Canadian Paediatric Society / Société canadienne de pédiatrie
Dietitians of Canada / Les diététistes du Canada
The College of Family Physicians of Canada / Le Collège des médecins de famille du Canada
Community Health Nurses of Canada / Infirmières et infirmiers en santé communautaire du Canada

A health professional's guide for using the new WHO growth charts

A collaborative statement from Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, and Community Health Nurses of Canada

Growth monitoring and promotion of optimal nutrition are essential components of health care for all children. Monitoring a child's growth helps to confirm a child's healthy growth and development, or identify early a potential nutritional or health problem. The consequences of poor nutrition during the early years include compromised immunity, cognitive problems (1) and stunted growth. Overnutrition may predispose to conditions such as obesity, diabetes and metabolic syndrome later in life (2,3). When potential problems are identified early, health professionals and parents can work together to initiate action before the child's nutritional status or health is seriously compromised.

The main objectives of growth monitoring and promotion of optimal growth are the following (4,5):

- to provide a tool for nutrition and health evaluation of individual children;
- to initiate effective action in response to abnormal patterns of growth;
- to teach parents how nutrition, physical activity, genetics and illness can affect growth and, in doing so, motivate and facilitate individual initiative and improved child care practices; and
- to provide regular contact with primary health care services and facilitate their use.

Activities linked to growth monitoring and promotion at the individual level include the following (4):

- accurately measuring weight, length or height, and head circumference;
- precisely plotting measurements on the appropriate validated growth chart;
- correctly interpreting the child's pattern of growth; and
- discussing the child's growth pattern with the parents or caregiver, and agreeing on subsequent action when required.

Regular assessment of growth should occur at well-health visits. Suggested monitoring intervals are within one to two weeks of birth, at two, four, six, nine, 12, 18 and 24 months (6), then once per year for children older than two years of age and for adolescents (6). Growth assessment should also occur at acute care visits (6) because illnesses may affect weight.

Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, and Community Health Nurses of Canada recommend the adoption of the World Health Organization (WHO) growth charts (7,8) in Canada (9), replacing previous recommendations (6) to use the growth charts from the American Centers for Disease Control and Prevention (CDC).

- The 2006 WHO Child Growth Standards for birth to five years are recommended because they are based on children raised according to current Canadian (10) and international health and nutrition recommendations. Breastfed infants were used as the normative model for growth and development. These charts illustrate the way all healthy children should grow and are considered to be the gold standard for assessing the growth of young children.
- The WHO Reference 2007 growth charts are recommended for monitoring the growth of children and adolescents between the ages of five and 19 years because they have been updated to address the obesity epidemic and, therefore, are considered to be closer to growth standards.

The present guide introduces the WHO growth charts, provides some key features of the charts and illustrates how to perform accurate anthropometric measurements in children.

WHAT ARE SOME OF THE FEATURES OF THE WHO GROWTH CHARTS?

The WHO 2006 Child Growth Standards charts:

- are based on a breastfed population, whereas only 50% of infants sampled for the CDC growth charts were breastfed;
- generally reflect a lighter, longer/taller sample (11,12);

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- can be used for multiethnic populations in Canada, because the data set is international, representing the growth of children in six different countries (Brazil, Ghana, India, Norway, Oman and USA) for whom minimal differences in the rate of linear growth were noted (7);
- provide a wider range of available charts by age for younger children (birth to six months, birth to two years, birth to five years, six months to two years, two to five years);
- transition to an older age group chart at five years of age, whereas the CDC growth charts transition at two years or 36 months;
- emphasize the use of body mass index (BMI) for age as the index of weight relative to height starting at two years of age, rather than weight for height or per cent ideal body weight; and
- show a perfect match of measurements at five years of age between the Growth Standards and Growth References (13).

The WHO Growth Reference 2007 charts:

- take into account the obesity epidemic by including data that reflect healthy growth; and
- BMI-for-age values suggestive of overweight (BMI of 25 kg/m^2) and obesity (BMI of 30 kg/m^2) match almost perfectly with respective adult cut-offs for overweight and obesity, at 19 years of age.

