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JAMA. published online Jan 13, 2010; (doi:10.1001/jama.2009.2012)

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Prevalence of High Body Mass Index in US Children and Adolescents, 2007-2008

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HIGH BODY MASS INDEX (BMI) among children and adolescents continues to be a public health concern in the United States. Children with high BMI often become obese adults,¹ and obese adults are at risk for many chronic conditions such as diabetes, cardiovascular disease, and certain cancers.² High BMI in children may also have immediate consequences, such as elevated lipid concentrations and blood pressure.³ Since 1980, the prevalence of BMI for age at or above the 95th percentile (sometimes termed “obese”) has tripled among school-age children and adolescents, and it remains high at approximately 17%.⁴⁻⁶ However, the prevalence of BMI for age at or above the 95th percentile among children and adolescents showed no significant changes between 1999 and 2006 for both boys and girls or among non-Hispanic white, non-Hispanic black, and Mexican American individuals.⁶

Using data from 2007-2008, this article provides the most recent estimates of high BMI among children and adolescents aged 2 through 19 years and high weight for recumbent length among infants and toddlers. In addition, trends in prevalence between 1999 and 2008 are analyzed.

See also pp 235 and 275.

Context The prevalence of high body mass index (BMI) among children and adolescents in the United States appeared to plateau between 1999 and 2006.

Objectives To provide the most recent estimates of high BMI among children and adolescents and high weight for recumbent length among infants and toddlers and to analyze trends in prevalence between 1999 and 2008.

Design, Setting, and Participants The National Health and Nutrition Examination Survey 2007-2008, a representative sample of the US population with measured heights and weights on 3281 children and adolescents (2 through 19 years of age) and 719 infants and toddlers (birth to 2 years of age).

Main Outcome Measures Prevalence of high weight for recumbent length (≥ 95 th percentile of the Centers for Disease Control and Prevention growth charts) among infants and toddlers. Prevalence of high BMI among children and adolescents defined at 3 levels: BMI for age at or above the 97th percentile, at or above the 95th percentile, and at or above the 85th percentile of the BMI-for-age growth charts. Analyses of trends by age, sex, and race/ethnicity from 1999-2000 to 2007-2008.

Results In 2007-2008, 9.5% of infants and toddlers (95% confidence interval [CI], 7.3%-11.7%) were at or above the 95th percentile of the weight-for-recumbent-length growth charts. Among children and adolescents aged 2 through 19 years, 11.9% (95% CI, 9.8%-13.9%) were at or above the 97th percentile of the BMI-for-age growth charts; 16.9% (95% CI, 14.1%-19.6%) were at or above the 95th percentile; and 31.7% (95% CI, 29.2%-34.1%) were at or above the 85th percentile of BMI for age. Prevalence estimates differed by age and by race/ethnic group. Trend analyses indicate no significant trend between 1999-2000 and 2007-2008 except at the highest BMI cut point (BMI for age ≥ 97 th percentile) among all 6- through 19-year-old boys (odds ratio [OR], 1.52; 95% CI, 1.17-2.01) and among non-Hispanic white boys of the same age (OR, 1.87; 95% CI, 1.22-2.94).

Conclusion No statistically significant linear trends in high weight for recumbent length or high BMI were found over the time periods 1999-2000, 2001-2002, 2003-2004, 2005-2006, and 2007-2008 among girls and boys except among the very heaviest 6- through 19-year-old boys.

JAMA. 2010;303(3):doi:10.1001/jama.2009.2012

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METHODS

Analyses are based on data from the National Health and Nutrition Examination Survey (NHANES), a complex, multistage probability sample of the US civilian, noninstitutionalized population.⁷ The survey was conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) and was reviewed and approved by the NCHS institutional review board. Parents provided

informed written consent for children younger than 18 years, and children aged 7 years and older provided assent. Standardized protocols and calibrated equipment were used to obtain measurements of height and weight.

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Excess weight in infants and toddlers is defined⁸ as weight at or above the 95th percentile of the sex-specific 2000 CDC weight-for-recumbent-length growth charts (which are independent of age). Excess weight among children and adolescents aged 2 through 19 years is defined based on BMI in relation to the 2000 CDC sex-specific BMI-for-age growth charts.⁹ Body mass index is calculated as weight in kilograms divided by height in meters squared, rounded to 1 decimal place.

There have been recent changes in the nomenclature for specific levels of high BMI for age in children. In the 1980s and 1990s, expert committees recommended that children and adolescents aged 2 through 19 years at or above the 95th percentile of BMI for age be labeled "overweight" and children between the 85th and 95th percentiles be labeled "at risk for overweight."^{10,11} A more recent expert committee recommended that these groups of children be labeled "obese" and "overweight," respectively.¹²

In this article, we present estimates for infants and toddlers at or above the 95th percentile of weight for recumbent length and for children and adolescents at 3 levels of high BMI: BMI for age at or above the 97th, at or above the 95th, and at or above the 85th percentiles. For children and adolescents, because of recent changes in terminology and because we present an estimate for at or above the 97th percentile, which does not have a recommended label, we use the phrase "high BMI" to refer to all 3 BMI-for-age cut points. Because the 95th percentiles of BMI for age among 18- and 19-year-old females and 19-year-old males are above 30, a teenager could be considered obese by the adult definition but not have a high BMI based on the 95th percentile of BMI for age. Consequently, the percentage of adolescents (12-19 years of age) at or above the adult definition of obesity ($BMI \geq 30$)² was also estimated.

