The Use of Growth Charts for Assessing and Monitoring Growth in Canadian Infants and Children

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

Abstract

Recent changes to commonly used growth charts, including the addition of charts for body mass index, have raised questions on which growth charts to use for Canadian children and how to apply body mass index in the paediatric population. This statement, developed collaboratively by key organizations in paediatric health care, is intended for use as a practice guideline for medical practitioners and clinical and community health (public health, home health) professionals. The desired outcome is the provision of recommendations that will promote consistent practices in monitoring growth and assessing atypical patterns of linear growth and weight gain in infants, children and adolescents.
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Résumé

Les changements récents dans les courbes de croissance usuelles, notamment l'ajout de courbes pour l'indice de masse corporelle, soulèvent la question de savoir quelles courbes de croissance on doit utiliser pour les enfants canadiens et comment appliquer l'indice de masse corporelle chez cette population. Cet énoncé, élaboré en collaboration avec des organismes clés des soins en pédiatrie, est un guide pratique à l'intention des praticiens des milieux médicaux et des professionnels des milieux cliniques et communautaires (santé publique, soins à domicile). Il a pour but de présenter des recommandations qui contribueront à promouvoir des pratiques uniformes dans la surveillance de la croissance et dans l'évaluation des modèles atypiques de croissance linéaire et de gain de poids chez les bébés, les enfants et les adolescents.
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STATEMENT OF PROBLEM

Growth disorders often go unrecognized, and therefore undiagnosed, for several reasons. Some infants and children are not routinely weighed and measured at their regular health care visits. Some children see a health care professional only for acute care and may not be measured at all. Measurements incorrectly taken, inaccurately plotted, or not plotted at all may lead to erroneous interpretation of growth patterns and unnecessary or missed referrals. A fixation on weight alone fails to address linear growth and body shape and misses the opportunity to educate children and their caregivers about atypical *and* normal patterns of growth. Growth charts used to monitor and assess growth vary across the country, as do systems for classification of body size and growth deviation. Updated versions of commonly used growth charts have recently been released and now include pediatric charts for body mass index. The availability of these new charts and systems of classification has caused uncertainty as to which are the most desirable for use in Canadian children.

EVIDENCE

This statement provides recommendations that are graded based on the available evidence (Appendix A) (1). A search of the electronic literature was conducted on three databases (MEDLINE from 1966 to June 2002, CINAHL from 1993 to June 2002, all EBM reviews) using the subject headings anthropometry, child growth, child health, failure to thrive, growth, growth charts, growth assessment, growth monitoring, height, and nutritional status. Searches were limited to the English language, and the age group 'all child'. Additional papers were retrieved from cross-checking reference lists.

INTRODUCTION

Optimal growth depends on genetic constitution, normal endocrine function, adequate nutrition, absence of chronic disease, and a nurturing environment. Fetal, infant, environmental, and maternal factors can interact to impair intrauterine and postnatal growth (2). Observed genetic differences in birthweight among various populations are small and although there are some racial/ethnic differences in growth, these differences are relatively minor compared to worldwide variations in growth due to health and environmental influences (i.e., poor nutrition, infectious disease, socio-economic status) (3-5). Few ethnic differences in weight and growth of infants and children would remain if they all lived in a similar environment and received the same optimal nutrition and care (3, 6-8).

Growth assessment is the single most useful tool for defining health and nutritional status in children at both the individual and population levels. This is because disturbances in health and nutrition, regardless of their etiology, almost always affect growth (8). Proper growth monitoring consists of serial assessments of both weight and height measurements

over time so that growth velocity can be assessed. In some situations, a single set of measurements may be used for screening populations or individuals to identify abnormal nutritional status and priority for treatment. Growth monitoring strives to improve nutrition, reduce the risk of inadequate nutrition, educate caregivers, and produce early detection and referral for conditions manifested by growth disorders (9). At the population health level, cross-sectional surveys of anthropometric data help define health and nutritional status for purposes of program planning, implementation, and evaluation. In all settings, growth monitoring is also used to assess the response to intervention (10).

The most common physical measurements for evaluating growth are recumbent length (birth to age two or three) and standing height (children ≥ age two who are able to stand straight), weight, and head circumference (until age two). Weight and height reflect the *size* of a child (i.e. large or small) and head circumference reflects brain size. Assessment of weight alone (i.e. weight-for-age) is not useful because it cannot distinguish a tall, thin child from one who is short but well-proportioned. A much better anthropometric index for determining nutritional status considers a child's weight relative to his/her height, which is a measure of shape (i.e. fatness, thinness or *wasting*). There are several such indices (percent ideal body weight*, weight-for-length/stature, body mass index) and they are better associated with body composition and nutritional status than weight on its own. A second preferred anthropometric index is length/height-for-age, an indicator of tallness, shortness or *stunting*. Low length/height-for-age is frequently associated with chronic malnutrition, organic disorders, or chronic disease.