SELECTING THE APPROPRIATE GROWTH CHARTS FOR THE HEALTHY TERM INFANT

There are various WHO growth charts available. Growth charts recommended for use in Canada are available to download from <www.dietitians.ca/growthcharts>.

Selecting the appropriate growth charts depends on the work setting. Table 1 is a sampling of growth charts suggested for a primary health care setting, including public health/community settings, as well as primary care/physician office settings.

SELECTING THE APPROPRIATE GROWTH CHARTS FOR PRETERM INFANTS (LESS THAN 37 WEEKS) AND CHILDREN WITH SPECIAL HEALTH CARE NEEDS

The WHO growth standards did not include data on premature infants or very low birth weight infants (less than 1500 g); the growth of these infants differs from infants born at an appropriate age or size, such that they appear not to catch up during early childhood (14).

- The growth of preterm infants (less than 37 weeks) after discharge from the neonatal intensive care unit can be monitored using the WHO Child Growth Standards:
  - Measurements should be plotted using corrected postnatal age for prematurity (ie, postnatal age in weeks – [40 weeks – gestational age in weeks]) until 24 or 36 months of age (15,16).
    - For example, at 12 weeks' postnatal age, an infant born at 30 weeks' gestational age would be 12 – [40–30] or two weeks' corrected postnatal age.
  - Breastfed infants born with low birth weight will be expected to track along the lower percentiles of the WHO charts because exclusive breastfeeding does not change the fact that they were small for age at birth.
  - Alternative charts to assess growth of preterm and low birth weight infants in the neonatal intensive care unit or early postdischarge setting include
    - Fenton's (17) updated Babson and Benda chart for tracking growth from 22 weeks' gestational age to 10 weeks post-term, and
    - the Infant Health and Development Program charts (14) for tracking growth from two to 38 months.
- Children with intellectual, developmental, genetic or other disorders often have growth patterns that are different from healthy children. Their growth can also be monitored on the WHO growth charts alone, or in conjunction with specific growth curves that exist for some of these disorders (18-21).

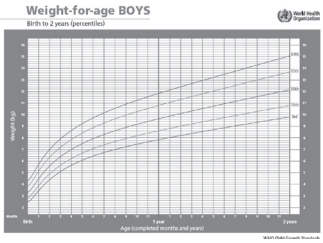
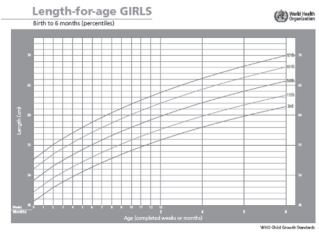
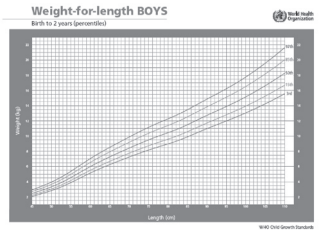
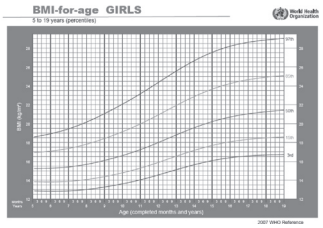
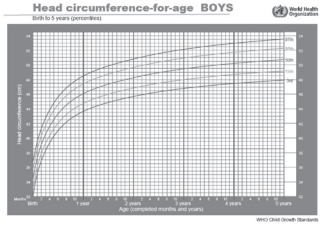
HOW ARE MEASUREMENTS INTERPRETED?

Growth measurements have little meaning until they are accurately plotted on the growth chart. The curves on the growth chart represent selected percentiles of the measurements of large numbers of children in the reference population who were studied to develop that growth chart. These percentile curves can be used to identify the child's rank relative to other children of similar age and sex. For example, if a child's weight is at the 85th percentile, it means that 85 of 100 children (85%) weigh less and 15 (15%) weigh more.

HOW SHOULD GROWTH BE ASSESSED?

