Overview of the CDC Growth Charts

INTRODUCTION

Childhood growth depends on nutritional, health, and environmental conditions. Changes in any of these influence how well a child grows and develops. Historically, pediatric health care providers have used height, weight and head circumference measurements to assess changes in growth and development. These anthropometric measurements, a basic component of health care services for children, have been used to screen individuals and populations for nutrition related health problems. This introductory module describes the CDC Growth Charts and the reference population used to develop them along with commonly used anthropometric indices and evaluation criteria used to assess growth. An instruction sheet for using and interpreting the CDC Growth Chart is included at the end of this module.

OBJECTIVES

Upon completion of this module, you will be able to:

- Select the CDC Growth Charts on the Internet that are appropriate for your setting
- Describe the reference population used to develop the CDC Growth Charts
- Use the CDC Growth Charts to plot anthropometric measurements

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1. WHAT GROWTH CHARTS ARE AVAILABLE?

The CDC Growth Charts, released in May 2000, consist of revised versions of the growth charts developed by the National Center for Health Statistics (NCHS) in 1977 and the addition of the new Body Mass Index (BMI)-for-age charts. CDC recommends that the BMI-for-age charts be used for all children 2 to 20 years of age in place of the weight-for-stature charts developed in 1977.

Because BMI has not commonly been used in the pediatric population, the weight-for-stature charts are included as an option for assessing children primarily between 2 and 5 years of age as pediatric health care providers make the transition to the BMI-for-age chart. The weight-for-stature charts can be used to plot stature from 77 to 121 centimeters. Between the ages of 24 and 36 months, clinicians may choose to measure recumbent length rather than stature (i.e., standing height), and plot it on the weight-for-length chart for infants from birth to 36 months. The method of choice for measuring a child (i.e., stature or length) determines the growth chart that will be used since length can not be plotted on the BMI-for-age chart and stature can not be plotted on the weight-for-length chart for infants birth to 36 months.

The 14 gender and age specific charts and 2 optional charts are listed below:

Gender and age	**Charts**
Boys, birth to 36 mos.	Weight-for-length
Boys, birth to 36 mos.	Weight-for-age
Boys, birth to 36 mos.	Length-for-age
Boys, birth to 36 mos.	Head circumference-for-age
Girls, birth to 36 mos.	Weight-for-length
Girls, birth to 36 mos.	Weight-for-age
Girls, birth to 36 mos.	Length-for-age
Girls, birth to 36 mos.	Head circumference-for-age
Boys, 2 to 20 yrs.	BMI-for-age
Boys, 2 to 20 yrs.	Weight-for-age
Boys, 2 to 20 yrs.	Stature-for-age
Girls, 2 to 20 yrs.	BMI-for-age
Girls, 2 to 20 yrs.	Weight-for-age
Girls, 2 to 20 yrs.	Stature-for-age
Optional Charts	
Boys 2 to 5 yrs.	Weight-for-stature
Girls 2 to 5 yrs.	Weight-for-stature

2. INDIVIDUAL AND CLINICAL GROWTH CHARTS ARE AVAILABLE ON THE INTERNET

The CDC growth charts are available on the Internet at www.cdc.gov/growthcharts and include individual and clinical charts.

- The individual charts are formatted with one chart per page and the grid is scaled to English units (inches, pounds); metric units (centimeters, kilograms) are also shown.

- The clinical charts are most commonly used by health care providers and differ from the individual growth charts in three ways.

    1. Each clinical chart has a data entry box to record individual patient data.
    2. The clinical growth charts are formatted with two sets of percentile curves per page, with the exception of the BMI-for-age and the weight-for-stature charts, which have only one chart per page.
    3. The grid in the charts is scaled to metric units; English units are also shown.

Both the individual and clinical charts are provided in sets that display different percentile lines to meet the needs of various users. The percentile lines for the clinical charts are listed below.

Clinical Charts
Set 1 shows the 5th through the 95th percentiles. These charts will be used for the majority of the routine public health and clinical applications. The percentiles shown: 5th, 10th, 25th, 50th, 75th, 90th, and 95th; 85th on the BMI-for-age and weight-for-stature charts.
Set 2 shows the 3rd through the 97th percentiles. Pediatric endocrinologists and others providing services to special populations may choose to use these charts when caring for children growing at the outer percentiles. The percentiles shown: 3rd, 10th, 25th, 50th, 75th, 90th, and 97th; 85th and 95th on the BMI-for-age; 85th on the weight-for-stature chart.

3. WHY WERE THE GROWTH CHARTS REVISED?

One of the most important factors in assessing a child's growth is having an appropriate reference population. When the 1977 NCHS growth charts were developed, limited national survey data were available for young children although data on an infant population were available from the Fels Longitudinal Study. The Fels data were used to construct the infant charts (birth to 36 months). Limitations of the 1977 infant charts were primarily associated with characteristics of the Fels data and included:

- The sample consisted primarily of white middle-class infants from southwestern Ohio.
- Birth weights were collected from 1929 to 1975 and did not match recent national birth weight distributions.
- Nearly all infants included in the sample were formula-fed.
- Differences between recumbent length measurements from the Fels data and the stature measurements from the NCHS data sets were larger than expected when the transition was made from recumbent length to stature between 24 and 36 months.

4. NEW FEATURES OF THE CDC GROWTH CHARTS

Although the CDC Growth Charts appear similar to the 1977 NCHS charts, they differ in several important ways. First, the data used to construct the new charts included a nationally representative reference population of infants from birth to 36 months and of children and adolescents from 2 to 20 years of age. Second, improved statistical smoothing methods were used to fit the data from national surveys to create smooth curves.

