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CURRENT ISSUES

The Inside Story

Growth Monitoring of Infants and Children Using the 2006 World Health Organization [WHO] Child Growth Standards and 2007 WHO Growth References

QUESTIONS AND ANSWERS FOR HEALTH PROFESSIONALS



**Written in March 2010; Updated
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Introduction

In 2010, four leading national health professional associations released a collaborative public policy statement – *Promoting Optimal Monitoring of Child Growth in Canada: Using the New WHO Growth Charts*. Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada and Community Health Nurses of Canada have recommended that the 2006 WHO Child Growth Standards and the 2007 WHO Growth Reference charts now be used to monitor the growth of Canadian children (1). This recommendation updates the 2004 Collaborative Statement with respect to which growth charts should be used to monitor the growth of infants and children (2).

To support the implementation of these new growth monitoring tools, this edition of Current Issues addresses many of the frequently asked questions that arose during the review process of the updated Collaborative Statement.

Why track children's growth on a routine basis?

Growth monitoring helps the health care provider determine whether a child is growing as expected or if there are potential growth problems. Disturbances in health and nutrition in infants and young children, regardless of the cause, almost always affect their growth (3). Monitoring a child's growth also provides an excellent opportunity for health care providers to provide anticipatory guidance to parents/care givers that supports the

development of positive habits to promote healthy growth and development.

Which charts should be used to monitor the growth of infants?

Both breastfed and non-breastfed infants from birth to 5 years should be monitored using the 2006 WHO Child Growth Standards. These WHO charts were constructed based on the growth of healthy breastfed infants nurtured according to current Canadian (4) and international (5) nutrition and health recommendations, and clearly establish the breastfed infant as the normative model for growth and development. These growth charts represent the best description of physiological growth for children from birth to five years of age. They embody optimal growth and, as such, depict the rate of growth that should serve as a goal or prescription for all healthy Canadian infants and children to achieve, regardless of ethnicity, socioeconomic status, and type of feeding.

When should discussion take place about changes in a child's growth pattern?

Discussion of a child's growth pattern should be initiated as early as the first well-baby visit and continue at each visit thereafter so that it becomes a routine part of care. This provides the opportunity for health professionals to provide positive feedback on a child's growth and anticipatory guidance on feeding for the upcoming developmental period. Such an approach helps to build rapport and trust between the care giver and the health professional, so if and when there is need to



The Global Resource
for Nutrition Practice

CURRENT ISSUES

The Inside Story

take corrective action for growth faltering, the ground work has already been laid for that discussion.

How will the growth pattern of non-breastfed infants differ from the growth pattern of breastfed infants when the WHO Child Growth Standards are used?

Breastfed infants gain weight more quickly in the first 1 to 6 months than non-breastfed infants and more slowly in the second 6 months to 1 year (6). Since the WHO Child Growth Standards have been constructed based on the growth of infants that have been primarily breastfed, there is a shift upwards in the weight-for-age percentiles during the first year. When non-breastfed infants' growth is plotted on these charts, and observed to be below the norm, this may be misinterpreted as growth faltering. Therefore, health care professionals will need training to understand that the pattern of weight and linear growth and weight relative to length should be carefully considered before suggesting a change in feeding for either breastfed or non-breastfed infants.

What should the practical nutrition recommendations be when a health professional sees a 4 month-old non-breastfed infant growing above the upper centile for weight-for-age?

Within the first 1- 6 months, the weight of non-breastfed infants will generally track lower on

the WHO growth curves than breastfed infants. In this case, if the infant's weight has been consistently above the upper growth curve of weight-for-age, this may be the baby's normal growth trajectory. Consider the position of the baby's length on the growth chart and where it is relative to the upper centile for length-for-age. On the other hand, obtaining a history of amounts and frequency of feeding can help determine if the baby is being overfed. The table below is a general guideline on the daily intake of infant formula for a 4 month-old (7). Individual infants will vary in the amounts consumed.

