

PROTOCOL

Subject/Title: Growth Chart Use	Date: March 18, 2014
Authority: Nutrition Services	Date Revised: April 23, 2018, February 13, 2023
Classification: Protocol	Page: Page 1 of 16

OBJECTIVES

The objective of the protocol is to optimize [growth monitoring](#) practices and child health outcomes by providing guidelines to ensure accurate and reliable plotting, interpretation of growth, and appropriate actions using recommended growth charts for infants, children and adolescents (birth to 19 years of age). The growth charts that can be used in Alberta Health Services (AHS): the World Health Organization (WHO) Growth Charts for Canada Set 2 (WHO Set 2) or the Canadian Pediatric Endocrine Group (CPEG) growth charts. Both growth charts are based on WHO data. The Fenton 2013 Growth Charts are used for preterm infants.

This protocol will address:

1. Growth chart selection
2. Calculations: Age and BMI
3. Plotting
4. Understanding pediatric growth assessment and growth charts
5. Interpretation of growth
6. Further assessment, monitoring and referral

Appendices to the protocol include:

Appendix A – Growth monitoring summary sheet (CPEG and WHO Set 2)

Appendix B – CPEG growth charts (© 2012)

Appendix C – Fenton preterm growth charts (2013)

Appendix D – WHO Set 2 growth charts (© 2014)

APPLICABILITY

This protocol applies to all AHS staff and students involved in childhood growth monitoring within an AHS program or at an AHS site.

BACKGROUND

Growth monitoring and promotion of optimal growth are essential components of health care for all children.¹ Serial growth measurements (e.g. weight, length/height and head circumference), and interpretation of these measurements when plotted on an age and gender-appropriate growth chart, help to confirm a child's healthy growth and development.¹ They also help in the early identification of a potential nutritional or health problem, so that action can be taken before a child's health is seriously compromised.¹

Growth charts are graphic presentations of body measurements of a population that aid in the assessment of body size, as well as the observation of patterns in growth.¹ They are used in the assessment and monitoring of individual children and in screening whole populations.¹

The WHO multicentre growth reference study data for infants and preschool children (birth to 5 years) describes ideal physiological growth and development and is considered the gold standard for children's growth.¹ This data is from an international sample of healthy children raised according to fundamental health-promoting practices, including breastfeeding.¹ The WHO data for school-aged children and adolescents (5 to 19 years) is considered the best available historical data (National Centre for Health Statistics [NCHS]), collected prior to rising obesity rates.²

In Canada, available growth charts include the World Health Organization (WHO) Growth Charts for Canada (WHO Set 1 [2010] and WHO Set 2 [2014]) and the CPEG growth charts (2012). Both the CPEG and WHO Set 2 growth charts are accepted as standard growth charts for use in AHS. The CPEG growth charts are growth curves based on the WHO Growth Charts for Canada, with modifications.² These growth charts are all adapted from the WHO multicentre growth reference study and NCHS data.²

PROCEDURE

1) Growth chart selection

a) Term infants, children and adolescents

It is important to select the appropriate growth chart and growth parameters according to a child's age and gender. If using an electronic charting system, a growth chart may be automatically selected based on the child's age and gender.

Table 1. Parameters on WHO Set 2 and CPEG Growth Charts

Age Ranges	Growth Chart/Parameters
Birth–24 Months	Birth to 24 months: boys and girls head circumference weight-for-length
	Birth to 24 months: boys and girls length-for-age weight-for-age
2 – 19 Years	2 to 19 years: boys and girls body mass index (BMI)-for-age
	2 to 19 years: boys and girls height-for-age weight-for-age

b) Preterm infants (infants born **less than 37 weeks**):

Table 2. Plotting Preterm Infants

Age Ranges	Infants Born Less Than 37 Weeks, 0 Days Gestation
Up to 0 weeks <u>corrected age</u> (term/40 weeks* <u>postmenstrual age</u>) In the neonatal or pediatric intensive care unit or early post-discharge setting	Growth chart: Fenton preterm growth chart ^{1,3,4}
0 weeks corrected age (term) up to 24 months corrected age	Growth chart: Appropriate WHO Set 2 or CPEG growth chart Plot: According to corrected age ^{**5}
After 24 months corrected age, continue to plot on the appropriate WHO Set 2 or CPEG growth chart; age no longer needs to be corrected.	

