mm (-3 z-score according to growth standards for 5 year old boys)
- In children 10-14 years of age, a MUAC less than 160 mm.[38, 39]

[37] Weight for-age is inadequate for monitoring growth beyond childhood due to its inability to distinguish between relative height and body mass. The Sphere Project (2011). *Humanitarian Charter and Minimum Standards in Humanitarian Response, Chapter 3: Minimum Standards in Food Security and Nutrition*. Geneva: The Sphere Project.

[38] WHO 2009. *Guidelines for an integrated approach to the nutritional care of HIV-infected children (6 months -14 years)*. Geneva, WHO.

[39] The recommendation for children 10-14 years of age is consistent with WHO (2004). *Acute care. Integrated Management of Adolescent and Adult Illness. Interim Guidelines for First-Level Facility Health Workers at Health Centre and District Outpatient Clinic*. (2004). Geneva, WHO.

At the population level, surveys should only be done on this age group once an analysis of the causes of malnutrition has determined that the nutritional status of young children does not reflect the nutritional status of the general population, and in that case only if adequate human resources and technical support are available.[40] Surveys using BMI-for-age, however, have found unrealistically high levels of adolescent wasting in emergency-affected populations. This may be due to inaccurate age data and the fact that later sexual development affects body proportions among adolescents affected by emergencies. Surveys of older children and adolescents also tend to collect information on specific age ranges relevant for their particular purposes, which can vary based on the context and do therefore not represent a standardised group. No clear thresholds for classifying population level nutrition status based on older child and adolescent nutrition status exist.

Adults (20-59.9 years)

The basic information and body measurements needed to assess acute malnutrition in adults 20-59.9 years are weight, height, and MUAC in addition to the clinical signs of bilateral oedema and visible wasting. In emergencies, undernutrition (chronic energy deficiency) is the form of malnutrition of most concern among adults 20-59.9 years because it reflects recent conditions and can deteriorate quickly, leading to increased risk of morbidity and mortality.

The most useful measure of undernutrition in adults is BMI, an indicator of weight deficit in relation to height. BMI is not compared to a reference population, but is classified directly based on specific cut-off points (Table 4). An example of a BMI calculation is provided in **Box 6**.

Box 6: Example of the calculation of BMI

A young, non-pregnant woman's height is 1.60 m and her weight is 50 kg.

$$\text{BMI} = \frac{\text{Measured weight (kg)}}{\text{Height2 (m2)}}$$

$$= \frac{50\text{ kg}}{1.6\text{m2}}$$

$$\textbf{BMI = 19.5}$$

NB: This woman is not malnourished.

Table 4: Cut-off points for BMI in adults

	Well-nourished	Mild acute malnutrition	Moderate acute malnutrition	Severe acute malnutrition
BMI (WHO 1995)	≥ 18.5kg/m^2	<18 to ≥17kg/m^2	<17 to ≥16kg/m^2	< 16kg/m^2

BMI cannot be used for pregnant women because a pregnant woman's weight will be related to the growth of the baby and changes in the body related to pregnancy. BMI cannot distinguish between acute malnutrition and chronic undernutrition in an individual. There are also daily fluctuations in height (due to compression effect of gravity a person's height is greatest in the morning), weight (depending on fluid and food intake/digestion), and age related changes in body characteristics that affect these measures. BMI should not be calculated for adults with oedema because of the bias introduced by weight of extra body fluids.

Differences in body shape (e.g. sitting height-to-standing height ratio (SSR or SH/S) do impact the classification of acute malnutrition in adults using anthropometry. International guidelines[41] recommend that BMI should be adjusted for SSR, which in adults is called the *Cormic index*. The Cormic index varies between populations and within populations (Challenge 4). Such adjustments can substantially change the prevalence of wasting in adults, and may have important programmatic consequences. While this is recognized technically, this is not commonly practiced and not widely documented (see Case Example 2). Guidance on adjusting for Cormic Index is given in Annex 6.

[40] The Sphere Project (2011). *Humanitarian Charter and Minimum Standards in Humanitarian Response, Chapter 3: Minimum Standards in Food Security and Nutrition.* Geneva: The Sphere Project.

[41] Ibid.

Challenge 4: Variation in body shape in anthropometric measurements in adults

There are differences in adult body shape that vary between groups, even within the same country. In terms of variation between populations, the ratio of leg-length to trunk-length, sometimes called the *sitting height to standing height ratio* (SSR or SH/S) or Cormic index, varies from a ratio of 0.48 in Australian aborigines (e.g., long legs compared to a shorter trunk) to up to 0.55 in the Japanese (e.g., short legs compared to a longer trunk). These differences can have a considerable influence on the value of adult BMI.

Available information on the range of Cormic index in different populations indicates a typical ratio of 0.52-0.53 in European and Indo-Mediterranean populations, 0.54 in Western Pacific regions, and 0.51 to 0.52 in African populations. Practically speaking, a 0.01 difference in the Cormic index translates into a difference in BMI of 1kg/m squared[42]. The SSR can also vary widely within the same population. One example from an aboriginal population reported a range of 0.41 to 0.54 for the Cormic index, translating into a variation of more than 10 kg/m squared dependent on the body shape alone within that one population.

In addition, there are some ethnic groups who appear to be unusually tall and slim, including the Kenyan Samburu and the Dinka from Southern Sudan. As a result, the average adult BMI of these groups is below average, at around 17.6. There is, however, no evidence clearly defining the physiological outcomes associated with the lower BMI of these groups.

Documentation on the impact of these body shape differences on assessment of acute malnutrition in adults is limited, and the understanding of functional outcomes based on these differences is even less well understood.

Case Example 2: Adjusting for the Cormic Index in Somalia, 2009

No national level information on micronutrient status was available in Somalia. In order to address this gap, the Food Security and Nutrition Analysis Unit in collaboration with UNICEF, WFP, WHO, the Ministry of Health and the University College London Centre for International Heath and Development (UCL CIHD) initiated a national, two-stage, stratified, household cluster survey in 2009. Anthropometric information was collected, as well as information on household characteristics, dietary intake, micronutrient status, infant feeding practices, and malaria prevalence.

BMI was calculated for 1,929 non-pregnant women. The mean BMI of the population was 22.5 kg/m^2. The mean Cormic Index was 50.5%. While it was recognized that correction of BMI using the Cormic Index is required for comparison of prevalence data between populations, the different equations available and lack of consensus on the best method for use with Somali populations meant that the report presented unadjusted BMI. Using the cut-off point <18.5 for grade 1 thinness gave an overall prevalence of 21.5% (95% CI 19.4-25.8).