If it appears that the baby is being overfed, perhaps the caregiver may be misinterpreting fussiness as hunger, whereas it could indicate a need for a diaper change or perhaps the infant may want to be held and cuddled. The health professional should also inquire about how the formula is being reconstituted if a liquid concentrate or powdered infant formula is being used to ensure proper proportions of formula concentrate and water are used. Also ask whether anything is being added to the formula bottle such as infant cereal or whether other fluids or foods are being given.

Age	Weight Range (kg)	Estimated Energy Needs (EER)	Volume of Formula (at standard dilution) needed to meet EER
4 months	5.0 – 8.8	400 – 740 kcal/day	600 – 1100 mL/d or 20 – 36 oz/d



*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

Do the WHO Child Growth Standards replace currently existing “ethnic” growth charts?

The varied cultural and ethnic background of the sample population used to develop the WHO Child Growth Standards, and the striking similarity in growth between sites included in the study, are relevant not only to growth monitoring in the global community, but also for the multicultural mix of Canada’s children (8). Including data from multiple countries improves the estimate of variability of physiologic growth. An important finding from the WHO Multi-centre Growth Reference Study [MGRS] was that, in spite of differences in racial and ethnic background, there were minimal differences in the rates of linear growth observed among the 6 countries. After adjusting for age and sex, the variability in the measured length of participants from birth to 24 months was overwhelmingly due to differences among individuals (70% of the total variance) and only minimally due to differences between countries (3% of the total variance)(9). This strengthens the evidence that children of all ethnic backgrounds have similar potential for growth when raised in environmental conditions favourable to growth, particularly smoke-free households, access to health care, and good nutrition.

Can the WHO Growth Standards be used to monitor the growth of Chinese children?

Countries were invited to participate in the MGRS, and the final decision about which study sites to include was based on the availability of epidemiological data from other sources within the applying country, the geographic distribution of the sites, the presence of collaborative institutions able to implement the MGRS protocol and the availability of national or international funds (9). India was chosen as the geographical study site for Asia. While not all races were sampled in the MGRS, the fact

that only small differences in growth were associated with cultural/racial background would suggest that the trends in growth of children from non-sampled cultures, such as the Chinese culture, should be similar. One international standard for assessing the growth of all children exemplifies the compelling message that when nutritional, health, and key environmental needs are met, children around the world grow very similarly (5).

Do the WHO growth charts apply to Canada's First Nations, Inuit and Métis population?

The Canadian Paediatric Society First Nations, Inuit and Métis Health Committee provided feedback on the Collaborative Statement as part of the review process and concluded that the WHO Growth curves are applicable to the First Nations, Métis, and Inuit population for the same reasons that they apply to other cultural groups. The Committee has since retired its past position statement on growth charts for First Nations, Inuit and Métis populations. They have suggested three issues that may arise in the application and interpretation of the growth charts with this population group.

- a. Practitioners should recognize that in interpreting the WHO Growth Charts, a larger number of First Nations children will be “moved up” on the growth curve causing them to be classified as obese or overweight, whereas previously they would have been borderline normal in weight or BMI.
- b. Secondly, the new WHO curves may cause problems with the diagnosis of Fetal Alcohol Spectrum Disorder [FASD] that is based on growth retardation. The cut-off currently is the 10th percentile line.
- c. There will be a need for multiple growth charts in the nursing stations and health



*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

centres. Previously only one chart up to 3 years was needed, then another one for 3 years onwards. Having more growth charts may make it more difficult to track growth and require more paper in the medical chart.

Why have the WHO charts used different percentile lines than the CDC charts?

Distribution of anthropometric indices on growth charts can be expressed in terms of percentiles (centiles) or z-scores (standard deviation scores; SD). In developed countries, the vast majority of children fall between the 3rd and 97th percentiles, corresponding approximately to ± 2 SD from the median. These cut-offs define the central 95% of the reference distribution as the “normality” range. Therefore, in presenting height and weight data to describe the growth of children from relatively well-nourished populations, percentile distributions are most often used. In addition, percentiles are easy to interpret and explain to caregivers (10). The 3rd, 10th, 25th, 50th, 75th, 90th, and 97th percentiles were displayed on the CDC clinical charts.

