MODULE 3

Children and Adolescents 5–19 Years of Age

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What Does this Module Cover?

Module 3 focuses on anthropometry of children and adolescents 5–19 years of age (61–228 completed months). It is broken into specific sections that describe the importance of nutrition for children in this age group:

- common nutrition-related conditions identified by anthropometry
- the measurements and indices used to identify nutrition-related conditions
- interpretation of anthropometric measurements and classification of nutritional status
- and tools to assess child and adolescent nutritional status.

Users are encouraged to review Module 1 alongside this module because it explains key concepts that are relevant to all modules.

Who Is the Focus of Module 3?

Module 3 aligns with the age ranges in the WHO Growth Reference. In this module, "children and adolescents 5–19 years of age" refers to children age 61 months to 19 years (228 completed months). At age 19 years and 1 month, the WHO Growth Reference no longer applies to them.

Nutrition during Childhood and Adolescence: Why Does It Matter?

Children and adolescents 5–19 years of age have high nutritional needs because they are growing rapidly. This is especially true for adolescents (10–19 years of age[1]), whose growth can be as rapid as that of infants (Spear 2002). Adolescent boys and girls have higher calorie and nutrient needs than any other age group—with boys needing more overall calories— to meet the demands of growth spurts and the onset of puberty (Spear 2002; Salam and Bhutta 2015). Meeting these needs can be particularly challenging in poor and food insecure environments.

Undernutrition in this age group can delay sexual maturation, slow growth (Story 1992; Salam and Bhutta 2015), and reduce a child/adolescent's ability to learn, lowering school performance and achievement (Grantham-McGregor et al. 2007). Meanwhile overweight and obesity at this age are likely to persist into adulthood and increase the risk of chronic disease in the short and long term (U.S. Centers for Disease Control and Prevention [CDC] 2015). There is also evidence that obesity may be related to early puberty in girls and delayed puberty in boys (Burt Solorzano and McCartney 2011). In addition, pregnancy and lactation during adolescence can negatively impact a girl's nutritional status by stunting the girl's growth and lowering her nutritional stores as her needs compete with those of the fetus, increasing risk of pregnancy complications (Rah et al. 2008; WHO 2005). Malnutrition also affects pregnancy outcomes in adolescent girls. Underweight adolescents face higher risk of

[4] As defined by the World Health Organization

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Nutrition during Childhood and Adolescence: Why Does It Matter? (continued)

complications such as preterm birth and delivering a child with low birth weight, while overweight/obese adolescents are more likely to suffer pre-eclampsia and gestational diabetes and to require cesarean delivery (Sukavich et al. 2006; Luder and Alton 2005; WHO 2005). These complications have been found to contribute to the intergenerational cycle of malnutrition (Black 2013).

Adolescence is a transitional time in the life cycle, and the 2013 Maternal and Child Nutrition Lancet Series highlighted the importance of good adolescent nutrition for achieving a healthy and productive adult population (Black et al. 2013; Bhutta et al. 2013). However, addressing the needs of children and adolescents 5–19 years of age has not been a key area of focus among the nutrition community, and regular growth monitoring or nutritional assessment of this age group is uncommon. Anthropometric measurements of children and adolescents age 5–19 years are usually done only when they seek treatment for illnesses and/or show clinical signs of acute malnutrition. One reason for this lack of focus on children and adolescents 5–19 years of age is that they have lower morbidity and mortality risks associated with malnutrition compared to preschool children and therefore the limited resources for anthropometric measurement are rarely focused on this age group. However, adolescence presents a great opportunity to promote optimal nutrition behaviors because lifelong habits that can significantly influence health are formed during this period. To help address adolescent nutrition challenges, the World Health Organization (WHO) has recommended that anthropometric measurements be collected among adolescents "at every opportunity," including in primary health services to prevent both undernutrition and overweight (WHO 2005). Unfortunately, there is limited evidence and experience on the best anthropometric measurements to use and how to classify nutritional status among adolescents. In addition, interpretation of anthropometric measurements in this age group is complicated by puberty and differences among ethnic groups (Woodruff and Duffield 2000; Gong and Spear 1986; WHO 2005). Despite these challenges, increased focus on addressing the nutrition needs of this age group, in which anthropometric assessment is a useful tool, could not only improve health in the adolescent years, but also improve their health and nutrition in adulthood and help prevent malnutrition in their offspring, breaking the cycle of intergenerational malnutrition.

What Nutrition-Related Conditions Are Identified through Anthropometry?

This section provides a brief description of common nutrition-related conditions that can be identified in children and adolescents 5–19 years of age using anthropometric measurements and indices used to determine these nutrition conditions are described in the **Measurements** section.

CONDITIONS IN THIS SECTION

- Stunting
- Underweight
- Acute malnutrition
- Overweight and obesity
- Thinness
- Moderate acute malnutrition (MAM)
- Severe acute malnutrition (SAM)

Already familiar with nutrition-related conditions?

Jump ahead to the **Measurements** section.

CONDITION: **Stunting**

Stunting, reflecting chronic undernutrition, occurs when a child or adolescent does not grow to his/her potential because of the long-term cumulative effects of inadequate dietary intake, frequent illness/ infection, or both. The result is that the child or adolescent is shorter than would be expected for a healthy child of his/her age and sex. Stunting identified during adolescence is usually a result of poor growth during the first 1,000 days from pregnancy through age 2, after which it is difficult to regain lost growth and fully recover from the effects of stunting (Victora et al. 2010; Martorell et al. 1994). Stunting can not only impair an individual's health but is also associated with poor cognitive and motor development and lower school achievement (Grantham-McGregor et al. 2007; Hoddinott et al. 2008). The rapid growth of the adolescent years may be an opportunity to catch up on some lost growth, but it is still unclear when and how much linear growth can be regained (Leroy et al. 2015; Prentice et al. 2013) and whether the cognitive and productivity losses due to undernutrition in early childhood are reversible. Stunting is identified using the sex-specific height-for-age index.

