A Health Professional's Guide for using the

WHO GROWTH CHARTS FOR CANADA   *(Redesigned 2014)*

This Guide introduces the WHO Growth Charts for Canada which were first released in 2010 and redesigned in 2014 to address some primary design issues. It provides some key features of the charts and illustrates how to perform accurate anthropometric measurements in children.

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 undernutrition during the early years include compromised immunity, cognitive problems[1] and stunted growth. Over-nutrition 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 are seriously compromised.

Activities linked to growth monitoring and promotion at the individual level[4]:

1. accurately measuring weight, length or height, and head circumference
2. precisely plotting measurements on the appropriate, validated growth chart
3. correctly interpreting the child's pattern of growth
4. discussing the child's growth pattern with the parent(s)/caregiver and agreeing on subsequent action when required.

Regular assessment of growth should occur at well-health visits. Suggested monitoring intervals after birth are within one to two weeks of birth, at one, two, four, six, nine, 12, 18 and 24 months[5], then once per year for children over 2 years and for adolescents[5]. Growth assessment should also occur at acute care visits[5], keeping in mind that illnesses may affect weight.

Dietitians of Canada
Les diététistes du Canada

Canadian Paediatric Society
Société canadienne de pédiatrie

CPEG GCEP
Canadian Pediatric Endocrine Group
Groupe canadien d'endocrinologie pédiatrique

THE COLLEGE OF FAMILY PHYSICIANS OF CANADA
LE COLLÈGE DES MÉDECINS DE FAMILLE DU CANADA

CHNC
Community Health Nurses OF CANADA

IISCC
INFIRMIÈRES ET INFIRMIERS EN SANTÉ COMMUNAUTAIRE DU CANADA

Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, Community Health Nurses of Canada and, in 2014, the Canadian Pediatric Endocrine Group recommend the adoption of the World Health Organization [WHO] Growth Charts[6,7] in Canada[8].

- The *2006 WHO Child Growth Standards* for birth to five years are recommended because they are based on children raised according to current Canadian and international health and nutrition recommendations among communities where economics were likely to support appropriate growth. Breastfed infants were used as the normative model for growth and development. These charts illustrate the way 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 5 to 19 years because they have been updated to address the obesity epidemic and are therefore considered to be closer to growth standards.

What are some of the features of the WHO Growth Charts for Canada?

The WHO 2006 Child Growth Standard Charts:

- are based on a breastfed population, whereas only 50% of infants sampled for the Center for Disease Control (CDC) growth charts were breastfed at all

- generally reflect a lighter, longer/taller sample

- can be used for multi-ethnic populations in Canada, as the data set is international, representing the growth of children in six different countries (Brazil, Ghana, India, Norway, Oman, USA) for whom minimal differences in the rate of linear growth were noted[6]

- emphasize the use of BMI-for-age as the index of weight relative to height starting at two years of age, rather than weight-for-height or percent ideal body weight

- show a close match of measurements at five years of age between the Growth Standards and Growth References[9].

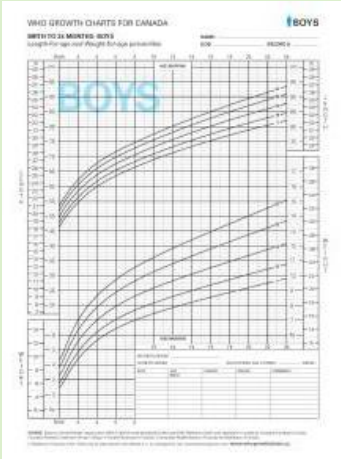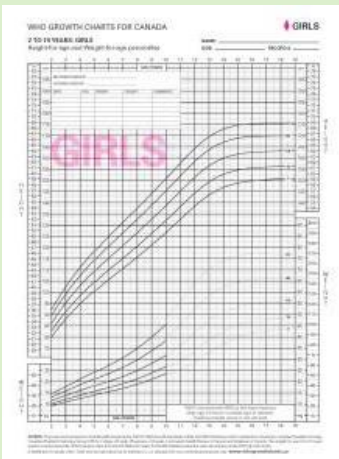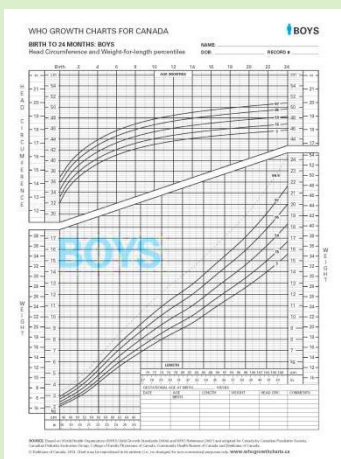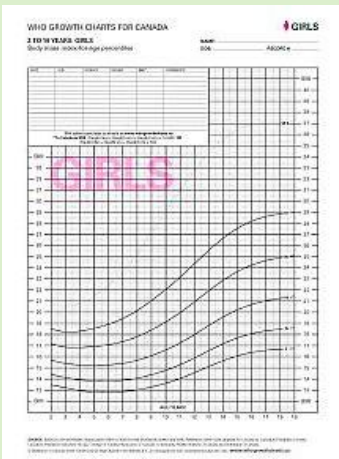**The WHO Growth Reference 2007 Charts:**