Towards the outer “extremes” of the reference distribution there is very little change in percentile values, when there is in fact substantial change in absolute weight or height status. As a result, percentiles are less useful in describing the extremes of the distribution. As an example, the weight-for-age percentile would change very little, despite a 30 kg weight gain, for an obese 14-year-old girl whose weight increased from 95 kg (99.3rd percentile) to 110 kg (99.7th percentile) to 125 kg (99.9th percentile). On the other hand, z-scores, unlike percentiles, are normally distributed and the same interval of z-score values corresponds to similar changes in height or weight, regardless of which part of the distribution the values fall in. For the same 14-year-old girl, the corresponding z-scores would better reflect the magnitude of the changes (weight-for-age z-score = +2.47; +2.82;

+3.08, respectively). For this and other reasons, the WHO has recommended use of z-scores over percentiles (and percent of the median) for many years (11).

The new WHO charts have been released with the growth curves labelled using either z-scores or percentiles. The percentiles displayed on the Canadian-WHO charts are those that correspond almost exactly with z-scores of 0, ± 1 , 2, and 3 (i.e. 0.1st, 3rd, 15th, 50th, 85th, 97th, 99.9th centiles). While the WHO charts with z-scores included curves for ± 3 SD, the corresponding charts with percentiles omitted the corresponding outer percentile curves. The Canadian-WHO charts include the 0.1st and the 99.9th percentiles to improve the ability to detect the extremes of underweight or obesity.

How much growth percentile “surfing” is considered normal?

With the exception of the first 2 years of life when channel “surfing” may be normal, and during puberty when the age at onset is variable, a sharp incline or decline in growth or a growth line that remains flat are suggestive of a problem. Serial measurements showing unexpected movement downwards on the curves from a previously established rate of growth could be a sign of failure-to-thrive or growth failure (12,13,14,15). Likewise, unexpected movement upwards on the weight curves may be a sign of development of overweight or obesity. Whether or not these situations actually represent a risk depend on where the change in growth pattern began and which direction the change is headed. A shift toward the 50th centile is possibly a good change, whereas a shift away from the 50th centile may signal a problem (16).

Historically, serial measurements showing unexpected crossing of 2 or more major centiles downwards or upwards from a previously established rate of growth have been considered reflective of failure-to-thrive (growth failure)(14,15), or rapid growth,



The Global Resource
for Nutrition Practice

CURRENT ISSUES

The Inside Story

respectively. This concept arose in the UK where the chosen percentiles depicted on the growth charts were evenly spaced (9 percentile curves spaced two-thirds of a SD score apart, i.e. 0.4th, 2nd, 9th, 25th, 50th, 75th, 91st, 98th, 99.6th percentiles), so that crossing any 2 percentiles had similar meaning. These criteria do not apply to the WHO growth charts. While the WHO and CDC charts both have 7 major centiles, measurements on the inner curves of the WHO charts (3rd, 15th, 50th, 85th, 97th) are farther apart than on the inner curves of the CDC charts (10th, 25th, 50th, 75th, 90th). Waiting for a child to cross 2 major centiles on the WHO charts would result in a child experiencing a greater loss or gain of weight or length/height before being identified as a problem, than when the CDC charts were used.

The shape of BMI-for-age curves is somewhat different than for other growth indices in that BMI-for-age begins to **decline** after about 1 year of age and continues falling until it reaches a minimum around 4-6 years of age. BMI-for-age begins a *gradual increase* after 4-6 years of age, continuing through childhood and adolescence. The rebound or increase in BMI that occurs after it reaches its lowest point is referred to as "adiposity" rebound. This is a normal pattern of growth occurring in all children. Research has shown that an early "adiposity" rebound, (i.e. an increase in BMI before 4-6 years old) is associated with obesity in adulthood. This early adiposity rebound would be noticed as a child's BMI moving upwards on the BMI-for-age curves before age 4-6 years.