Participants reported their race and ethnicity after being shown a list that

included an open-ended response. Participants aged 16 years and older reported their own race and ethnicity, and for children younger than 16 years, a family member reported race and ethnicity. For the purposes of this analysis, race/ethnic groups were categorized as non-Hispanic white, non-Hispanic black, total Hispanic, and Mexican American. Prevalence estimates are shown for both total Hispanic individuals and Mexican American individuals. Mexican American individuals have been oversampled since 1999-2000, so trend analyses were performed on the total population, non-Hispanic white, non-Hispanic black, and Mexican American race/ethnic groups. Total Hispanic individuals were not oversampled prior to 2007-2008. Analyses of the total population included an "other" group of primarily Asian individuals, but this group did not have sufficient sample size to be analyzed separately.

Examination response rates for NHANES 2007-2008 were similar to prior surveys.^{4-6,13} In 2007-2008, the overall unweighted examination response rate for children and adolescents was 82.1%, calculated as the number of examined children and adolescents divided by the total number selected to participate in the sample. Less than 1% of examined children were excluded from the analysis because of missing data for weight or height (or recumbent length for children younger than 2 years). This report includes data for 3281 children and adolescents (2-19 years of age) and 719 infants and toddlers (birth to 2 years of age) from 2007-2008. The sample size is smaller than that in 2005-2006 ($n=4207$) because adolescents were oversampled only in NHANES 1999-2006.

NHANES was designed to detect a 10% difference between proportions with 80% power, a design effect of 1.5, and a sample size of approximately 420. To test for smaller differences with the same power, a larger sample size is needed. For example, to test a change from 15% to 10% (a 5% difference) requires a sample size of approximately

1150. Because trend analyses combine several time periods, the statistical test for trends requires fewer sample persons per time period. Sufficient power exists when combining the survey periods to detect a change of 5%.

Statistical analyses were done using SAS (version 9.2; SAS Institute Inc, Cary, North Carolina) and SUDAAN (version 10; Research Triangle Institute, Research Triangle Park, North Carolina). All analyses excluded pregnant females. Sample weights were used to account for differential nonresponse and noncoverage and to adjust for planned oversampling of some groups. Standard errors were estimated with SUDAAN using Taylor series linearization, a design-based approach. Differences between age groups and race/ethnic groups were tested using logistic regression models. Because significant interactions were found between sex and race/ethnic group, sex-specific models were run. Overall and within each race/ethnic group, differences by sex were tested using *t* tests with a Bonferroni correction based on 4 comparisons (4 race/ethnic groups); thus, a *P* value of .05 divided by 4, .0125, is considered significant.

Linear trends were tested over 5 time periods (1999-2000, 2001-2002, 2003-2004, 2005-2006, and 2007-2008) using time period as both a continuous and a categorical variable in logistic regression models. Time period was analyzed as a categorical variable to examine the possibility that 1 or 2 time periods were leading to any differences that were found significant when time period was analyzed as a continuous variable. Odds ratios (ORs) associated with the trends and *P* values for the Satterthwaite adjusted *F* statistic from models that contain time period as a continuous variable are presented in the text. A Bonferroni correction was made based on 6 different comparisons (2 sexes and 3 race/ethnic groups); thus, a *P* value of .05 divided by 6, .008, is considered significant.

Analysis of trends was slightly different for different age groups given dif-

Table 1. Prevalence of High Weight for Recumbent Length Among US Children From Birth to 2 Years of Age, 2007-2008^{a,b}

	% (95% CI)				
	All ^c	Hispanic ^d	Mexican American	Non-Hispanic White	Non-Hispanic Black
Both sexes	9.5 (7.3-11.7)	12.5 (7.3-17.6)	9.2 (5.8-12.6)	8.7 (4.6-12.9)	10.3 (1.6-19.1) ^e
Boys	10.0 (6.8-13.1)	14.9 (8.2-21.5)	11.6 (5.7-17.5)	7.5 (3.8-11.2)	12.4 (0.7-24.0) ^e
Girls	9.0 (6.3-11.8)	10.2 (3.9-16.4)	6.7 (2.9-10.6)	10.0 (4.5-15.4)	Not shown ^f

Abbreviations: CI, confidence interval.
^a“High” indicates ≥95th percentile of the Centers for Disease Control and Prevention 2000 weight-for-recumbent-length growth charts.
^bData come from the National Health and Nutrition Examination Survey (NHANES).
^cIncludes racial/ethnic groups not shown separately.
^dIncludes Mexican American individuals.
^eDoes not meet standard of statistical reliability and precision (relative standard error ≥30% but <40%).
^fDoes not meet standard of statistical reliability and precision (relative standard error ≥40%).