LINKS TO RELATED CONTENT

Measurement: Height-for-age Interpretation: Cutoffs for height-for-age

CONDITION: **Acute Malnutrition**

Acute malnutrition is caused by an inadequate amount or quality of food, severe and/or repeated infections, or a combination of these, which results in a child or adolescent who loses weight rapidly, does not gain enough weight relative to his/her height, and/or experiences bilateral pitting edema. Acute malnutrition may be classified as either moderate or severe, and treatment is based on the severity of the condition.

There is a lot of terminology used in reference to acute malnutrition that may be confusing to readers. For simplicity, this guide has provided key terminology associated with acute malnutrition:

- **Thinness**
- **Moderate acute malnutrition (MAM)**
- **Severe acute malnutrition (SAM)**

CONDITION: **Acute Malnutrition**
↳ CONDITION: **Thinness**

Thinness is used to describe a child or adolescent whose weight is too low for his/her height. It is defined using the sex-specific BMI-for-age index. A child or adolescent with low BMI-for-age has either "severe thinness" or "moderate thinness," depending on the severity. This low BMI-for-age index is also referred to as "wasting."

LINKS TO RELATED CONTENT

Measurement: BMI-for-age

Interpretation: Cutoffs for BMI-for-age

CONDITION: Acute Malnutrition
↳ CONDITION: Moderate Acute Malnutrition (MAM)

Moderate acute malnutrition (MAM) is used to describe thinness according to BMI-for-age (also called moderate wasting) and/or low mid-upper arm circumference (MUAC) (under a certain cutoff).

Note: In children and adolescents 5–19 years of age, the term "moderate malnutrition" is commonly used instead of MAM (dropping the word "acute").

LINKS TO RELATED CONTENT

- Measurement: BMI-for-age
- Interpretation: Cutoffs for BMI-for-age
- Measurement: MUAC
- Interpretation: Cutoffs for MUAC

CONDITION: Acute Malnutrition
↳ CONDITION: **Severe Acute Malnutrition (SAM)**

Severe acute malnutrition (SAM) is used to describe severe thinness according to BMI-for-age (also called severe wasting), low MUAC (under a certain cutoff), and/or the presence of bilateral pitting edema of nutritional origin. Individuals with SAM need urgent medical treatment and specialized therapeutic foods to recover.

Note: In children and adolescents 5–19 years of age, the term "severe malnutrition" is commonly used instead of SAM (dropping the word "acute"). Severe wasting was formerly referred to as marasmus, and bilateral pitting edema was previously known as kwashiorkor. These terms are still occasionally used.

LINKS TO RELATED CONTENT

- Measurement: BMI-for-age
- Interpretation: Cutoffs for BMI-for-age
- Measurement: MUAC
- Interpretation: Cutoffs for MUAC
- Measurement: Bilateral pitting edema
- Interpretation: Classification of bilateral pitting edema

CONDITION: **Underweight**

Underweight occurs when a child 5–10 years of age weighs less than would be expected for a healthy, well-nourished child of the same age and sex. Underweight may indicate that the child is stunted, wasted, or both, but does not differentiate between the two. It may be caused by weight loss or a child's failure to gain weight or to grow in height at the expected pace. It is associated with illness and/or eating inadequate quantity or quality of food. Underweight can be assessed in children up to 10 years of age using the sex-specific weight-for-age index.

LINKS TO RELATED CONTENT

Measurement: Weight-for-age

Interpretation: Cutoffs for weight-for-age

CONDITION: **Overweight and Obesity**

Overweight and obesity (severe overweight) occur when a child or adolescent has too much body fat and weighs more than would be expected for a healthy person of the same age, height, and sex, putting his/her health at risk. Overweight and obesity are complex conditions with multiple causes, including an imbalance between calories consumed and calories expended, low levels of physical activity, medical conditions, and genetics, among others. The prevalence of obese children and adolescents age 5–19 years has been growing worldwide. In 2016, 124 million children worldwide were obese, a more than tenfold increase from 1975, when 11 million children were obese. If trends continue, global prevalence of child and adolescent obesity will surpass prevalence of underweight by 2022 (NCD Risk Factor Collaboration 2017). Overweight and obese children and adolescents are at increased risk for type 2 diabetes, asthma, and high blood pressure, among other diseases, and may experience psychological consequences including depression (WHO 2014). They are also more likely to be overweight/obese as adults, with increased risk of heart disease, stroke, diabetes, some cancers, and other chronic diseases (Freedman et al. 2005; WHO 2005; CDC 2015). Overweight and obesity can be identified in children and adolescents 5–19 years of age using the sex-specific BMI-for-age index.

LINKS TO RELATED CONTENT

Measurement: **BMI-for-age** Interpretation: **Cutoffs for BMI-for-age**

What Anthropometric Measurements and Indices Are Used for Children and Adolescents 5–19 Years of Age?

Several anthropometric measurements and indices are used to identify nutrition conditions in children and adolescents 5–19 years of age. This section describes the anthropometric measurements and indices most commonly used in development settings for this age group: height-for-age, weight-for-age, BMI-for-age, and MUAC. Bilateral pitting edema, a clinical indicator, is also included because it is commonly assessed along with anthropometry. The measurements and indices should be used along with supporting information such as health status, dietary intake, food security status, stage of puberty, growth trends, and care practices. Please note that **Module 4** addresses anthropometry for adolescents who are pregnant or up to 6 months postpartum; this module addresses anthropometry for non-pregnant adolescents up to 19 years of age.

