

# Understanding the CDC Growth Charts 2000

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and Prevention

National Center for Chronic Disease Prevention and Health Promotion

Division of Nutrition and Physical Activity

Maternal and Child Nutrition Branch



The importance of growth charts is well established. They represent a fundamental screening tool for assessing nutritional status in the pediatric population.

The new CDC growth charts were released in May 2000 at the National Nutrition Summit. The development of the growth charts was a collaborative effort between the Division of Health Examination Statistics and the Division of Nutrition and Physical Activity (DNPA) at CDC.

The new charts are based on a different reference population but they appear similar to the charts that have been in use. The 1977 charts consisted of 14 charts based on age, gender, weight-for-age, length-for-age, height-for-age, weight-for-length, and weight-for-height. The new charts have 16 charts including Body Mass Index (BMI)-for-age for boys and girls aged 2 to 20 years. The addition of BMI-for-age charts are a major change in the revised charts .

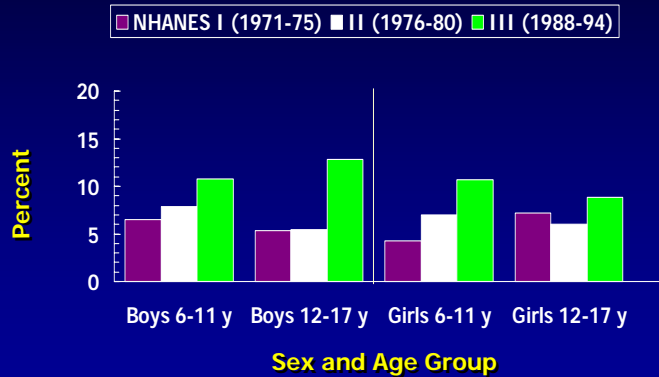
## Key Topics

- The prevalence of overweight in the pediatric population
- The rationale for tracking BMI-for-age
- How to use BMI-for-age as a screening tool



This presentation includes some of the science behind decisions made during development of the charts and discusses the rationale behind the decision to include the BMI-for-age charts and the advantages of using the BMI-for-age charts as a screening tool; you will have an opportunity to use the charts with a case study that includes an interpretation of the charts.

## Age-Adjusted Prevalence of Overweight\* From NHANES I to III<sup>1</sup>



\* > 95<sup>th</sup> percentile BMI-for-age

<sup>1</sup> Troiano et al, *Arch Pediatr Adolesc Med* 1995; 149: 1085-1091.

The rationale for excluding weight data for children 6 years and older is illustrated here. There were considerable increases in the prevalence of overweight using BMI-for-age from NHANES III compared with NHANES I and II. For boys and girls ages 6 to 11 and 12 to 17, when compared with NHANES I (purple bar) and II (white bar), there was a significant increase in the prevalence of overweight in the NHANES III data represented by the green bar. As indicated, it is desirable for a reference population to be stable over time.

If the data from NHANES III were included when the curves were being developed, fewer children would be identified as overweight.

## What Is BMI?

- Body mass index (BMI) =  
 $\text{weight (kg)}/\text{height (m)}^2$
- BMI is an effective **screening** tool; it is not a diagnostic tool
- For children, BMI is age and gender specific, so BMI-for-age is the measure used



Body Mass Index (BMI) is an anthropometric index of weight and height that is defined as body weight in kilograms divided by height in meters squared. BMI is the commonly accepted index for classifying adiposity in adults and it is recommended for use with children and adolescents.

Like weight-for-height, BMI is a screening tool used to identify individuals who are underweight or overweight. BMI is not a diagnostic tool. For example, a child who is relatively heavy may have a high BMI for his or her age or high weight-for-stature. To determine whether the child has excess fat or is overweight, further assessment is needed that might include triceps skinfold measurements, assessments of diet, health, and physical activity.

BMI is gender specific for children. Furthermore, whereas a fixed BMI cutoff is used for adults, for children, because BMI changes substantially as they get older, BMI-for-age is the measure used for ages 2 to 20 years.