What differences can be expected when making the transition from plotting a child's growth on the CDC chart to using the WHO chart for monitoring growth?

For children near the outer extremes of the growth curves, a switch to the WHO growth charts may result in a change in their previous classification of growth status compared to

when they were plotted on the CDC charts. Health care professionals will need to familiarize themselves with the underlying differences between the CDC and WHO charts in order for them to help children and parents understand whether this change is significant or not. A more complete discussion of the differences in the charts can be found in the full Collaborative Statement (1).

The WHO charts provide a wider range of available charts by age for younger children. The transition to an older age WHO growth chart occurs at 5 years of age, compared to 2 years or 36 months for the CDC charts.

Why does the Weight-for-Age Growth Chart end at age 10 rather than being extended to 19 years as with the Height-for-Age and BMI-for-Age Charts?

The WHO chose to stop weight-for-age charts at age ten years on the basis that it does not distinguish between height and body mass in an age period where many children are experiencing their pubertal growth spurt. Pubertal children may appear to have gained excess weight or be overweight when looking solely at the weight-for-age chart, when in fact they may have undergone a growth spurt and are now tall and at an appropriately heavier weight. At the other extreme, children with weights that are average for their age but who are short or stunted and who have not started their pubertal growth spurt would appear to be normal on a weight-for-age chart, when in fact they are overweight for their height. The WHO recommends that weight continue to be measured for children beyond ten years-of-age, but solely for the purpose of calculating, plotting and monitoring BMI-for-age (1).

The Canadian Pediatric Endocrine Group (CPEG) released a position statement on the WHO growth curves, and subsequently their own set of growth charts (17). Although their growth charts use WHO data, they retain the percentiles used in the Centre for Disease



*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

Control charts (3rd, 10th, 25th, 50th, 75th, 85th, 97th), they did not include the additional percentiles of 0.1, and 99.9 and they extended the weight-for-age curve in the 2 – 19 years growth charts on height-for-age/weight-for-age beyond age 10 which is not recommended by the WHO.

Prior to the development of the CPEG charts, Dietitians of Canada and the Public Health Agency of Canada communicated with WHO to explore extending the weight-for-age growth curves beyond age 10. WHO indicated that new charts with extended curves beyond 10 years for tracking weight-for-age would not be considered WHO charts, for the reasons asserted previously.

What are the advantages and concerns regarding the use of BMI to evaluate children's weight status?

BMI has traditionally been used to identify overweight and obesity. There is an established body of research linking paediatric BMI to obesity and adverse health/outcomes in the future (18,19,20). BMI-for-age is an effective screening tool for identifying children who have an unhealthy amount of body fat; however, it is not a diagnostic tool. It should be used as guidance for further assessment, referral, or intervention, rather than as a diagnostic criterion for classifying children.

Use of BMI to study underweight or growth-faltering is relatively new (12,13), but there is increasing reference to its use, primarily in children aged 2-20 years (21). BMI-for-age, but not weight-for-height or percent ideal body weight, was shown to be associated with outcomes in children older than 2 years with cystic fibrosis (22). Additionally, international cut-offs for BMI to define "thinness" in children older than 2 years have recently been developed based on adult cut-offs, but still need to be validated (23). While correlation between BMI and measures of body fat has

been shown, no correlation between BMI and lean body mass has been demonstrated.

To date, most of the study of pediatric BMI has been in children 2 years and older. Although BMI charts for children under 2 years of age have been available in the United Kingdom and several European countries for a number of years, reported experience in using BMI in this young population is very limited. Several issues must be considered when using BMI in infants & toddlers less than 2 years:

- a. One question revolves around the proper response when an infant or young toddler is identified as overweight or obese by BMI. Current recommendations would not support dietary restriction because of the potential negative impact on linear and brain growth and there is concern that food may be restricted inappropriately.
- b. Accurate measurement of length in infants is challenging because, despite use of standardized techniques and equipment (24,25), infants often resist full extension of their legs and rarely lie still during the measuring process. Since length/height is squared, and appears in the denominator, inaccurate lengths can result in significant errors in BMI.
- c. BMI increases sharply as an infant rapidly gains weight relative to length in the first 6 months of life. BMI rises from approximately 13.5 kg/m² at birth to a peak of 17.5 kg/m² at 6 months, before declining in later infancy and reaching a low around 4-6 years of age. BMI then begins to increase throughout childhood and adolescence. Slight differences in the timing of the rise in BMI and subsequent fall can lead to marked shifts among the BMI curves; therefore, BMI may be difficult to interpret in infancy, and infants on the outer or



*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

extreme centiles need to be viewed conservatively.