TABLE 3.1 Selected Anthropometric Measurements and Indices in this Module

	Height-for-Age	Weight-for-Age (5–10 years of age only*)	BMI-for-Age	MUAC	Bilateral Pitting Edema
Nutritional condition that the measurement/index identifies	Stunting	Underweight	Thinness, overweight/ obesity	Acute malnutrition	Severe acute malnutrition

*As defined in the 2007 WHO Growth Reference, children and adolescents 5–10 years of age refers to children 61 to 120 completed months of age (i.e., from 5 years and 1 month until the child has reached his/her 10th birthday). Children and adolescents 10–19 years of age refers to children age 120 to 228 completed months.

Already familiar with measurements and indices? Jump ahead to the **Interpretation** section.

MEASUREMENT: **Height-for-Age (HFA)**

Height-for-age (HFA) considers a child/adolescent's height relative to his/her age and sex and is used to identify stunting.

LINKS TO RELATED CONTENT

Condition: Stunting Interpretation: Cutoffs for height-for-age

MEASUREMENT: **Weight-for-Age (age 5–10 years)**

Weight-for-age (age 5–10 years) considers a child's weight relative to his/her age and sex and identifies underweight. It may reflect wasting, stunting, or both, but it cannot distinguish between the two. WHO included weight-for-age for children age 5–10 years (i.e., 61 to 120 completed months) in its 2007 WHO Growth Reference so that countries that use weight-for-age in growth monitoring programs may extend growth monitoring for individual children throughout childhood and make comparisons to earlier growth.

In **children 10 years of age and older**, BMI-for-age and height-for-age, especially when used together, provide a better indication of nutritional status than weight-for-age. This is because weight-for-age does not distinguish whether weight reflects relative height or body mass, which is particularly important during an age when children and adolescents are experiencing pubertal growth spurts and may appear to have excess weight when they are simply tall (de Onis et al. 2007).

LINKS TO RELATED CONTENT

Condition: Underweight Interpretation: Cutoffs for weight-for-age

MEASUREMENT: **BMI-for-age**

BMI-for-age is used to indicate both thinness and overweight/obesity in children and non-pregnant adolescents 5–19 years of age. BMI is not a direct measurement of body fat and does not distinguish between muscle weight and body fat weight. It is a ratio of weight relative to height—calculated using the formula (weight in kilograms)/(height in meters)^2—and is interpreted according to age and sex. This age- and sex-specific interpretation is necessary because this age group is still growing and the relationship among weight, height, and fat depends on their stage of development and sex. In adolescents, BMI-for-age is affected by the stage of sexual maturation, which can vary widely among adolescents of the same age. There are no universal guidelines on how to interpret BMI-for-age based on stage of sexual maturation due to the variability of the pubertal growth spurt. Therefore, clinicians should keep a child/adolescent's growth trajectory and current context (e.g., health, diet, exercise levels) in mind when assessing their nutritional status (see the Interpretation section for more information on how to interpret BMI-for-age, taking into account the stages of puberty).

BOX 3.1 BMI-FOR-AGE AND PREGNANCY/ POSTPARTUM PERIOD

BMI-for-age is not used to assess pregnant/postpartum adolescent girls because it doesn't distinguish between muscle weight, body fat weight, and pregnancy-associated weight gain. However, knowing an adolescent girl's pre-pregnancy BMI-for-age can indicate her nutritional status before conceiving and help guide counseling and nutritional support decisions. This is extremely important as optimal pre-pregnancy weight and weight gain during pregnancy are critical to a healthy pregnancy and birth (see Module 4 for more information).

BOX 3.2 BMI-FOR-AGE IN EMERGENCIES

There are some concerns with using BMI-for-age to collect data on wasting in emergencies as there is some evidence of unrealistically high levels of adolescent wasting found in surveys of populations affected by emergencies. This may be due to inaccurate age data or delayed sexual development, which affects the body proportions of adolescents. (Emergency Nutrition Network 2011).

LINKS TO RELATED CONTENT

Condition: Acute malnutrition Condition: Overweight/obesity Interpretation: Cutoffs for BMI-for-age

MEASUREMENT: **MUAC**

MUAC is used to identify acute malnutrition by measuring the circumference of the mid-upper arm and comparing it to an established cutoff. Commonly used to assess the nutritional status of children under 5 and adults, MUAC is increasingly being used with children over 5 and adolescents, especially those living with HIV, to determine eligibility for support programs (Tang et al. 2013). However, because MUAC measurements are typically compared to a single cutoff for a specific age range, MUAC does not typically account for sex- and age-specific differences. At the time of this guide's publication, there were no universal internationally accepted MUAC cutoffs for children and adolescents, although several countries have established their own cutoffs.

LINKS TO RELATED CONTENT

Condition: Acute malnutrition Interpretation: Cutoffs for MUAC

MEASUREMENT: **Bilateral Pitting Edema**

Bilateral pitting edema is a clinical sign of a specific form of SAM known as nutritional edema, edematous malnutrition, SAM with edema, or kwashiorkor. Bilateral pitting edema is an abnormal accumulation of fluid in body tissues that causes swelling beginning in both feet in its mild form and is generalized to both feet, legs, hands, arms, and face in its most severe form. It is characterized by a lasting pitting (indentation) of the skin when pressure is applied to both feet for 3 seconds. Even mild bilateral pitting edema indicates SAM or another serious medical condition; cases should be referred for further assessment and treatment. See the Interpretation section for information on how to classify bilateral pitting edema.

LINKS TO RELATED CONTENT

Condition: Severe acute malnutrition Interpretation: Classification of bilateral pitting edema

How to Interpret Anthropometric Indicators and Classify Nutritional Status

This section provides guidance on how to interpret anthropometric measurements and indices to better understand the nutritional status of children and adolescents 5–19 years of age. For this age group, the WHO Growth Reference provides guidance for interpreting most of the anthropometric measurements and indices described in this guide, including cutoffs to classify child and adolescent nutritional status. For MUAC, which does not have universally accepted cutoffs, the guide provides information on some commonly used cutoffs.