Although growth monitoring is an important standard component of pediatric services throughout the world, little research has been performed to evaluate its potential benefits and harms (9, 11). A Cochrane Systematic Review found only two well-designed studies that evaluated benefits and possible harms of routine growth monitoring on the child and mother (9, 11). Evaluation of these two programs in developing countries demonstrated no real health benefits or harms. This shortage of evidence should not be misconstrued as an indication that growth monitoring is unnecessary, but rather as a sign that research is needed in the area, in developed as well as developing countries. The potential for harm relates to inappropriate practice. Practices that suggest blame or result in feelings of guilt or shame or those that focus on physical appearance rather than healthy eating and lifestyle habits have the potential to cause harm and should be avoided. Growth monitoring is an opportunity for health providers to increase awareness and provide anticipatory guidance on the importance of healthy feeding and eating practices.

LITERATURE REVIEW AND DISCUSSION

Importance of accurate measurements

Accurate, reliable measurements are fundamental to growth tracking and sound clinical judgement. A number of studies have illustrated a disturbing frequency of inaccurate growth measurements in a variety of health care settings (12-15). Accurate measurements have three components: a standardized measurement technique, quality equipment which is regularly calibrated and accurate, and trained measurers who are reliable and accurate (10, 16). Reliable growth data do not require expensive equipment, just careful technique and accurate charting. Information on the appropriate equipment and techniques for accurate weighing and measuring of infants, children, and adolescents is readily available (17, 18). Using a consistent growth chart, appropriate for age and gender, a child's measurements should be recorded in the data table of the chart and then plotted to identify any disturbances in height or weight gain.

Frequency of growth monitoring

There is limited research to support a prescribed frequency for performing anthropometric measurements in order to identify children with physical growth disorders. Serial measurements of height, weight, and head circumference as part of scheduled well-baby and well-child health visits are suggested (19, 20). Although the ideal number of health maintenance visits for children has not been established (1, 21), current recommendations are that they be organized according to the immunization schedule with additional visits within the first month and also at nine months (i.e. within one or two weeks of birth, at one, two, four, six, nine, 12, 18, 24 months and four to six years) (21, 22). The optimal frequency for monitoring height and weight in healthy children over age six has not been evaluated; however, it seems reasonable to continue annual monitoring of growth for the early identification and referral of a child whose abnormal stature or rate of weight gain may indicate a problem that might require treatment. In cases where a growth problem is suspected, or a child's response to therapy is being monitored, more frequent measurements may be indicated. For children who are not followed at Public Health Child Health Clinics nor brought to the physician for well-child visits, anthropometric measures should be taken at the time of illness visits.

GROWTH CHARTS

Growth charts are a graphic presentation of body measurements that aid in the assessment of body size and shape, and in the observation of trends in growth performance. They are used in the assessment and monitoring of individual children and in screening whole populations (23). Growth charts are not diagnostic and should be used in conjunction with other information when evaluating a child's general health. There is an important distinction between a *growth reference* and a *growth standard*. A *reference* simply describes its sample without making any claims about the health of its sample, whereas a *standard* represents 'healthy' growth of a population and suggests a model or target to try and achieve (24-26). Growth charts currently in use describe existing growth patterns and are therefore references, not prescriptive standards (23).

Canada does not have a national pediatric surveillance system for collecting anthropometric and nutritional data;

*Percent ideal body weight (% IBW): plot length or height on growth chart to identify length- or height-for-age percentile. Locate ideal body weight as the weight at the same percentile as the height, for the same age and gender. Calculate % ideal body weight by dividing actual weight by ideal body weight and multiplying x 100.

therefore, national growth charts do not exist for Canadian children. Growth references have been developed from small populations of Canadian children that were not nationally representative (27-31). Over the last three decades, there has been substantial discussion on which reference population to use in assessing adequacy of childhood growth. Increasing evidence that growth patterns of well-fed, healthy preschool children from diverse ethnic backgrounds were comparable (3-5) supported the use of a single international growth reference based on healthy, well-nourished children from different geographic and genetic origins who had fully met their growth potential (7, 8, 10, 32).