Additionally, there are several clinically significant new features of the charts that include:

BMI-for-age charts for children and adolescents age 2 to 20 years

The 85th percentile to identify at risk of overweight added to the BMI-for-age chart and weight-for-stature chart

The 3rd and 97th percentiles added to specific charts

The limits for length and height were lowered

On the weight-for-length chart for children from birth to 36 months old, length was extended from 49 to 45 cm. On the optional weight-for-stature chart, the extension from 90 to 77 cm allows almost all 2-year-old children to be plotted on the chart.

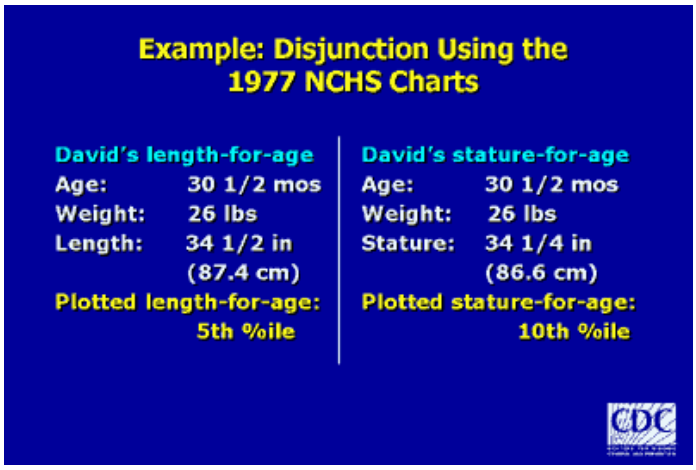
Smoothed percentile curves and z-scores agree

Correction in the disjunction that occurred between 24 and 36 months of age when switching from length to stature using the 1977 NCHS growth charts.

Example: Reduction in the Disjunction between the 1977 and 2000 Charts

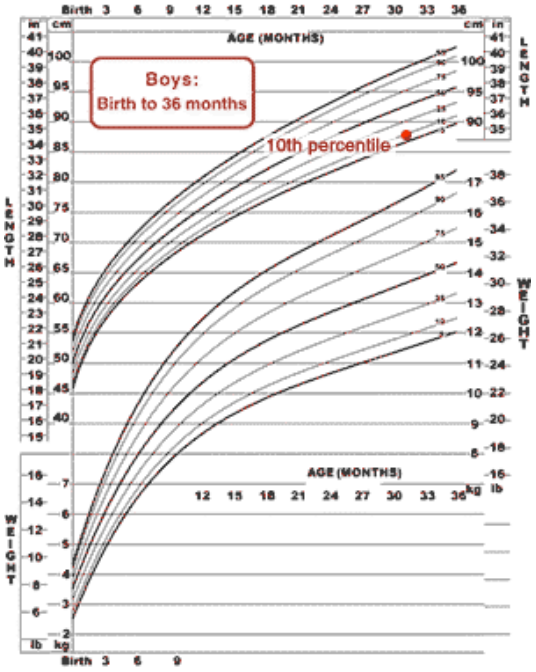
David's age is 30 ½ months.
His weight is 26 pounds.
His length measurement is 34 ½ inches (87.4 cm).
His stature measurement is 34 ¼ inches (86.6 cm).

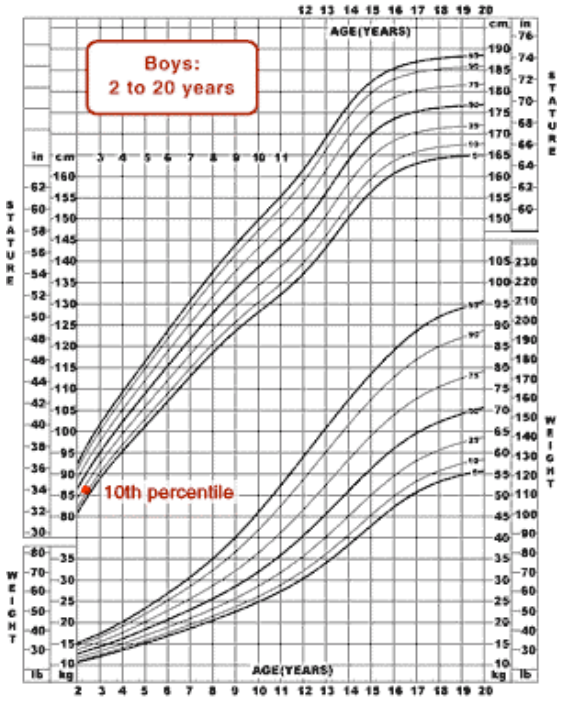
Note that the difference between recumbent length and stature in national survey data is approximately 0.8 cm and this is the difference shown in this example.



When plotted on the 1977 charts, David's length-for-age is at the 5th percentile while his stature-for-age is at the 10th percentile. When changing from recumbent length to stature, there appeared to be an upward shift in stature. This could be misinterpreted as an improvement in linear growth, when it is actually an artifact of the 1977 charts. This disjunction occurred in part because recumbent length data for the 1977 charts were obtained from the Fels Longitudinal Study while stature data were obtained from NCHS data.

In the new CDC growth charts, there is no longer a disjunction between length and stature because recumbent length and stature data were taken from the same child. When David's measurements are plotted on the CDC Growth Charts, he is at the 10th percentile on both the length-for-age and stature-for-age charts.





5. THE CDC GROWTH CHART REFERENCE POPULATION

The reference population used to develop the CDC Growth Charts is a nationally representative sample.

