

# Decreasing Prevalence of Obesity Among Young Children in Massachusetts From 2004 to 2008

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## KEY WORDS

obesity, BMI, child, infant, prevalence, trends, epidemiology

## ABBREVIATIONS

CENTURY—Collecting Electronic Nutrition Trajectory Data Using e-Records of Youth

CI—confidence interval

GEE—generalized estimating equation

HVMA—Harvard Vanguard Medical Associates

OR—odds ratio

PedNSS—Pediatric Nutrition Surveillance System

Dr Wen contributed to the development of study aims, led the analytic plan, conducted all data analyses, and wrote the manuscript; Dr Gillman contributed to the development of study aims and the analytic plan, interpreted the results, and made major contributions to revising the manuscript; Ms Rifas-Shiman contributed to the development of study aims, prepared the data set, checked SAS programming, and revised the manuscript; Dr Sherry contributed to the development of study aims, result interpretation, and revision of the manuscript; Dr Kleinman contributed to the development of study aims and the analytic plan, guided data analysis, and revised the manuscript; Dr Taveras was the principal investigator of this study and contributed to the development of the study aims and the analytic plan, result interpretation, and revision of the manuscript; Dr Wen has full access to the data and takes responsibility for its integrity and the accuracy of the data analysis.

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**WHAT'S KNOWN ON THIS SUBJECT:** Following a rapid increase from 1980 to 2001, the prevalence of obesity among school-age children and adolescents in the United States has plateaued. Few studies have examined obesity trends among younger children in the past decade, and findings are inconsistent.



**WHAT THIS STUDY ADDS:** Among children aged <6 years at this multisite pediatric practice, the prevalence of obesity was fairly stable during 1999–2003, but substantially decreased during 2004–2008. This decrease was smaller among children insured by Medicaid than children insured by non-Medicaid health plans.

## abstract



**OBJECTIVE:** To examine whether the obesity prevalence is increasing, level, or decreasing among young US children (aged <6 years) in the past decade; and to compare regional data to those of 2 national databases.

**METHODS:** We analyzed data from 108 762 well-child visits (36 827 children) at a multisite pediatric practice in eastern Massachusetts during 1999–2008. By using the Centers for Disease Control and Prevention 2000 gender-specific growth charts, we defined obesity as weight-for-length  $\geq 95$ th percentile for children aged <24 months and BMI  $\geq 95$ th percentile for children aged 24 to <72 months. By using multivariable logistic regression, we estimated gender-specific obesity trends in 2 separate periods, 1999–2003 and 2004–2008, adjusting for age group, race/ethnicity, health insurance, and practice site.

**RESULTS:** From 1999 to 2003, the obesity prevalence was fairly stable among both boys and girls. From 2004 to 2008, the obesity prevalence substantially decreased among both boys and girls. The decline in obesity prevalence during 2004–2008 was more pronounced among children insured by non-Medicaid health plans than among those insured by Medicaid.

**CONCLUSIONS:** Among children aged <6 years at this multisite pediatric practice, obesity prevalence decreased during 2004–2008, which is in line with national data showing no increase in prevalence during this time period. The smaller decrease among Medicaid-insured children may portend widening of socioeconomic disparities in childhood obesity. *Pediatrics* 2012;129:823–831

After a rapid increase from 1980 to 2001,<sup>1,2</sup> recent reports indicate that the prevalence of childhood obesity in the United States may have reached a plateau or even started to decline.<sup>3–7</sup> Most of these reports have included school-age US children and adolescents, whereas few focus on obesity among infants, toddlers, and preschool-age children. Weight status is more modifiable, and thus obesity is more preventable in early childhood than at later ages,<sup>8</sup> because children's behaviors and lifestyles are developing<sup>9</sup> and dominantly influenced by parents and family environments.<sup>10</sup> Furthermore, evidence suggests that early treatment of obesity is often more effective than starting at later age.<sup>8,11</sup> Thus, there is a need for additional study of the trends in obesity prevalence among young children.