British charts

A few pediatric centres in Canada preferred British charts by Tanner and Whitehouse (33-35) for their longitudinal data collection, truer velocity charts, depiction of standards for stages of pubertal development and allowance for variability in onset and duration of puberty, and a table simplifying precise calculation of age. These charts have been declared obsolete and have been replaced with the UK90 references, which were based on more recent, larger cross-sectional data (36). The new British charts include weight, height, BMI, head circumference and stages of puberty, from birth to 20 years. These charts, which are now 13 years old, used data from seven different sources, not all of which were nationally representative.

American charts

Because no geographically diverse growth chart existed, in 1978 the World Health Organization (WHO) adopted the reference curves of the American National Centre for Health Statistics (NCHS) (37) for international use (38, 39). Until recently, these reference charts were the most widely used in Canada. Secular changes in growth, availability of improved statistical methods for smoothing growth curves, and concerns related to limitations of the existing infant growth charts (32, 40, 41) led to revisions of these charts and the release in May 2000 of 16 new growth charts from the CDC (42). They consist of charts for infants from birth to age three for weight, recumbent length, head circumference, and weight-for-recumbent length, and a set for children and adolescents from ages two to 20 for weight, height, and body mass index. Weight-for-stature charts, which are only applicable for weights and heights covering ages two to approximately five, were also continued, in order to smooth the transition to using the BMI charts. The charts are available in two forms. *Individual* charts include only one set of percentile curves per page (e.g. weight-for-age) and have the grid scaled with English units (pounds, inches). *Clinical* charts include two sets of curves per page (e.g. weight-for-age and height-for-age), have the grid scaled to metric units with English units in a secondary scale, and contain a data entry box to record individual patient measurements and parental heights. The clinical charts were designed for use by health care providers.

The 2000 CDC charts offer numerous improvements to the 1977 NCHS charts (43), including:

- more recent national survey data (1963-94) plus supplemental infant data to better portray the racially and ethnically diverse population and more closely match current national birthweights
- addition of 3rd and 97th percentiles to provide more realistic cut-offs for referral than the previous 5th and 95th outer curves (a larger sample size and improved statistical methods made it possible to estimate these outer centiles more accurately)
- addition of BMI-for-age curves to evaluate weight as a function of height, a feature that had been missing for older children and adolescents
- improved representation of breastfed infants based on their national distribution over the past 30 years (50% breastfed; ~ 33% breastfed ≥ 3 months); however, the curves continue to show somewhat different patterns of growth than typically observed in healthy breastfed infants (44), due to the relatively short duration of breastfeeding (43).
- correction of the previous disjunction that occurred between 24 and 36 months when switching from length to stature. A small disjunction still remains because stature is shorter than length measurement by approximately 0.8 cm.

In an example of a trend towards creating a *standard* rather than a *reference*, the CDC excluded data from two populations: preterm, very low birth weight infants (< 1500 g), and weight data for children six years and older from the most recent NHANES III survey (1988-94). Very low birth weight infants were excluded because they have different growth patterns. NHANES III weight data for six-year-olds were excluded to avoid an upward shift in weight-for-age and BMI-for-age curves. An upward shift would be a reflection of the recent secular increase in the prevalence of obesity in American children, which is an unhealthy and undesirable occurrence. Higher weight curves and BMI curves would mean that fewer overweight and obese children and adolescents would be identified as such, because the norms would have been raised 42, 45).The 2000 CDC charts meet both clinical and research needs. They are simple to use and readily accessible. High quality reproducible copies, free of advertising logos, can be downloaded from the CDC web site (42) as well as the full data set, education materials, training tools and modules pertaining to their use. An electronic nutrition module that plots children on growth charts and calculates percentiles and Z-scores is also available (46).

WHO charts (in development)

The WHO, in collaboration with the United Nations Children's Fund and others, is developing a new international growth reference representative of children (birth to age five) being raised according to recommended health practices (32, 47). These conditions include:

1. exclusive or predominant breastfeeding for four to six months, complementary foods by six months, continued breastfeeding for 12 months or more;
2. an optimal environment without microcontaminants or conditions that could limit growth (smoking, altitude >1500 metres); and
3. optimal health care (immunizations, good routine pediatric care). This desirable approach in extensively prescribing the nature of the sample population is another example of creating a reference to approximate a *standard*. The

multicentred global study (Brazil; Ghana; India; Jordan; Norway; U.S.A) has been initiated to collect longitudinal data from birth to 24 months from a large sample of infants(~1800) and cross-sectional data on children(~ 8400) 18-60 months old. Use of data from diverse sites will avoid political controversies that arise from using a single country's growth patterns as the reference for optimal growth internationally (8). Targeted for release in 2005, it is difficult to predict if and how the charts will differ from the 2000 CDC growth charts (47). When it is time to consider implementing these WHO charts for Canadian infants and young children, it will be important to see if differences were detected in the growth of children across the six sites and to evaluate issues that may arise when switching to the CDC charts at age five, such as whether there is a disjunction at age five between the two curves (47).