- One-time measurements, taken and plotted accurately on a growth chart, reflect a child's size and may be used to screen children for nutritional risk using the cut-off percentiles shown in Table 2. However, they do not provide adequate information to assess a child's growth. A series of weight and length/height measurements over time are more informative and reflect a child's growth pattern.
- In most children, serial length/height and weight measurements follow consistently along a percentile curve or between the same percentile curves.
- It is normal for children to change one to two percentile curves for both weight and length during the first two to three years of life, and settling toward the 50th percentile curve (22). The 50th percentile, or 'average', is not the goal for each child because some children have the genetic potential to be taller or shorter than average. More importantly, children's weight should be proportional to their length/height.
- With the exception of the first two to three years of life when crossing percentile curves may be normal, and again in puberty when the age of onset is variable, a sharp incline or decline in growth, or a growth line that

TABLE 1
WHO Growth charts available for the primary care setting

Parameter	Sample growth chart	Age ranges*	Percentiles
Weight for age		Birth–2 years; 2–5 years; 5–10 years	0.1st, 3rd, 15th, 50th, 85th, 97th, 99.9th
Length or height for age		Birth–2 years; 2–5 years; 5–19 years	0.1st, 3rd, 15th, 50th, 85th, 97th, 99.9th
Weight for length		Birth–2 years	0.1st, 3rd, 15th, 50th, 85th, 97th, 99.9th
Body mass index (BMI) for age		2–5 years; 5–19 years	0.1st, 3rd, 15th, 50th, 85th, 97th, 99.9th
Head circumference		Birth–5 years	0.1st, 3rd, 15th, 50th, 85th, 97th, 99.9th

**For each age range cited, such as birth to six months or birth to five years, the range should be interpreted as up to, but not including the sixth month, or up to, but not including five years, etc. The Growth Charts in Table 1 have been reproduced with permission from the World Health Organization*

remains flat, is potentially a sign of growth disturbance. A shift toward the 50th percentile is likely a healthy change, whereas a shift away from the 50th percentile may signal a problem (23).

- Serial measurements showing unexpected movement downward on the curves from a previously established rate of growth could be a sign of 'failure to thrive' (24-27).
  - A child who crosses two major percentiles on the WHO growth charts would experience a greater loss or gain of weight or length/height before being identified as a problem, because the inner curves of the WHO growth charts (3rd, 15th, 50th, 85th and 97th) are farther apart than the inner curves in the CDC growth charts (10th, 25th, 50th, 75th and 90th).
  - Changes in weight or length/height should be investigated before a child crosses two percentile lines.
- Unexpected movement upward on the curves may be a sign of the development of overweight or obesity.
- Consider the following factors when evaluating growth that does not follow a healthy pattern for all children: parental height, the child's environment, nutritional intake, and presence of chronic illness or special health care needs (ie, Down's syndrome,

cerebral palsy, etc), and for infants also consider gestational age, birth weight and type of feeding (breast or formula).

USING BMI FOR AGE

- BMI is defined as weight in kilograms divided by height in meters squared: BMI = weight (kg) ÷ height $(m)^2$.
- BMI correlates with body fat; paediatric BMI has been linked to future obesity and adverse health outcomes (28). BMI begins to decrease in later infancy, reaching a low around four to six years of age after which it begins to increase through childhood and adolescence. The rebound or increase in BMI that occurs after it reaches its lowest point is referred to as the 'adiposity' or BMI rebound, and is reflected in the BMI-for-age charts (29). Early adiposity rebound (ie, before the age of four to six years) is associated with an increased risk for obesity later in life (30,31).
- Unlike adults, age-related increases in BMI are associated with increases in fat mass and fat-free mass (32); the extent to which each component contributes to changes in BMI depends on age, sex and pubertal maturation of the child (33). Other factors such as comorbidities, family history, ethnic background, level of physical activity, frame size and clinical judgement should also be considered before determining growth status based on Table 2.
- BMI for age is the recommended nutritional indicator for screening children two years and older to identify individuals who are potentially wasted, overweight or obese.
- There is a lack of convincing evidence that BMI for age is more effective than weight for age or weight for length at assessing adequacy of feeding, and under- and overweight in children younger than two years of age.