The NHANES<sup>2–4,12,13</sup> and the Pediatric Nutrition Surveillance System (PedNSS)<sup>14,15</sup> are 2 main national data sources for monitoring obesity trends among children aged <6 years. However, NHANES has a small sample size of young children, especially for those aged <2 years,<sup>2–4,12,13</sup> limiting its ability to examine reliable obesity trends among young children, particularly within age, racial/ethnic, and socioeconomic subgroups. The PedNSS<sup>14,15</sup> primarily comprises low-income children who participate in federally funded supplemental nutrition programs, limiting its generalizability. These limitations may lead to inconsistencies in observed obesity trends among young children in these 2 national samples. For example, NHANES data showed that the obesity prevalence among children aged 2 to 5 years was 13.9% in 2003–2004, 11.0% in 2005–2006, and 10.4% in 2007–2008,<sup>3,4</sup> whereas in PedNSS, the obesity prevalence was fairly stable.<sup>7,16–18</sup> These findings raise the possibility that decreases in obesity prevalence are beginning to appear among children of

higher, but not lower, socioeconomic status, which has not been examined in either NHANES or PedNSS data. Alternatively, by using data from clinical records of well-child visits at a large, diverse pediatric practice, our research team previously reported a continuous increase in obesity prevalence among children aged <6 years from 1980 through 2001,<sup>19</sup> largely paralleling the trends reported by NHANES<sup>13</sup> and PedNSS<sup>7,14</sup> during similar periods. In this study, we report current trends during the past decade (1999–2008).

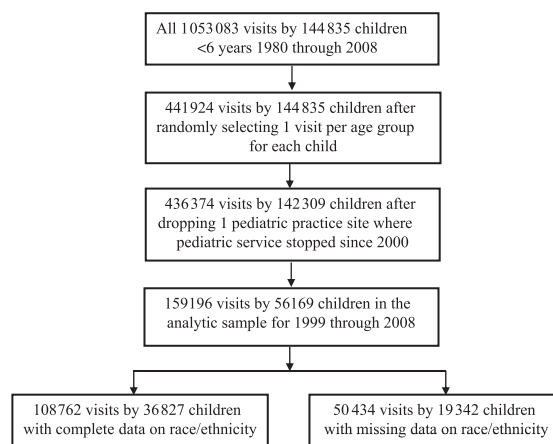
We had 3 purposes in these analyses: (1) to assess trends in obesity among young children (aged <6 years) during 1999–2008 by using our CENTURY data; (2) to examine gender, age, race/ethnicity, and socioeconomic differences in these trends; and (3) to compare these trends with those based on NHANES and PedNSS.

## METHODS

### Sample

By using the Collecting Electronic Nutrition Trajectory Data Using e-Records of Youth (CENTURY) Study data, we extracted length/height, weight, and demographics from electronic medical records of 312 857 children seen at 2 121 511 well-child visits from 1980

through 2008 at Harvard Vanguard Medical Associates (HVMA), a multisite group pediatric practice in eastern Massachusetts. We have previously published details of data collection methods in our analysis of obesity trends from 1980 through 2001.<sup>19</sup> For the purposes of this analysis, we initially restricted visits in which children were <72 months of age and grouped children's ages into 5 intervals: 0 to <6, 6 to <12, 12 to <24, 24 to <36, and 36 to <72 months. Then we randomly chose 1 visit within each age interval for each child to allow for estimated prevalence and logistic regression within the same data set, similar to the method used by The Centers for Disease Control and Prevention (CDC) in PedNSS reports.<sup>7</sup> We excluded 1 HVMA practice site because pediatric service was unavailable at this site after 2000. Among the remaining sample, we included 159 196 visits by 56 169 children between January 1, 1999, and December 31, 2008. Given the importance of race/ethnicity, we further excluded 50 434 visits by 19 342 children with missing data on race/ethnicity. Thus, the final analysis was conducted among 108 762 visits by 36 827 children. Figure 1 shows the participant flowchart for this analysis.