Which growth charts to use for Canadian children?

On the basis of their more current and representative anthropometric data, and the improvements made to the NCHS charts, it is recommended that the 2000 CDC growth charts, containing the 3rd and 97th percentiles, now be used for assessing and monitoring the growth of Canadian infants and children. Up to now, the 5th and 95th percentiles have been commonly used as the decision region for referral for abnormal growth. However, the resulting high false positive referral rate, and the recent ability to accurately estimate the 3rd and 97th percentiles, which are closer to the mean plus or minus two standard deviations (SD), have led us to recommend use of the 3rd and 97th percentiles as cut-off points for all indexes, with the exception of BMI-for-age.

Considerations in interpreting growth charts

Distribution of anthropometric indices can be expressed in terms of Z-scores (SD), percentiles, and percent of the median. Percentiles are commonly used in the clinical or community setting because they indicate simply and clearly a child's position within the context of the reference population. As an example, if an infant has a weight-for-length at the 3rd percentile, then 97% of the population who are the same age, gender and height weigh more than that child. In North America and the UK, percentiles are used as cut-off points with the vast majority of children falling between the 3rd and 97th percentiles, corresponding approximately to plus or minus two SD from the median. These cut-offs define the central 95% of the reference distribution as the "normality" range. To aid in clinical screening or population-based surveillance, those outside of the range have been considered to have abnormal size/shape/growth requiring further investigation or referral (16).

There are several key points to remember when interpreting patterns of growth on a growth chart:

- In general, the percentile positions of various anthropometrics will be approximately the same in a normal child, with a gross difference in one indicating a potential problem.
- The more deviant an individual's anthropometric measure is, the more likely it is that a problem exists (6).
- Despite many parents' perceptions, the 50th percentile is not the goal for each child.
- The direction of serial measurements on the curve is more important than the actual percentile.
- In most children, height and weight measurements follow consistently along a 'channel' (i.e. on or between the same centile(s)). Normal children often shift percentiles for both length and weight in the first two to three years of life with the majority settling into a channel towards the 50th percentile (i.e. regression toward the mean) rather than away (48).
- With the exception of the first two to three years of life when channel 'surfing' is normal and during puberty, when the age at onset is variable, crossing centiles or channels is a potential sign of a growth disturbance (2, 16, 49). Serial measurements showing unexpected crossing of two or more centiles downwards from a previously established rate of growth is considered to reflect failure-to-thrive (FTT) or growth failure (16, 50).
- Breastfed infants grow differently from formula-fed infants during the first year of life (51). In particular, breastfed infants tend to become leaner after three to four months of life. These differences should be anticipated when assessing growth of an exclusively breastfed infant in order to avoid unnecessary investigations, supplementation with formula or early introduction of solids.
- Health care providers are encouraged to take the time to teach children and their caregivers how to interpret the growth chart and what the target growth pattern should be.

Growth charts for special populations

Preterm infants (outside the neonatal intensive care unit [NICU] setting)

Growth in low birthweight (<2500 g) and very low birthweight (VLBW; < 1500 g) preterm infants differs from term infants born at an appropriate weight, such that they appear not to catch up during early childhood (52). For this reason, they were excluded from the CDC growth charts. There is no current reference that reflects ideal growth of VLBW infants rather than typical growth that may be significantly compromised by illness. The CDC therefore recommends using either the Casey (52) (Infant Health and Development Program; IHDP) (53) VLBW-specific growth charts or the CDC growth charts, depending on the purpose (54). The IHDP charts, which start at two months before term, are recommended for comparing the growth of a VLBW infant with other infants who are VLBW infants. On the other hand, the CDC charts, which begin at term, are recommended for comparing the growth of a VLBW infant with that of non-VLBW infants (54). Regardless of which reference is used, postnatal age should be corrected for prematurity before plotting (i.e. postnatal age in weeks – [40 weeks – gestational age]). Failing to adjust for prematurity can lead to inappropriate referrals for FTT. The optimal duration for use of corrected age is unclear; however, findings indicate that it should continue until at least 24[55] or 36 months.[56] Correcting for prematurity in VLBW infants has been shown to continue to make a difference to Z-scores to the age of 7[57] or 8 years[58].