There is limited evidence linking anthropometric indicators to functional or health outcomes in children and adolescents 5–19 years of age. However, interpretation of anthropometric data is still fairly straightforward and age-specific cutoffs are available to help to classify nutritional status for certain indicators. Interpretation becomes more complicated for adolescents who enter puberty and reach sexual maturation—which affects growth and body composition—at different ages and paces. Because of the large variability in the timing of growth spurts for individual children as well as different populations, age is often a poor indicator of physiological maturity and nutritional needs (Spear 2002). In addition to individual variations, there might be differences in growth potential across ethnicities that make it difficult to establish meaningful cutoffs that are applicable internationally. Furthermore, even if there weren't wide variations of what is "normal" at a given age, age-specific cutoffs may be problematic among adolescents who do not know their age (WHO 1995; Woodruff and Duffield 2000; Cogill 2003).

To avoid misclassifying an individual's nutritional status or a population's risk, one must be cautious in interpreting adolescent anthropometric data. Ideally, more than one type of measurement or index would be used[5] (e.g., both height-for-age and BMI-for age), and in addition to using the cutoffs described below, it is important to consider other information such as an individual's growth pattern over time, dietary practices, pubertal stage, health status, food security status, familial growth patterns (e.g., height of parents/siblings), physical activity, and care practices. Also, additional assessments that measure the degree of secondary sexual characteristics, such as Tanner Stages, can be

[5] Note: There is no current guidance on how to interpret different types of measurements together to assess nutritional status. However, using more than one type of measurement could help identify inconsistencies.

How to Interpret Anthropometric Indicators and Classify Nutritional Status (continued)

useful but may be considered intrusive outside of a clinical setting (see **Box 3.3**) (Spear 2002). In population-based surveys, the broader context should be considered, including food security and illness levels in the community and changes in the overall population's nutritional status.

Despite the challenges of interpreting anthropometric data for adolescents, anthropometry remains a key method of determining eligibility for certain care and support programs, promoting healthy growth and development, and preventing nutrition-related chronic disease. Also, tracking the nutritional status of the adolescent population along with other at-risk groups may help to more effectively design nutrition programs and allocate resources.

BOX 3.3 ASSESSING STAGES OF PUBERTY

In population-based surveys, it may be helpful to make statistical adjustments to account for differences in maturational age, requiring additional (and potentially more intrusive) assessments (WHO 1995) such as Tanner Stages. Used for classifying sexual maturity, Tanner Stages are based on the development of sex characteristics on a scale from 1 (pre-puberty) to 5 (adult). In boys, the stages follow development of genitals and pubic hair; in girls, the stages consider the development of breasts and pubic hair (Spear 2002).

Other methods for assessing and interpreting adolescent anthropometric data to address the challenges of variable growth and stages of puberty are available (Spear 2002; Woodruff and Duffield 2000). However, there is limited evidence on the best way to conduct these assessments in program settings.

More information on Tanner Stages is available here (WHO 2010).

Putting Anthropometry in Context: WHO Growth Reference

In 2007, WHO developed a growth reference for children and adolescents 5–19 years of age that serves as the main resource for guidance on interpreting anthropometric measurements and indices among this age group. The 2007 WHO Growth Reference is a reconstruction of the 1977 National Center for Health Statistics (NCHS)/WHO reference (using statistical modeling methods and additional data) and is designed to complement the 2006 WHO Growth Standards, creating a smooth transition from the standards to the reference at age 5 years.

The WHO Growth Reference for children and adolescents 5–19 years does not represent how children and adolescents should grow. Rather, since it is a reference and not a standard, it provides a comparison point for each child to a reference group by age and sex. The reference is not prescriptive and does not indicate functional outcomes.

The reference includes growth charts and tables that can be used to assess growth and development from 5 to 19 years of age (61 to 228 completed months), according to various key growth indicators (listed on the next page). Since girls and boys grow differently, the reference and accompanying growth charts are sex-specific.

For more information on the WHO Growth Reference, see WHO's website.

The WHO Growth Reference uses the following indicators:

- **BMI-for-age (5–19 years)**
- **Height-for-age (5–19 years)**
- **Weight-for-age (5–10 years)**

BOX 3.4 KEY DEFINITIONS

A **growth standard** is prescriptive. It demonstrates how healthy children grow under ideal circumstances.

A **growth reference** describes how a specific population has grown but does not necessarily reflect optimal growth.

A **cutoff** is a threshold beyond which an individual is determined to be malnourished. It also identifies the severity of undernutrition or overweight/obesity in an individual. Cutoffs can be used at the population level to signify when a nutrition situation is considered to be of public health concern.

TIP

For children who are exactly 5 years of age (i.e., their fifth birthday is the day of measurement), the 2006 WHO Growth Standards should be used. When they are age 5 years and 1 month, the 2007 WHO Growth Reference cutoffs should be used.

Making Sense of the Data: Z-Scores

Within the WHO Growth Reference are two different systems that are commonly used to classify nutritional status based on anthropometric measurements: z-scores (or standard deviation scores) and percentiles. This guide focuses on z-scores, which WHO recommends using to interpret anthropometric data (See **Box 3.5**).

What Are Z-Scores and What Do They Tell Us?

Anthropometric z-scores describe how far and in what direction an individual's measurement is from the reference populations' median value. Z-scores that fall outside of the normal range indicate a nutritional issue (undernutrition or overweight). If a z-score is outside the normal range, its distance from the median indicates the severity of the nutritional issue; the further away, the more severe. When a high proportion of individuals in a given population have z-scores outside of the "normal" range, there is a population-level nutrition problem.