In order to more fully understand the assessment of adults in Somalia, additional analysis was conducted to compare adjusted and non adjusted prevalence of GAM. When BMI was adjusted with the Cormic Index, it reduced GAM prevalence in non pregnant women by 2-3%.

Source: FSNAU, FAO, UCL, WHO, UNICEF, WFP, MOH (2009). National Micronutrient and Anthropometric Survey, and personal communication.

MUAC in adults should also be collected and, in combination with clinical signs, is often used by international agencies to screen adults for admittance to feeding centres. There is no international consensus on the cut-off points for classifying severe malnutrition in adults using MUAC. In practice, the cut-offs shown in Table 5 are commonly used by international agencies during emergencies.

For **pregnant women of any age**, MUAC is recommended as the preferred nutritional index for pregnant women, since it does not change significantly during pregnancy. MUAC has also been found to be a good predictor of risk of giving birth to a low birthweight infant. In practice, cut-off points used for identification of women at nutritional risk range from 210mm (21cm) to 230mm (23cm). The Sphere Minimum Standards recommend a cut-off point of 210mm for identification of nutritional risk in pregnant women in emergencies.[43]

[42] Ibid.

[43] The Sphere Project (2011). *Humanitarian Charter and Minimum Standards in Humanitarian Response, Chapter 3: Minimum Standards in Food Security and Nutrition.* Geneva: The Sphere Project.

Table 5: Classification of acute malnutrition in adults with MUAC

Nutrition Indicator	Moderate Acute Malnutrition (MAM)	Severe Acute Malnutrition (SAM)
MUAC (WHO 1995)[i]	≥ 214 mm and ≤221 mm (women) ≥ 224 mm and ≤231 mm (men)	< 214 mm (women) < 224 mm (men)
MUAC (Ferro-Luzzi 1996)[ii]	< 190 mm (women) < 200 mm (men)	<160 mm (women) < 170 mm (men)
MUAC (SCN 2000)[iii]	< 185 and ≥ 160 mm plus clinical signs[iv]	< 160 mm
Bilateral Oedema	No	Yes

i WHO (1995). Physical Status: The Use and Interpretation of Anthropometry – Report of a WHO Expert Committee. Technical Report Series 854. Geneva, WHO.
ii Ferro-Luzzi, Anna and W. P. T. James (1996). Adult malnutrition: simple assessment techniques for use in emergencies. British Journal of Nutrition, 75.
iii United Nations Standing Committee on Nutrition (2000). Adults: Assessment of Nutritional Status in Emergency-affected Populations. Geneva: SCN.
iv Clinical signs include inability to stand, evident dehydration and presence of oedema.

Older people (60 years and above)

The basic information and body measurements needed to assess acute malnutrition in people 60 years and above are weight and height in addition to the clinical signs of bilateral oedema and visible wasting. Older people are a difficult group to define and a particularly difficult group to assess anthropometrically. In developing countries, a person may be considered elderly from the age of 45 years onwards, whereas in developed countries, old age is considered to start at around 60 years of age.

As older people are more likely to be disabled, bedridden or unable to stand straight, accurately measuring height is difficult. Furthermore, declines in height (due to stooping and compression of the vertebrae) occur with age at a rate of 1cm to 2cm per decade after the age of 40, and even more rapidly in older age. Research suggests that measures such as the arm length and knee length can be used to estimate height in older people. However, no standard method of estimating height from these proxy measures has been established.

In emergencies if there is an indication that older people are a particularly vulnerable group, if possible BMI should be assessed and the same cut-off points as for adults applied. Case example 3 provides some insight into the use of other criteria to define nutritional risk in older people.

Anthropometry, stunting and underweight in children 6-60 months[44]

Anthropometry can identify three forms of growth failure (undernutrition): wasting, stunting, and underweight (Table 1). The three nutritional indices of WFH, HFA, and WFA each assess different aspects of growth failure. As a result, they may or may not identify the same children with each form of undernutrition. The WHO GS have separate tables to determine Z-score for HFA and WFA, and are used in the same way as WFH tables.

Stunting: Chronic undernutrition

Stunting, or low height for age (HFA) in children 0-59 months, is commonly used in large scale assessments of population nutrition status in terms of monitoring progress towards development goals. Stunting is generally irreversible after 2 years of age. At the individual and population level, it does not change rapidly. The cut-off points are:

Nutrition Indicator	Moderate stunting	Severe stunting
HFA (stunting)	<-2 SD to ≥-3 SD	< -3 SD

44 Note that assessment of acute malnutrition, stunting and underweight for infants under 6 months is not well defined using anthropometric cut-offs, although they are included in the WHO GS.

Case Example 3: HelpAge and nutritional assessment in older people

HelpAge has been working in West Darfur, Sudan, for more than 25 years in order to address the needs of older people. Activities were focussed in Internally Displaced Person (IDP) camps. For the purpose of its programming, and taking into account cultural norms, HelpAge defined an older person as someone over 55 years old. In order to target individuals for programmes, they relied on assessment of vulnerability, including social isolation, living with dependents, level of mobility, and lack of a general food distribution ration card.

In May 2006, HelpAge conducted a rapid assessment in order to assess the health and nutrition status of older people living in IDP camps.to identify older people's profiles and their social vulnerability risk factors, as the basis for further programme work.

Anthropometric status was based on MUAC because of the ease of measurement, but anthropometric information was only one factor to define overall vulnerability and follow up programming. Clinical risk factors included bilateral famine oedema, inability to stand, extreme weakness, dehydration or anorexia, while social factors included living alone without family support, physical or mental disability, incapacity to do household activities, very low social economic status or psychological trauma.

Nutrition Status	MUAC (mm)	Clinical Risk Factors	Social Risk Factors	Action needed
Normal	>185	Yes/No	No	Do not admit
High Nutrition Risk	>185	Yes/No	Yes	Community Support Programme
Moderate Malnutrition	160-185	No	Yes/No	Supplementary Feeding Programme
Severe Malnutrition	160-185	Yes	Yes/No	Therapeutic Feeding Programme
Severe Malnutrition	<160	Yes/No	Yes/No	Therapeutic Feeding Programme

The information gathered was used to better target HelpAge programming as well as to advocate with humanitarian programming in other sectors to address the specific vulnerabilities of older people.

Source: HelpAge International (2006). *Rebuilding lives in longer-term emergencies: Older people's experience in Darfur*. London: HelpAge International.
HelpAge International (2006). *Health and Nutrition Rapid Assessment of Older People in West Darfur State, Sudan-Final report*.