# Indicators of Nutritional Status

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## Risk of overweight

BMI-for-age

85<sup>th</sup> to 95<sup>th</sup> percentile

## Overweight

Weight-for-length  
BMI-for-age

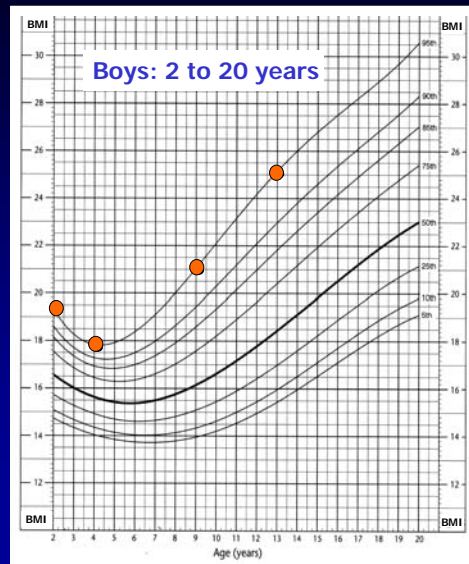
≥95<sup>th</sup> percentile



“Overweight” rather than obesity is the term preferred for describing infants or children greater than or equal to the 95th percentile of weight-for-length or BMI-for-age. The 85th percentile is included on the BMI-for-age and the weight-for-stature charts. Expert committees have indicated that children and adolescents aged 2 to 20 years between the 85th and 95th percentiles are at risk of being overweight.

Evaluating a child’s pattern of growth over time is more important than a single measure of size. The pattern of growth is based on periodic measurements which are tracked on a percentile line as a child grows.

## For Children, BMI Differs by Age



Example: 95th  
Percentile Tracking

Age	BMI
2 yrs	19.3
4 yrs	17.8
9 yrs	21.0
13 yrs	25.1

Because adiposity varies with age and gender, BMI must be age and gender specific. As illustrated here, growth has been established along the 95th percentile with BMI-for-age reaching a minimum at 4 years of age and then increasing.

From age 6 to 19 years, values of BMI-for-age for females exceed those for males.

## Advantages of BMI-for-Age

- Provides a reference for adolescents that was not previously available
- Consistent with adult standards so can be used continuously from 2 years of age to adulthood
- Tracks childhood overweight into adulthood

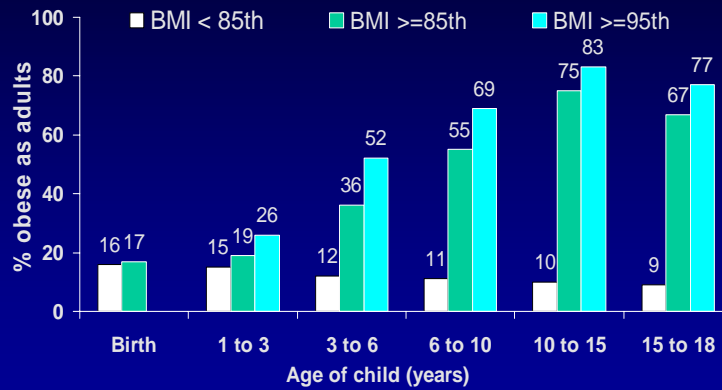


There are several advantages to using BMI-for-age as a screening tool for overweight and underweight. BMI-for-age provides a reference for adolescents that was not previously available. When the 1977 NCHS growth charts were developed, weight-for-height percentiles were provided only for prepubescent girls up to 10 years and for boys up to 11.5 years. Age and stage of sexual maturation are highly related to body fatness. BMI-for-age is the only indicator that allows us to plot a measure of weight and height with age on the same chart. BMI-for-age was not available in the 1977 charts.

Another advantage is that BMI-for-age is the measure that is consistent with the adult index so it can be used continuously from 2 years of age to adulthood.

These characteristics allow us to use the BMI to track body size throughout the life cycle. BMI in childhood is a determinant of adulthood BMI.