ferent definitions for excess weight and differences in prevalence between age groups. Sex-specific trend analyses were done separately for infants and children aged from birth to 2 years and for preschool children aged 2 through 5 years, based on multiple logistic regression models adjusted for race/ethnicity. Preliminary analyses showed no difference in prevalence between the 6- through 11-year-old and 12- through 19-year-old age groups, which is consistent with previous NHANES studies. Consequently, we combined these

Table 2. Prevalence of High BMI in US Children and Adolescents Aged 2 Through 19 Years by Sex, Age, and Race/Ethnicity, 2007-2008^{a,b}

	% (95% CI) by Age				
	2-19 y	6-19 y	2-5 y	6-11 y	12-19 y
All^c					
BMI for age ≥97th percentile					
Both sexes	11.9 (9.8-13.9)	13.3 (11.1-15.5)	6.9 (4.8-9.0)	14.5 (12.2-16.8)	12.5 (9.9-15.0)
Boys	13.0 (10.5-15.5)	15.1 (12.3-17.9)	5.8 (3.4-8.2)	16.3 (13.4-19.1)	14.3 (10.8-17.8)
Girls	10.6 (8.5-12.8)	11.4 (9.2-13.5)	8.1 (4.6-11.7)	12.6 (9.3-15.9)	10.4 (8.0-12.8)
BMI for age ≥95th percentile					
Both sexes	16.9 (14.1-19.6)	18.7 (15.8-21.7)	10.4 (7.6-13.1)	19.6 (17.1-22.2)	18.1 (14.5-21.7)
Boys	17.8 (14.7-20.8)	20.1 (16.5-23.6)	10.0 (7.0-13.1)	21.2 (17.9-24.6)	19.3 (14.6-23.9)
Girls	15.9 (12.6-19.1)	17.3 (13.9-20.7)	10.7 (6.4-15.1)	18.0 (13.6-22.4)	16.8 (12.7-20.9)
BMI for age ≥85th percentile					
Both sexes	31.7 (29.2-34.1)	34.7 (32.2-37.2)	21.2 (17.3-25.1)	35.5 (32.4-38.7)	34.2 (30.5-37.8)
Boys	32.1 (28.6-35.6)	35.3 (31.4-39.2)	21.0 (16.0-26.0)	35.9 (30.1-41.6)	35.0 (30.0-39.9)
Girls	31.3 (27.8-34.8)	34.1 (30.1-38.1)	21.4 (16.8-26.0)	35.2 (29.5-40.8)	33.3 (28.3-38.3)
Hispanic Individuals^d					
BMI for age ≥97th percentile					
Both sexes	15.2 (12.9-17.5)	17.0 (14.2-19.8)	9.8 (6.7-12.9)	19.3 (15.9-22.6)	15.2 (11.5-18.9)
Boys	17.6 (14.5-20.7)	19.6 (15.8-23.4)	12.0 (8.3-15.8)	21.5 (17.7-25.4)	18.1 (12.8-23.3)
Girls	12.6 (9.2-16.0)	14.3 (10.3-18.4)	7.4 (2.9-11.8)	17.0 (12.1-21.9)	12.1 (6.8-17.5)
BMI for age ≥95th percentile					
Both sexes	20.9 (18.0-23.8)	23.2 (20.0-26.4)	14.2 (10.3-18.2)	25.1 (20.5-29.7)	21.7 (18.0-25.4)
Boys	24.4 (20.8-28.1)	26.7 (22.7-30.8)	17.8 (12.8-22.8)	28.3 (23.5-33.1)	25.5 (20.4-30.7)
Girls	17.2 (13.6-20.8)	19.5 (15.3-23.7)	10.4 (5.7-15.1)	21.9 (16.1-27.8)	17.5 (11.2-23.9)
BMI for age ≥85th percentile					
Both sexes	38.2 (34.3-42.2)	41.8 (37.1-46.5)	27.7 (22.6-32.7)	42.6 (37.8-47.4)	41.2 (34.5-48.0)
Boys	39.9 (34.9-45.0)	43.1 (36.8-49.4)	30.7 (24.1-37.4)	43.7 (38.3-49.2)	42.7 (32.2-53.1)
Girls	36.4 (31.5-41.4)	40.5 (34.5-46.5)	24.3 (18.7-30.0)	41.5 (34.3-48.7)	39.7 (30.7-48.6)
Mexican American Individuals					
BMI for age ≥97th percentile					
Both sexes	14.9 (11.4-18.4)	17.2 (12.7-21.8)	8.4 (5.8-11.0)	19.6 (14.9-24.3)	15.2 (8.9-21.4)
Boys	17.7 (13.3-22.1)	19.9 (14.4-25.5)	11.8 (8.3-15.3)	21.4 (15.9-26.9)	18.7 (10.6-26.7)
Girls	11.9 (8.4-15.4)	14.5 (9.7-19.3)	Not shown ^e	17.8 (11.1-24.5)	11.6 (5.3-17.8)
BMI for age ≥95th percentile					
Both sexes	20.8 (16.3-25.3)	23.4 (18.2-28.6)	13.7 (8.9-18.6)	24.7 (18.8-30.6)	22.2 (15.8-28.6)
Boys	24.9 (20.1-29.7)	26.9 (20.8-33.1)	19.3 (14.7-24.0)	27.1 (18.8-35.4)	26.8 (19.6-34.0)
Girls	16.5 (11.3-21.8)	19.7 (13.8-25.6)	7.5 (1.5-13.6)	22.3 (15.3-29.3)	17.4 (8.3-26.5)
BMI for age ≥85th percentile					
Both sexes	38.9 (33.6-44.3)	43.0 (37.0-49.0)	27.7 (20.2-35.2)	41.7 (34.7-48.7)	44.1 (35.3-52.9)
Boys	41.7 (36.2-47.1)	45.1 (36.9-53.3)	32.4 (23.7-41.2)	44.0 (35.3-52.7)	46.1 (31.5-60.6)
Girls	36.1 (30.0-42.1)	40.8 (35.0-46.6)	22.5 (12.9-32.1)	39.3 (29.1-49.5)	42.1 (33.8-50.5)