**FIGURE 1** Flowchart of the analytic sample, CENTURY Study data, 1999–2008.

Compared with the sample excluded because of missing race/ethnicity data, the analytic sample did not differ substantially in gender (female participants, 48.8% in the excluded sample vs 49.1% in the analytic sample), age (mean, 21.2 vs 21.7 months), Medicaid insurance (12.7% vs 14.1%), or the prevalence of obesity (8.5% vs 8.6%). However, the analytic sample contained greater proportions of recent visits during 2006–2008.

### Measures

At each well-child visit, children's weight and length/height were measured by medical assistants according to the written protocol of HVMA. Anthropometric equipments are calibrated annually at HVMA, and a master trainer conducts periodic quality checks for anthropometric measures by medical assistants. Weight without heavy clothes and shoes was measured with pediatric scales and rounded to the nearest 0.25 pound. Length without shoes was measured in recumbent position by using a paper-and-pencil technique for children <24 months and height without shoes in standing position for those aged  $\geq 24$  months.

In a validation study among 0- to 24-month-old infants conducted at 1 of our pediatric practice sites, we found that the paper-and-pencil method systematically overestimated children's length compared with a reference method. Thus, as in our previous work, we used a regression correction factor to partially adjust for this systematic overestimation:  $[(0.953 \times \text{length measured by paper-and-pencil method}) + 1.8 \text{ cm}]$ .<sup>20</sup> Using the CDC 2000 growth charts, we calculated weight-for-length percentile specific to gender and age for children aged <24 months and BMI (BMI = weight in kilograms/height in meters<sup>2</sup>) percentile by gender and age for children aged  $\geq 24$  months.<sup>21</sup> To be consistent regarding reference population, we did

not use World Health Organization charts for children aged >24 months. We defined obesity as weight-for-length or BMI  $\geq 95$ th percentile in this analysis,<sup>22</sup> assuming that both measures could indirectly reflect body adiposity to a similar extent. However, we recognize slight differences between these 2 measures due to the use of supine length for weight-for-length assessment of <24-month-olds versus the use of standing height for BMI assessment of children  $\geq 24$  months of age.

Race and ethnicity of children were reported by parents. We recoded the original categories into non-Hispanic white, non-Hispanic African American, Hispanic, Asian American, and other race/ethnicity. Health insurance type (Medicaid versus non-Medicaid) was retrieved from medical records.