Children with special health care needs (CSHCN)

Children with mental handicaps and developmental,

genetic or other disorders often have growth patterns that are different from references. Specific growth curves have been created for some of these disorders (59, 60, 61); however, they have been developed from very small samples and relatively old data. As a result, disorder-specific charts may not reflect newer treatment protocols and may conceal an existing nutrition or growth problem. With consideration of the limitations of each chart, the specialized charts can provide additional useful information in the overall growth assessment, when used in conjunction with the normal reference charts. Alternative anthropometric measurements (e.g. sitting height, segment lengths such as upper arm or lower leg, skinfolds) may be required when muscular contractures, spasms, or scoliosis challenge the ability to obtain accurate measurement of weight or length/height in children with neuromuscular disabilities (31, 62).

BODY MASS INDEX (BMI)

The escalating incidence of world-wide obesity has been called a global epidemic (63). Since 1981, the prevalence of childhood overweight and obesity in Canadian children aged seven to 13 has doubled and tripled, respectively (64, 65). Similar trends are reported in the U.K. (66) and United States (67), where obesity has become the most prevalent nutritional disease of children and adolescents (68). Worldwide, obesity has replaced undernutrition as the most common public health concern for infants and children (63). This trend is concerning because excess body fat in children has been associated with health problems, including increased risks of cardiovascular disease, hypertension, abnormal lipids, and type II diabetes, as well as increased risks of adult obesity and obesity-related morbidity and mortality in adulthood (68-71). Obese children also suffer significant social and emotional difficulties (72).

Direct measures of body fatness, such as underwater weighing and dual energy x-ray absorptiometry are not practical for clinical or community practice. Traditional indirect markers of pediatric obesity have been measures that have considered both weight and height, such as calculated percent of ideal body weight or weight-for-length/stature percentile on the growth charts. These indirect markers are surrogate indicators of adiposity because weight is not identical to adiposity. An ideal marker would compare a child's weight with a reference population of the same sex, age, and stature; however, to have enough children with the same sex, age and stature to create reference percentiles for each sex-age-stature combination requires a sample size much larger than currently available. Weight-for-length/stature does not consider age, which is problematic during periods of life when body fat content differs substantially (e.g. short toddlers are compared with tall infants).

Body mass index (BMI) is an anthropometric index of weight and height, defined as body weight in kilograms divided by height in meters squared.

$$BMI = \text{weight (kg)}/\text{height (m)}^2$$

In adults, BMI has been the most widely investigated and commonly accepted index for classifying adiposity, as well as the most useful indicator for identifying health risk associated with overweight. International recommendations for the use of BMI as a first indicator in assessing fatness in children and adolescents are relatively new (73-75). Because adiposity varies with age and gender during childhood and adolescence, BMI is age and gender specific; consequently, BMI is plotted according to age, using sex-specific charts. BMI-for-age provides a reference of overweight for older children and adolescents that was previously not available. It is consistent with adult BMI, so it can be used continuously from age two to adulthood, and can therefore track body size throughout the lifecycle. In addition, BMI-for-age is also a predictor of health risks and future risk of being overweight (70). It is strongly associated with clinical risk factors for the diseases associated with overweight. BMI is significantly correlated with direct measures of body fat, as well as subcutaneous measures. BMI is now recommended for screening overweight in children (over age two) and adolescents, rather than weight-for-stature (75, 76). BMI values at ages below two have not been associated with adolescent or adult obesity; use of BMI before 24 months of age is therefore not recommended. Weight-for-stature and BMI-for-age are not interchangeable and do not produce equivalent results (77). Weight- for-stature percentiles tend to be lower than BMI-for-age centiles.

American BMI charts

In 1995 the WHO recommended[10] use of BMI values based on American data from 1971-1974 [78]; however, this data has been updated in the 2000 CDC BMI charts.[42, 79] The CDC utilizes the following cut-off points and terminology to classify abnormal body weights which could pose medical risks:[45]

BMI-for-age $\geq 95^{th}$ centile	Overweight
85^{th} centile $\leq$ BMI-for-age $< 95^{th}$ centile	Risk of overweight
BMI-for-age $< 5^{th}$ centile	Underweight

"Overweight" and "At risk of overweight" are the terms chosen to refer to children and adolescents whose excess body weight could pose medical risks. The CDC has chosen to use the term "overweight" to avoid potential negative connotations associated with the term "obesity". At the 95^{th} percentile, very few children will be incorrectly classified, although some children with excess adiposity will be missed (i.e. low sensitivity and high specificity).[75] This approach avoids potential psychological and physical harm from misclassifying and treating children who are not obese. An additional cut-off point at the 85^{th} percentile was set to lessen the chance of missing at risk children.