(continued)

Table 2. Prevalence of High BMI in US Children and Adolescents Aged 2 Through 19 Years by Sex, Age, and Race/Ethnicity, 2007-2008^{a,b} (continued)

	% (95% CI) by Age				
	2-19 y	6-19 y	2-5 y	6-11 y	12-19 y
Non-Hispanic White Individuals					
BMI for age \geq 97th percentile					
Both sexes	10.5 (7.2-13.9)	11.9 (8.1-15.6)	5.5 (2.2-8.9)	14.0 (10.0-18.1)	10.5 (6.4-14.6)
Boys	11.4 (7.7-15.1)	14.0 (9.6-18.4)	Not shown ^e	16.2 (10.9-21.5)	12.5 (7.6-17.5)
Girls	9.6 (5.6-13.5)	9.6 (5.6-13.6)	9.5 (2.9-16.1) ^f	11.6 (6.4-16.9)	8.3 (4.2-12.4)
BMI for age \geq 95th percentile					
Both sexes	15.3 (11.0-19.6)	17.0 (12.2-21.7)	9.1 (4.8-13.3)	19.0 (14.5-23.5)	15.6 (9.9-21.3)
Boys	15.7 (11.5-19.9)	18.2 (13.4-23.0)	6.6 (2.1-11.0) ^f	20.5 (14.9-26.0)	16.7 (10.7-22.7)
Girls	14.9 (9.6-20.2)	15.6 (9.8-21.5)	12.0 (4.6-19.4)	17.4 (10.2-24.5)	14.5 (7.8-21.1)
BMI for age \geq 85th percentile					
Both sexes	29.3 (25.2-33.5)	32.5 (28.3-36.8)	17.4 (11.2-23.6)	34.5 (30.4-38.5)	31.3 (25.2-37.3)
Boys	29.5 (24.4-34.6)	33.4 (28.1-38.6)	15.6 (8.0-23.2)	34.6 (26.1-43.2)	32.6 (25.3-39.8)
Girls	29.2 (22.9-35.5)	31.6 (24.4-38.9)	19.5 (11.6-27.4)	34.3 (24.7-43.9)	29.9 (21.5-38.2)
Non-Hispanic Black Individuals					
BMI for age \geq 97th percentile					
Both sexes	14.9 (12.4-17.4)	16.6 (13.6-19.6)	8.7 (5.0-12.4)	13.8 (9.3-18.3)	18.5 (14.7-22.4)
Boys	14.1 (9.0-19.2)	15.7 (9.5-21.9)	8.0 (3.8-12.3)	12.2 (5.0-19.3)	18.2 (11.0-25.5)
Girls	15.7 (12.0-19.5)	17.5 (14.3-20.8)	Not shown ^e	15.6 (7.6-23.5)	18.9 (15.1-22.7)
BMI for age \geq 95th percentile					
Both sexes	20.0 (17.3-22.6)	22.3 (19.8-24.9)	11.4 (7.1-15.8)	19.4 (13.9-24.8)	24.4 (21.7-27.0)
Boys	17.3 (12.3-22.2)	18.9 (13.4-24.4)	11.1 (5.5-16.7)	17.7 (10.3-25.1)	19.8 (13.9-25.6)
Girls	22.7 (17.7-27.8)	25.9 (21.1-30.7)	11.7 (1.7-21.7) ^f	21.1 (11.2-31.0)	29.2 (23.2-35.2)
BMI for age \geq 85th percentile					
Both sexes	35.9 (32.6-39.3)	38.7 (34.5-43.0)	26.0 (20.5-31.5)	37.6 (32.7-42.5)	39.5 (33.5-45.5)
Boys	33.0 (26.8-39.3)	34.4 (26.7-42.1)	28.1 (19.1-37.1)	36.4 (28.7-44.0)	33.0 (23.2-42.8)
Girls	39.0 (34.0-43.9)	43.3 (37.3-49.2)	23.9 (13.2-34.7)	38.9 (29.6-48.3)	46.3 (38.3-54.2)

Abbreviations: BMI, body mass index; CI, confidence interval.