## Tracking BMI-for-Age from Birth to 18 Years with Percent of Overweight Children who Are Obese at Age 25<sup>1</sup>



Whitaker et al. *NEJM*: 1997;337:869-873



The tracking of BMI that occurs from childhood to adulthood is clearly shown in data from a study by Robert Whitaker (Children's Hospital Medical Center in Cincinnati) and his colleagues. They examined the probability of obesity in young adults in relation to the presence or absence of overweight at various times during childhood. For example, in children 10 to 15 years old, 10% of those with BMI-for-age < 85th percentile were obese at age 25 whereas 75% of those with a BMI-for-age  $\geq$  85th percentile were obese as adults and 80% of those with a BMI-for-age  $\geq$  95th percentile were obese at age 25. (The sample size for the study was 854.) From this study, it is clear that an overweight child is more likely than a child of normal weight to be obese as an adult.

Other studies have shown this same trend of tracking occurring from childhood to adulthood.

## Advantages of BMI-for-Age

- **BMI-for-age relates to health risks**
  - Correlates with clinical risk factors for cardiovascular disease including hyperlipidemia, elevated insulin, and high blood pressure
  - BMI-for-age during pubescence is related to lipid levels and high blood pressure in middle age
- **Compares well with**
  - Weight-for-stature measurements
  - Measures of body fat



Another advantage of using BMI-for-age to screen for overweight or at risk of overweight in children is that it correlates with clinical risk factors for cardiovascular disease including hyperlipidemia, elevated insulin and high blood pressure. Freedman and colleagues used data from the Bogalusa Heart Study and found that approximately 60% of 5 to 10 year-old children who were overweight had at least one biochemical or clinical risk factor for cardiovascular disease such as those just mentioned, and 20% had two or more risk factors.\*

We know that risk factors in children become chronic diseases in adults. BMI-for-age during pubescence is related to lipid and lipoprotein levels and blood pressure in middle age.

\*Freedman et al., The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. *Pediatrics* 1999;103:1175-1182

BMI-for-age compares well with both weight-for-stature measurements and measures of body fat.

A study completed by researchers at CDC compared the performance of BMI-for-age and weight-for-stature with fatness measured by dual energy x-ray absorptometry, a direct measure of adiposity. NHANES III data were used to test how well BMI-for-age predicts underweight (below 15th percentile) and overweight (>85th percentile) relative to the traditional weight-for-stature in children 2 to 19 years old. Both BMI-for-age and weight-for-stature performed equally well in screening for underweight and overweight among children 3 to 5 years of age. For school-aged children (6 to 11 and 12 to 19 age groups), BMI-for-age was slightly better than weight-for-stature in predicting underweight and overweight. Ratios of weight relative to stature such as BMI-for-age and weight-for-height may be used as indirect measures of overweight that correlate with more direct measures.

BMI-for-age is significantly correlated with subcutaneous and total body fatness in adolescents. It is not a measure of body fatness but rather a proxy for body fat.

## Why Use BMI-for-Age?

- Recommended by expert committees to evaluate overweight
  - Guidelines for Overweight in Adolescent Preventive Services ([Am J Clin Nutr](#) 1994;59:307-316)
  - Obesity Evaluation and Treatment: Expert Committee Recommendations ([Pediatrics](#) 1998 Sept;(102)3:e 29)
  - Assessment of Childhood and Adolescent Obesity: International Obesity Task Force ([Am J Clin Nutr](#) 1999, 70,suppl)



Because of the numerous advantages of using BMI-for-age for assessing overweight in children and adolescents several expert committees and advisory groups have recommended BMI-for-age as the accepted measure. The published references are given here.

In 1994, an expert committee was convened by the Maternal and Child Health Bureau (MCHB), American Academy of Pediatrics and the American Medical Association with support from the CDC, to advise *Bright Futures: National Guidelines for Health Supervision of Infants, Children and Adolescents and Guidelines for Adolescent Preventive Services* (GAPS). The committee recommended using BMI-for-age to routinely screen for overweight in adolescents.