Data Used to Create the Growth Charts

- **General Information**

Data for the CDC Growth Charts included:

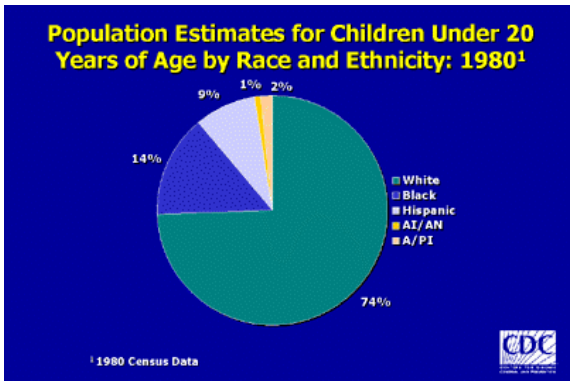
- physical measurements of stature or length, and weight from infants, children, and adolescents up to 20 years of age.
- head circumference measurements from infants and children up to 36 months of age were also used.

The measurement data were obtained from a series of national health examination surveys conducted by NCHS from 1963 to 1994 and from supplemental data sources. These surveys and data sources included:

- the National Health Examination Survey (NHES), Cycles II and III
- the National Health and Nutrition Examination Survey (NHANES) I, II, and III
- U.S. Vital Statistics
- Wisconsin Vital Statistics
- Missouri Vital Statistics
- Fels Longitudinal Study
- Pediatric Nutrition Surveillance System

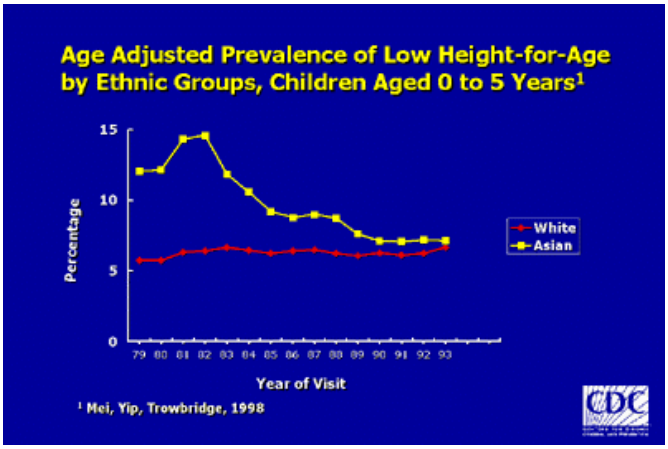
In each of the cross-sectional surveys, a national probability sample of the civilian, non-institutionalized population of the United States was examined. Survey-specific sample weights were applied to the national survey sample data to assure representation of the U.S. population according to age, gender, and racial/ethnic composition at the time the surveys were conducted. Supplemental data sources provided data for birth to 2 months of age. The large sample size in these surveys and the pooling of older data added precision for calculation of the outlying percentile estimates, especially the 3rd and 97th percentiles, to better assess children who are growing at the extremes.

The racial and ethnic distribution in the reference population is representative of the U.S. population at the time each of the NHES and NHANES surveys were conducted.



Results of a CDC analysis of the 1980 census provide a reasonable basis for describing racial/ethnic representation in the growth reference. In 1980, 74 percent of U.S. children under 20 years of age were White, non-Hispanic; 14 percent were Black, non-Hispanic; 9 percent were Hispanic; 2 percent were Asian/Pacific Islander; and 1 percent were American Indian/Alaskan Native (Census Bureau, 1992).

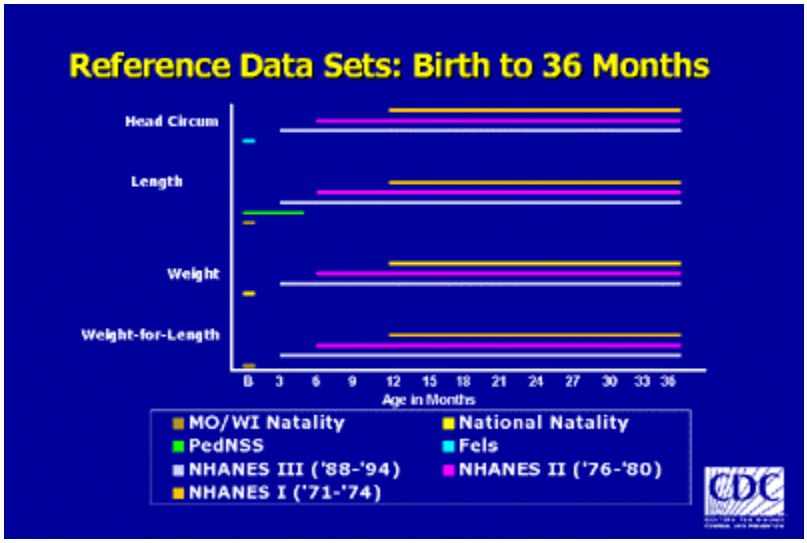
CDC promotes one set of growth charts for all racial and ethnic groups. Racial- and ethnic-specific charts are not recommended because studies support the premise that differences in growth among various racial and ethnic groups are the result of environmental rather than genetic influences (Lusky, 2000; Mei, Yip, Trowbridge, 1998; Martorel, Mendoza, Castello, 1989). Also, the reference population lacked sufficient numbers of specific racial and ethnic groups to consider separate charts.



This graph shows the prevalence of low height-for-age or stunting of recently immigrated refugee children from Southeast Asia in the early 1980s (yellow line) compared to white children (red line). By the 1990s, the prevalence of low height-for-age had declined among Asian children and heights for age were almost identical to that of white children in the United States. This study illustrates the effect of environmental factors on growth. Changing socioeconomic status often is associated with improved growth.