^aBased on the Centers for Disease Control and Prevention 2000 growth charts.^bBody mass index (calculated as weight in kilograms divided by height in meters squared) was rounded to 1 decimal place. Pregnant adolescents were excluded. Data come from the National Health and Nutrition Examination Survey (NHANES).^cIncludes racial/ethnic groups not shown separately.^dIncludes Mexican American individuals.^eDoes not meet standard of statistical reliability and precision (relative standard error \geq 40%).^fDoes not meet standard of statistical reliability and precision (relative standard error \geq 30% but $<$ 40%).

ages to obtain a larger sample size and allow for separate trend analyses for each sex and race/ethnic subgroup. For all analyses of children and adolescents aged 2 through 19 years, trend analyses were conducted on 3 mutually exclusive BMI groups: greater than or equal to the 97th percentile of BMI for age, less than the 97th percentile but greater than or equal to the 95th percentile, and less than the 95th percentile but greater than or equal to the 85th percentile of BMI for age. Alternative analyses on overlapping groups would represent dependent trend tests and were less efficient. Prevalence estimates shown in tables and figures are shown for each BMI cut point cumulatively (eg, BMI for age \geq 85th, \geq 95th, and \geq 97th percentiles) because they

represent the usual custom. For graphical comparisons of BMI, the frequency distributions of BMI from 1999-2000 and 2007-2008 were smoothed using a nonparametric smoothing algorithm, based on sequential calculations of running medians for groups of adjacent points.¹⁴ This algorithm essentially draws a line through a histogram.

RESULTS

Unweighted sample sizes for NHANES 2007-2008 by age, race/ethnicity, and sex are shown in the eTable (available at <http://www.jama.com>).

Detailed prevalence estimates of high weight for recumbent length among infants and toddlers in 2007-2008 are shown in TABLE 1. Approximately 10%

(9.5%; 95% confidence interval [CI], 7.3%-11.7%) of infants and toddlers younger than 2 years were at or above the 95th percentile of the weight-for-recumbent-length growth charts. Similarly, detailed estimates for children and adolescents aged 2 through 19 years are found in TABLE 2. In this age group, 11.9% (95% CI, 9.8%-13.9%) were at or above the 97th percentile, 16.9% (95% CI, 14.1%-19.6%) were at or above the 95th percentile, and 31.7% (95% CI, 29.2%-34.1%) were at or above the 85th percentile of BMI for age. More than 10% of 2- through 5-year-old children (10.4%; 95% CI, 7.6%-13.1%), 19.6% (95% CI, 17.1%-22.2%) of 6- through 11-year-old children, and 18.1% (95% CI, 14.5%-21.7%) of 12- through 19-year-old ado-

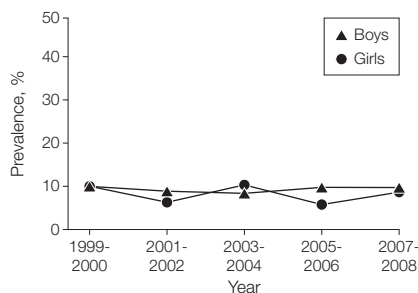
Table 3. Odds Ratios Based on Logistic Regression of High BMI, 2007-2008^a

	Odds Ratio (95% CI)		
	BMI for Age \geq 97th Percentile ^b	BMI for Age \geq 95th Percentile ^b	BMI for Age \geq 85th Percentile ^b
Boys			
Age, y			
2-5	0.36 (0.23-0.57)	0.45 (0.30-0.68)	0.48 (0.36-0.65)
6-11	1.15 (0.90-1.47)	1.12 (0.85-1.46)	1.03 (0.76-1.41)
12-19	[Reference]	[Reference]	[Reference]
Race/ethnicity			
Non-Hispanic white	[Reference]	[Reference]	[Reference]
Non-Hispanic black	1.27 (0.77-2.09)	1.12 (0.75-1.67)	1.18 (0.85-1.64)
Hispanic	1.72 (1.13-2.63)	1.80 (1.26-2.58)	1.65 (1.14-2.38)
Girls			
Age, y			
2-5	0.77 (0.47-1.25)	0.60 (0.38-0.97)	0.55 (0.38-0.78)
6-11	1.27 (0.89-1.82)	1.12 (0.78-1.60)	1.10 (0.82-1.49)
12-19	[Reference]	[Reference]	[Reference]
Race/ethnicity			
Non-Hispanic white	[Reference]	[Reference]	[Reference]
Non-Hispanic black	1.77 (1.09-2.88)	1.70 (1.07-2.71)	1.58 (1.13-2.20)
Hispanic	1.37 (0.73-2.57)	1.21 (0.74-1.99)	1.43 (0.95-2.15)

Abbreviations: BMI, body mass index; CI, confidence interval.

^aBody mass index (calculated as weight in kilograms divided by height in meters squared) was rounded to 1 decimal place. Pregnant adolescents were excluded. Data come from the National Health and Nutrition Examination Survey (NHANES).

^bBased on the 2000 Centers for Disease Control and Prevention (CDC) growth charts.

Figure 1. Prevalence of Weight for Recumbent Length at or Above the 95th Percentile in Boys and Girls From Birth to 2 Years of Age, 1999-2008

Sample sizes, sample design, and relative standard error were consistent over the survey years.

lescents were at or above the 95th percentile of BMI for age. Based on the adult definition of obesity (BMI \geq 30), in 2007-2008, 12.6% (95% CI, 9.0%-16.2%) of adolescents aged 12 through 19 years were obese.