* For infants not yet discharged from the neonatal or pediatric intensive care unit, health professionals working in those settings may choose to continue plotting on the Fenton preterm growth chart until 50 weeks postmenstrual age.

** See Section 2 for an example of calculating corrected age.

Note: Preterm infants grow differently than healthy term infants¹ and may not have “caught up” to the growth of their peers by age 2. For practical purposes, including limited accuracy given the scale provided on the 2- to 19-year growth chart, postnatal/chronological age should be used to plot growth measurements after 24 months for preterm infants. In some clinical situations, the age of preterm infants may be corrected up to 36 months.

c) Infants, children, and adolescents with medical conditions:

For infants, children, and adolescents with intellectual, developmental, genetic or other conditions (e.g. Down syndrome, cerebral palsy, Turner syndrome):

- Use the appropriate WHO Set 2 or CPEG growth chart according to the child’s age and gender (See Table 1).
- Use the 2015 Down Syndrome growth charts to monitor the growth of children with Down Syndrome, found at <http://www.cdc.gov/ncbddd/birthdefects/downsyndrome/growth-charts.html>. For children ages 2–20 years with Down Syndrome, use the appropriate WHO Set 2 or CPEG BMI growth chart.

Note: These curves were carefully produced, incorporated longitudinal measures and were developed using good measurement techniques. Users should remember that the growth curves may represent current trends, but may not necessarily reflect optimal growth.

- Specific growth curves are also available for some other conditions.^{6–9} The benefits of these charts are that they were developed for specific medical conditions. The limitations of these charts are that they used small sample sizes, are based on relatively old data prior to improved nutrition care, and may not reflect newer treatments.¹ Considering these limitations, growth charts for specific medical conditions may be used by specialists/in specialty clinics in conjunction with the standard growth chart to provide further useful information in the overall growth assessment.^{6,10,11}

Note: In 2015, growth charts were developed for assessing the growth of children with Down Syndrome.⁶

Calculations: Age and BMI

d) Calculating age:

Incorrect calculation of age can be a source of error in plotting and can result in an incorrect assessment of the growth of a child.^{12,13}

i) **Term infants, children and adolescents:**

Age can be calculated using a calendar.

A child born on 27/Jan/2013 will be 8 calendar months old on 27/Sept/2013 and 9 months old on 27/Oct/2013.

If today's date were 13/Oct/2013, the child born on 27/Jan/2013 would be 8 months, 2 weeks and 2 days old.

ii) **Preterm infants:**

Corrected age can be calculated using the equations below.

Step 1:

of weeks preterm = 40 weeks – [gestational age](#) at birth ([completed weeks](#))

Step 2:

Corrected age = [postnatal/chronological age](#) (completed months and weeks)
– # of weeks preterm

Note: Although a month contains an average of 4.33 weeks, for the purpose of this calculation approximate that a month is equal to four weeks.

Example:

A baby was born preterm at 34 weeks and is now 6 months 3 weeks old (postnatal/chronological age).

Step 1: # of weeks preterm = 40 weeks – 34 weeks = 6 weeks preterm

Step 2: Corrected age = (6 months 3 weeks) – 6 weeks = 5 months, 1 week

e) Determining BMI:

To assess weight status, BMI-for-age should be determined for all children ages two years and older.⁵ BMI-for-age should be used to assess weight relative to height and to screen for possible wasting, overweight and obesity.¹ The World Health Organization recommends against the use of weight-for-age after age 10 years, as “it does not distinguish between height and body mass in an age period when many children are experiencing their pubertal growth spurt.”¹ In certain circumstances, short-term changes in weight may impact linear growth and reflect disease activity. To understand the full growth picture, clinicians may choose to track weight-for-age and height-for-age as complementary measures along with BMI-for-age over age 10.²

A child's [BMI value](#) needs to be determined prior to plotting on the 2 to 19 year: body mass index (BMI) for age growth chart.