In addition to providing information on current nutritional status, z-scores can be used to follow an individual child/adolescent's growth over time. This helps health care providers see whether a child or adolescent is growing well, is at risk of undernutrition or overweight, or is on the path to recovery from malnutrition.

BOX 3.5 Z-SCORES AND PERCENTILES

A **z-score** indicates how far and in what direction an individual's anthropometric measurement deviates from the median of the reference population and is expressed in standard deviations. For example, if a girl's weight-for-age z-score is -2, her weight-for-age is two standard deviations below the median weight-for-age of other girls her age.

A **percentile** indicates where an individual's anthropometric measurement falls relative to other people of the same age and sex in the reference population. For example, if a girl's weight-for-age is in the 85th percentile, she weighs more than 85 percent of other girls her age.

It is possible to convert z-scores to percentiles and vice versa. For example:

- A z-score of +2 is equivalent to the 97.7th percentile.
- A z-score of 0 is equivalent to the 50th percentile.
- A z-score of -2 is equivalent to the 2.3rd percentile.

However, the cutoffs used in each system are not exactly equivalent. For example, while a child in the 5th percentile would likely be identified as having a growth problem, the equivalent z-score of -1.65 would still be considered to be in normal range.

Source: Wang and Chen 2012.

Why Z-Scores?

A major advantage of z-scores is that at the population level, z-scores can be used to calculate summary statistics such as means, which allows the entire population's nutritional status to be assessed. They are also very useful for identifying individual children and adolescents with extreme measurements that differ substantially from those of normal, healthy children and adolescents. This is especially important in populations with high levels of malnutrition because children and adolescents at the extreme ends of the distribution have the most severe forms of malnutrition (Gorstein et al. 1994; WHO 1995; Gibson 2005).

Who Needs to Understand Z-Scores and Why?

Z-score cutoffs are used to define malnutrition according to anthropometric indices and measurements. Therefore, health care workers and nutrition program staff need to understand what z-scores are, how to interpret them, and what they mean at individual and population levels to make informed decisions at both the individual level (e.g., for growth monitoring and entry into/graduation from feeding programs) and population level (e.g., for nutrition assessments or situational reports for a population and monitoring and evaluation of programs).

TIP

In clinic or community settings, health workers are not expected to discuss z-scores with patients. Instead, they should talk about the individual's nutritional status (e.g., MAM) and growth pattern (e.g., growing well, growing too slowly, or lagging far behind).

How Is a Z-Score Determined?

Z-scores can be estimated using growth charts/tables (see below for more detail), obtained using computer software, or calculated by hand. In a clinical context, such as during health facility visits or growth monitoring, sex-specific growth charts or tables are used to estimate a child/adolescent's z-score or percentile and classify nutritional status, based on anthropometric measurements and sometimes age. In a research or survey setting, where exact z-scores are needed, special software programs such as WHO AnthroPlus[6] and Epi-Info can calculate z-scores. The WHO website also provides macros for the SPSS, Stata, SAS, S-Plus, and R statistical software packages to calculate the anthropometric indicators in the growth standards. For specific guidance on how a z-score is calculated, see Annex 2.

[6] WHO Anthro is used to calculate z-scores for children 0–60 months of age only. For older children (5–19 years of age), WHO AnthroPlus is used. WHO Anthro and AnthroPlus are available on the WHO website at: http://www.who.int/childgrowth/software/en/ and http://www.who.int/growthref/tools/en/, respectively.

Using Anthropometry to Classify Nutritional Status of Children and Adolescents 5–19 Years of Age

Tables 3.2 to 3.4 provide information on classifying a child/adolescent's nutritional status using all of the measures and indices described in this module.

TABLE 3.2 WHO Growth Reference Classification

ANTHROPOMETRIC INDICATOR AND CONDITION	AGE	Z-SCORE						
		< -3	≥ -3 to < -2	≥ -2 to < -1	≥-1 to ≤ +1	> +1 to ≤ +2	> +2 to ≤+3	> +3
Height-for-age Stunting	5–19 years	Severe stunting	Moderate stunting	Normal				Extreme tallness is not usually a nutrition issue. May indicate endocrine disorder.
Weight-for-age Underweight	5–10 years	Severe underweight	Moderate underweight	Normal		Do not use weight-for-age to determine overweight. A child or adolescent is best assessed by BMI-for-age.		
BMI-for-age Thinness Overweight/obesity	5–19 years	Severe thinness	Moderate thinness	Normal		Overweight	Obesity	

Source: 2007 WHO Growth Reference.

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BOX 3.6 OVERWEIGHT AND OBESITY CLASSIFICATION USING BMI-FOR-AGE IN CHILDREN 5–19 YEARS OF AGE

The 2006 WHO Child Growth Standards BMI-for-age z-score cutoffs for overweight and obesity in children 0–60 months of age begin at >+2 for overweight and >+3 for obesity. However, at 61 months of age, children move into the age group where the 2007 Growth Reference is used to determine if they are a healthy weight for their sex and age, and overweight begins at > +1 z-score and obesity at >+2 z-score. This can be confusing to interpret, as it is possible for a child who is 60 months of age to be identified as overweight by the 2006 Growth Standards and then, 1 month later (at 61 months of age), be considered obese under the 2007 Growth Reference, even though his/her z-score has not changed.

It is recommended that clinicians keep in mind the child's individual growth trajectory as they make decisions about the child's health and weight. If necessary (or available), more proximate measurements of body fat, such as triceps and subscapular skinfold measurements (for which WHO references exist but are not discussed in this guide) can be used to support the analysis and make decisions on the child's health.

For more information, see de Onis and Lobstein 2010.