Overall, among 2- through 19-year-old children and teens, there were no statistically significant differences by sex at the 3 different BMI cut points. However, among Mexican American chil-

dren and adolescents aged 2 through 19 years, boys were more likely than girls to have high BMI (using all 3 BMI cut points) (\geq 97th percentile, $P = .003$; \geq 95th percentile, $P = .003$; \geq 85th percentile, $P = .01$). Among all Hispanic individuals aged 2 through 19 years, boys were more likely to be at or above the 95th percentile of BMI for age ($P = .002$). Differences by sex among Hispanics were not significant using the other 2 BMI cut points. There were no significant differences among non-Hispanic white or non-Hispanic black individuals.

Significant differences in prevalence of high BMI among US children aged 2 through 19 years continued to exist between age groups and race/ethnic groups at each of the 3 BMI cut points. Logistic regression model results based on data from 2007-2008 (TABLE 3) indicated that Hispanic boys had significantly higher odds of having high BMI at all 3 BMI cut points compared with non-Hispanic white boys (\geq 97th percentile, OR, 1.72; 95% CI, 1.13-2.63; \geq 95th percentile, OR, 1.80; 95% CI, 1.26-2.58; and \geq 85th

percentile, OR, 1.65; 95% CI, 1.14-2.38), but there was no statistically significant difference between non-Hispanic white and non-Hispanic black individuals. Among girls, non-Hispanic black girls were significantly more likely than non-Hispanic white girls to have high BMI at all 3 BMI cut points (\geq 97th percentile, OR, 1.77; 95% CI, 1.09-2.88; \geq 95th percentile, OR, 1.70; 95% CI, 1.07-2.71; and \geq 85th percentile, OR, 1.58; 95% CI, 1.13-2.20), but there was no difference between Hispanic girls and non-Hispanic white girls.

In addition, preschool boys (aged 2-5 years) had significantly lower odds of having high BMI at all 3 BMI cut points compared with adolescents (aged 12-19 years) (\geq 97th percentile, OR, 0.36; 95% CI, 0.23-0.57; \geq 95th percentile, OR, 0.45; 95% CI, 0.30-0.68; and \geq 85th percentile OR, 0.48; 95% CI, 0.36-0.65). Among girls, preschool children had lower odds of having BMI at or above the 95th percentile (OR, 0.60; 95% CI, 0.38-0.97) or BMI at or above the 85th percentile (OR, 0.55; 95% CI, 0.38-0.78) compared with adolescents. There was no significant difference in prevalence of high BMI at any BMI cut point between elementary school children (aged 6-11 years) and adolescents (aged 12-19 years).

Trends in high weight for recumbent length among infants and toddlers from birth to 2 years of age are shown in FIGURE 1 for boys and girls separately. No statistically significant linear trends were found for either boys or girls after adjusting for race/ethnicity ($P > .99$ and $P = .56$, respectively). Analysis of sex-specific trends between 1999-2000 and 2007-2008 for 2- through 5-year-old preschool children were not statistically significant at any mutually exclusive BMI level (P values between .15 and .73) after adjusting for race/ethnicity. FIGURE 2 contains observed trend estimates at the 3 BMI cut points (cumulative categories) for both boys and girls aged 2 through 5 years.

Among 6- through 19-year-old children and adolescents, there was a sta-

tistically significant linear trend only for boys at or above the 97th percentile for the total population (OR, 1.52; 95% CI, 1.17-2.01; $P < .004$) and for non-Hispanic white boys (OR, 1.87; 95% CI, 1.22-2.94; $P < .005$). Trends were not statistically significant for any group using the other mutually exclusive BMI percentile categories (P values between .05 and .82). Among girls, no test for trends was statistically significant (P values between .08 and .39). Analysis of trends with time period as a categorical variable indicated that the only significant difference in prevalence was among boys between the 2 time periods 1999-2000 and 2007-2008 at the 97th percentile of BMI for age. FIGURE 3 shows trends in high BMI among 6-through 19-year-old boys and girls at the 3 BMI cut points (cumulative categories). Trend tests on cumulative categories (≥ 85 th and ≥ 95 th percentiles) showed the same results as the test on the mutually exclusive BMI categories between the 85th and 95th percentiles and between the 95th and 97th percentiles.

To further investigate the change in BMI between 1999-2000 and 2007-2008, FIGURE 4 and FIGURE 5 show the smoothed distribution of BMI among school children aged 6 through 11 years and adolescents aged 12 through 19 years in 1999-2000 compared with 2007-2008 for both boys and girls. These graphs show the change in BMI distribution of the entire population of boys and girls. The curves were done separately by age group (and not for the 6- through 19-year-old group together) because BMI varies by age and a BMI of 15 in a 6-year-old is very different from a BMI of 15 in a 19-year-old. Combining the groups would result in confounding. In boys aged 6 through 11 years and 12 through 19 years, there appeared to be a change in the distribution between 1999-2000 and 2007-2008. In boys, the BMI distribution appeared more skewed in 2007-2008 compared with 1999-2000, which is consistent with the increase in prevalence above the 97th percentile. For girls aged 6 through 11 years, there ap-

peared to be a slight change in the distribution, but this was not reflected in any significant change in prevalence of high BMI. Among 12- through 19-year-old girls, the BMI distributions appeared to be virtually identical in 1999-2000 and 2007-2008.