i) **Paper growth charts:**

- BMI can be calculated as follows using a standard calculator:
 - $\text{BMI} = \text{Weight (kg)} \div \text{Height (cm)} \div \text{Height (cm)} \times 10\,000$
This equation can be found on the growth charts.
 - The BMI value should be rounded to one decimal place.^{14,15}
- A BMI wheel can also be used to determine BMI using the process below.
 - Locate the child's weight to the nearest 0.1 kilogram (kg) on the top row of the wheel.
 - Keep the wheel in the same position:
 - Locate the child's height to the nearest 0.1 centimetre (cm) on the bottom of the wheel.
 - Read the BMI value.

ii) **Electronic charting systems:**

Some electronic systems calculate BMI-for-age automatically when a child's age, weight, and height values are entered.

Example:

A child's weight is 12.7 kg and height is 97.8 cm.

$\text{BMI} = 12.7 \text{ kg} \div 97.8 \text{ cm} \div 97.8 \text{ cm} \times 10\,000$ BMI = 13.277

BMI = 13.3

2) Plotting

Points of emphasis:

- Plotting should be as accurate as possible.
- [Tables 3 and 4](#) provide information regarding the plotting increments on the growth charts.
- After plotting a child's measurements, judge whether the plotted point seems reasonable (e.g. one would expect that an infant's length should not be shorter than at the previous visit) and is consistent with the child's previous visits (e.g. the child is roughly on or between the same percentile lines as before).^{12,14}
- If not, check the age calculation, measurements and/or plotting, and if necessary, re-measure the child^{1,12,14} (see [Childhood Growth Measurement – Public Health and Clinical Settings, Protocol, AHS April 4, 2014; Revised March 18, 2015](#)).

a) Plotting on paper growth charts:

Plot the recorded measurements for the current visit on the appropriate growth chart (See [Table 1](#)). It is only possible to assess trends when points are plotted for two or more visits.¹⁴

- **On the horizontal axis:** find the child's age or length, depending on the growth chart being used.
- **On the vertical axis:** find the child's weight, length/height, BMI or head circumference, depending on the growth chart being used.
- Use a straight-edge ruler or right-angle triangle to follow the child's age/measurements from the horizontal and vertical axis' to find the point on the growth chart where they intersect (See Figure 1).
- Draw a small dot at the intersecting point.

Figure 1: Plotting using a right-angle triangle



Table 3. Increments on the WHO Set 2 and CPEG Growth Charts – Birth to 24 Months

Parameter	Increments
Length-for-age	Length: Each large increment represents 5 cm. Each small increment represents 1 cm. Age: Each small increment (half month) represents approximately 2 weeks.*
Weight-for-age	Weight: Each large increment represents 1 kg. Each small increment represents 0.2 kg. Age: Each small increment (half month) represents approximately 2 weeks.*
Weight-for-length	Weight: Each large increment represents 1 kg. Each small increment represents 0.2 kg. Length: Each large increment represents 2 cm. Each small increment represents 1 cm.
Head circumference	Head circumference: Each large increment represents 2 cm. Each small increment represents 0.4 cm. Age: Each small increment (half month) represents approximately 2 weeks.*

*Although a month contains an average of 4.33 weeks, for plotting purposes, it can be assumed that each small increment (half month) on the horizontal axis for age represents approximately 2 weeks.

Table 4. Increments on the WHO Set 2 and CPEG Growth Charts – 2 to 19 Years

Parameter	Increments
BMI for-age	BMI: Each large increment represents 1 BMI point. Each small increment represents 0.2 BMI points. Age: Each small increment represents 3 months.
Height-for-age	Height: Each large increment represents 5 cm. Each small increment represents 1 cm. Age: Each small increment represents 3 months.
Weight-for-age	Weight: Each large increment represents 5 kg. Each small increment represents 1 kg. Age: Each small increment represents 3 months.

b) Plotting electronically:

Electronic systems may have the capability of automatically populating the growth chart within the electronic system. Refer to site guidelines for details on the functionality of each system.

c) Describing a plotted point:

Plotted points can be described as being on a specific percentile line (e.g. on the 75th percentile), between 2 percentile lines (e.g. between the 50th and the 75th percentile) or just above or below a percentile line (e.g. just above the 75th percentile).