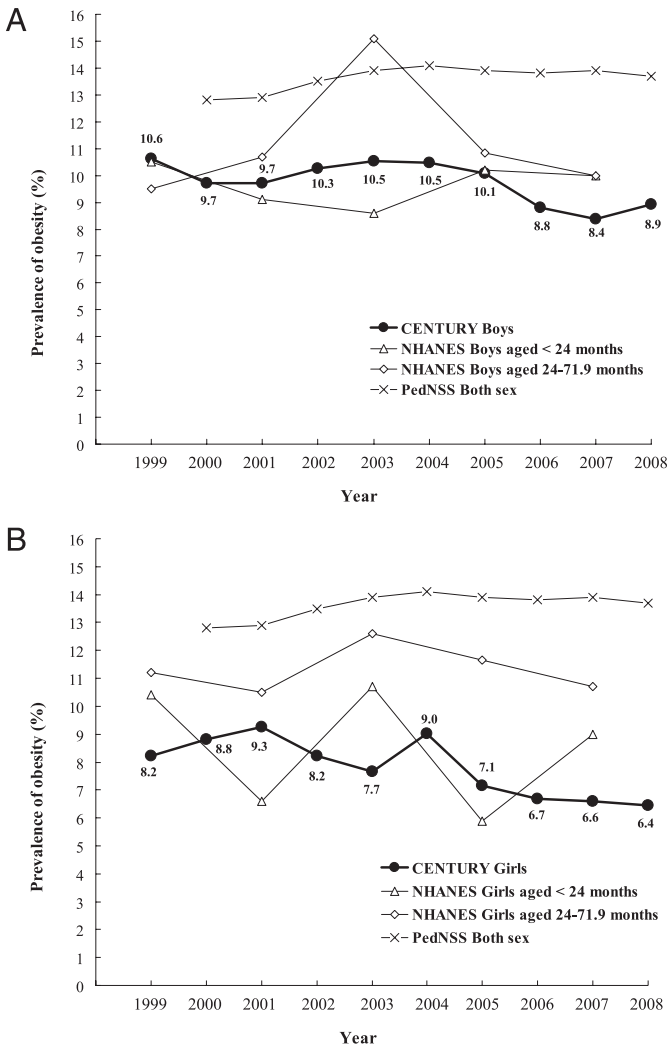
### Statistical Analysis

Given gender differences in childhood growth, we conducted all analyses separately for boys and girls. To examine trends in the prevalence of obesity over time, we first estimated obesity prevalence in each year (visualized in Fig 2) and then performed multivariable logistic regression to adjust for potential changes in demographics (ie, age, race/ethnicity, types of health insurance) and practice sites across years.

Because initial observation of obesity prevalences and 2-slope tests of trends (data not shown,  $P$  value < .01 for boys and  $P$  value = .07 for girls) suggested a turning point between 2003 and 2004, we fit multivariable logistic regression models during two 5-year periods separately: from 1999 to 2003 and from 2004 to 2008. We conducted linear trend tests by including calendar year as a continuous independent variable in logistic regression models with obesity as the binary dependent variable. The estimated odds ratios (ORs) and their confidence intervals (CIs) corresponded to the change in odds of obesity per year

during each 5-year period. To account for the correlation between multiple visits by the same child, we used generalized estimating equations (GEEs) to fit logistic regression models. To examine interactions between time trend and demographics (ie, age, race/ethnicity, and health insurance), we conducted stratified analyses among the 5 age subgroups, the 5 race/ethnicity subgroups, and the 2 health insurance subgroups. We used ordinary logistic regression (instead of GEEs) for age-stratified analysis, because there was no more than 1 visit for each child within each age group.

In addition, we analyzed trends among 2 broader age subgroups (0 to <24 and 24 to <72 months) and also grouped visit years into 5 biannual periods (1999–2000, 2001–2002, 2003–2004, 2005–2006, and 2007–2008) to facilitate external comparison of obesity prevalence to 2 national samples of NHANES and PedNSS data during 1999–2008. For simplicity, we report comparisons across these 3 samples only during 3 biannual periods: 1999–2000, 2003–2004, and 2007–2008. We obtained sample size, obesity prevalences, and standard errors in 1999–2000, 2003–2004, and 2007–2008 NHANES from published articles<sup>2,3,4,12</sup> and online updates,<sup>23</sup> and supplemental details on age <24 months were obtained through personal communication with the lead author (Dr Cynthia L. Ogden, September 27, 2010) of these articles. We obtained sample size and obesity prevalences in 2000, 2003, 2004, 2007, and 2008 PedNSS from summary tables<sup>16</sup> published online ([http://www.cdc.gov/pednss/pednss\\_tables/tables\\_health\\_indicators.htm](http://www.cdc.gov/pednss/pednss_tables/tables_health_indicators.htm)). For PedNess, we used the year of 2000 as the proxy for 1999–2000, collapsed 2003 and 2004 as 2003–2004, and collapsed 2007 and 2008 as 2007–2008. We included all available samples in PedNSS summary tables, reasoning that the slight variation in



**FIGURE 2** Trend in prevalences of obesity among children aged 0 to <72 months during 1999–2008 in a multisite pediatric practice, CENTURY Study data. Compared with NHANES and PedNSS data during the similar period: A, among boys; B, among girls. Note: biannual data in NHANES (1999–2000, 2001–2002, 2003–2004, 2005–2006, and 2007–2008); lack of 1999 data in PedNSS; children aged 0 to <60 months in PedNSS; PedNSS reports did not separate boys and girls; data labels for CENTURY only.

participating states/tribal governments/territories during 1999–2008 (46 vs 52) should not substantially impact the overall estimates. We did not calculate standard errors of prevalence in PedNSS, because it can be viewed as a census sample. We completed all analyses in SAS version 9.2 (SAS Institute Inc., Cary, NC).