HOW WILL GROWTH OF THE BREASTFED VERSUS NONBREASTFED BABY DIFFER WHEN PLOTTED ON THE WHO GROWTH CHARTS COMPARED WITH THE CDC GROWTH CHARTS?

- Breastfed infants tend to grow more quickly than nonbreastfed infants in the first six months and tend to grow more slowly in the second six months of life. Because the WHO Child Growth Standards charts have been constructed based on the growth of infants that have been primarily breastfed, the breastfed infant will no longer look as though they are growing too rapidly during the first six months nor will they look as though they are failing to grow sufficiently from six to 12 months.
- Nonbreastfed infants may now appear to be growing on a lower percentile during the first six months and more rapidly during the second six months of life.
- Overall, the WHO growth charts will result in higher rates of children classified as underweight or wasted/thin in the first six months of life and higher rates of

TABLE 2
Cut-off points

Growth status	Indicator	Percentile
Birth to 2 years		
Underweight	Weight for age	<3rd
Severely underweight	Weight for age	<0.1st
Stunted*	Length for age	<3rd
Severely stunted	Length for age	<0.1st
Wasted†	Weight for length	<3rd or < 89% IBW‡
Severely wasted	Weight for length	<0.1st
Risk of overweight	Weight for length	>85th
Overweight§	Weight for length	>97th
Obese¶	Weight for length	>99.9th
Head circumference**	Head circumference for age	<3rd or >97th percentile

		Percentile	
Growth status	**Indicator**	**2–5 years**	**5–19 years**
Two to 19 years			
Underweight	Weight for age††	<3rd	<3rd
Severely underweight	Weight for age††	<0.1st	<0.1st
Stunted*	Height for age	<3rd	<3rd
Severely stunted	Height for age	<0.1st	<0.1st
Wasted†	BMI for age	<3rd	<3rd
Severely wasted	BMI for age	<0.1st	<0.1st
Risk of overweight	BMI for age	>85th	N/A‡‡
Overweight§	BMI for age	>97th	>85th
Obese¶	BMI for age	>99.9th	>97th
Severely obese	BMI for age	N/A‡‡	>99.9th

***Stunted** – the infant or child may be short because the parents are short, or they may be stunted because of long-term malnutrition, delayed maturation, chronic illness or a genetic disorder; †**Wasted** – may be indicative of recent malnutrition, dehydration or a genetic disorder. Traditional measures of underweight (weight for age, weight for length or per cent ideal body weight [% IBW]) continue to be recommended for children younger than two years of age until the validity of using body mass index (BMI) for age in this age group has been demonstrated; ‡**% IBW** – plot length or height on growth chart to identify length-for-age percentile. Locate IBW as the weight at the same percentile as the length, for the same age and sex. Calculate % IBW = (actual weight ÷ IBW) x 100; §**Overweight** – further evaluation necessary. Look for comorbidities and possible causes. The cut-offs recommended for younger children (birth to five years) are more cautious to avoid the risk of health professionals or parents putting young children on diets. The cut-offs recommended for the older children (five to 19 years) coincide at 19 years of age with the adult cut-off for overweight (ie, BMI of 25 kg/m^2); ¶**Obese** – denotes excess body fat and reflects the associated serious health risks. The cut-offs recommended for the younger children (birth to 5 years) are more cautious to avoid the risk of health professionals or parents putting young children on diets. The cut-offs recommended for the older children (five to 19 years) coincide at 19 years of age with the adult cut-off for obesity (ie, BMI of 30 kg/m^2); ****Head circumference** – reflects brain size and is used for screening for potential health, nutrition or developmental problems among infants from birth to two years of age; ††**Weight for age** – use BMI for age instead. Weight for age is not recommended as a nutritional parameter beyond 10 years of age because of the wide variability in age at onset of puberty and its associated changes in body composition. There is no distinction between height and body mass in an age period in which many children are experiencing their pubertal growth spurt. Pubertal children may appear as having excess weight by weight for age when, in fact, they are just tall; at the other extreme, overweight children who are short or stunted would appear to be normal when weight for age is used to screen for overnutrition. The World Health Organization recommends that weight continue to be measured for children beyond 10 years of age, but solely for the purpose of calculating, plotting and monitoring BMI for age (13); ‡‡**N/A** – not applicable for this age group*