Note: A slight shift in an individual child's growth pattern may be observed when switching between paper and electronic plotting due to the ability for increased accuracy with electronic plotting. If the growth pattern for a child who was previously plotted on paper, and is now being plotted electronically, appears to have shifted slightly, consider plotting the recorded lengths and weights from the previous visit(s) into a new record.

3) Understanding pediatric growth assessment and growth charts

a) Understanding percentiles:

The following percentiles are marked on WHO Set 2 and CPEG growth charts.

Table 5. Percentiles on WHO Set 2 and CPEG Growth Charts

Growth Chart	Growth Chart and Parameter	Percentiles								
		3 rd	10 th	25 th	50 th	75 th	85 th	90 th	97 th	99.9 th
CPEG	Birth to 24 Months: All growth charts							✓		
	2 to 19 Years: Height and weight for age							✓		
	2 to 19 Years: BMI for age	✓	✓	✓	✓	✓	✓		✓	
WHO Set 2	Birth to 24 Months: Head Circumference, Length and weight for age							✓		
	Birth to 24 Months: Weight for length						✓			✓
	2 to 19 Years: Height and weight for age							✓		
	2 to 19 Years: BMI for age						✓			✓

These percentile curves can be used to identify where a child plots relative to other children of the same age and sex. For example, if a child's weight is on the 75th percentile, it means that 75 of 100 children (75%) in the WHO growth studies weighed less and 25 (25%) weighed more.

Despite many parents' perceptions, the 50th percentile is not the goal for each child as children can have the genetic potential to be taller, shorter, lighter, or heavier than average.^{11,16}

b) Core growth messages:

Pediatric growth assessment and counselling is based on the Core Growth Messages¹⁷ outlined below:

- Growth assessment is a health **screening** tool.¹⁷ A growth assessment alone is not a diagnostic tool and should always be used in conjunction with other information.
- Growth is one sign of **general health**. Growth monitoring is the single most useful tool for assessing health and nutritional status in children.¹ However, growth should be considered along with other factors when determining a child's overall health. Children of all ethnic backgrounds have similar potential for growth when raised in environmental conditions favourable to growth.¹
- Growth patterns are assessed for the **individual**.¹⁷ In most children, height and weight measurements usually follow consistently along a 'channel', on or between the same percentile line(s).¹ Some shifts in a child's growth pattern may be expected in the first two years of life and during puberty.¹
- Growth reflects **family** growth patterns. A child's size and growth rate are influenced by factors such as parental stature and special genetic conditions, and also by gestational age, birth weight, chronic illness, food intake, and activity level.
- Growth pattern **over time** is more important than one single measurement.¹⁷ Measurements taken one time only describe a child's size and do not provide adequate information to assess a child's growth. A series of weight and length/height measurements over time are required to reflect a child's growth pattern.¹

4) Interpretation of growth

Points of emphasis:

- Growth pattern over time is more important than one single measurement.¹⁷
- Considering all growth measurements (length/height, weight, weight-for-length, BMI, head circumference) collectively will allow for a more complete picture of a child's growth.¹⁴
- An incline or decline from a child's previously established growth pattern can signal a growth concern and requires further assessment. This is especially the case if the change is nearing a cut-off point (See [Tables 6 and 7](#)) or is a sharp change.¹⁴
- Movement across percentiles, especially if nearing a cut-off point (See [Tables 6 and 7](#)), can signal a growth concern and requires further assessment.¹⁴
- A growth pattern that remains flat is usually a growth concern and requires further assessment.¹⁴
- Cut-off points (See [Tables 6 and 7](#)) provide guidance for further assessment, monitoring or referral. They should **not** be used as diagnostic criteria.¹

a) Growth related to mode of feeding:

Both the WHO Set 2 and CPEG growth charts are based on data reflecting the growth of infants who were primarily breastfed and raised under optimal health conditions. After the first few months of life, non-breastfed infants may show an upward shift in growth on the WHO set 2 growth charts.^{11,18,19} A child's growth pattern and whether they are breast or non-breastfed should be considered prior to suggesting any changes in feeding.¹¹

b) Shifts in growth pattern:

Historically, crossing two percentile lines was used as a signal of a potential growth concern, however, this criterion is not supported by evidence in terms of being a sensitive or specific indicator of a growth concern.²⁰ Depending on which two percentile lines are crossed, the magnitude of the growth change needed to cross two percentile lines can vary substantially. In addition, crossing percentile lines is common over the first two years of life and during puberty.¹

Although movement across a particular number of percentile lines can not be identified as a specific indicator of a growth concern, the following situations require further assessment:

- inclines or declines on the growth chart from a child's previously established growth pattern, especially if the change is nearing a cut-off point (See [Tables 6 and 7](#)) or is a sharp change;
- a growth pattern that shows movement across percentiles, especially if the movement is nearing a cut-off point (See [Tables 6 and 7](#)); and
- a growth pattern that remains flat.

c) Using cut-off points:

Cut-off points are specified percentiles that provide guidance for further assessment, monitoring or referral.¹ They should **not** be used as diagnostic criteria.¹

i) **Head circumference:**

For children birth to 24 months of age, there is generally no cause for concern if a child's head circumference-for-age is on or above the 3rd percentile and on or below the 97th percentile and growth is consistent with the child's previous growth pattern.

Head circumference-for-age that is either below the 3rd percentile and growing slowly, **or** above the 97th percentile and growing rapidly **may** be a normal growth pattern, however, it signals a need for further assessment, monitoring or referral.^{21,22}

ii) **Weight-for-length:**

For children birth to 24 months of age, there is generally no cause for concern if a child's weight-for-length is at or above the 3rd percentile and at or below the 97th percentile, and growth is consistent with the child's previous growth pattern.

Weight-for-length below the 3rd percentile or above the 97th percentile **may** be a normal growth pattern, however, it signals a need for further assessment, monitoring, or referral.

iii) **BMI-for-age children 2 to 5 years of age:**

For children 2 to 5 years of age, there is generally no cause for concern if a child's BMI-for-age is on or above the 3rd percentile and on or below the 97th percentile and growth is consistent with the child's previous growth pattern.

BMI-for-age below the 3rd percentile or above the 97th percentile **may** be a normal growth pattern, however, it signals a need for further assessment, monitoring, or referral.

BMI-for-age children 5 to 19 years of age:

For children 5 to 19 years of age, there is generally no cause for concern if a child's BMI-for-age is on or above the 3rd percentile and on or below the 85th percentile and growth is consistent with the child's previous growth pattern.

BMI-for-age below the 3rd percentile or above the 85th percentile **may** be a normal growth pattern, however it signals a need for further assessment, monitoring, or referral.

Further assessment:

When further assessment is indicated, it is important to consider the many factors that could be affecting growth. These factors may include the child's overall health, presence or recent history of acute or chronic illness, nutrition (e.g. breast or formula feeding, formula preparation), feeding relationship, stress or change in child's life, family growth patterns, availability/access to healthy foods, physical activity and sleep.

Refer to **Appendix A: Growth Monitoring Summary Sheet** for an outline of these discussion points and information on monitoring and referral.

Table 6. Cut-off Points and Key Messages for Children Birth to 24 Months^{14,23}

The growth concern related to each cut-off point is for health professional reference only. The key messages for families (right-hand column) provide language for use with clients. Growth measurements on or between identified cut-offs and consistent with previous growth pattern would likely indicate a normal growth pattern.

Indicator	Percentile cut-off point	Growth concern for health professional reference only	Key messages for families
Weight-for-age	<3	Possibly underweight	Weight may be low
Length-for-age	<3	Possibly stunted	Length may be low
Weight-for-length	<3	Possibly wasted	Weight may be low
	>97	Possibly overweight	Weight may be ahead of length
	>99.9*	Possibly obese	
Head circumference-for-age	<3	Microcephaly	Head circumference is small
	>97	Macrocephaly	Head circumference is large

* The extreme outer percentile line (99.9th percentile) is not displayed on the CPEG growth charts.²

Table 7. Cut-off points and key messages for children 2 to 19 years^{14,23,24}

The growth concern related to each cut-off point is for health professional reference only. The key messages for families (right-hand column) provide language for use with clients. Growth measurements on or between identified cut-offs and consistent with previous growth pattern would likely indicate a normal growth pattern.