## RESULTS

### Sample Characteristics

Table 1 shows the sample characteristics by visit years. Approximately 50%

of the children were boys, a proportion that was stable over the study period. Likewise, the age distribution was similar across the study period. In contrast, we observed substantial changes in the distribution of race/ethnicity from 1999 through 2008, with decreasing percentages of non-Hispanic white (63.6% in 1999–2000 vs 57.7% in 2007–2008) and non-Hispanic African Americans (18.3% vs 13.5%) but an increasing percentage of Asian Americans (5.7% vs 12.8%). HVMA did not accept Medicaid insurance before 1999 and part of 2000, leading

to a dramatic increase in the proportion of Medicaid-insured children from 1999–2000 to 2001–2002; it increased slowly afterward. The distribution of well-child visits by young children across HVMA pediatric practice sites was fairly stable during the study period, except for a decline in percentages of well-child visits by young children (the number at each site divided by the total number at all sites) occurred at site 6 and an increase at site 8.

### Trend in Prevalences of Obesity

Figure 2 shows gender-specific prevalences of obesity from 1999 through 2008. Tables 2 and 3 show results of the multivariable regression analyses on change in obesity risk per year among boys and girls, respectively. From 1999 to 2003, the risk of obesity was fairly stable among both boys (10.6%–10.5%; adjusted OR per year increment, 0.99 [0.96–1.02]) and girls (8.2%–7.7%; OR, 0.97 [0.94–1.00]). In contrast, from 2004 to 2008, we observed substantial decreases in the risk of obesity among both boys (10.5%–8.9%; OR, 0.94 [0.92–0.97]) and girls (9.0%–6.4%; OR, 0.93 [0.90–0.96]). Stratified analyses among boys and girls showed some differences in obesity trends by age and by racial/ethnic groups (Tables 2 and 3). A statistically significant decline of obesity from 2004 to 2008 was observed among more age and race/ethnic subgroups of girls (6 out of 12) than boys (3 out of 12). In addition, among both boys and girls the decline in obesity during 2004–2008 was more pronounced among those insured by non-Medicaid health plans (boys, OR = 0.93 [0.90–0.96]; girls, OR = 0.91 [0.88–0.95]) than among those insured by Medicaid (boys, OR = 0.97 [0.92–1.03]; girls, OR = 0.96 [0.90–1.03]).

We noticed a substantial increase in obesity prevalence for girls in 2004 (Fig 2). To identify the possible reasons, we did a supplemental analysis to