- **Infant Data in the CDC Growth Chart Reference**

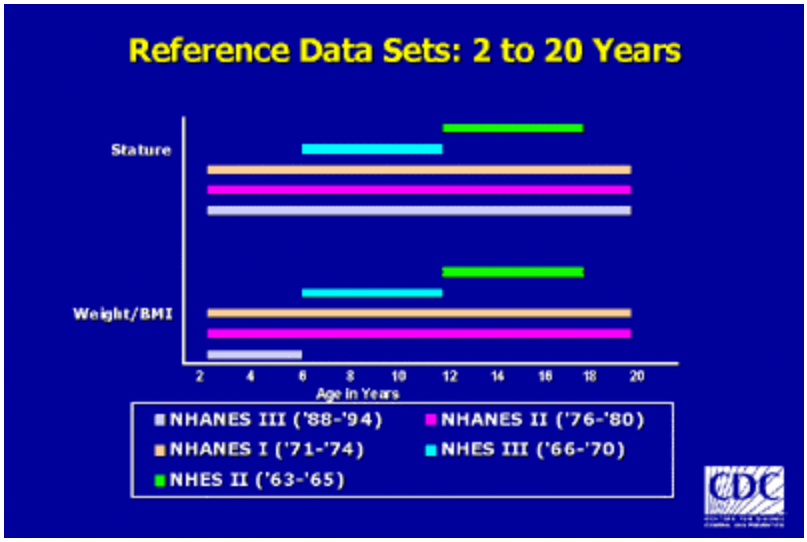
For the first time, nationally representative data were used to construct the growth charts for infants from birth to 36 months of age.



The new infant growth charts were developed using data from several sources. NHANES III provided weight, length, and head circumference data beginning at 2 months of age. NHANES II provided data beginning at 6 months of age and NHANES I provided data beginning at 12 months of age. Because national surveys did not collect data between birth and 2 months of age, supplemental data was used. These data included 1) birth data from U. S. vital statistics; 2) length and weight-for-length data from Missouri and Wisconsin birth certificates; 3) length data from infants between 0.5 and 4.5 months of age in the Pediatric Nutrition Surveillance System; and 4) head circumference measurements at birth from the Fels Longitudinal Study.

- **Child and Adolescent Data in the CDC Growth Chart Reference**

Data used to create the growth charts for children and adolescents 2 to 20 years of age were nationally representative and obtained from 5 national survey data sets.

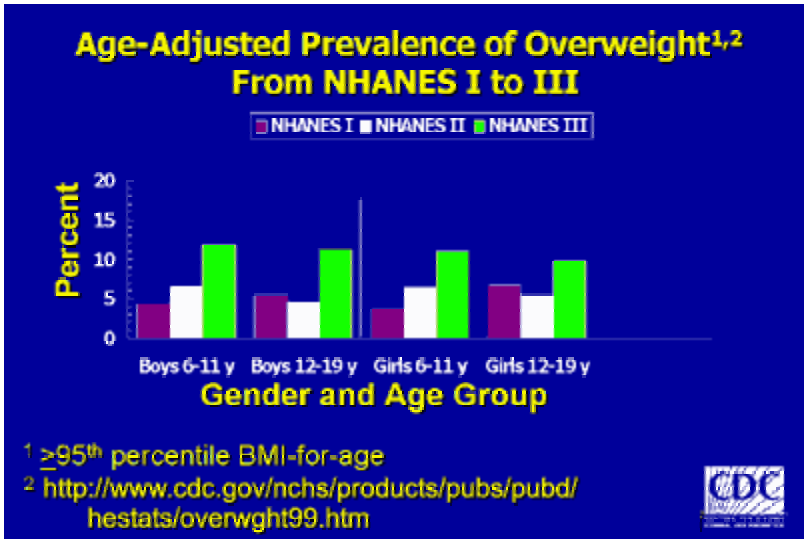


The new growth charts for children and adolescents aged 2 to 20 were developed using data from various sources. NHES, Cycle II, included weight and stature data from children and adolescents from 6 through 11 years of age. Data from Cycle III of NHES represented children and adolescents from 12 through 17 years of age. NHANES I, II, and III provided weight and stature data for children from 2 to 20 years of age. However, the NHANES III weight measures were excluded for children 6 years of age and older.

Exclusions from the Data

- **NHANES III Weight Data for Children Aged 6 Years and Older**

These data were excluded to avoid an upward shift in the weight-for-age and BMI-for-age curves (Kuczmarski et al., 2000).



There was a significant increase in the prevalence of overweight in the NHANES III (green bar) for boys and girls ages 6 to 11 and 12 to 19 when compared to NHANES I (purple bar) and II (white bar). If data from NHANES III had been included, the resulting 95th percentile curve would have been higher.

- **Very Low Birth Weight (VLBW) Infants (<1500 grams)**

Whereas low birth weight infants (≥1500 grams and <2500 grams) were included in the reference data, VLBW infants were excluded because the growth pattern of VLBW infants, who are almost always born premature, is markedly different from that of term infants weighing 2500 gms or more (Casey et al., 1991). The number of VLBW infants in the reference data was small resulting in the exclusion of less than 1 percent of the data from birth through 35 months old.