The CDC cut-off point for underweight is based on WHO recommendations[10]; however, scientific research and clinical experience are lacking regarding its use in underweight and the choice of the 5^{th} percentile as the cut-off. While BMI-for-age $< 5^{th}$ percentile may be used, with an awareness of its limitations, the current practice of using body weight $< 89\%$ of ideal (i.e. $\leq 89\%$ IBW)[80] or weight-for-length/stature $< 3^{rd}$ percentile as surrogate measures of underweight in Canadian infants and children continues to be recommended.

International BMI charts

More recently, an international group (73), which included key representatives from the American CDC, proposed new BMI cut-off points for pediatric overweight and obesity that are based on pooled international data and linked to the widely accepted adult obesity cut off points (BMI > 25 kg/m^2 for overweight and > 30 kg/m^2 for obesity) (81). These definitions are less arbitrary than the CDC's because the adult BMI values to which they are linked are related to health risk. They may also be considered more internationally acceptable because they were based on pooled reference data from six countries geographically spread out around the world (Brazil, Great Britain, Hong Kong, Netherlands, Singapore, U.S.A.) (81). Data from a Canadian database were intentionally excluded from this international dataset because of small sample size. It is noteworthy, although unexplained, that the Canadian data are skewed upwards, making them a clear outlier during puberty, when compared to this international reference.

The International and American BMI cut-offs give similar but not identical results. The international reference gives lower estimates of body fatness than the CDC charts for young children but higher estimates for older children (79). The international cut-off points are recommended for use in international comparisons of prevalence of overweight and obesity.

Which BMI charts to use for Canadian children?

There are no Canadian BMI references; the CDC BMI-for-age charts (42), containing the 5th, 85th and 95th percentiles, are therefore recommended for monitoring the BMI of individual Canadian children age two and over. This recommendation is made so that all of an individual child's anthropometric measures (i.e. length- or height-for-age, weight-for-age, body mass index) are compared to the same data set. For comparing prevalence data for BMI of Canadian populations against other populations, use of the international BMI charts (81) is recommended for their geographical diversity.

Considerations in interpreting BMI-for-age

BMI rises steeply in infancy, falls during the preschool years to a minimum around ages four to six and rises again into adulthood (82). The upward trend after the low point, or dip, is called the *adiposity rebound*. Children whose adiposity rebound begins before age 5.5 have an increased risk of later obesity (70). Children who are crossing BMI percentiles in an upward direction may also be at risk (83). Unlike adults, age-related increases in BMI during growth are associated with increases in both fat mass and fat-free mass (83). The extent to which each component contributes to the change in BMI depends on the age, sex and pubertal maturation of the child (84). Ethnic differences in pediatric BMI have not been thoroughly investigated. An initial study demonstrated that white subjects had higher body fatness for a given BMI than did black subjects (85).

Internationally, universal use of BMI cut-off points for adults has been debated, because health-related risks for obesity are observed at different levels of BMI for different populations (86). Variations in body fat distribution (intra-abdominal versus visceral) or the degree of muscularity may explain these differences.

BMI-for-age is an effective screening tool for identifying children who are unnaturally fat; however, it is not a diagnostic tool. It should be used as guidance for further assessment, referral, or treatment, rather than as a diagnostic criterion for labelling children. A decision about whether a child with a given BMI is truly fat requires additional information such as skinfold thickness measurements, comorbidity, family history, and recent health history (73). As with other anthropometric measures, periodic measurements are more revealing.

The rise in childhood obesity and an understanding of its impact on both short- and long-term health has emphasized the need for prevention and early identification. Evidence to support routine screening for obesity as part of the pediatric health maintenance visit has previously been classified as modest due to the lack of effective interventions that can be implemented when obesity is detected (19, 63). Recent progress in the treatment for obese children has occurred as a result of developments in diet, exercise, and behaviour change and although most pediatric obesity interventions achieve relatively small changes in weight or adiposity and considerable relapse, there is some evidence for long-term efficacy (87-90).

The primary goal of treatment is sustainable, healthy lifestyle changes that include healthy eating (following dietary guidelines), an increase in daily physical activity, and a reduction in sedentary activity (20, 75, 76, 88, 90, 91). Treatment should begin early, involve the family, and institute permanent changes in a stepwise manner (76). Dietitians may be particularly well suited to implement these techniques because they are skilled at diet evaluation and modification, and experienced in counselling to promote healthy eating and physical activity (91, 92). Recommendations from expert advisory groups suggest that children suspected to be overweight who have a BMI-for-age at or above the 85th percentile with complications of obesity, or a BMI-for-age at or above the 95th percentile, with or without complications, should undergo evaluation for possible underlying genetic or endocrine causes and referral for treatment (76, 91).[76, 91] Weight loss is recommended if complications such as hyperlipidemia or hypertension are identified and for children age seven or older who are classified as overweight (76). Otherwise, weight maintenance is recommended. Concerns about negative physiologic or psychological effects of treatment, such as the potential to impair linear growth or cause eating disorders, have been raised. To date, limited research has not shown these concerns to be true when therapy is conducted appropriately; however, more work is needed in these areas (76, 87).