Subsequently, an expert committee on pediatric obesity was convened by the MCHB to consider recommendations for children. They recommended that BMI-for-age be used to screen children aged 2 years and older for overweight and risk of overweight.

In 1999, a workshop convened by the International Obesity Task Force concluded that BMI is a reasonable measure assessing overweight in children and adolescents and they recommended using percentiles that correspond to a BMI of 25 and 30, respectively, in young adults to identify at risk of overweight and overweight in children and adolescents.

## Can you *see* risk?



Photo from UC Berkeley Longitudinal Study, 1973

### Patient A

- This boy is 3 years, 3 weeks old.
- Is his BMI-for-age
  - below the 5<sup>th</sup> percentile?
  - 5<sup>th</sup> to <85<sup>th</sup> percentile: normal?
  - ≥85<sup>th</sup> to <95<sup>th</sup> percentile: at risk for overweight?
  - - ≥95<sup>th</sup> percentile: overweight?

*What do you think?*

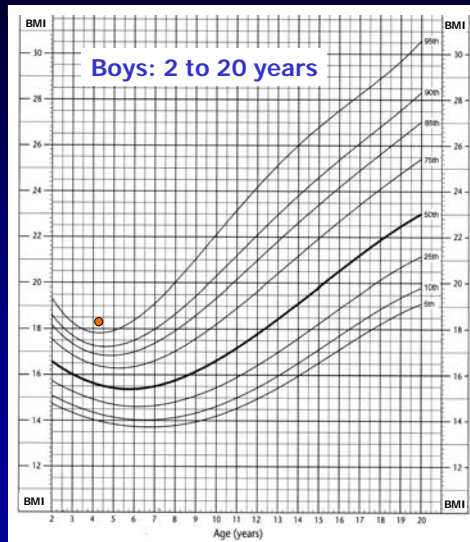
In the next three slides, we want you to do a self-test to see how well you can screen for risk of overweight in children by looking. We want you to try to identify children with a BMI-for-age equal to or greater than the 85th percentile and less than the 95th percentile.

It has been said that “few medical conditions can be diagnosed as confidently by untrained individuals as gross obesity.” Yet it is very difficult to distinguish children who are at risk of overweight from normal children. In childhood, the distinction is made more difficult by age-related physiological variations.

So, see how you do with the three photos we will show you. This first one is a boy who is 3 years old. Does he appear underweight, normal, at risk of overweight, or overweight?

What do you think?

## Plotted BMI-for-Age



### Patient A

#### Measurements:

Age= 3 years, 3 weeks

Height= 100.8 cm  
(39.7 in)

Weight= 18.6 kg  
(41 lb)

BMI = 18.3

BMI-for-age =  
>95<sup>th</sup> percentile  
**Overweight**

This boy's height is 39.7 inches and his weight is 41 pounds. Using his height and weight, we calculated his BMI-for-age to be 18.3.

Plotted on the BMI-for-age chart for boys, his BMI-for-age falls above the 95th percentile. Likewise, when plotted on the weight-for-stature grid, it falls above the 95th percentile.

## Can you *see* risk?



### Patient B

- This girl is 4 years, 4 weeks old.
- Is her BMI-for-age
  - below the 5<sup>th</sup> percentile?
  - 5<sup>th</sup> to <85<sup>th</sup> percentile: normal?
  - $\geq 85^{\text{th}}$  to <95<sup>th</sup> percentile: at risk for overweight?
  - -  $\geq 95^{\text{th}}$  percentile: overweight?