Underweight: a composite indicator that includes acute malnutrition and/or chronic undernutrition

Underweight, or low weight for age (WFA), is commonly used in growth monitoring programmes for children 0-59 months. It is also monitored as a key indicator in the Millennium Development Goals. It cannot differentiate between the contribution of acute malnutrition and chronic undernutrition. The cut-off points are:

Nutrition Indicator	Moderate underweight	Severe underweight
WFA (underweight)	<-2 SD to ≥-3 SD	< -3 SD

Multiple anthropometric failures

While the different forms of growth failure have been presented as separate issues, it is possible for one individual to be identified with more than one form of growth failure at the same time. Some underweight children may be identified with stunting and/or wasting, some stunted children may not have any other form of undernutrition, while others might have all three-stunting, wasting, and underweight. Being classified with more than one form of malnutrition is also called *multiple anthropometric failures*. The limited information available suggests that those children with multiple anthropometric failures are more likely to be ill. Of those with multiple anthropometric failures, those that exhibit all three were shown to have the greatest morbidity risk.[45]

[45] Nandy, S, Irving, M, Gordon, D, Subramania, SV, & Davey Smith, G (2005). *Poverty, child undernutrition and morbidity: new evidence from India*. Bulletin of the World Health Organization, 83 (3): 210-216.

There is no single protocol for defining this degree of multiple failures in an individual, the functional outcomes if the child is experiencing multiple anthropometric failures, nor the appropriate action to be taken by the health or nutrition staff at clinic and community level. Each anthropometric indicator has a different meaning, hence to get a comprehensive picture of a child's nutritional status, it would be important to derive all three nutrition indices. This is not always possible in an emergency.

Annex 1: Anthropometric Measurement of Children Aged Six Months to Five Years[46]

It is critical to ensure that training on taking anthropometric measures and identifying presence and grade of bilateral oedema includes both theoretical and practical training. It is also critical to ensure that adequate supervision and assessment of measurement and calculations is available.

WEIGHT

To increase accuracy and precision, two people are needed to measure weight. Weight can be measured using a Salter-type hanging spring scale (as is commonly found in the field) or an electronic scale such as the United Nations Children's Fund (UNICEF) UNISCALE, which is more reliable and allows a child to be measured in the mother/caregiver's arms.

Hanging Spring (Salter) Scale

A 25 kilogram (kg) hanging spring scale, graduated by 0.1 kg, is most commonly used. In the field setting, the scale is hooked to a tree, a tripod or a stick held by two people. In a clinic, it is attached to the ceiling or a stand. Weighing pants (or a weighing hammock for smaller infants) are attached to the scale. Culturally adapted solutions, such as a mother's wrap, basin or grass basket, might be preferable to use to weigh the child. The weighing pants or hammock is suspended from the lower hook of the scale, and the scale is readjusted to zero. The child's clothes are removed and the child is placed in the weighing pants or hammock. The scale should be read at eye level.

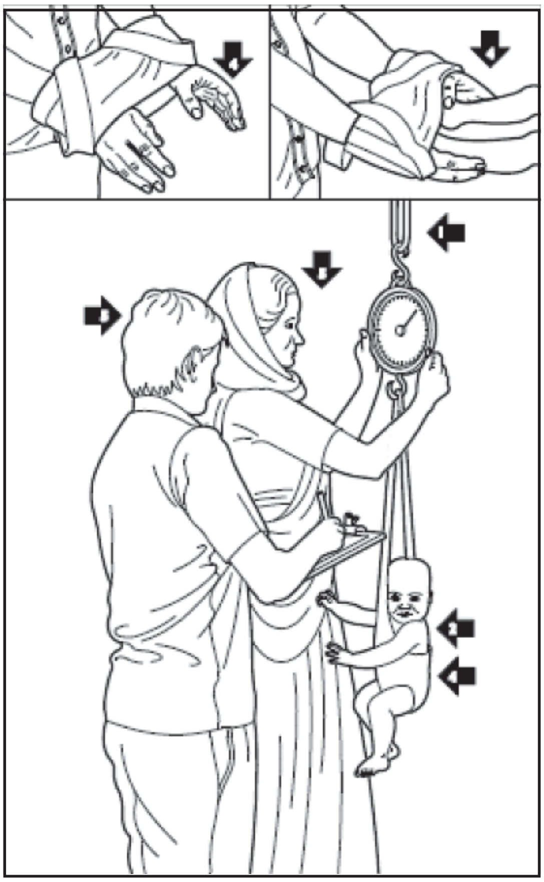
How to use the Salter Scale:

- Before weighing the child, take all his/her clothes off.
- Zero the weighing scales (i.e., make sure the arrow is on 0).
- Place the child in the weighing pants/hammock, making sure the child is touching nothing.
- Read the child's weight. The arrow must be steady and the weight/scale should be read at eye level.
- Record the weight in kg and to the nearest 100 grams (g) (e.g., 6.4 kg).

Considerations when using the Salter Scale:

- The scale should be checked daily against a known weight. To do this, set the scale to zero and weigh objects of known weight (e.g., 5.0 kg, 10.0 kg, 15.0 kg). If the measure does not match the weight to within 10 grams the springs must be changed or the scale should be replaced.
- Make sure the child is safely in the weighing pants or hammock with one arm in front and one arm behind the straps to help maintain balance.
- In cold climates or in certain cultures it might be impossible or impractical to undress a child completely. The average weight of the clothes should be estimated and deducted from the measure. It is helpful to retain similar clothing for girls and boys during weighing to help to standardise weight deductions.
- When the child is steady and settled, the weight is recorded in kg to the nearest 100g. If the child is moving and the needle does not stabilise, the weight should be estimated by recording the value at the midpoint of the range of oscillations. The measurer reads the value on the scale aloud, and the assistant repeats it for verification and records it on the anthropometric form or treatment card. The child is then dressed.

[46] FANTA-2. (2010). *Generic CMAM Job Aids*. Washington DC. Fanta Project. & Mozambique Ministry of Health, UNICEF and FANTA-2 (201). Pacote de Formação para o Programa de Reabilitação Nutricional.



Electronic Scale (e.g., UNISCALE)

The UNISCALE is powered by a lithium battery which should last for one million weighings. It has a solar switch that turns the device on in daylight or a normally lit room. One important feature is that it allows a mother/caregiver to hold the child while the child is being weighed. The scale comes with instructions.