Are there potential harms in classifying children as overweight, obese, and normal weight using BMI?

BMI is an important screening tool, but it must be integrated with other information in the health assessment. A decision about whether a child with a given BMI is truly over-"fat" or simply over-"weight" requires additional information such as their state of pubertal maturation, comorbidities, family history and ethnic background, level of physical activity, somatotype and frame size, and use of good clinical judgment (16,26). Care must be taken not to confuse heavy musculature with obesity in a minority of children (27). As with other anthropometric measures, serial measurements of BMI are more revealing and the pattern of BMI-for-age on the growth chart is more informative than the actual BMI number.

Concerns about screening and classifying children as overweight or obese center around issues of "labelling" that may lead to stigmatization, poor self-concept, disordered eating, or negative impact from parental concerns (28). These theoretical harms are inferred from studies of limited design. A recent study of the psychological impact of an "opt-in" school-based weight measurement and feedback program found that adverse effects were minimal for participating children and parents, even when feedback indicated overweight (29). A minority of participants found the feedback distressing, which highlights the importance of managing the feedback and counseling process sensitively in order to minimize embarrassment or harm to self-esteem. Health providers are encouraged to be supportive, empathetic, and nonjudgmental (29). Discussing the condition of excess weight in the context of a health problem helps to set the proper frame.

It has been suggested that the clinical terms overweight and obesity be used for documentation and risk assessment but that more-neutral terms, such as "weight", "excess weight", and BMI be used in discussing the problem with individual children and families (29).

How should health professionals approach the discussion of an abnormal growth pattern [over- or underweight] when a problem with a child's growth is identified, without being judgmental or instilling guilt?

Start with an explanation about the purpose of growth monitoring, i.e. to see if the child is growing as expected, or if there is any growth problems. Explain the points on the growth chart and describe any trends clearly and simply without using medical jargon, or if you need to use a medical term explain its meaning. If the child is growing well, be sure to say so and compliment the caregiver. When there are problems identified, it is still important to keep the conversation positive and build trust by communicating that together you and the care giver can determine what the cause of the problem is and make a plan to correct the problem (27).

For example, "You may have noticed that your child has become very thin. See how the growth line on this chart has gone sharply down. That shows that she has very low weight for her height. There are ways to help her gain weight – we can talk about some of the options if that is all right with you (27)."

The health professional may use a similar approach for a child who seems to be at risk for becoming overweight. "You may have noticed from the record we have been keeping on your child's growth that he is tending to gain weight quickly. See how the growth line on this chart has gone sharply upward. That shows that his weight is high compared with his height. If it's all right with you, can we talk about what some



*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

of the reasons might be for this weight gain and make a plan together to slow down the rate of gain.”

Many social and environmental factors can affect a child’s feeding, care and resulting growth [either under- or overweight], so it is very important to determine the most important causes of a problem for a particular child before giving advice. One needs to determine if there are direct causes such as illness, or underlying causes such as insufficient household food security; inadequate maternal and child care; insufficient health services or unhealthy environment (27). Also, since some people have larger frames and more muscle mass genetically, they may be slightly heavier and still healthy.

It is important to agree on actions to improve the child’s growth that are feasible for the caregiver. Limit the number of actions so as not to overwhelm the caregiver and encourage the caregiver to bring the child back for follow-up (27).

Why were smaller regional data sets used in assessing applicability of the WHO Child Growth Standards to Canadian Children?