Indicator	Percentile cut-off point		Growth concern for health professional reference only	Key messages for families
	2-5** years	5-19 years		
Weight-for-age*	<3		Possibly underweight	Weight may be low
Height-for-age	<3		Possibly stunted	Height may be low
BMI-for-age	<3		Possibly wasted	Weight may be low
	>97	>85	Possibly overweight	Weight may be ahead of height
	>99.9***	>97	Possibly obese	
	—	>99.9	Possibly severely obese	

* There are no cut-offs for interpretation of weight-for-age after 10 years of age; BMI-for-age cut-offs can be used as a guide to assist with assessment of growth.¹

** Up to but not including 5 years of age¹¹

*** The extreme outer percentile line (99.9th percentile) is not displayed on the CPEG growth charts.²

5) Further assessment, monitoring and referral

Appendix A – Growth Monitoring Summary Sheet provides key messages for describing a child's growth pattern to families and identifies appropriate actions to take in response to potential growth concerns. Health professional judgment is required along with this information to determine the best course of action for an individual child.

Definitions:

Body mass index (BMI): an index of weight and height; is defined as body weight in kilograms divided by height in meters squared.¹¹ When calculating BMI for young children, the following equation can be used:

$$\text{BMI} = \text{Weight (kg)} \div \text{Height (cm)} \div \text{Height (cm)} \times 10\,000.$$

This equation can be found on the CPEG growth charts.

BMI-for-age: refers to the plotting of BMI according to age on gender-specific charts. This is done because adiposity varies with age and gender during childhood and adolescence. BMI-for-age is used continuously from age two to adulthood as a predictor of health risks.¹¹

Chronological age: See postnatal age.

Completed months/weeks: used in corrected age calculations. It is calculated by determining how many “full” or “complete” months or weeks of age a child has completed.

Corrected age: for preterm infants (less than 37 weeks, 0 days gestation), the age of the infant from birth minus the number of weeks born before 40 weeks of gestation.^{1,25}

Gestational age: used to describe the age of a fetus or newborn infant.²⁵ It is calculated according to the time elapsed between the first day of the last normal menstrual period and the day of delivery.²⁵

Growth monitoring: the serial weighing and measuring of the length/height (and head circumference if ≤ 24 months old) of a child and graphing the measurements on a growth chart.^{1,26}

Head circumference: reflects brain size and is used for screening for potential health, nutrition or developmental problems.¹¹

Height-for-age: reflects a child’s height compared to their age.

Length-for-age: reflects a child’s length compared to their age.

Macrocephaly: refers to large head size and is commonly defined as a head circumference more than two standard deviations above the mean,²² which corresponds approximately to the 97th percentile on the CPEG growth charts. The causes are numerous and include normal familial growth patterns, hydrocephalus, malformations, and genetic, metabolic, and other disorders.²²

Microcephaly: refers to small head size and is most often defined as a head circumference more than two standard deviations below the mean,²² which corresponds approximately to the 3rd percentile on the CPEG growth charts. Microcephaly may be due to chromosomal abnormalities, prenatal exposure to toxins, maternal infections and chemical agents, or an infection, trauma, metabolic disorder or anoxia during infancy.^{27,28}

Plotted point: the plotted point on a graph where a line extended from a measurement on the horizontal axis (e.g. age) intersects with a line extended from a measurement on the vertical axis (e.g. weight).¹⁴

Postmenstrual age: used to describe the age of an infant; it is equivalent to gestational age plus postnatal (chronological) age.²⁵

Postnatal age: (also known as chronological age) is used to describe a child's age after birth. It is calculated according to the time elapsed after birth.²⁵

Weight-for-age: reflects body weight compared to a child's age.¹⁴

Weight-for-length: reflects a child's weight in proportion to attained growth in length.¹⁴

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