**TABLE 1** Characteristics of the Analytic Sample, CENTURY Study Data, by Biannual Years of Visit

|   | 1999–2000        | 2001–2002 | 2003–2004 | 2005–2006 | 2007–2008 |
|---|------------------|-----------|-----------|-----------|-----------|
| Total number of visits                  | 19 580           | 16 927    | 18 217    | 21 510    | 32 528    |
| Gender, %                               |                  |           |           |           |           |
| Boys                                    | 51.1             | 50.2      | 50.8      | 51.1      | 51.2      |
| Girls                                   | 48.9             | 49.8      | 49.2      | 48.9      | 48.8      |
| Age group, %                            |                  |           |           |           |           |
| 0–<6 mo                                 | 17.0             | 17.9      | 19.6      | 21.4      | 20.9      |
| 6–<12 mo                                | 18.9             | 17.7      | 19.1      | 20.2      | 19.9      |
| 12–<24 mo                               | 21.5             | 18.9      | 20.1      | 19.7      | 20.6      |
| 24–<36 mo                               | 18.9             | 18.7      | 17.5      | 17.5      | 15.3      |
| 36–<72 mo                               | 23.6             | 26.9      | 23.7      | 21.2      | 23.3      |
| Race/ethnicity, %                       |                  |           |           |           |           |
| Non-Hispanic white                      | 63.6             | 62.4      | 62.1      | 61.1      | 57.7      |
| Non-Hispanic African American           | 18.3             | 17.6      | 15.6      | 13.8      | 13.5      |
| Hispanic                                | 5.9              | 6.2       | 6.3       | 6.3       | 6.8       |
| Asian                                   | 5.7              | 7.3       | 8.7       | 10.5      | 12.8      |
| Others                                  | 6.5              | 6.6       | 7.3       | 8.3       | 9.2       |
| Health insurance, %                     |                  |           |           |           |           |
| Medicaid                                | 0.3 <sup>a</sup> | 14.1      | 16.4      | 17.5      | 18.7      |
| Non-Medicaid                            | 99.7             | 85.9      | 83.6      | 82.5      | 81.3      |
| Pediatric practice site, <sup>b</sup> % |                  |           |           |           |           |
| Boston downtown                         |                  |           |           |           |           |
| Site 1                                  | 10.6             | 8.8       | 7.6       | 7.1       | 8.1       |
| Site 2                                  | 10.7             | 11.4      | 10.9      | 10.1      | 10.3      |
| Site 3                                  | 3.7              | 3.9       | 4.0       | 4.2       | 5.5       |
| North of Boston                         |                  |           |           |           |           |
| Site 4                                  | 4.7              | 3.5       | 3.0       | 3.4       | 2.6       |
| Site 5                                  | 3.0              | 3.9       | 6.4       | 6.3       | 6.4       |
| Site 6                                  | 10.2             | 8.6       | 6.9       | 6.0       | 6.3       |
| Site 7                                  | 5.5              | 5.6       | 4.9       | 4.0       | 3.8       |
| Northwest of Boston                     |                  |           |           |           |           |
| Site 8                                  | 3.2              | 3.5       | 6.3       | 11.2      | 10.0      |
| Site 9                                  | 10.7             | 12.1      | 12.8      | 12.1      | 12.4      |
| West of Boston                          |                  |           |           |           |           |
| Site 10                                 | 6.3              | 5.1       | 4.8       | 5.1       | 5.2       |
| Site 11                                 | 6.6              | 5.5       | 4.6       | 4.1       | 5.4       |
| South of Boston                         |                  |           |           |           |           |
| Site 12                                 | 6.1              | 8.0       | 8.7       | 9.0       | 9.3       |
| Site 13                                 | 18.6             | 20.1      | 19.0      | 17.6      | 14.6      |

<sup>a</sup> No children with Medicaid in 1999; the practice did not accept Medicaid insurance until late 2000.

<sup>b</sup> The number of visits at each site / the total number at all sites.

compare the distribution of age, race/ethnicity, and health insurance plan in 2004 with that in 2003 or 2005, and did not find significant differences in any of these characteristics (data not shown). Interestingly, a similar “blip” in 2003–2004 also appeared in NHANES data (Fig 2).

### Comparison of CENTURY Results With NHANES and PedNSS

Table 4 shows the comparison of trends in prevalences of obesity in CENTURY, NHANES, and PedNSS samples across 3 cycles: 1999–2000, 2003–2004, and 2007–2008; Fig 2 shows gender-stratified

data across more years. Among children aged 0 to <24 months, the prevalence of obesity decreased from 1999–2000 to 2003–2004 in both CENTURY (relative change, –6.2%) and NHANES (–8.7%) samples but increased in PedNSS (7.5%). From 2003–2004 to 2007–2008, the corresponding prevalence leveled off in NHANES (0.0%) and PedNSS (–2.2%), whereas the prevalence continued to decrease in CENTURY (–17.2%). Among children aged 24 to <72 months, the prevalence of obesity increased during 1999–2004 in all three samples: CENTURY (relative change, 9.7%), NHANES (35.0%), and PedNSS (11.8%). From 2003–2004

to 2007–2008, the corresponding prevalence decreased in CENTURY (–20.2%) and NHANES (–25.2%), whereas leveled off in PedNSS (0.0%).