Mid-Upper Arm Circumference and Mid-Upper Arm Circumference-for-Age

To date, universal internationally accepted evidence-based MUAC cutoffs have not been established for children and adolescents 5–19 years of age, and there is limited research examining the relationship between MUAC and adolescent nutritional status or health outcomes (Tang et al. 2013). Because MUAC is simpler to measure than other indicators, many countries and programs use MUAC to assess child and adolescent nutritional status in clinical settings and have established their own cutoffs for SAM and MAM. These cutoffs are not sex-specific and apply to wide age ranges (e.g., 5–9 years, 10–14 years, 15–17 years). FANTA has compiled the age-specific MUAC cutoffs used in FANTA-supported countries as of 2016 (see **Table 3.3** for a summary of the most commonly used cutoffs and **Box 3.7** for sample country-specific MUAC cutoffs). These cutoffs demonstrate the range of cutoffs used by different countries and may be a useful resource for development programs seeking to operate in those locations. However, this list is not exhaustive, and implementers should be aware of the limitations in using these cutoffs as they have not been validated or standardized and are therefore not internationally endorsed. In selecting cutoffs associated with enrollment in nutrition support programs, it will also be important to be aware of available resources. For example, a higher cutoff would qualify more people for enrollment, so it is important to ensure that a program has funds and supplies to provide support for all who qualify (UNHCR and World Food Programme [WFP] 2011).

In 2017, work by Mramba et al. to construct growth curves for MUAC-for-age for children 5–19 years of age provided new evidence that MUAC-for-age is at least as effective as BMI-for-age for assessing mortality risks associated with undernutrition among African school-age children and adolescents. The resulting growth curves, which were developed using data and methods similar to those used to construct the 2007 WHO Growth Reference for BMI-for-age, may potentially provide a universal MUAC-for-age reference for this age group (Mramba et al. 2017). Additional research will help clarify the role of MUAC and MUAC-for-age in assessing nutritional status of children and adolescents 5–19 years of age.

TABLE 3.3 Summary of MUAC Cutoffs for Children and Adolescents

	Nutritional Status (identifies wasting/acute malnutrition)		
	SAM	MAM	Normal
Commonly used country-specific cutoffs (from a sample countries)			
5–9 years	< 135 mm	≥ 135 to < 145 mm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm
Cutoffs based on the WHO 2009 *Guidelines for an Integrated Approach to the Nutritional Care of HIV-Infected Children (6 months to 14 years)*			
	SAM		
5–10 years*	< 129 mm		
10–14 years**	< 160 mm		

* This cutoff was determined because it is equivalent to -3 z-score of the WHO Growth Standards for boys age 5 years.

** This cutoff is based on the WHO Integrated Management of Adolescent and Adult Illness guidelines.

LINKS TO RELATED CONTENT

Measurement: MUAC Condition: Moderate acute malnutrition Condition: Severe acute malnutrition

BOX 3.7 SAMPLE COUNTRY-SPECIFIC MUAC CUTOFFS FOR CHILDREN AND ADOLESCENTS

The tables here provide MUAC cutoffs used by several countries to define severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) in children and adolescents 5–19 years of age. These cutoffs, which were current as of 2016, vary from country to country. They are categorized according to age ranges, which differ among countries, and are not sex-specific. This list is not exhaustive and is shared here to show the range of cutoffs used. Organizations working in a given country should reach out to the Ministry of Health to find out how acute malnutrition is assessed in that country and what cutoffs are used.

Country/ Age Groups	SAM	MAM	Normal
Democratic Republic of Congo			
5–9 years	< 135 mm	≥ 135 to < 145 mm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm
Ethiopia			
5–9 years	< 135 mm	≥ 135 to < 145 mm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 180 mm	≥ 180 mm
Malawi			
5–9 years	< 130 mm	_	_
10–11 years	< 160 mm	_	_
12–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm
15–18 years	< 185 mm	≥ 185 to < 220 mm	≥ 220 mm
Mozambique			
5–10 years	< 130 mm	≥ 130 to < 145 mm	≥ 145 mm
11–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm
15–18 years	< 210 mm	≥ 210 to < 230 mm	≥ 230 mm
Namibia			
5–9 years	< 135 mm	≥ 135 to < 145 mm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm

Country/ Age Groups	SAM	MAM	Normal
Tanzania			
5–9 years	< 135 cm	≥ 135 to < 145 cm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm
≥ 15 years (non-pregnant/non-postpartum)	< 185 mm	≥ 185 to < 220 mm	≥ 220 mm
≥ 15 years (pregnant/ postpartum)	< 190 mm	≥ 190 to < 230 mm	≥ 230 mm
Uganda			
5–9 years	< 135 mm	≥ 135 to < 145 mm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm
15–17 years	< 185 mm	≥ 185 to < 210 mm	≥ 210 mm
Zambia			
5–9 years	< 135 mm	≥ 135 to < 145 mm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm
15–17 years	< 185 mm	≥ 185 to < 210 mm	≥ 210 mm

Adapted from: Food and Nutrition Technical Assistance III Project (FANTA). 2016. *Nutrition Assessment, Counseling, and Support (NACS): A User's Guide—Module 2: Nutrition Assessment and Classification, Version 2.* Washington, DC: FHI 360/FANTA.

Clinical Assessment: Bilateral Pitting Edema

The classification system shown in **Table 3.4** is the same one used in children under 5. However, determining the grade and severity of edema and distinguishing between nutritional and non-nutritional causes may be more complicated in older children and adolescents, as some cases of edema may be non-nutrition related.