- take into account the obesity epidemic by including data that reflect healthy growth

- BMI-for-age values suggestive of overweight (85th to 97th percentile) and obesity (>97th percentile) 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

WHO Growth Charts for Canada are available to download from ***www.whogrowthcharts.ca***.

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

Table 1: Growth Charts for the Primary Health Care Setting

Birth-24 Months*	2-19 Years*
Length-for-age and Weight-for-age	Height-for-age and Weight-for-age
Head circumference and Weight-for-length	Body Mass Index (BMI) -for-age

* The Growth Charts in Table 1 have been adapted for Canada with permission from the World Health Organization.

Two versions of the WHO Growth Charts for Canada are available with alternative percentile choices:

Set 1: 3rd, 15th, 50th, 85th, 97th and the 99.9th centile for Birth-24 months, Weight-for-length; and 2-19 years, BMI-for-age (as shown in Table 1).

Set 2: 3rd, 10th, 25th, 50th, 75th, 90th, 97th (substituting 85th for 90th centile and including the 99.9th centile for Birth to 24 months, Weight-for-length; and 2-19 years, BMI-for-age).

Selecting the appropriate growth charts for preterm infants (<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 (<1500 g); 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[10].

- The growth of preterm infants (<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 (i.e. postnatal age in weeks – [40 weeks – gestational age in weeks]) until 24 or 36 months of age[11].
    - For example, at 12 weeks postnatal age, an infant born at 30 weeks gestational age would be 12 – [40-30] or 2 weeks corrected postnatal age.
  - Alternate charts to assess growth of preterm and low birth weight infants in the neonatal intensive care unit or early post-discharge setting include:
    - Fenton's[12] Preterm growth chart for tracking growth from 22 weeks gestational age to 10 weeks post term.
- 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[13, 14, 15, 16].

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 that were studied to develop that growth chart. These percentile curves can be used to identify the child's growth relative to other children of similar age and sex. For example, if a child's weight is on 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 and z-scores 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 weight-for-length, BMI, length/height, and weight measurements follow consistently along a percentile curve.

- It can be normal for children to change one to two percentile curves for both weight and length during the first two to three years of life[17]. The 50th percentile, or "average", is not the goal for each child, as most children have the genetic potential to be taller or shorter, and heavier or lighter, than average. More importantly children's weight should be proportional to their length/height – proportionality is evaluated by considering the child's weight-for length or BMI. Proportionality is generally defined at being within the 3rd to 85th percentiles (within -2 to +1 z-scores).

- 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 pubertal onset is variable, a sharp incline or decline in growth, or a growth line that remains flat, is potentially a sign of growth disturbance.

    – Serial measurements showing unexpected movement downwards on the curves from a previously established rate of growth could be a sign of failure-to-thrive (FTT)[18, 19, 20, 21].

    – Although crossing two centile curves has been used historically to identify growth that needs further examining, this method has not been validated as a method of identifying growth problems[20] and could lead to delayed investigation of abnormal growth. Changes in height/weight-for-length/BMI percentiles should be assessed before crossing two percentile lines, particularly in children and adolescents.

- Unexpected movement upwards on the weight-for-length or BMI curves may be a sign of development of overweight or obesity.
- Consider the following factors when evaluating growth that does not follow a healthy pattern for all children: parental height, nutritional intake, and presence of chronic illness or special health care needs (i.e. Down's Syndrome, Cerebral Palsy etc), and for infants also consider gestational age, birth weight, and type of feeding (breast or formula).

Using Body Mass Index-for-Age

- BMI is defined as weight in kilograms divided by height in meters squared:
BMI= Wt (kg) ÷ (Ht (m)^2).