SUMMARY/CONCLUSIONS

The objective of growth monitoring is timely identification of disturbances in normal weight gain and linear growth in order to instigate corrective therapy and achieve full growth potential. Growth monitoring also provides health care providers with an opportunity to discuss healthy eating and active living with children and their caregivers. Optimal growth monitoring requires accurate anthropometric measurements using appropriate equipment and techniques and accurate plotting on a consistent growth chart appropriate for age and gender. Differences in growth between populations are affected primarily by environmental factors and the role

of genetic factors is smaller than previously thought. Therefore, use of a single international growth chart is appropriate. In the absence of such a geographically diverse chart, the American CDC growth charts are recommended for use by pediatric health care providers for the assessment and monitoring of growth in Canadian infants and children. When the new WHO growth standards become available, their use for Canadian infants and children from birth to age five should be strongly considered and evaluated. While local growth charts are unnecessary, this does not argue against the collection and use of local anthropometric survey data to facilitate monitoring of the overall nutritional and health status of Canadian infants and children and trends within this population (6).

The dramatic increase in pediatric obesity is a call to action. Chronic conditions and illnesses once seen only in obese adults are now appearing in the pediatric population. The intractable nature of adult obesity is well known; therefore, clinical and community health practitioners must be more attentive to preventing and identifying overweight in children and adolescents.

Evidence demonstrating the benefits of growth monitoring on clinical outcomes is quite limited. This likely reflects the paucity of research, rather than providing proof against such rewards. More research is needed in this area and as data become available in the future, recommendations contained in this document should be re-examined.

RECOMMENDATIONS

1. Serial measurements of recumbent length (birth to ages two or three) or height (≥ age two), weight, and head circumference (birth to age two) should be part of scheduled well-baby and well-child health visits in order to identify infants and children with disturbances in rates of weight gain or physical growth. Although the ideal number of health maintainance visits for children has not been established,[1,22] current recommendations are that they be organized according to the immunization schedule with additional visits within the first month and also at 9 months of age (i.e. within one to two weeks of birth and at one, two, four, six, nine, 12, 18, 24 months and four to six years). The frequency for monitoring older children and adolescents is unknown; however, it seems reasonable to continue monitoring growth on an annual basis at primary care visits for the early identification and referral of a child whose growth appears abnormal. More frequent monitoring may be indicated in cases when potential or real growth concerns are identified or a child's response to therapy is being monitored. Measurements should be performed at the time of illness visits for children who are not brought for recommended well-baby and well-child health visits. **[I recommendation]**
2. To yield accurate measurements, weights and measures should be obtained using calibrated, well-maintained quality equipment and standardized measurement techniques. An individual child's measurements should be recorded in the data table of a consistent growth chart appropriate for age and gender, and then plotted to identify any disturbances in height or weight gain. Corrected age should be used at least until 24 to 36 months of age when plotting anthropometric measurements of premature infants. Interpretation of plotted measurements should consider their percentile rank, their relationship to each other, recommended cut-of values, parental heights (for stature measurements), and comparison with previous percentile ranks to identify major shifts in growth patterns. **[B recommendation]** Suggested guidelines and training modules are available from the CDC (17,18).
3. Until internationally diverse growth charts are available and have been reviewed for use in Canada, the growth charts from the American Centers for Disease Control and Prevention (CDC) are recommended as the charts of choice for use by Canadian family physicians, pediatricians, dietitians, nurses, and other health professionals. **[I recommendation]** The clinical set of charts, including the 3rd and 97th percentiles, are favoured. The international charts currently under development by the WHO are awaited with favourable anticipation, given their international representation of children (birth to age five) being raised according to recommended health practices.
4. Health care providers are encouraged to take the time to teach children and their caregivers how to interpret the growth chart and what the target growth pattern should be. **[I recommendation]**
5. The growth of breastfed infants can be evaluated on the CDC growth charts. Health care providers should be aware that breastfed infants grow differently from formula-fed infants during the first year of life, and in particular that breastfed infants tend to become leaner after 3-4 months of life (51). These differences should be anticipated when assessing growth of an exclusively breastfed infant in order to avoid unnecessary investigations, supplementation with formula or early introduction of solids. **[B recommendation]**
6. BMI-for-age is recommended to screen children from age two onwards to identify those who may be at risk for conditions and illnesses related to excess body fat. **[B recommendation]**
7. For Canadian children, the CDC BMI-for-age charts (42) are recommended for use in clinical and community settings. When comparing prevalence data for BMI for populations, use of the international BMI charts (81) is recommended. **[I recommendation]**
8. Traditional measures of underweight, such as percent ideal body weight or weight-for-length/stature percentile (available for use up to approximately age five) continue to be recommended until the validity of using BMI to assess underweight is established. Alternatively, BMI-for-age may be used to screen for underweight (in children from age two onwards), with an awareness of the existing limited experience of its role in underweight. **[I recommendation]**
9. The following cut-offs are recommended as guidance for further assessment, referral, or treatment, but not as diagnostic criteria for labelling children:
    a. shortness or stunting: length-for-age or height-for-age below 3rd percentile **[I recommendation]**
    b. underweight or wasting: BMI-for-age below 5th percentile *or* body weight at or below 89% of