TABLE 3.4 Nutritional Status Classification of Bilateral Pitting Edema

Description	Grade of Edema	Nutritional Status
No bilateral pitting edema	Absent (O)	Does not have edematous malnutrition
Present in both feet/ankles	Mild (+)	SAM/severe malnutrition
Present in both feet/ankles, plus lower legs, hands, or lower arms	Moderate (++)	SAM/severe malnutrition
Generalized, including both feet, legs, hands, arms, and face	Severe (+++)	SAM/severe malnutrition

Sources: WHO 2013; WHO e-Library of Evidence for Nutrition Actions (eLENA) n.d. (a); WHO eLENA n.d. (b).

LINKS TO RELATED CONTENT

Measurement: Bilateral pitting edema

Condition: Severe acute malnutrition

BOX 3.8 SPECIAL CONDITIONS

Certain developmental, neurologic, and genetic conditions, such as Down syndrome, achondroplasia, and cerebral palsy, may alter an individual's body composition, size, growth pattern, and/or overall growth potential. In addition, it can be challenging to accurately measure individuals with conditions that affect the ability to stand; straighten their arms, legs, or back; or hold their head steady. In addition, comparing the weight of amputees to a reference population of non-amputees is problematic. When assessing people with special needs, it is important to be aware of the implications of their condition and potential explanations for their altered growth.

There is limited guidance on applying anthropometry to individuals with special needs. While the CDC has provided some alternative measurement options for individuals, WHO has not issued specific guidelines or references. However, alternative anthropometric references exist for certain conditions. The alternative charts have been developed from small, homogeneous samples and may not have used standardized measurement techniques or accounted for secondary conditions that affect growth. Therefore, although they may be a useful reference to understand how a condition may affect growth or anthropometric measurements, they should be used with caution and in conjunction with the WHO standards and references.

For more information on the CDC's alternative approaches for measuring an individual with special needs, see The CDC Growth Charts for Children with Special Health Care Needs.

For alternative anthropometric references, see:

Amputation: Mini Nutritional Assessment (Appendix 3: Determining BMI for Amputees)

Down syndrome: UK Down Syndrome 0–18 years

Cerebral palsy: The Life Expectancy Project charts, according to gross motor function classification system

Cornelia de Lange syndrome: Girls Boys

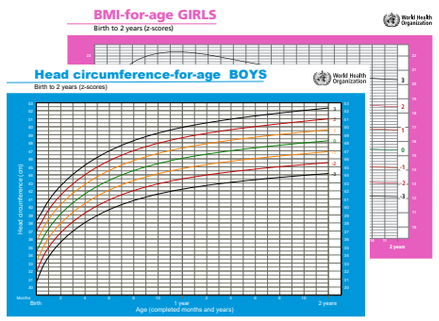
Additional resources: The Greenwood Genetic Center in the United States published a set of references (1998) from age 25 weeks through adulthood for several conditions, including achondroplasia, Marfan syndrome, and Turner syndrome, among others. They are available for purchase.

Source: Gibson 2005; U.S. Department of Health and Human Services n.d.; CDC 2013; Life Expectancy Project 2011; Nestle Nutrition Institute n.d.

Tools to Assess, Classify, and/or Monitor Nutritional Status of Children and Adolescents 5–19 Years of Age

This section provides information on various anthropometric tools (growth charts, reference tables, and a BMI wheel) that can be used to assess, classify, and/or monitor nutritional status of children and adolescents 5–19 years of age.

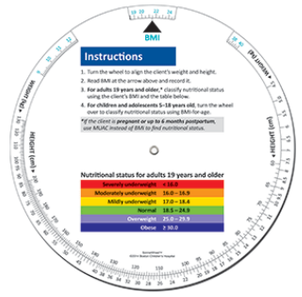
TOOL: **Growth Charts**



WHO has produced growth charts for the Growth Reference so that health workers conducting anthropometric screening or assessment in a community, clinic, or health facility can plot a child/adolescent's weight-for-age, height-for-age, and/or BMI-for-age. The chart shows where a child/adolescent's measurement falls and allows growth to be tracked over time, indicating if s/he is growing at a healthy pace or if there is cause for concern. For more information on how to use growth charts, see Annex 1 and visit WHO's website to access the sex-specific growth charts for weight-for-age (5–10 years), height-for-age, and BMI-for-age.

Visit the WHO website for more information.

TOOL: **BMI Wheel**



Another tool that can be used to calculate and interpret BMI-for-age for children and adolescents 5–19 years of age is the FANTA BMI wheel. This small, hand-held tool is made of sturdy card stock and is portable. On one side of the wheel, health workers can use a child/adolescent's height (cm) and weight (kg) to determine his/her BMI. On the other side, health workers can classify the nutritional status according to the child/adolescent's age and sex. Note that the BMI wheel uses the term "underweight" for low BMI-for-age, while this guide uses the term "thinness." More information on the BMI wheel, including a video on how to use it and how to have it printed is available.

Visit the FANTA website for more information.

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TOOL: **Quick Reference Tables**

Simple, sex-specific reference tables are another tool available to interpret anthropometric measures and classify a child/adolescent's nutritional status using weight-for-age, height-for-age, and BMI-for-age. The tables provide a classification based on one point in time and do not provide trend information. The WHO website provides simplified field tables, which include a cutoff for each classification for weight-for-age, height-for-age, and BMI-for-age. FANTA has developed sex-specific quick reference look-up tables for BMI-for-age with ranges for each nutritional status classification. The FANTA BMI-for-age quick reference tables are available on the next page.