Other Characteristics of the Growth Reference

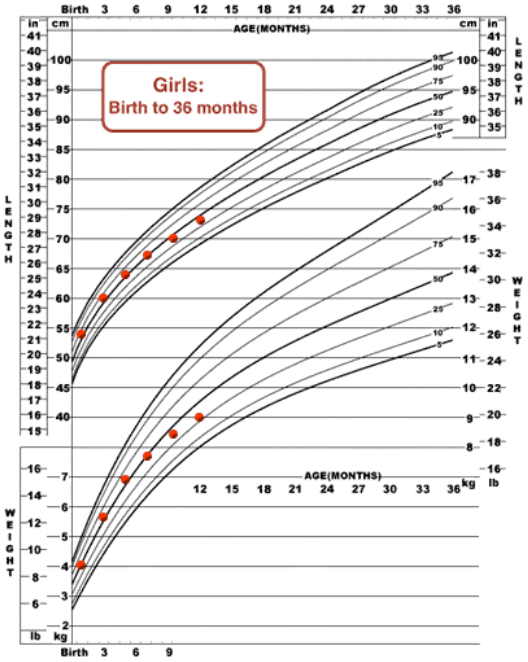
- **Growth Patterns of Exclusively Breast-fed Infants**

The new reference represents the combined growth pattern of breast and formula fed infants in the U.S. About 50 percent of the infants were reported to breastfeed with about 33 percent breastfeeding for 3 months or longer. Because the patterns of growth for exclusively breastfed and formula fed infants differ, caution must be used when interpreting growth of exclusively breastfed infants. Currently, a reference for exclusively breastfed infants is not available. The American Academy of Pediatrics (AAP) recommends exclusively breastfeeding for the first 6 months and continuing for at least 12 months. To better understand the growth patterns of exclusively breastfed infants, 'read more' for a comparison of exclusively breastfed infants to the reference population for the 2000 growth charts.

Growth Patterns of Exclusively Breast-fed Infants

The red points plotted on the CDC growth chart below were derived from a World Health Organization (WHO) data set of exclusively breastfed girls measured at 1, 3, 5, 7, 9 and 12 months of age and represent their mean length-for-age and weight-for-age (WHO, 1994). When these measurements were plotted on the new CDC growth charts birth to 36 months, length-for-age remains fairly stable throughout the first year of life. Weight-for-age plots slightly above the 50th percentile until between 3 and 5 month of age when it begins and continues to decline throughout the first year of life.

CDC is collaborating with WHO to develop a set of international growth charts for infants and children through 5 years of age based on the growth of predominantly breastfed infants. Data collection is currently underway.



- **VLBW Infants' Growth Patterns**

It is difficult to recommend a growth chart to use for assessing the growth status of VLBW infants because of the significant limitations of the two best options: 1) the VLBW Infant Health and Development Program (IHDP) chart (Guo et al., 1996; Casey et al., 1991; Casey et al., 1990); and 2) the CDC growth chart (NCHS, 2000). The best available VLBW-specific growth chart, the IHDP chart, was developed in 1985, prior to the implementation of current medical and nutritional care protocols that may significantly improve growth, and the CDC growth charts do not include VLBW infants.

Either of these charts is acceptable to use, however users need to consider the following:

1. post-natal age needs to be corrected for gestational age from birth to at least 24 months of age, irrespective of which chart is used (Roche, 1999).

2. the growth of VLBW infants plotted on the CDC charts will be similar to that of VLBW infant plotted on the IHDP growth charts with the possible exception of weight-for-length. Their weight-for-length may show less falling off in growth than is apparent when the VLBW IHDP growth charts are compared to the CDC growth charts (Sherry et al., in review).

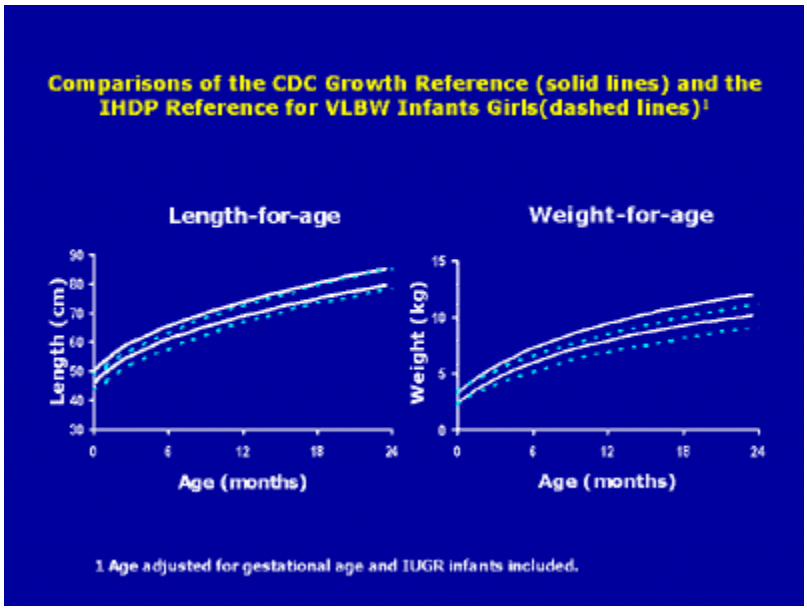
3. the following differences are likely to exist between the growth of VLBW infants and that of non-VLBW infants as depicted in the CDC growth charts (Sherry et al., in review):

a) VLBW infants usually are and will continue to be smaller in length-for-age and in weight-for-age than the non-VLBW infants. Thus, VLBW infants will fall in the lower percentiles.

b) VLBW infants will exhibit some catch-up growth in length-for-age and head circumference-for-age, however, there will likely be a falling off in weight-for-age and weight-for-length. Thus, they will exhibit an increase in percentiles in length-for-age and in head circumference-for-age and exhibit a decrease in percentiles in weight-for-age and in weight-for-length.

c) VLBW infants are likely to be heavier for their length than non-VLBW infants until they reach 65 cm, at which point they cross over the CDC percentile lines and will become thinner for their length than non-VLBW infants.