How to use the UNISCALE:

- Regular calibration (e.g. each morning).
- Place the scale on a flat surface in a well-lit area, making sure that all four of the scale's feet are on the ground.
- Remove as much of the child's clothing as possible.
- Wave a hand over the solar switch to turn on the scale. The scale shows a picture of an adult, indicating that it is ready to weigh an adult.
- The mother/caregiver stands on the scale first, without the child. The scale shows the weight and stores it in its memory. The adult remains on the scale.
- Wave a hand over the solar switch again. The scale shows a picture of an adult holding a child indicating that it is ready to weigh an adult with a child.
- Pass the child to be weighed to the adult on the scale. The adult should remain still.
- The scale shows the child's weight.

HEIGHT

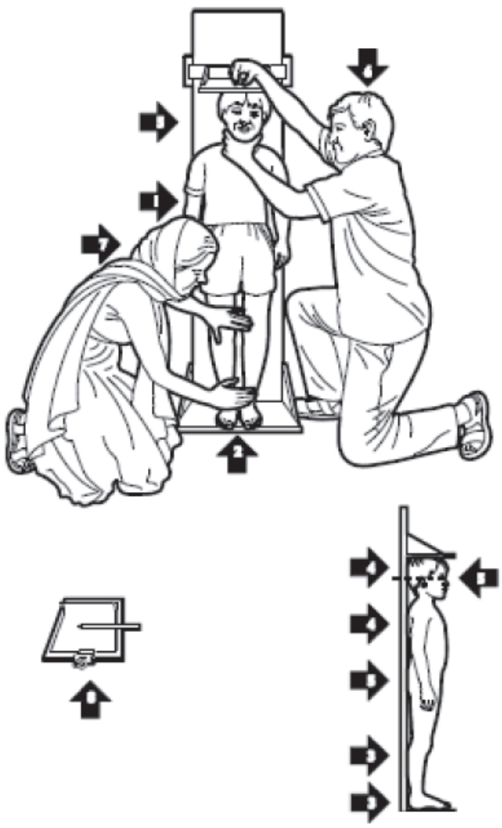
To increase accuracy and precision, two people are always needed to measure length and height.

Children 2 years or older (24 months and upwards) are measured standing up, while those under 2 (23.9 months or below) are measured lying down. If the age is difficult to assess, children with a height of 87 cm tall or above are measured standing and those less than 87 cm are measured lying down (WHO Standards). The difference in recumbent length versus standing height is 0.7cm, meaning that a child who is measured lying down will appear artificially taller than they would if they were measured standing up. The artificial additional height will then tend to overestimate the degree of wasting in that individual. While it is possible to correct for this in the analysis by subtracting 0.7cm from the measurement (e.g. if a child age 2 or older or with a height of 87 cm or above are measured lying down, 0.7 cm is subtracted from the measurement), it is recommended to ensure that children are measured either standing up or lying down according to age (or height cut-offs in the absence of age determination).

For Children 2 Years or Older or With a Height of 87 cm or Greater

Steps for and considerations in measuring HEIGHT (standing up):

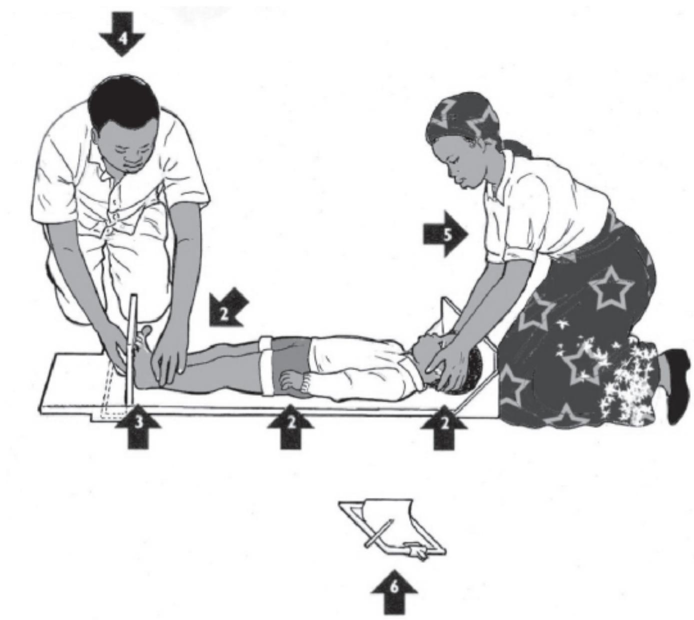
- The child's shoes are removed.
- The child is placed on the height board, standing upright in the middle of the board with arms at his/her sides.
- The assistant firmly presses the child's ankles and knees against the board while the measurer holds the child's head straight.
- The child's heels, back legs, buttocks, shoulders and head should be touching the back of the board, and his or her feet should be close together.
- The child's head should be straight and looking ahead. A line between the ears and eyes should be parallel to the floor.
- The measurement is always made with two people: one assistant is holding the child's legs and feet, and the measurer the child's head. The person holding the head reads the measurement out loud to the nearest 0.1cm. The assistant repeats it for verification and records it on the anthropometric form or treatment card.

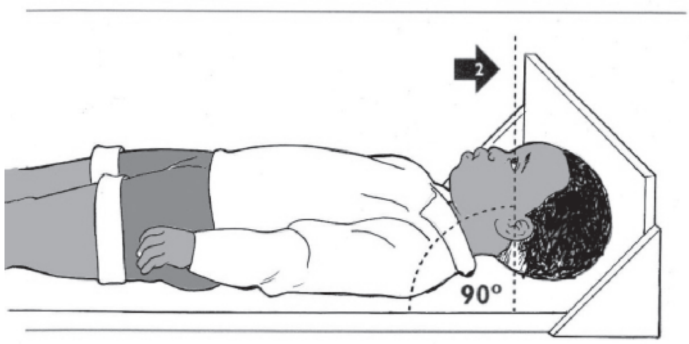


For Children under 2 or With a Height Less Than 87 cm

Steps for and considerations in measuring LENGTH (Lying Down):

- The height board is placed on the ground.
- The child's shoes are removed.
- The child is gently placed on his or her back on the middle of the board, facing straight up with arms at his/her sides and feet at right angles.
- The measurement is always made with two people
- The one assistant holds the sides of the child's head and positions it on the board.
- While holding down the child's ankles or knees, the other person who takes the measurement moves the sliding board up against the bottom of the child's feet and reads the child's length to the nearest 0.1 cm.
- The measurer announces the measurement, and the assistant repeats it for verification and records it on the anthropometric form or treatment card.