## DISCUSSION

In a large sample of well-child visits among children aged <6 years from a multisite group practice, we found that from 1999 to 2003, the overall prevalence of obesity was fairly stable. From 2004 to 2008, however, there was a substantial decrease in the prevalence of obesity among both genders. The declines in obesity were apparent across more age and race/ethnicity subgroups of girls than of boys and steeper among children insured by non-Medicaid health plans than among children insured by Medicaid.

### Comparison With NHANES and PedNSS

Many methodological issues, such as sampling strategies, response rate, age group, measure accuracy, should be considered when comparing obesity prevalences and secular trends from different data sources.<sup>24</sup> Overall, our prevalence of obesity in 2007–2008 was somewhat lower than those in NHANES<sup>3</sup> and PedNSS<sup>7,16–18</sup> during the same periods. This difference may be explained partially by the facts that CENTURY data contains a higher proportion of Asian American children as well as a potentially higher socioeconomic status in contrast to NHANES, which is nationally representative; PedNSS is a predominantly low-income sample; and all CENTURY Study children have some form of health insurance. In addition, the obesity prevalence estimates in NHANES, and thus trend data, are relatively insensitive to detect moderate secular changes as the sample sizes of young children in NHANES are much smaller than in CENTURY Study and PedNSS. Nevertheless, an increasing trend in obesity prevalence among

**TABLE 2** Obesity Prevalence and Adjusted ORs of Change in Obesity Risk Among Boys Aged <6 Years During 1999–2008, CENTURY Study

|                                | 1999–2003             |      |                              |   | 2004–2008             |      |                              |   |
|--------------------------------|-----------------------|------|------------------------------|---|-----------------------|------|------------------------------|---|
|                                | Obesity Prevalence, % |      |                              | Adjusted OR (95% CI) <sup>b</sup><br>per year increment | Obesity Prevalence, % |      |                              | Adjusted OR (95% CI) <sup>b</sup><br>per year increment |
|                                | 1999                  | 2003 | Relative Change <sup>a</sup> |   | 2004                  | 2008 | Relative Change <sup>c</sup> |   |
| All sample                     | 10.6                  | 10.5 | −1.0                         | 0.99 (0.96,1.02)  | 10.5                  | 8.9  | −14.7                        | 0.94 (0.92,0.97) <sup>d</sup>                           |
| Stratified by age group (mo)   |                       |      |                              |   |                       |      |                              |   |
| 0–<6                           | 5.6                   | 4.8  | −15.7                        | 0.97 (0.88,1.07)  | 5.3                   | 4.0  | −24.1                        | 0.94 (0.87,1.03)  |
| 6–<12                          | 11.6                  | 8.8  | −24.0                        | 0.93 (0.87,0.99) <sup>d</sup>                           | 10.7                  | 9.5  | −10.9                        | 0.97 (0.91,1.03)  |
| 12–<24                         | 11.5                  | 13.2 | 15.6                         | 1.02 (0.96,1.08)  | 13.4                  | 11.1 | −17.1                        | 0.94 (0.90,1.00)  |
| 24–<36                         | 7.8                   | 7.1  | −8.2                         | 0.93 (0.85,1.01)  | 7.8                   | 4.6  | −40.7                        | 0.88 (0.82,0.96) <sup>d</sup>                           |
| 36–<72                         | 15.2                  | 16.8 | 10.8                         | 1.03 (0.98,1.09)  | 14.2                  | 13.1 | −8.0                         | 0.96 (0.91,1.00)  |
| Stratified by race/ethnicity   |                       |      |                              |   |                       |      |                              |   |
| Non-Hispanic white             | 9.7                   | 9.6  | −1.2                         | 0.98 (0.95,1.02)  | 9.8                   | 8.5  | −13.6                        | 0.95 (0.91,0.98) <sup>d</sup>                           |
| Non-Hispanic African American  | 13.2                  | 13.8 | 4.5                          | 1.02 (0.95,1.10)  | 12.2                  | 11.7 | −3.9                         | 0.97 (0.91,1.03)  |
| Hispanic                       | 13.9                  | 13.1 | −6.2                         | 0.96 (0.86,1.07)  | 13.9                  | 12.9 | −7.5                         | 0.95 (0.87,1.04)  |
| Asian                          | 6.8                   | 5.5  | −19.1                        | 0.97 (0.84,1.12)  | 7.1                   | 5.0  | −30.3                        | 0.91 (0.82,1.01)  |
| Others                         | 12.9                  | 15.1 | 16.6                         | 1.04 (0.92,1.17)  | 13.3                  | 10.2 | −23.2                        | 0.91 (0.84,1.00)  |
| Stratified by health insurance |                       |      |                              |   |                       |      |                              |   |
| Medicaid                       | — <sup>e</sup>        | 13.6 | —                            | 0.97 (0.83,1.13)  | 12.3                  | 11.5 | −6.2                         | 0.97 (0.92,1.03)  |
| Non-Medicaid                   | 10.6                  | 9.9  | −6.8                         | 1.00 (0.96,1.03)  | 10.1                  | 8.3  | −17.3                        | 0.93 (0.90,0.96) <sup>d</sup>                           |