4. external VLBW data set comparisons show that with the exception of weight-for-length, the pattern of growth of VLBW infants more closely follows the pattern of the IHDP charts than that of the CDC charts. The VLBW infant pattern of growth in weight-for-length in these external data sets shows that they more closely resemble that of the CDC growth charts. This is particularly apparent when their Z-scores are compared.



Here you see the 50th and 5th percentiles of length-for-age and weight-for-age for girls for both the IHDP growth reference for VLBW infants (dashed lines) and the CDC Growth Charts (solid lines). This comparison suggests that VLBW infants included in the IHDP reference have rapid linear growth allowing them to nearly catch up with the infants in the CDC reference for length-for-age by 24 months of age. Whereas, in weight-for-age, the very low birth weight infants in the IHDP reference have less rapid growth resulting in their being thinner than the infants in the CDC reference.

Regardless of which reference is used, the child's gestation-adjusted age at birth must be determined before plotting. The gestation-adjusted age should continue to be used for all plots up to 24 months of age.

Other Characteristics of the Reference Population

Following Kessler and Dawson (1999), calculate a very low birth weight infant's gestation-adjusted age as follows:

- Determine the infant's gestational age in weeks. [Ultrasonographic examination provides a more accurate measure of gestational age than post-natal assessments (Alexander et al., 1992).]
- Subtract the child's gestational age in weeks from 40 weeks (gestational age of term infant) to determine the adjustment for prematurity in weeks.
- Subtract the adjustment for prematurity in weeks from the child's post-natal age in weeks to determine the child's gestation-adjusted age.

EXAMPLE

Randy was born prematurely on March 19, 2001. His gestational age at birth was determined to be 30 weeks based on ultrasonographic examination. At the time of the June 11, 2001, clinic visit, his postnatal age is 12 weeks. What is his gestation-adjusted age?

- 30 = gestational age in weeks
- 40 - 30 = 10 weeks adjustment for prematurity
- 12 - 10 = 2 weeks gestation-adjusted age

If this were plotted on a growth chart, anthropometric measurements would be plotted for a 2 week old infant.

6. USING THE CDC GROWTH CHARTS

Anthropometric Indices

Weight, stature, length and head circumference are commonly used to assess size and growth. When any of these measures are combined with age or length/stature the result is an anthropometric index (for example, weight-for-age). The CDC Growth Charts reflect five anthropometric indices that are gender specific.

BMI-for-age is an anthropometric index of weight and height combined with age. BMI-for-age is used to classify children and adolescents as underweight, overweight, or at risk of overweight.

Stature/length-for-age describes linear growth relative to age. Stature- or length-for-age is used to define shortness or tallness.

Weight-for-age reflects body weight relative to age and is influenced by recent changes in health or nutritional status. It is not used to classify infants, children and adolescents as under or overweight. However, it is important in early infancy for monitoring weight and helping explain changes in weight-for-length and BMI-for-age in older children.

Weight-for-length/stature reflects body weight relative to length and requires no knowledge of age. It is an indicator to classify infants and young children as overweight and underweight.

Head circumference-for-age is critical during infancy and can be charted up to 36 months of age. Head circumference measurements reflect brain size.

Nutritional Status Indicators

The nutritional status indicators for the CDC Growth Charts include overweight, at risk of overweight, underweight, and short stature.

Percentiles are used to rank an individual or a group on a growth chart and indicate where either fits in the context of the reference population.

Each anthropometric index, percentile cutoffs and nutritional status indicator used to screen children in the CDC Growth Charts is listed below:

Anthropometric Index	Percentile Cut Off Value	Nutritional Status Indicator
BMI-for-age	≥ 95th Percentile	Overweight
Weight-for-length/stature	> 95th Percentile	Overweight
BMI-for-age	≥ 85th and < 95th Percentile	At risk of Overweight
BMI-for-age Weight-for-length	< 5th Percentile	Underweight
Stature/length-for-age	< 5th Percentile	Short Stature
Head Circumference -for-age	< 5th Percentile > 95th Percentile	Developmental Problems

An appropriate reference population, accurate measurements and age calculations are important factors when assessing childhood growth. Comparing body measurements to the appropriate age and gender specific growth chart enables pediatric health care providers to monitor growth and identify potential health or nutrition related problems.

For detailed information on using the new growth charts, the instruction guide on "Use and Interpretation of the CDC Growth Charts" provides six steps to follow.

Prevalence of Nutritional Status Indicators: Comparison of the New Reference Curves with the 1977 Reference Curves Using NHANES III Data

To look at the impact that the new reference has on the prevalence of nutritional status indicators including overweight, underweight, and shortness, NHANES III data were used to compare the 1977 reference (old) with the 2000 reference (new). The following table summarizes the comparisons and shows that there are only slight differences in the prevalence rates of specific indicators when using the new versus the old reference. The greatest difference is found in the prevalence of underweight in 2 to 5 year-old girls and boys.