MID-UPPER ARM CIRCUMFERENCE OR MUAC

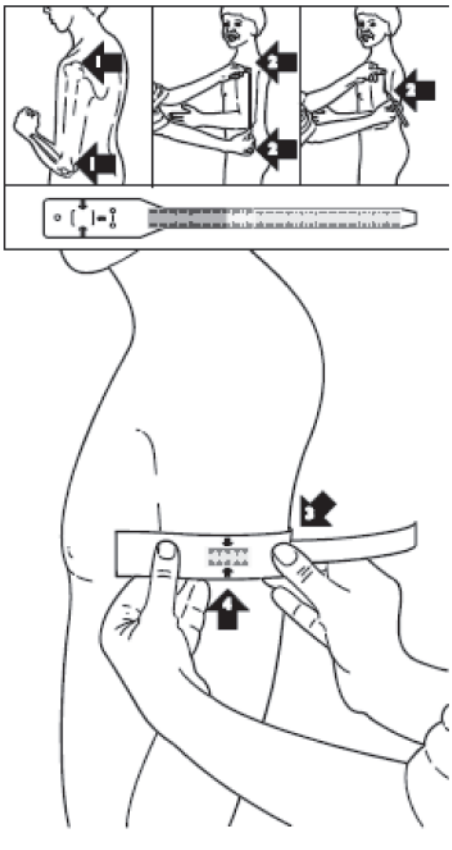
MUAC is used for children 6-59 months. It is essential to use the age cutoff of 6 months for MUAC. It is not recommended to use a height cutoff as proxy for 6 months.[47] If the birth date is unconfirmed, use the recall of the mother/caregiver to estimate the infant's age.

How to measure MUAC:

- The MUAC is always taken on the left arm.
- Measure the length of the child's left upper arm, between the bone at the top of the shoulder and the elbow bone (the child's arm should be bent).
- Mark the middle of the child's upper arm with a pen. It is helpful to use a string to find the midpoint rather than the MUAC tape.
- The child's arm should then be relaxed, falling alongside his/her body.
- Wrap the MUAC tape around the child's arm, such that all of it is in contact with the child's skin. It should be neither too tight, nor too loose.
- Read the MUAC in millimetres (mm).

For the numbered tapes, feed the end of the tape down through the first opening and up through the third opening. **The measurement is read from the middle window where the arrows point inward. MUAC can be recorded with a precision of 1 mm.**

For the simple three-color tape (red, yellow, green), slide the end through the first opening and then through the second opening. Read the colour that shows through the window at the point the two arrows indicate.



[47] In a stunted population many infants 6 months or older will have a height less than 65 centimetres (cm).

Estimating age

Emergency nutrition surveys frequently measure the weight and height of children aged six months to five years. However, in many rural areas of the developing world, the age of children is not known. In general, the younger the child is, the more accurately you can estimate her/his month of birth.

The following methods are helpful for determining or estimating the age of a child, if the mother does not know.

- Look up age in official registers. In rural communities, you normally cannot find local official registers of births or a baptismal certificate book. Instead, some households may have the child's immunization card. If health workers properly recorded the date of birth on the immunization card, then you can copy the date from the card. Therefore, when trying to determine a child's age, you should always ask to see the child's immunization card.
- Use the birth date of a neighbour's child as a reference. If the age of a neighbour's child is known, then you can ask other women whether or not their child was born before or after the reference child.
- Use a local events calendar. A local events calendar shows all the dates on which important events took place during the past five years. It can show local holidays, hailstorms, the opening of a nearby school or clinic and political elections, etc. You should ask the mother whether or not the child was born before or after a certain event, and work out a fairly accurate age in this way.

BILATERAL PITTING OEDEMA

Bilateral pitting oedema can be verified when thumb pressure applied on top of both feet for three seconds leaves a pit (indentation) in the foot after the thumb is lifted. The pit will remain in both feet for several seconds. Bilateral pitting oedema usually starts in the feet and ankles. It is important to test both feet; if the pitting is not bilateral, the oedema is not of nutrition origin. A second person repeats the test to confirm the presence of bilateral pitting oedema.

There are three grades of bilateral pitting oedema. When there is no bilateral pitting oedema, the grade is çabsent.é Grades of bilateral pitting oedema are classified by plus signs.

Grade+

Mild: both feet/ankles

Grade++

Moderate: both feet, plus lower legs, hands, or lower arms

Grade+++

Severe: generalized oedema including both feet, legs, hands, arms and face

Annex 2: Common Measurement Errors

Common errors	Solution
1. All measurements	
Restless child	Postpone measurement. Involve parent in procedure.
Inaccurate reading	Training and retraining stressing accuracy
Recording	Record results immediately after taking measurements and confirm record.
2. Length/height	
Incorrect method for age	Measure length when child is < 2 years or < 87 cm.
Foot wear/headgear	Remove – in privacy if necessary.
Head not in correct plane, chin too high or too close to body	Correct technique and get child to hold head straight by talking to him/her and crouching down to his or her level and looking into his/her eyes. The child will be encouraged to look at you, so position yourself to get head at right angle.
Child not straight along board, knees bent, feet pointing down when lying down	Correct technique with practise and regular retraining. Provide adequate assistance – three people needed. One for head, one for arms and middle and one for knees, feet and measurement taking. Get parent in middle to hold arms and talk to child to calm them.
Sliding board not firmly against heels/head	Settle child. Ensure adequate pressure applied. If measuring a child standing up, move head board to compress hair and ensure head touches board. If measuring a child lying down, move the sliding board to firmly touch the bottom of the feet.
Child not straight along height board – feet apart or knees bent	Don't take measurements while child is struggling. Ensure assistants and parent all help to position child. One for legs and feet, one for head and measurement taking. Parent can talk to child.
3. Weight	
Scale not calibrated	Recalibrate after every measurement.
Child wearing heavy clothing or amulets	Remove in private or make allowances for clothing and amulets by subtracting their weight equivalent from child weight, e.g., 100 g of clothes for underwear.
Child moving or anxious in hanging pants	Wait until child is calm. The more he or she moves and tries to grab measurers, the more likely the measurement is to be up to 1 kg off. One assistant to talk to child and other to position head in front of scales at the right angle to read measurement as soon as the scale stabilizes.
4. MUAC	
Child won't let go of mother	Get mother to hold child on her hip with child's left arm facing measurer.
Mid-upper arm point incorrect	Find tip of shoulder and elbow carefully. Practise finding half way between the two.
MUAC tape too loose or too tight giving an incorrect reading	Practise, supervise and retrain. Get measurer to practice on calm, older children and adults. Demonstrate.