- BMI correlates with body fat; pediatric BMI has been linked to future obesity and adverse health outcomes[22]. BMI decreases in later infancy and remains relatively stable from ages 2 to 5 years then increases through childhood and adolescence. The point of maximal leanness or minimal BMI has been called the adiposity or BMI rebound and is reflected in the BMI-for-age charts[23]. Early adiposity rebound before the age of 5.5 years is associated with an increased risk for obesity later in life[24, 25].

- Unlike adults, age-related increases in BMI are associated with increases in both fat mass and fat free mass[26]; the extent to which each component contributes to changes in BMI depends on age, sex and pubertal maturation of the child[27]. Other factors such as co-morbidities, 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 better than weight-for-length at assessing adequacy of feeding, and under- and overweight in infants and toddlers under two years of age.

How will growth of the breastfed vs. non-breastfed baby differ when plotted on the WHO Growth Charts compared to the CDC Growth Charts?

Breastfed infants tend to grow more quickly than non-breastfed infants in the first six months and tend to grow more slowly in the second six months of life[28]. Since 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 6 to 12 months, compared to the CDC charts.

- 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 children classified as stunted, overweight and obese after that time, compared to the CDC charts given the differences in feeding method and selection of healthy non-disadvantaged children[29]. Assessing the pattern of weight, linear growth and weight relative to length and whether the infant is breast or non-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 5 to 19 years. The recommended cut-off criteria for determining overweight and obesity status are different for children birth to five years and 5 to 19 years of age.

Table 2: Cut-off Points

Birth to 2 years

Growth Status	Indicator	Percentile	z-scores (approximate values)
Underweight	Weight-for-age	<3rd	<-2
Severely underweight	Weight-for-age	<0.1[st]	<-3
Stunted[b]	Length-for-age	<3rd	<-2
Severely stunted	Length-for-age	<0.1[st]	<-3
Wasted[c]	Weight-for-length	<3rd or ≤89% IBW[d]	<-2
Severely wasted	Weight-for-length	<0.1[st]	<-3
Overweight[e]	Weight-for-length	>97th	>2
Obese[f]	Weight-for-length	>99.9[th]	>3
Head Circumference[g]	Head Circumference-for-age	<3rd or >97th percentile	<-2 or >2

Two to 19 years

Growth Status	Indicator	2-5 years		5-19 years	
		Percentile	z-scores (approx.)	Percentile	z-scores (approx.)
Underweight	Weight-for age[a]	<3rd	<-2	<3rd	<-2
Severely underweight	Weight-for age[a]	<0.1[st]	<-3	<0.1[st]	<-3
Stunted[b]	Height-for-age	<3rd	<-2	<3rd	<-2
Severely stunted	Height-for-age	<0.1[st]	<-3	<0.1[st]	<-3
Wasted[c]	BMI-for-age	<3rd	<-2	<3rd	<-2
Severely wasted	BMI-for-age	<0.1[st]	<-3	<0.1[st]	<-3
Overweight[e]	BMI-for-age	>97th	>2	>85th	>1
Obese[f]	BMI-for-age	>99.9[th]	>3	>97th	>2
Severely obese	BMI-for-age	N/A[h]	N/A[h]	>99.9[th]	>3

[a] **Weight-for-age -** Use BMI-for-age instead. Weight-for-age alone is not recommended as a nutritional parameter for any age, and especially beyond 10 years of age because of the wide variability in age at onset of puberty and its associated changes in body composition. When weight-for-age alone is used to screen for over nutrition, 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 that are short or stunted would appear to be normal. The WHO recommends that weight continue to be measured for children beyond 10 years of age, for the purpose of calculating, plotting and monitoring BMI-for-age[11]. Similarly, BMI-for-age should also be interpreted in the context of height as a child who is declining for both height and weight centiles may have a preserved BMI.

[b] **Stunted** - The infant or child may be short because parents are short (3% of normal children are expected to have heights less than the 3rd percentile) or they may be stunted because of long-term malnutrition, delayed maturation, chronic illness or a genetic disorder/syndrome or abnormal prenatal environment.

[c] **Wasted** - May be normal as 3% will be expected to have weights-for-age and BMI less than the 3rd percentile, or it may be indicative of recent malnutrition, dehydration or a genetic disorder. Traditional measures of underweight (weight-for-age, weight-for-length or % IBW) continue to be recommended for children under 2 years of age until validity of using BMI–for-age in this age group has been demonstrated.