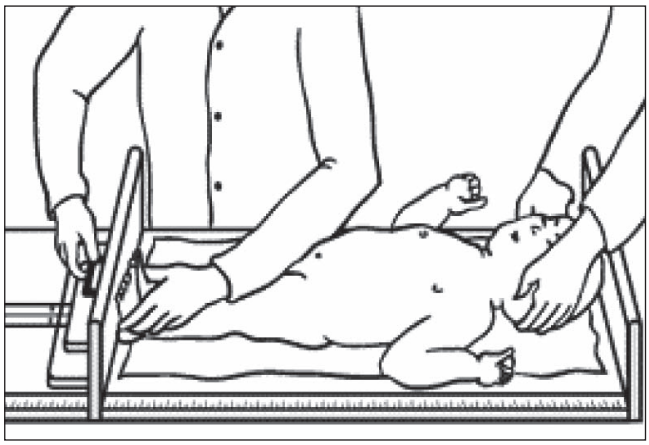


Figure 1) *An illustration on how to measure an infant's length. Illustration © Nardella M, Campo L, Ogata B, eds. Nutrition Interventions for Children with Special Health Care Needs, Olympia, WA, State Department of Health, 2001 (38). Used with permission*

Figure 2) *An illustration on how to measure an infant's head circumference. Illustration © Nardella M, Campo L, Ogata B, eds. Nutrition Interventions for Children with Special Health Care Needs, Olympia, WA, State Department of Health, 2001 (38). Used with permission*

children classified as stunted, overweight and obese after that time. Assessing the pattern of weight, linear growth and weight relative to length, and whether the infant is breastfed, is necessary before suggesting changes in feeding.

RECOMMENDED CUT-OFF POINTS AND TERMINOLOGY

Cut-off points for anthropometric measurements are intended to provide guidance for further assessment, referral or intervention. They should not be used as diagnostic criteria. Longitudinal patterns of growth should always be considered when applying cut-offs. Cut-off criteria are separated into birth to two years, two to five years, and five to 19 years. The recommended cut-off criteria for determining overweight and obesity status are different for children birth to five years and five to 19 years of age.

ACCURATE WEIGHING AND MEASURING

Accurate, reliable measurements are fundamental to growth monitoring and to making sound clinical judgments on the appropriateness of a child's pattern of growth. Accurate measurements have three components:

- a standardized measurement technique,
- high-quality equipment that is regularly calibrated and accurate, and
- trained measurers who are consistent and precise in their technique (27,34).

Accurate measurement equipment and techniques

Weighing infants (35):

- The infant should be weighed nude on a calibrated beam or electronic scale.
- The scale should be accurate and reliable, with a maximum weight of 20 kg in 1 g or 10 g increments, and easily 'zeroed' and recently calibrated. The 'average weight' feature is desirable on an electronic scale to accommodate infants who do not remain still during weight measurements.

Measuring infant length (Figure 1) (35):

- Use a calibrated length board with fixed headpiece and movable foot piece that is perpendicular to the surface of the table.
- Two trained individuals are needed to get an accurate measurement.
- Measure the infant without shoes and wearing light underclothing or a diaper.
- The infant should be placed on its back in the centre of the board lying flat against the surface. Eyes should be looking up. Both legs should be fully extended and toes should be pointing upward, with feet flat against the foot piece.
- Measure length to the nearest 0.1 cm.

Measuring head circumference (Figure 2) (35):

- Position the tape just above the eyebrow, above the ears and around the biggest part on the back of the head.
- Use a flexible, nonstretchable tape.
- Measure to the nearest 0.1 cm.

Weighing children and adolescents (35):

- A child older than 24 to 36 months of age is weighed standing on a beam balance or digital scale, provided they can stand on their own.
- The child is weighed wearing light undergarments or lightweight outer clothing.
- Weight is recorded to the nearest 0.1 kg.