Annex 3: Partial Samples of WHO Growth Standard Look-up Table for Birth – 2 years

World Health Organization

Weight-for-length GIRLS Birth to 2 years (z-scores)

Length (cm)	L	M	S	Z-scores (weight in kg)						
				-3SD	-2SD	-1SD	Median	1SD	2SD	3SD
45.0	-0.3833	2.4607	0.09029	1.9	2.1	2.3	2.5	2.7	3.0	3.3
45.5	-0.3833	2.5457	0.09033	2.0	2.1	2.3	2.5	2.8	3.1	3.4
46.0	-0.3833	2.6306	0.09037	2.0	2.2	2.4	2.6	2.9	3.2	3.5
46.5	-0.3833	2.7155	0.09040	2.1	2.3	2.5	2.7	3.0	3.3	3.6
47.0	-0.3833	2.8007	0.09044	2.2	2.4	2.6	2.8	3.1	3.4	3.7
47.5	-0.3833	2.8667	0.09048	2.2	2.4	2.6	2.9	3.2	3.5	3.8
48.0	-0.3833	2.9741	0.09052	2.3	2.5	2.7	3.0	3.3	3.6	4.0
48.5	-0.3833	3.0636	0.09056	2.4	2.6	2.8	3.1 3.4	3.7	4.1	
49.0	-0.3833	3.1560	0.09060	2.4	2.6	2.9	3.2	3.5	3.8	4.2
49.5	-0.3833	3.2520	0.09064	2.5	2.7	3.0	3.3	3.6	3.9	4.3
50.0	-0.3833	3.3518	0.09068	2.6	2.8	3.1	3.4	3.7	4.0	4.5
50.5	-0.3833	3.4557	0.09072	2.7	2.9	3.2	3.5	3.8	4.2	4.6
51.0	-0.3833	3.5636	0.09076	2.8	3.0	3.3	3.6	3.9	4.3	4.8
51.5	-0.3833	3.6754	0.09080	2.8	3.1	3.4	3.7	4.0	4.4	4.9
52.0	-0.3833	3.7911	0.09085	2.9	3.2	3.5	3.8	4.2	4.6	5.1
52.5	-0.3833	3.9105	0.09089	3.0	3.3	3.6	3.9	4.3	4.7	5.2
53.0	-0.3833	4.0332	0.09093	3.1	3.4	3.7	4.0	4.4	4.9	5.4
53.5	-0.3833	4.1591	0.09098	3.2	3.5	3.8	4.2	4.6	5.0	5.5
54.0	-0.3833	4.2875	0.09102	3.3	3.6	3.9	4.3	4.7	5.2	5.7
54.5	-0.3833	4.4179	0.09106	3.4	3.7	4.0	4.4	4.8	5.3	5.9
55.0	-0.3833	4.5498	0.09110	3.5	3.8	4.2	4.5	5.0	5.5	6.1
55.5	-0.3833	4.6827	0.09114	3.6	3.9	4.3	4.7	5.1	5.7	6.3
56.0	-0.3833	4.8162	0.09118	3.7	4.0	4.4	4.8	5.3	5.8	6.4
56.5	-0.3833	4.9500	0.09121	3.8	4.1	4.5	5.0	5.4	6.0	6.6

WHO Child Growth Standard

Simplified field tables

Weight-for-length BOYS Birth to 2 years (z-scores)

World Health Organization

CM	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
45.0	1.9	2.0	2.2	2.4	2.7	3.0	3.3
45.5	1.9	2.1	2.3	2.5	2.8	3.1	3.4
46.0	2.0	2.2	2.4	2.6	2.9	3.1	3.5
46.5	2.1	2.3	2.5	2.7	3.0	3.2	3.6
47.0	2.1	2.3	2.5	2.8	3.0	3.3	3.7
47.5	2.2	2.4	2.6	2.9	3.1	3.4	3.8
48.0	2.3	2.5	2.7	2.9	3.2	3.6	3.9
48.5	2.3	2.6	2.8	3.0	3.3	3.7	4.0
49.0	2.4	2.6	2.9	3.1	3.4	3.8	4.2
49.5	2.5	2.7	3.0	3.2	3.5	3.9	4.3
50.0	2.6	2.8	3.0	3.3	3.6	4.0	4.4
50.5	2.7	2.9	3.1	3.4	3.8	4.1	4.5
51.0	2.7	3.0	3.2	3.5	3.9	4.2	4.7
51.5	2.8	3.1	3.3	3.6	4.0	4.4	4.8
52.0	2.9	3.2	3.5	3.8	4.1	4.5	5.0
52.5	3.0	3.3	3.6	3.9	4.2	4.6	5.1
53.0	3.1	3.4	3.7	4.0	4.4	4.8	5.3
53.5	3.2	3.5	3.8	4.1	4.5	4.9	5.4
54.0	3.3	3.6	3.9	4.3	4.7	5.1	5.6
54.5	3.4	3.7	4.0	4.4	4.8	5.3	5.8
55.0	3.6	3.8	4.2	4.5	5.0	5.4	6.0
55.5	3.7	4.0	4.3	4.7	5.1	5.6	6.1
56.0	3.8	4.1	4.4	4.8	5.3	5.8	6.3
56.5	3.9	4.2	4.6	5.0	5.4	5.9	6.5
57.0	4.0	4.3	4.7	5.1	5.6	6.1	6.7
57.5	4.1	4.5	4.9	5.3	5.7	6.3	6.9
58.0	4.3	4.6	5.0	5.4	5.9	6.4	7.1
58.5	4.4	4.7	5.1	5.6	6.1	6.6	7.2
59.0	4.5	4.8	5.3	5.7	6.2	6.8	7.4
59.5	4.6	5.0	5.4	5.9	6.4	7.0	7.6
60.0	4.7	5.1	5.5	6.0	6.5	7.1	7.8
60.5	4.8	5.2	5.6	6.1	6.7	7.1	8.0
61.0	4.9	5.3	5.8	6.3	6.8	7.4	8.1
61.5	5.0	5.4	5.9	6.4	7.0	7.6	8.3
62.0	5.1	5.6	6.0	6.5	7.1	7.7	8.5
62.5	5.2	5.7	6.1	6.7	7.2	7.9	8.6
63.0	5.3	5.8	6.2	6.8	7.4	8.0	8.8
63.5	5.4	5.9	6.4	6.9	7.5	8.2	8.9
64.0	5.5	6.0	6.5	7.0	7.6	8.3	9.1