Summary: Impact of the New Reference on the Prevalence of Nutritional Status Indicators

Nutritional Status Indicators	Changes in Prevalence by Age Groups Using the New Reference			
	< 2 Years	**2 to 5 Years**	**6 to 11 Years**	**12 to 19 Years**
Overweight[1]				
Female	2 % lower	No change[4]	1 % higher	NA[5]
Male	2 % higher	1 % higher	No change	NA
Underweight[2]				
Female	2 % higher	3 % higher	1 % higher	NA
Male	1 % higher	4 % higher	1 % higher	NA
Shortness[3]				
Female	2 % lower	1 % lower	2 % higher	No Change
Male	1 % lower	1 % lower	No Change	1 % lower

[1] Overweight: for children < 2 years old: weight-for-length >95th percentile; for children 2-19 years: BMI-for-age $\geq$ 95th percentile for the new reference and weight-for-height $\geq$ 95th percentile for the old reference
[2] Underweight: for children < 2 years old: weight-for-length < 5th percentile; for children 2-19 years: BMI-for-age < 5th percentile for the new reference and weight-for-height < 5th percentile for the old reference
[3] Shortness: for children < 2 years old: length < 5th percentile; for children 2-19 years: height-for-age < 5th percentile
[4] No change means the change between the two references is a $\leq$ 0.2 % change in either direction.
[5] Values are not available for comparison for the 12 to 19 year-old group since the 1977 weight-for-height percentiles were provided only for girls up to approximately 10 years and for boys up to 11.5 years.

The prevalence rates for four commonly used nutrition indicators by gender and age group were calculated to compare the new and old references. When using the new growth charts, only slight differences are seen in the prevalence rates of overweight, risk of overweight, underweight and shortness.

> *In general, when rounded, the prevalence estimates obtained with the new growth charts in comparison with those obtained with the old growth charts differ by 2 percent or less. The exceptions are for underweight in children ages 2 to 5 years and at risk of overweight in males ages 6 to11 years, where the differences are approximately 4 percent.*

Prevalence of Nutritional Status Indicators by Age Groups and Gender Using the New and Old References with NHANES III Data

Nutritional Status Indicators	< 2 Years		2 to 5 Years		6 to 11 Years		12 to 19 Years	
	New	Old	New	Old	New	Old	New	Old
Overweight[1]								
Female	8	10	8	8	11	10	10	NA[5]
Male	10	8	6	5	12	12	11	NA
At Risk of Overweight[2]								
Female			11	10	13	12	16	NA
Male			11	8	14	10	13	NA
Underweight[3]								
Female	3	1	4	1	4	3	4	NA
Male	4	3	5	1	4	3	4	NA
Shortness[4]								
Female	2	4	4	5	4	2	4	4
Male	3	4	3	4	3	3	4	5

[1] Overweight: for children < 2 years: weight-for-length >95th percentile; for children 2-19 years: BMI-for-age $\geq$ 95th percentile for the new reference and weight-for-height > 95th percentile for the old reference
[2] At risk of overweight for children 2-19 years: BMI-for-age $\geq$ 85th percentile and < 95th percentile. Estimates for the old reference are hypothetical since this classification did not exist prior to the new charts.
[3] Underweight: for children < 2 years: weight-for-length < 5th percentile; for children 2-19 years: BMI-for-age < 5th percentile for the new reference and weight-for-height < 5th percentile for the old reference
[4] Shortness: for children < 2 years: length < 5th percentile; for children 2-19 years: height-for-age < 5th percentile
[5] Values are not available for comparison for the 12 to 19 year-old group since the 1977 weight-for-height percentiles were provided only for girls up to approximately 10 years and for boys up to 11.5 years.

Summary

- The CDC 2000 growth charts provide health care providers and researchers with an improved tool to assess the growth of infants, children and adolescents up to 20 years of age.

- CDC promotes one set of growth charts for all racial and ethnic groups.

- The CDC growth charts can be used for both breast and formula fed infants because the growth charts represent the combined growth pattern of breast and formula fed infants. The growth of exclusively breastfed infants must be interpreted with caution because they have different growth patterns than formula fed infants.

- The CDC growth charts can be used to assess the growth of both LBW and VLBW infants. However, because VLBW infants were excluded from the reference population gestation-adjusted age must be calculated and their growth pattern must be interpreted with caution because they have different patterns of growth than infants with higher birth weight. An additional option is to use the IHDP growth charts to assess growth of VLBW infants.

7. REFERENCES

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GLOSSARY

Coefficient of Variation: the ratio of the standard deviation to the mean.

Exclusively breastfed: infant that is fed breastmilk only during the first 4 to 6 months of life. No supplements of water, food, or other drink are provided during this time, however the infant can receive vitamin drops/syrups or medicine.

Gestational Age: age of infant calculated from the date of conception.

Mean: an average computed by summing the values of observations and dividing by the number of observations. Example: the average of four children aged 3, 7, 10, 12: 3 + 7 + 10 +12 = 32/4 = 8

Median: representative of the value in the middle. Example: The 50th percentile in a percentile ranking of 1 to 100.

Postnatal Age: age of infant calculated from the date of birth.

Recumbent length: distance from the crown of the head to the bottom of the feet while the child is lying down.

Stature: also referred to as height.

Skewness: a measure of the tendency for the distribution of values to be more spread out on one side than the other. Example: Positive skewness indicates that values located to the right of the mean are more spread out than are values located to the left of the mean.

Weight-for-stature: the weight of a child at a specific stature regardless of age.

Z-score: in a standard normal distribution, the z-score represents the number of standard deviations away from the population mean. In other words, it indicates the degree to which an individual's measurement deviates from what is expected for that individual.

Self-Test Questions (Answers are provided on the following page)

1. True or False: The BMI-for-age chart is recommended in place of the weight-for-stature and weight-for-length charts?

2. True or False: The clinical charts that include the 3rd and 97th percentile curves will be used for most routine clinical applications.