[d] **% IBW** - Percent ideal body weight: plot length or height on growth chart to identify length-for-age percentile. Locate ideal body weight as the weight at the same percentile as the length, for the same age and gender. Calculate % IBW= actual weight÷ideal body weight x 100.

[e] **Overweight** - Further evaluation necessary. Look for co-morbidities and possible causes. 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. Some children in this category are not overweight - weight-for-length and BMI cut-offs do not take body composition and high muscle mass into account. The cut-offs recommended for the older children (5 to 19 years) coincide at 19 years old with the adult cut-off for overweight (ie, BMI of 25 kg/m^2).

[f] **Obese** – Usually 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 diets. The cut-offs recommended for the older children (5 to 19 years) coincide at 19 years old with the adult cut-off for obesity (ie, BMI of 30 kg/m^2).

[g] **Head Circumference** - Reflects brain size and is used for screening for potential health, nutrition or developmental problems amongst infants from birth to 2 years old.

[h] **N/A** - Not applicable for this age group.

Accurate weighing and measuring

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

Accurate measurements have three components:

- A standardized measurement technique
- High quality equipment which is regularly calibrated and accurate and
- Trained measurers who are consistent and precise in their technique[24,30].

Accurate measurement equipment and techniques

Weighing infants[31]:

- 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 or 10 g increments and easily "zeroed" and recently calibrated. The "average weight" feature is desirable on an electronic scale to accommodate those infants who do not remain still during the weight taking.

Measuring infant length[31]:

- Use calibrated length board with fixed headpiece and movable foot piece which is perpendicular to the surface of the table

- Two trained people are needed to get an accurate measurement

- Measure infant without shoes and wearing light underclothing or diaper

- The infant should be placed on his/her 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
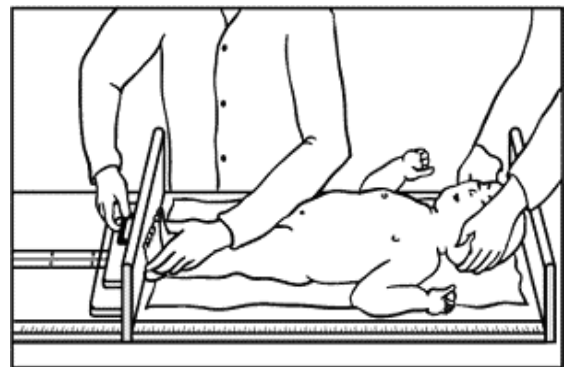
- Measure length to nearest 0.1 cm.

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Measuring head circumference[31]:

- Position the tape just above the eyebrow, above the ears and around the biggest part on the back of the head

- Use a clean, flexible, non-stretchable tape

- Measure to nearest 0.1 cm.

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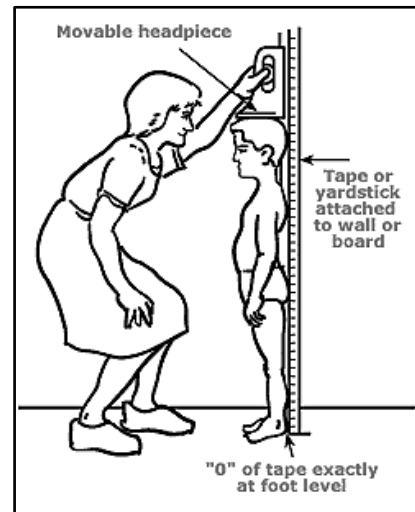
Weighing children and adolescents[31]:

- A child older than 24 to 36 months is weighed standing on a beam-balance or digital scale, provided they can stand on their own
- 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 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 wheel chair scales.

Measuring height in children and adolescents[31]:

Young children from 24 to 36 months may have either length or height measured. Children with physical disabilities (unable to stand) may require length measured using a recumbent board or may require the usage of other segment length measurements[32].

- Measure height for children over 24 months who can stand unassisted
- Unless using a wall-mounted digital stadiometer, a stadiometer for height measurements requires:
    - a wall mounted vertical board with an attached metric rule
    - a horizontal headpiece that can be brought into contact with the superior part of the head

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- Child or adolescent stands against the stadiometer without shoes, with heels together, legs straight, arms at sides, shoulders relaxed
- Ensure that the child is looking straight ahead
- Bring 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 like sitting heights, segmental lengths, arm span, girths and skin folds require special skills and equipment.

To access the 2014 WHO Growth Charts for Canada and the following resources visit *www.whogrowthcharts.ca*.

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