CM	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
64.5	5.6	6.1	6.6	7.1	7.8	8.5	9.3
65.0	5.7	6.2	6.7	7.3	7.9	8.6	9.4
65.5	5.8	6.3	6.8	7.4	8.0	8.7	9.6
66.0	5.9	6.4	6.9	7.5	8.2	8.9	9.7
66.5	6.0	6.5	7.0	7.6	8.3	9.0	9.9
67.0	6.1	6.6	7.1	7.7	8.4	9.2	10.0
67.5	6.2	6.7	7.2	7.9	8.5	9.3	10.2
68.0	6.3	6.8	7.3	8.0	8.7	9.4	10.3
68.5	6.4	6.9	7.5	8.1	8.8	9.6	10.5
69.0	6.5	7.0	7.6	8.2	8.9	9.7	10.6
69.5	6.6	7.1	7.7	8.3	9.0	9.8	10.8
70.0	6.6	7.2	7.8	8.4	9.2	10.0	10.9
70.5	6.7	7.3	7.9	8.5	9.3	10.1	11.1
71.0	6.8	7.4	8.0	8.6	9.4	10.2	11.2
71.5	6.9	7.5	8.1	8.8	9.5	10.4	11.3
72.0	7.0	7.6	8.2	8.9	9.6	10.5	11.5
72.5	7.1	7.6	8.3	9.0	9.8	10.6	11.6
73.0	7.2	7.7	8.4	9.1	9.9	10.8	11.8
73.5	7.2	7.8	8.5	9.2	10.0	10.9	11.9
74.0	7.3	7.9	8.6	9.3	10.1	11.0	12.1
74.5	7.4	8.0	8.7	9.4	10.2	11.2	12.2
75.0	7.5	8.1	8.8	9.5	10.3	11.3	12.3
75.5	7.6	8.2	8.8	9.6	10.4	11.4	12.5
76.0	7.6	8.3	8.9	9.7	10.6	11.5	12.6
76.5	7.7	8.3	9.0	9.8	10.7	11.6	12.7
77.0	7.8	8.4	9.1	9.9	10.8	11.7	12.8
77.5	7.9	8.5	9.2	10.0	10.9	11.9	13.0
78.0	7.9	8.6	9.3	10.1	11.0	12.0	13.1
78.5	8.0	8.7	9.4	10.2	11.1	12.1	13.2
79.0	8.1	8.7	9.5	10.3	11.2	12.2	13.3
79.5	8.2	8.8	9.5	10.4	11.3	12.3	13.4
80.0	8.2	8.9	9.6	10.4	11.4	12.4	13.6
80.5	8.3	9.0	9.7	10.5	11.5	12.5	13.7
81.0	8.4	9.1	9.8	10.6	11.6	12.6	13.8
81.5	8.5	9.1	9.9	10.7	11.7	12.7	13.9
82.0	8.5	9.2	10.0	10.8	11.8	12.8	14.0
82.5	8.6	9.3	10.1	10.9	11.9	13.0	14.2
83.0	8.7	9.4	10.2	11.0	12.0	13.1	14.3
83.5	8.8	9.5	10.3	11.2	12.1	13.2	14.4

Annex 4: Calculation of Z-score for normally distributed measurements (height for age) and percentage of the median

A. Calculation of Z-score by hand for HFA

The distribution of height data is normal, e.g. bell shaped, and uses a more simple equation than for non-normal (weight) information for calculation of Z-score.

In this example, a boy measures 84.2 cm in length and is 27 months old. Based on the WHO GS Height-for-Age for Boys, 2-5 years (Z-scores), the median height for boys of 27 months of age is 89.6 and the SD for the distribution for boys of 27 months of age is 3.2928. Using these values, and the formula provided, it is possible to calculate a height for age Z-score.

1. Z-score

$$\frac{\text{measured height} - \text{median height of 27 month boy in WHO GS population}}{\text{Z-score of the WHO GS population}}$$

$$\frac{84.2\text{-}89.6}{3.2928} = \mathbf{-1.64\ Z\text{-}score}$$

B. Calculation of Percentage of the median

Percentage of the median expresses the child's measurements as a percentage of the expected value for the reference population. The percentage of the median will classify slightly fewer children as malnourished compared to when Z-scores are used. Percentage of the median used to be the primary admission and discharge criteria for programmes addressing acute malnutrition.

In this example, a boy measures 84.2 cm in length and weighs 9.9 kg. The reference population data for this example is from the NCHS GR (since calculation of Z-scores is recommended with the WHO GS) and shows that the reference median weight for boys of 84 cm is 11.7 kg and that the SD for the reference distribution for boys of 84 cm is 0.908. Using these values, and the formula provided, it is possible to calculate a weight for height percentage of the median.

2. Percentage of the median

$$\frac{\text{Measured weight x 100}}{\text{Percentage of the Median = Median of reference population}}$$

$$\frac{9.9\text{ kg x }100}{11.5\text{ kg}}$$

$= \mathbf{86.1\%\ of\ the\ median}$

Cut-off points for undernutrition based on percentage of the median for children 6-59 months

Nutrition Indicator	Moderate undernutrition	Severe undernutrition
Bilateral oedema	No	Yes
Weight for height (wasting)	≥ 70% to <80%	< 70%
Height for age (stunting)	≥ 85% to <90%	< 85%
Weight for age (underweight)	≥ 60% to <80%	< 60%

Annex 5: Partial Samples of 2007 WHO Growth Reference Look Up Tables for 5-19 Years

World Health Organization

BMI-for-age BOYS 5 to 19 years (z-scores)