*What do you think?*

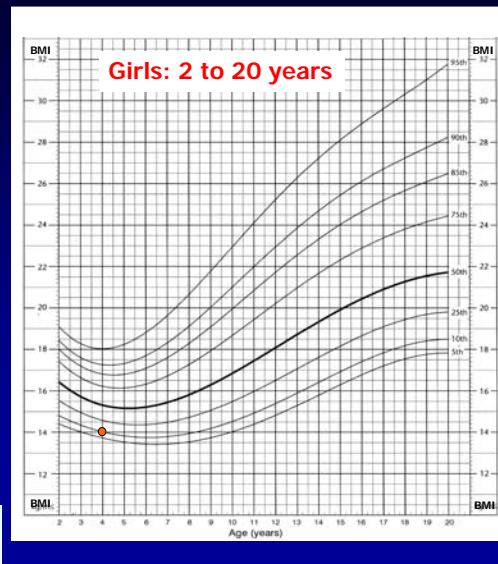


Photo from UC Berkeley Longitudinal Study, 1974

Here is a 4-year-old girl. Does she appear underweight, normal, at risk for overweight, or overweight?

What do you think?

## Plotted BMI-for-Age



### Patient B

#### Measurements:

Age= 4 years, 4 weeks

Height= 106.4 cm  
(41.9 in)

Weight= 15.7 kg  
(34.5 lb)

BMI = 13.9

BMI-for-age=  
10<sup>th</sup> percentile  
**Normal**

This girl's height is 41.9 inches and her weight is 34.5 pounds. Using her height and weight we calculated BMI-for-age to be 13.9.

Plotted on the BMI-for-age chart for girls, her BMI-for-age falls on the 10th percentile. Likewise, when plotted on the weight-for stature grid, it falls around the 10th percentile.

## Can you see risk?



### Patient C

- This girl is 4 years old.
- Is her BMI-for-age
  - below the 5<sup>th</sup> percentile?
  - 5<sup>th</sup> to <85<sup>th</sup> percentile: normal?
  - $\geq$ 85<sup>th</sup> to <95<sup>th</sup> percentile: at risk for overweight?
  - $\geq$ 95<sup>th</sup> percentile: overweight?

*What do you think?*



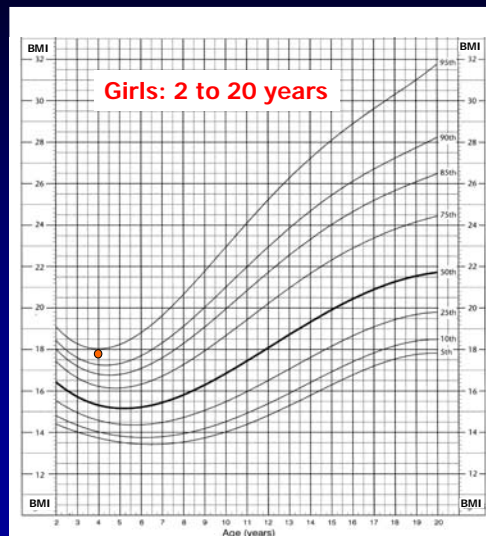
Photo from UC Berkeley Longitudinal Study, 1973

Here is an image of another 4-year-old girl.

Does she appear at risk of overweight?

What do you think?

## Plotted BMI-for-Age



### Patient C

#### Measurements:

Age=4 years

Height=99.2 cm  
(39.2 in)

Weight=17.55 kg  
(38.6 lb)

BMI = 17.8

BMI-for-age=  
94<sup>th</sup> percentile

**At risk for overweight**

This girl's height is 39.2 inches and her weight is 38.6 pounds. Using her height and weight we calculated BMI-for-age to be 17.8.

Plotted on the BMI-for-age chart for girls, her BMI-for-age falls on the 94th percentile. Likewise, when plotted on the weight-for-stature grid, it falls above the 94th percentile.

She is classified as at risk of overweight.

The point of this exercise is to demonstrate the difficulty of making an accurate visual assessment of at risk of overweight. BMI-for-age must be determined and plotted on the appropriate growth chart.

## Calculating BMI with the English System

**Formula:**  $\text{weight (lb)} / [\text{height (in)}]^2 \times 703$

**Calculation:**  $[\text{weight (lb)} / \text{height (in)} / \text{height (in)}] \times 703$

**Example: A child's weight = 37 pounds, 4 ounces and  
height = 41 1/2 inches  
(convert fractions to decimal value)**

**BMI =  $[37.25 \text{ lb} / 41.5 \text{ in} / 41.5 \text{ in}] \times 703 = 15.2$**



We will show you two methods for determining BMI, one using the English numeric system and one using the metric system.