3. True or False: The clinical charts, which contain a data entry box to record patient data and gridlines that are scaled to metric units, can be obtained from the Internet at www.cdc.gov/growthcharts.

4. True or False: A limitation of the 1977 growth charts was the non-representative sample of primarily formula-fed, white, middle-class infants that did not accurately reflect the national population.

5. True or False: The disjunction that occurs between 24 and 36 months of age when switching from length-for-age to stature-for-age using the 1977 growth charts has been corrected in the new growth charts.

6. Which one of the following does not accurately describe a new feature of the growth charts?
    a. BMI-for-age charts are for use with infants, children and adolescents
    b. The 85th percentile to identify at risk of overweight was added to the BMI-for-age chart and weight-for-stature chart
    c. The 3rd and 97th percentiles were added to specific charts
    d. The lower limits of length and height were extended
    e. Smoothed percentile curves and z-scores agree

7. True or False: The CDC Growth Charts are appropriate to use when assessing growth in breastfed infants.

8 In NHANES III, why were the weights of children 6 years of age and older excluded from the growth reference used to develop the CDC Growth Charts?
    a. Measurement errors in NHANES III make the data invalid.
    b. The smaller sample size of older children in NHANES III made the curves statistically unreliable.
    c. There was a decrease in the prevalence of overweight among children aged 6 years and older which would change the growth reference.
    d. There was an increase in the prevalence of overweight among children aged 6 years and older in NHANES III data compared to previous data, which would have changed the growth reference by classifying fewer children and adolescents as overweight or at risk of overweight.

9. True or False: The 85th percentile curve appears on the BMI-for-age, weight-for-stature, and weight-for-length growth charts.

10. Which anthropometric index considers a child's weight, height and age?
    a. Weight-for-stature
    b. Weight-for-length
    c. BMI-for-age
    d. Weight-for-age

11. True or False: Percentiles are used to rank an individual on a given growth chart and indicate the percent of the reference population of the same gender the individual equals or exceeds.

Answers to Self-Test Questions:

1. True or False: The BMI-for-age chart is recommended in place of the weight-for-stature and weight-for-length charts?

Answer: False. The BMI-for-age chart is recommended in place of the weight-for-stature chart and is used for children 2 years and older. The weight-for-length chart is used for infants 0 to 36 months of age.

2. True or False: The clinical charts that include the 3rd and 97th percentile curves will be used for most routine clinical applications.

Answer: False. The clinical charts that will be used for most routine clinical applications contain the 5^{th} and 95^{th} percentile curves.

3. True or False: The clinical charts, which contain a data entry box to record patient data and gridlines that are scaled to metric units, can be obtained from the Internet at www.cdc.gov/growthcharts.

Answer: True

4. True or False: A limitation of the 1977 growth charts was the non-representative sample of primarily formula-fed, white, middle-class infants that did not accurately reflect the national population.

Answer: True. Since limited national survey data were available for young children, data on an infant population were available from the Fels Longitudinal Study and used to construct the infant charts (birth to 36 months). The Fels data were not representative of the national population.

5. True or False: The disjunction that occurs between 24 and 36 months of age when switching from length-for-age to stature-for-age using the 1977 growth charts has been corrected in the new growth charts.

Answer: True. The disjunction between recumbent length (length-for-age chart) and stature (stature-for-age) has been minimized. It has not been completely eliminated.

6. Which one of the following does not accurately describe a new feature of the growth charts?
    a. BMI-for-age charts are for use with infants, children and adolescents
    b. The 85th percentile to identify at risk of overweight was added to the BMI-for-age chart and weight-for-stature chart
    c. The 3rd and 97th percentiles were added to specific charts
    d. The lower limits of length and height were extended
    e. Smoothed percentile curves and z-scores agree

Answer: A – The BMI-for-age charts are for children and adolescents aged 2 to 20 not for infants and children less than 2 years of age.

7. True or False: The CDC Growth Charts are appropriate to use when assessing growth in breastfed infants.

Answer: True. Although breast and formula fed infants follow different growth patterns, the new growth reference represents the growth pattern of breast and formula fed infants combined. When assessing infants, who are breastfed exclusively, health care professionals should consider that they grow more rapidly than formula fed infants during the first 3-4 months of life. Growth is not as rapid for the remainder of the first year of life.

8. In NHANES III, why were the weights of children 6 years of age and older excluded from the growth reference used to develop the CDC Growth Charts?
    a. Measurement errors in NHANES III make the data invalid.
    b. The smaller sample size of older children in NHANES III made the curves statistically unreliable.
    c. There was a decrease in the prevalence of overweight among children aged 6 years and older which would change the growth reference.
    d. There was an increase in the prevalence of overweight among children aged 6 years and older in NHANES III data compared to previous data, which would have changed the growth reference by classifying fewer children and adolescents as overweight or at risk of overweight.

Answer: D - because a growth reference should remain stable over time; consequently, weight data for children aged 6 years and older were excluded

9. True or False: The 85th percentile curve appears on the BMI-for-age, weight-for-stature, and weight-for-length growth charts.

Answer: False. The 85^{th} percentile curve appears on the BMI-for-age and weight-for-stature charts only because at risk of overweight is used only with children 2 years and older.

10. Which anthropometric index considers a child's weight, height and age?
    a. Weight-for-stature
    b. Weight-for-length
    c. BMI-for-age
    d. Weight-for-age

Answer: C - BMI-for-age is an anthropometric index of weight and height combined with age.

11. True or False: Percentiles are used to rank an individual on a given growth chart and indicate the percent of the reference population of the same gender the individual equals or exceeds.

Answer: True

[END OF MODULE]