While Canadian Community Health Survey (CCHS) 2.2 data includes a national sample of measured heights and weights for children from 2 to 19 years (30), there was no similar Canadian data for younger children. Because the major differences between the WHO Child Growth Standards and the CDC growth charts are evident in the first 2 years of life, the Collaborative Statement Advisory Committee felt it was important to compare the growth of Canadian children in the younger age group [birth to 2 years] to the WHO Child Growth Standards to determine how their growth tracked on these versus the CDC charts. As we identified usable electronic databases we were also able to obtain data on children up to age 5

and so they were also included in the regional data analyses (31).

What countries have adopted the WHO Child Growth Standards and WHO References?

Over 140 countries had adopted the WHO Standards (as of March 2011) and are at different stages of their implementation. Similarly, many scientific bodies have endorsed the use of the WHO Growth Standards, while United Nations agencies use them as the common yardstick to assess and monitor child growth. The shift from the old US National Center for Health Statistics (NCHS) reference charts to the new WHO Growth Standards charts has provided a unique opportunity to promote best practices. For example, many countries have started measuring height and assessing body mass index to monitor the double burden of malnutrition, that is, problems of chronic under-nutrition, like stunting, and problems of overweight and obesity (32)

The following groups/agencies have adopted the WHO Child Growth Standards (33,34,35):

- The International Pediatric Association
- United Nations Standing Committee on Nutrition
- International Union of Nutrition
- United Kingdom - UK Joint Scientific Advisory Committee on Nutrition
- Expert Group on Growth Standards of the Royal College of Paediatrics and Child Health
- United Kingdom Department of Health
- The American Academy of Pediatrics (AAP) has affirmed the recommendation from its Committee on Nutrition that the AAP support the transition to the WHO growth charts from 0-2 years, and recommend the use of these grids by



*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

pediatricians and others who care for children (35).

- The CDC also recommends that health care providers use the WHO Growth Standards to monitor growth for infants and children ages 0 to 2 years of age in the U.S. and then use the CDC growth charts to monitor growth for children age 2 years and older.
- The Academy of Nutrition and Dietetics (formerly American Dietetic Association in its position statement on breastfeeding (36) encourages public health agencies and health professionals to use the WHO Standards for growth assessment for all infants and children.

The Canadian Nutrition for Healthy Term Infants Recommendations From Birth to Six Months includes the following statement regarding routine growth monitoring for assessing infant health and nutrition – “Use the World Health Organization (WHO) Growth Charts for Canada for optimal monitoring of infant growth” (37).

It will take some time for the WHO Reference 2007 to be of widespread use, however, there are some countries already using the 5 to 19 year charts (e.g., Philippines, Malaysia, Honduras). Certain international initiatives are now using the WHO 2007 Reference, such as the European Childhood Obesity Surveillance Initiative (involving 18 European countries), the Global School-based Student Health Survey (an initiative of WHO and CDC that had been using the IOTF cut-offs for their surveys of 13-15 year-olds in multiple countries around the world), the Atomic Energy Agency coordinated multi-country projects in Asia and the Pacific entitled “Control and Prevention of Childhood Malnutrition in Asia” (The Philippines, Vietnam, China, Lebanon, Malaysia, Thailand) and another global research project entitled “Body Fat and its Relationship with Metabolic

Syndrome Indicators in Overweight Pre-Adolescents and Adolescents” (Australia, Bangladesh, Brazil, China, India, Iran, Jamaica, Lebanon, Malaysia, Mexico, Morocco) (34).

Written (February 2010) by Lynda Corby, MSc, Med, RD, FDC and Donna Secker, PhD, RD FDC and reviewed by Cheryl Armistead RN, MScN; Cindy Dalton N, MSc(A); Tanis Fenton, PhD, RD; Eunice Misskey, MEd, RD; Linda Quennell, RN, BScN.

Updated (March 2012) by Lynda Corby, MSc, MEd, RD, FDC.

Updated (November 2013) by Janice MacDonald, MEd, RD, FDC.

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*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

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*The Global Resource
for Nutrition Practice*

CURRENT ISSUES

The Inside Story

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