Note: Children unable to stand unsupported may need to be weighed while being held by someone, with the weight of the person holding the child subtracted from

their combined weight. A larger child with special needs may need to be weighed on sit-down or wheelchair scales.

Measuring height in children and adolescents (Figure 3) (35): Young children from 24 to 36 months of age may have either length or height measured. Children with physical disabilities (eg, unable to stand) may require length measured using a recumbent board or may require the use of other segment length measurements (36,37).

- Measure height for children older than 24 months of age who can stand unassisted.
- A stadiometer for height measurements requires
  - a wall-mounted vertical board with an attached metric rule, and
  - a horizontal headpiece that can be brought into contact with the superior part of the head.
- The child or adolescent stands against the stadiometer without shoes, with heels together, legs straight, arms at sides and shoulders relaxed.
- Ensure that the child is looking straight ahead.
- Bring the perpendicular headpiece down to touch the crown of the head.
- Measurer's eyes are parallel with the headpiece.
- Measure to the nearest 0.1 cm.

Note: Alternative measurements, such as sitting heights, segmental lengths, girths and skin folds require special skills and equipment. They are performed at some paediatric centres for monitoring growth in children with special health needs (6,37).

For more information about the assessment of growth refer to the following resources and references

- WHO Child Growth Standards and Growth Reference 2007 charts. <www.dietitians.ca/growthcharts>.
- Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, and Community Health Nurses of Canada. Promoting optimal monitoring of child growth in Canada: Using the new World Health Organization growth charts. <www.cps.ca/english/publications/Nutrition.htm>.
- Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, and Community Health Nurses of Canada. Promoting optimal monitoring of child growth in Canada: Using the new WHO growth charts. Executive summary. <www.cps.ca/english/publications/Nutrition.htm>.
- Is my child growing well? Questions and answers for parents – a fact sheet designed for parent education. <www.caringforkids.cps.ca/growing&learning/Growth.htm>.
- Maternal and Child Health Bureau training modules. Accurately weighing and measuring: Technique. <http://depts.washington.edu/growth/module5/text/page1a.htm>.

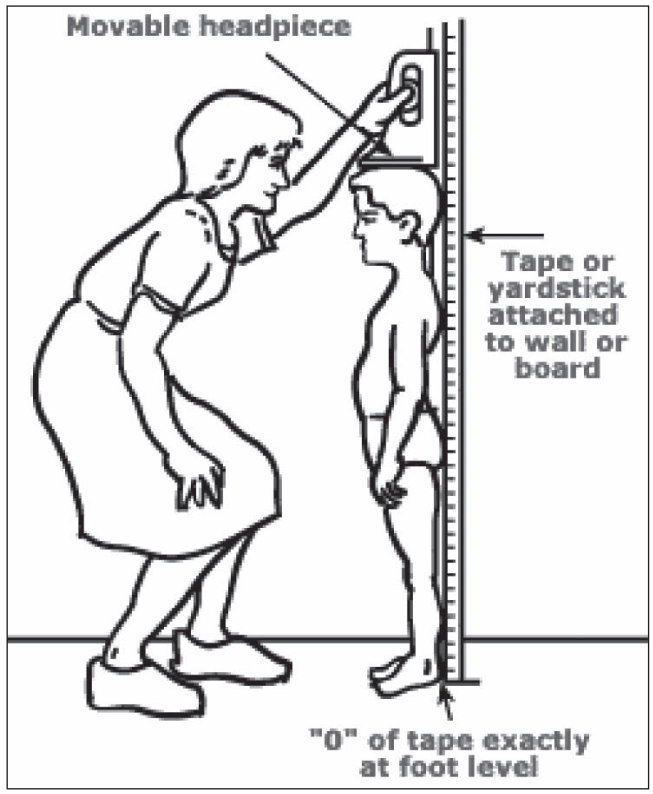


Figure 3) *An illustration on how to measure the height of children and adolescents. Illustration © Nardella M, Campo L, Ogata B, eds. Nutrition Interventions for Children with Special Health Care Needs, Olympia, WA, State Department of Health, 2001 (38). Used with permission*

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