Year: month	Month	L	M	S	Z-scores (BMI in kg/m²) -3SD	-2SD	-1SD	Median	1SD	2SD	3SD
5:1	61	-0.7387	15.2641	0.08390	12.1	13.0	14.1	15.3	16.6	18.3	20.2
5:2	62	-0.7621	15.2616	0.08414	12.1	13.0	14.1	15.3	16.6	18.3	20.2
5:3	63	-0.7856	15.2604	0.08439	12.1	13.0	14.1	15.3	16.7	18.3	20.2
5:4	64	-0.8089	15.2605	0.08464	12.1	13.0	14.1	15.3	16.7	18.3	20.3
5:5	65	-0.8322	15.2619	0.08490	12.1	13.0	14.1	15.3	16.7	18.3	20.3
5:6	66	-0.8554	15.2645	0.08516	12.1	13.0	14.1	15.3	16.7	18.4	20.4
5:7	67	-0.8785	15.2684	0.08543	12.1	13.0	14.1	15.3	16.7	18.4	20.4
5:8	68	-0.9015	15.2737	0.08570	12.1	13.0	14.1	15.3	16.7	18.4	20.5
5:9	69	-0.9243	15.2801	0.08597	12.1	13.0	14.1	15.3	16.7	18.4	20.5
5:10	70	-0.9471	15.2877	0.08625	12.1	13.0	14.1	15.3	16.7	18.5	20.6
5:11	71	-0.9697	15.2965	0.08653	12.1	13.0	14.1	15.3	16.7	18.5	20.6
6:0	72	-0.9921	15.3062	0.08682	12.1	13.0	14.1	15.3	16.8	18.5	20.7
6:1	73	-1.0144	15.3169	0.08711	12.1	13.0	14.1	15.3	16.8	18.6	20.8
6:2	74	-1.0365	15.3283	0.08741	12.2	13.1	14.1	15.3	16.7	18.6	20.8
6:3	75	-1.0584	15.3408	0.08771	12.2	13.1	14.1	15.3	16.8	18.6	20.9
6:4	76	-1.0801	15.3540	0.08802	12.2	13.1	14.1	15.4	16.8	18.7	21.0
6:5	77	-1.1017	15.3679	0.08833	12.2	13.1	14.1	15.4	16.9	18.7	21.0
6:6	78	-1.1230	15.3825	0.08865	12.2	13.1	14.1	15.4	16.9	18.7	21.1
6:7	79	-1.1441	15.3978	0.08898	12.2	13.1	14.1	15.4	16.9	18.8	21.2
6:8	80	-1.1649	15.4137	0.08931	12.2	13.1	14.2	15.4	16.9	18.8	21.3
6:9	81	-1.1856	15.4302	0.08964	12.2	13.1	14.2	15.4	17.0	18.9	21.3
6:10	82	-1.2060	15.4473	0.08998	12.2	13.1	14.2	15.4	17.0	18.9	21.4
6:11	83	-1.2261	15.4650	0.09033	12.2	13.1	14.2	15.5	17.0	19.0	21.5
7:0	84	-1.2460	15.4832	0.09068	12.3	13.1	14.2	15.5	17.0	19.0	21.6
7:1	85	-1.2656	15.5019	0.09103	12.3	13.2	14.2	15.5	17.1	19.1	21.7
7:2	86	-1.2849	15.5210	0.09139	12.3	13.2	14.2	15.5	17.1	19.1	21.8

2007 WHO Reference

Simplified field tables

World Health Organization

BMI-for-age GIRLS 5 to 19 years (z-scores)

Year: month	Month	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
5:1	61	11.6	12.7	13.9	16.2	16.8	18.9	21.3
5:2	62	11.6	12.7	13.9	16.2	16.8	18.9	21.4
5:3	63	11.6	12.7	13.9	16.2	16.8	18.9	21.5
5:4	64	11.6	12.7	13.9	16.2	16.8	18.9	21.5
5:5	65	11.7	12.7	13.9	16.2	16.8	19.0	21.6
5:6	66	11.7	12.7	13.9	16.2	16.8	19.0	21.7
5:7	67	11.7	12.7	13.9	16.2	16.8	19.0	21.7
5:8	68	11.7	12.7	13.9	16.3	17.0	19.1	21.8
5:9	69	11.7	12.7	13.9	16.3	17.0	19.1	21.9
5:10	70	11.7	12.7	13.9	16.3	17.0	19.1	22.0
5:11	71	11.7	12.7	13.9	16.3	17.0	19.2	22.1
6:0	72	11.7	12.7	13.9	16.3	17.0	19.2	22.1
6:1	73	11.7	12.7	13.9	16.3	17.0	19.3	22.2
6:2	74	11.7	12.7	13.9	16.3	17.0	19.3	22.3
6:3	75	11.7	12.7	13.9	16.3	17.1	19.3	22.4
6:4	76	11.7	12.7	13.9	16.3	17.1	19.4	22.5
6:5	77	11.7	12.7	13.9	16.3	17.1	19.4	22.6
6:6	78	11.7	12.7	13.9	16.3	17.1	19.5	22.7
6:7	79	11.7	12.7	13.9	16.3	17.2	19.5	22.8
6:8	80	11.7	12.7	13.9	16.3	17.2	19.6	22.9
6:9	81	11.7	12.7	13.9	16.4	17.2	19.6	23.0
6:10	82	11.7	12.7	13.9	16.4	17.2	19.7	23.1
6:11	83	11.7	12.7	13.9	16.4	17.3	19.7	23.2
7:0	84	11.8	12.7	13.9	16.4	17.3	19.8	23.3
7:1	85	11.8	12.7	13.9	16.4	17.3	19.8	23.4
7:2	86	11.8	12.8	14.0	16.4	17.4	19.9	23.5
7:3	87	11.8	12.8	14.0	16.5	17.4	20.0	23.6
7:4	88	11.8	12.8	14.0	16.5	17.4	20.0	23.7
7:5	89	11.8	12.8	14.0	16.5	17.5	20.1	23.9
7:6	90	11.8	12.8	14.0	16.5	17.5	20.1	24.0

Annex 6: Correction of BMI with the Cormic Index (SSR or SH/S)[48]

In order to standardise BMI to take into account changes in SH/S ratio we recommending using the equations below to calculate BMI standardised to the actual SH/S ratio for the population under study.

Male subjects – BMI = 0.78(SH/S) -18.43

Female subjects – BMI = 1.19(SH/S) -40.34

Note: SH/S ratios should be expressed as a percentage The observed BMIs can then be standardised to a SH/S ratio of 0.52 by adding the differences between the observed BMI and BMI standardized for the population SH/S ratio to a BMI standardized to 0.52 using the equation below:

BMISstd = BMI0.52 + (BMIob-BMIes),

Where BMIstd = standardised BMI,
BMI0.52 = estimated BMI at SH/S of 0.52
BMIob = actual BMI
BMIes = estimated BMI at actual SH/S

Examples

1. A Male population "A" has a mean BMI of 18.5 kg m-2 and a mean SH/S ratio of 50%. TheBMI0.52 = 0.78 * 52-18.43 = 22.13. The BMIes = 0.78 * 50-18.43 = 20.57. Therefore the BMIstd = 22.13 + (18.5 - 20.57) = 20.06kg m-2
2. A Female population "A" has a mean BMI of 17.0 kg m-2 and a mean SH/S ratio of 54%. The BMI0.52 = 1.19 * 52-40.34 = 23.92. The BMIes = 1.19 * 54-40.34 = 21.54. Therefore the BMIstd = 21.54 + (17.0 - 23.92) = 14.62 kg m-2

[48] Taken from United Nations Standing Committee on Nutrition (2000). *Adults: Assessment of Nutritional Status in Emergency-affected Populations*. Geneva: SCN.