- WHO's BMI-for-Age Field Tables
- WHO's Height-for-Age Field Tables
- WHO's Weight-for-Age Field Tables
- FANTA's BMI and BMI-for-Age Look-Up Tables

BMI-for-Age Tables

BOYS

Age (years: months)	SAM Less than –3 (BMI)	MAM –3 to less than –2 (BMI)	Normal –2 to less than +1 (BMI)	Overweight +1 to +2 (BMI)	Obesity Greater than +2 (BMI)
5:1	< 12.1	12.1–12.9	13.0–16.6	16.7–18.3	> 18.3
5:6	< 12.1	12.1–12.9	13.0–16.7	16.8–18.4	> 18.4
6:0	< 12.1	12.1–12.9	13.0–16.8	16.9–18.5	> 18.5
6:6	< 12.2	12.2–13.0	13.1–16.9	17.0–18.7	> 18.7
7:0	< 12.3	12.3–13.0	13.1–17.0	17.1–19.0	> 19.0
7:6	< 12.3	12.3–13.1	13.2–17.2	17.3–19.3	> 19.3
8:0	< 12.4	12.4–13.2	13.3–17.4	17.5–19.7	> 19.7
8:6	< 12.5	12.5–13.3	13.4–17.7	17.8–20.1	> 20.1
9:0	< 12.6	12.6–13.4	13.5–17.9	18.0–20.5	> 20.5
9:6	< 12.7	12.7–13.5	13.6–18.2	18.3–20.9	> 20.9
10:0	< 12.8	12.8–13.6	13.7–18.5	18.6–21.4	> 21.4
10:6	< 12.9	12.9–13.8	13.9–18.8	18.9–21.9	> 21.9
11:0	< 13.1	13.1–14.0	14.1–19.2	19.3–22.5	> 22.5
11:6	< 13.2	13.2–14.1	14.2–19.5	19.6–23.0	> 23.0
12:0	< 13.4	13.4–14.4	14.5–19.9	20.0–23.6	> 23.6
12:6	< 13.6	13.6–14.6	14.7–20.4	20.5–24.2	> 24.2
13:0	< 13.8	13.8–14.8	14.9–20.8	20.9–24.8	> 24.8
13:6	< 14.0	14.0–15.1	15.2–21.3	21.4–25.3	> 25.3
14:0	< 14.3	14.3–15.4	15.5–21.8	21.9–25.9	> 25.9
14:6	< 14.5	14.5–15.6	15.7–22.2	22.3–26.5	> 26.5
15:0	< 14.7	14.7–15.9	16.0–22.7	22.8–27.0	> 27.0
15:6	< 14.9	14.9–16.2	16.3–23.1	23.2–27.4	> 27.4
16:0	< 15.1	15.1–16.4	16.5–23.5	23.6–27.9	> 27.9
16:6	< 15.3	15.3–16.6	16.7–23.9	24.0–28.3	> 28.3
17:0	< 15.4	15.4–16.8	16.9–24.3	24.4–28.6	> 28.6
17:6	< 15.6	15.6–17.0	17.1–24.6	24.7–29.0	> 29.0
18:0	< 15.7	15.7–17.2	17.3–24.9	25.0–29.2	> 29.2

GIRLS

Age (years: months)	SAM Less than –3 (BMI)	MAM –3 to less than –2 (BMI)	Normal –2 to less than +1 (BMI)	Overweight +1 to +2 (BMI)	Obesity Greater than +2 (BMI)
5:1	< 11.8	11.8–12.6	12.7–16.9	17.0–18.9	> 18.9
5:6	< 11.7	11.7–12.6	12.7–16.9	17.0–19.0	> 19.0
6:0	< 11.7	11.7–12.6	12.7–17.0	17.1–19.2	> 19.2
6:6	< 11.7	11.7–12.6	12.7–17.1	17.2–19.5	> 19.5
7:0	< 11.8	11.8–12.6	12.7–17.3	17.4–19.8	> 19.8
7:6	< 11.8	11.8–12.7	12.8–17.5	17.6–20.1	> 20.1
8:0	< 11.9	11.9–12.8	12.9–17.7	17.8–20.6	> 20.6
8:6	< 12.0	12.0–12.9	13.0–18.0	18.1–21.0	> 21.0
9:0	< 12.1	12.1–13.0	13.1–18.3	18.4–21.5	> 21.5
9:6	< 12.2	12.2–13.2	13.3–18.7	18.8–22.0	> 22.0
10:0	< 12.4	12.4–13.4	13.5–19.0	19.1–22.6	> 22.6
10:6	< 12.5	12.5–13.6	13.7–19.4	19.5–23.1	> 23.1
11:0	< 12.7	12.7–13.8	13.9–19.9	20.0–23.7	> 23.7
11:6	< 12.9	12.9–14.0	14.1–20.3	20.4–24.3	> 24.3
12:0	< 13.2	13.2–14.3	14.4–20.8	20.9–25.0	> 25.0
12:6	< 13.4	13.4–14.6	14.7–21.3	21.4–25.6	> 25.6
13:0	< 13.6	13.6–14.8	14.9–21.8	21.9–26.2	> 26.2
13:6	< 13.8	13.8–15.1	15.2–22.3	22.4–26.8	> 26.8
14:0	< 14.0	14.0–15.3	15.4–22.7	22.8–27.3	> 27.3
14:6	< 14.2	14.2–15.6	15.7–23.1	23.2–27.8	> 27.8
15:0	< 14.4	14.4–15.8	15.9–23.5	23.6–28.2	> 28.2
15:6	< 14.5	14.5–15.9	16.0–23.8	23.9–28.6	> 28.6
16:0	< 14.6	14.6–16.1	16.2–24.1	24.2–28.9	> 28.9
16:6	< 14.7	14.7–16.2	16.3–24.3	24.4–29.1	> 29.1
17:0	< 14.7	14.7–16.3	16.4–24.5	24.6–29.3	> 29.4
17:6	< 14.7	14.7–16.3	16.4–24.6	24.7–29.4	> 29.4
18:0	< 14.7	14.7–16.3	16.4–24.8	24.9–29.5	> 29.5

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