COMMENT

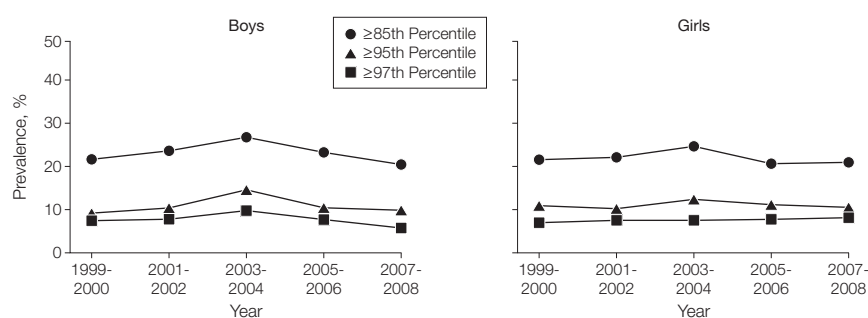
In 2007-2008, approximately 10% of infants and toddlers younger than 2 years were at or above the 95th percentile of the weight-for-recumbent-length growth charts. Almost 12% of 2- through 19-year-old children and adolescents were at or above the 97th percentile of the BMI-for-age growth charts while almost 17% were at or above the 95th percentile and almost 32% were at or above the 85th percentile. No statistically significant linear

trends in weight for length or high BMI for any cut point were found over the time periods 1999-2000, 2001-2002, 2003-2004, 2005-2006, and 2007-2008 among girls of any age.

Among 6- through 19-year-old boys, however, there was a significant linear trend at the highest BMI cut point (BMI for age ≥ 97 th percentile) but not at the lower cut points, nor was there a significant trend in the younger age groups. The categorical analysis of survey period suggests that among 6- through 19-year-old boys the difference is only significant between the 2 time periods 1999-2000 and 2007-2008, so it not possible to tell if the 2007-2008 estimate is the continuation of a trend or not.

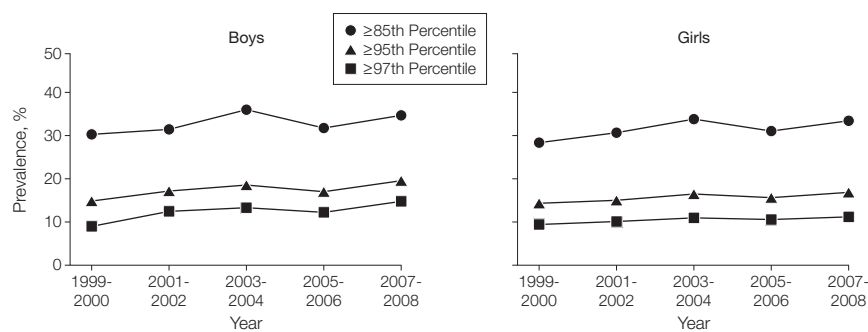
The stabilization in prevalence of high BMI between 1999-2000 and

Figure 2. Prevalence of High Body Mass Index for Age in Boys and Girls Aged 2 Through 5 Years, 1999-2008



Sample sizes, sample design, and relative standard error were consistent over the survey years.

Figure 3. Prevalence of High BMI for Age in Boys and Girls Aged 6 Through 19 Years, 1999-2008



Sample sizes, sample design, and relative standard error were consistent over the survey years. The prevalence among boys in the category of body mass index (BMI) at or above the 97th percentile showed a statistically significant increasing trend ($P < .004$).

2007-2008 found in girls and possibly in boys at lower BMI cut points has also been recorded in other data systems, although these systems employ different methods than NHANES. In the Pediatric Nutrition Surveillance System (PedNSS), based on children aged 0 to 5 years from low-income families who participate in federal nutrition programs, no changes in prevalence were found between 2003 and 2008.¹⁵ In addition, a nationally representative school-based survey of high school students, the Youth Risk Behavior Surveillance System (YRBS),^{16,17} found a plateau between 2005 and 2007 among grades 9 through 12, although the 2007 estimate of approximately 13% based on self-reported data in the YRBS is lower than the 18.1% found here among 12- through 19-year-old adolescents.