ideal (≤ 89% IBW) *or* weight-for-length/-stature < 3rd percentile (charts available from birth to age five) **[I recommendation]**

c. overweight: 85th percentile < BMI-for-age below 95th percentile **[I recommendation]**
d. obesity: BMI-for-age at or above 95th percentile **[B recommendation]**

10. Given the rising prevalence and associated short- and long-term health risks of pediatric obesity, routine screening for obesity as part of the pediatric health maintenance visit is recommended. **[I recommendation]**
11. Children suspected to be overweight, with a BMI-for-age at or above 85th percentile with complications of obesity, or with a BMI-for-age at or above 95th percentile with or without complications, should undergo evaluation and possible treatment. **[I recommendation]** A family-centred approach to counselling to promote healthy eating and physical activity and reduce sedentary activity is recommended. **[B recommendation]**
12. A Canadian Pediatric Nutrition Surveillance System should be developed for organized and ongoing collection of anthropometric measurements to follow growth and nutritional status of Canadian children and describe trends in key indicators of their nutritional status. Data could be used for program planning, targeting, development, and evaluation of health and nutrition interventions such as breastfeeding rates, as well as monitoring progress toward health objectives for Canada. Collaboration with key stakeholders in the community health/population health sector is needed.
13. Research is required in the following areas: benefits of growth monitoring, optimum frequency for growth monitoring, validity of using BMI-for-age to assess underweight, development of a weight classification system for Canadian children, effective strategies for the prevention and treatment of pediatric obesity.

IMPLICATIONS

Recent revisions to growth references have provided an excellent opportunity for heightening awareness of health care professionals about the importance of routine and accurate growth monitoring, and appropriate use and interpretation of growth charts. New information on the appropriateness of using BMI in children and the relationship between childhood obesity and future health has a number of implications for health care professionals, including:

1. the need for easily accessible training for busy practitioners on performing accurate and reliable anthropometric measurements, use of the new CDC growth charts, and calculating and interpreting BMI in children and adolescents. Examples of relevant programs are the independent training modules on the CDC web site (49).
2. the demand for resources, including accurate measuring equipment (which in the community setting may need to be portable), population health strategies for the prevention of excessive weight gain, treatment programs for pediatric obesity, and health care professionals trained in behaviour modification therapy.
3. the need for collaborative efforts of professional organizations and health agencies to:
   a. publicize the gravity of the obesity epidemic and remind their members to address the problem with individuals and the public
   b. maximize limited community resources to realize healthy outcomes for children.

These same groups can collectively lobby for:

a. a Canadian Pediatric Nutrition Surveillance System to monitor nutritional status and growth of our children
b. a national multisector strategy to address prevention and treatment of obesity in children and adolescents, to include promoting healthy eating, decreasing sedentary activity, and increasing physical activity for all school-aged children and their families.

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Competing interests: The statement was developed independent of influence from commercial or other interest groups.

Appendix A. Grades for Recommendations*

Level of Evidence	Description
A	There is **good** evidence to recommend this action
B	There is **fair** evidence to recommend this action
C	The existing evidence is **conflicting** and does not allow to make a recommendation for or against this action; however, other factors may influence decision-making
D	There is **fair** evidence to recommend against this action
E	There is **good** evidence to recommend against this action
I	There is **insufficient** evidence in quantity or quality to make a recommendation; however, other factors may influence decision-making. This recommendation is made based on 'expert opinion'

*Adapted from: Canadian Task Force on Preventive Health Care. New grades for recommendations from the Canadian Task Force on Preventive Health Care (1).

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