When using English measurements, the formula is expressed as weight in pounds divided by height in inches squared, multiplied by a conversion factor of 703.

Now we will calculate a sample male patient's weight with the English numeric system. His weight is 37 pounds and 4 ounces and his height is 41 1/2 inches. Before continuing, we must change the fractions and ounces to decimal values. Thus the patient's weight becomes 37.25 and his height becomes 41.5. You then divide the patient's weight, 37.25, by 41.5 squared or divide his weight by 41.5 two times. Multiply the value you get by 703. His BMI is 15.2.

## Calculating BMI with the Metric System

**Formula:**  $\text{weight (kg)} / [\text{height (m)}]^2$

**Calculation:**  $[\text{weight (kg)} / \text{height (cm)} / \text{height (cm)}] \times 10,000$

**Example:** A child's weight=16.9 kg and height=105.4 cm

**BMI =  $[16.9 \text{ kg} / 105.4 \text{ cm} / 105.4 \text{ cm}] \times 10,000 = 15.2$**



Using the metric system, BMI is calculated using weight in kilograms divided by height in meters squared. Because height is rarely recorded in meters, it can be converted from meters to centimeters by multiplying meters by 100. Then divide weight by centimeters squared, which is the same as dividing weight by the height twice as shown in the formula. Then multiply by 10,000. Suppose we know that the patient's weight is 16.9 kg and his height is 105.4 cm. When the calculations are completed we find his BMI to be 15.2.

BMI can also be determined by looking it up on a standard table of BMI values or using a Web calculator.

BMI can be calculated with a standard hand calculator and using the same mathematical formula.

## Interpreting the BMI-for-Age Chart

- BMI-for-age indicates a child's weight in relation to his/her height for a specific age and gender
- Need a series of BMI plots to determine the growth trend
- If indices deviate from normal growth patterns, further assessment may be needed



To summarize:

For children, BMI is age and gender specific

When assessing physical growth, it is necessary to have a series of accurate measurements to establish a growth pattern. Having a series of measurements takes into consideration short- and longer-term conditions.

Growth patterns that fall outside the established parameters, the 5th and 95th percentile for any given anthropometric indices, suggest the need to recheck measurements, plots, and calculations and make any necessary corrections or adjustments. If these are correct, further evaluation is required to determine the cause.

# CDC Growth Charts

## Electronic Copies

<http://www.cdc.gov/growthcharts/>

## Online Growth Chart Training

<http://www.cdc.gov/nccdphp/dnpa/growthcharts/training/modules/index.htm>

## BMI Calculation Tools

[http://www.cdc.gov/nccdphp/dnpa/growthcharts/bmi\\_tools.htm](http://www.cdc.gov/nccdphp/dnpa/growthcharts/bmi_tools.htm)



To get copies of the BMI-for-age clinical growth charts download or print from the following Web site <http://www.cdc.gov/growthcharts/>

To receive additional training on the BMI-for-age growth charts online go to <http://www.cdc.gov/nccdphp/dnpa/growthcharts/training/modules/index.htm>

To receive additional BMI Calculation Tools go to the following Website [http://www.cdc.gov/nccdphp/dnpa/growthcharts/bmi\\_tools.htm](http://www.cdc.gov/nccdphp/dnpa/growthcharts/bmi_tools.htm)

## Additional Resources

Pediatrics, Supplement, Volume 110, #1, July 2002

Center for Weight and Health at UC Berkeley

<http://nature.berkeley.edu/cwh/resources/childrenandweight.shtml>

<http://nature.berkeley.edu/cwh/resources/educationtoolsint.shtml>



PEP-1644L (6/03)

For additional resources for understanding the issue of pediatric overweight and obesity, comprehensive information is available in the special supplement to *Pediatrics*, volume 110, #1 published in July 2002.

Other useful information and resources can be found at the University of California at Berkeley Center for Weight and Health web sites shown here.