The possible increase in BMI at or above the 97th percentile and the increasing skewness in the distribution among boys is consistent with data for

men, which suggest a slight but statistically significant increase in obesity between 1999 and 2006.¹⁸

Differences in prevalence and in trends between boys and girls have been reported in other countries. Similar to the results among Hispanic individuals seen here, the prevalence of obesity (BMI for age \geq 95th percentile) is significantly higher among boys than among girls in Mexico.¹⁹ Moreover, a leveling off of childhood obesity trends has been documented in Stockholm, where there was a marginally significant difference in obesity trends in girls vs boys. The decrease in prevalence was greater in girls than in boys.²⁰ In England, an analysis of 3-year moving averages of obesity prevalence suggests that the trend in obesity may be leveling off in the most recent 3 years (2005-2007).²¹ The only exception was among girls (but not boys), where there was a significant decrease in prevalence of obesity between 2005 and 2006

among 2- through 15-year-olds. Looking back to 1995, there was an increase in obesity prevalence from 13.5% in 1995 to 17.6% in 2007 among 11-through 15-year-old boys while there was no significant increase among girls of the same age. In 2007, there was no difference in prevalence between boys and girls,²¹ suggesting boys have “caught up” with girls. Because prevalence estimates are relative to sex-specific distributions from the past (eg, the BMI-for-age CDC growth charts based on data from the 1960s and 1970s), it is possible that there were differences between boys and girls in the 1960s and 1970s that are reflected in sex differences in prevalence seen today.

Interpreting the prevalence of high BMI requires some caveats. Body mass index does not measure adiposity directly. In children, BMI is correlated with adiposity and that correlation is higher at higher levels of BMI for age than at lower levels of BMI for age. Moreover, there are differences in adiposity between black and white individuals at the same BMI level.²² Because BMI varies by age and sex in children, cut points relate to a reference population, in this case the CDC growth charts. These cut points are statistical and are not based on health outcomes.²³

There are currently many efforts under way aimed at preventing childhood obesity. Funded research on interventions related to school food and physical activity environments, taxes, food marketing, and physical environment (for example, park characteristics in urban environments) have shown some promise.²⁴ Moreover, the Task Force on Community Preventive Services' systematic review of behavioral interventions related to obesity found that interventions aimed at reducing screen time had sufficient evidence of effectiveness for reducing measured screen time and improving weight-related outcomes.²⁵ But the results presented here indicate that the prevalence of high BMI in childhood has remained steady for 10 years and has not declined. Moreover, the

Figure 4. Change in Distribution of Body Mass Index in Boys Aged 6 Through 11 Years and 12 Through 19 Years, 1999-2000 and 2007-2008

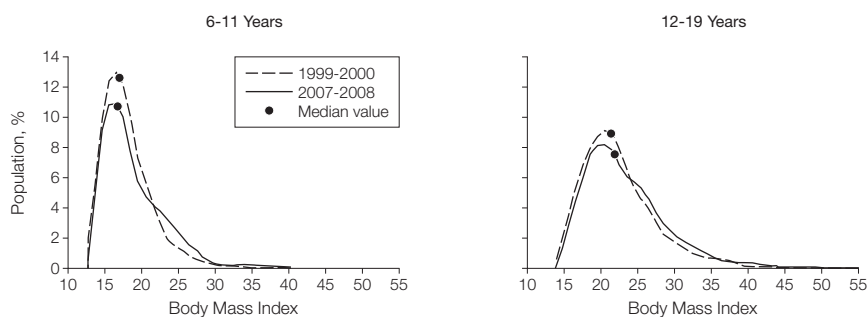
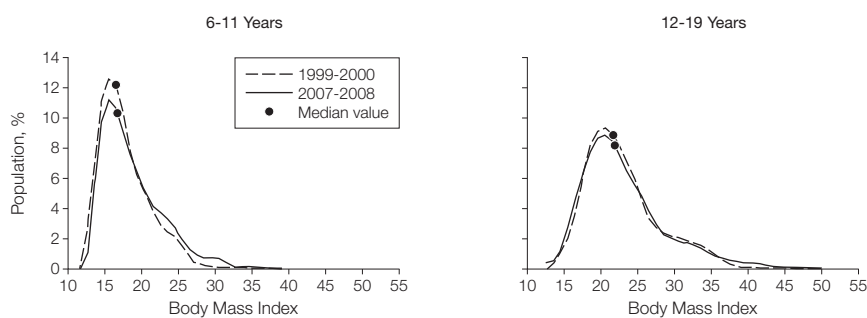


Figure 5. Change in Distribution of Body Mass Index in Girls Aged 6 Through 11 Years and 12 Through 19 Years, 1999-2000 and 2007-2008



heaviest boys may be getting even heavier. More research is needed to identify the behavioral, biological, and environmental factors sustaining these levels of high BMI in US children.

Published Online: January 13, 2010 (doi:10.1001/jama.2009.2012).

Author Contributions: Dr Ogden had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Ogden, Lamb, Flegal.

Analysis and interpretation of data: Ogden, Carroll, Curtin, Lamb, Flegal.

Drafting of the manuscript: Ogden.

Critical revision of the manuscript for important intellectual content: Ogden, Carroll, Curtin, Lamb, Flegal.

Statistical analysis: Ogden, Carroll, Curtin, Flegal.

Financial Disclosures: None reported.

Role of the Sponsor: All data used in this study were collected by the National Center for Health Statistics, Centers for Disease Control and Prevention. The Centers for Disease Control and Prevention reviewed and approved this report before submission.

Disclaimer: The findings and conclusions in this report are those of the authors and not necessarily of the agency.

Online-Only Material: The eTable is available at <http://www.jama.com>.

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