<sup>a</sup> Relative change = 100% \* (Prevalence in 2003 − Prevalence in 1999) / Prevalence in 1999.

<sup>b</sup> Adjusted for age group, race / ethnicity, health insurance, and pediatric practice site in all sample; adjusted for other socio-demographics and pediatric practice site in stratified samples.

<sup>c</sup> Relative change = 100% \* (Prevalence in 2008 − Prevalence in 2004) / Prevalence in 2004.

<sup>d</sup> Significant adjusted OR.

<sup>e</sup> No sample with Medicaid in 1999.

children aged 24 to <72 months during 1999–2003 was apparent in all 3 samples, although the magnitude of increase differed. Regarding the decline in obesity prevalence during 2004–2008

in this age group, our sample was somewhat similar to NHANES report, in contrast to the stabilization observed in PedNSS. We also observed that obesity prevalence decreased substantially

among children aged 0 to <24 months, trends not observed in NHANES or PedNSS in 2003–2008.

The declines in obesity in our sample and possibly in NHANES as well, along

**TABLE 3** Obesity Prevalence and Adjusted ORs of Change in Obesity Risk Among Girls Aged <6 Years During 1999–2008, CENTURY Study

|                                | 1999–2003             |      |                              |   | 2004–2008             |      |                              |   |
|--------------------------------|-----------------------|------|------------------------------|---|-----------------------|------|------------------------------|---|
|                                | Obesity prevalence, % |      |                              | Adjusted OR (95% CI) <sup>b</sup><br>per year increment | Obesity prevalence, % |      |                              | Adjusted OR (95% CI) <sup>b</sup><br>per year increment |
|                                | 1999                  | 2003 | Relative Change <sup>a</sup> |   | 2004                  | 2008 | Relative Change <sup>c</sup> |   |
| All sample                     | 8.2                   | 7.7  | −7.0                         | 0.97 (0.94,1.00)  | 9.0                   | 6.4  | −28.5                        | 0.93 (0.90,0.96) <sup>d</sup>                           |
| Stratified by age group (mo)   |                       |      |                              |   |                       |      |                              |   |
| 0–<6                           | 4.7                   | 3.3  | −29.7                        | 0.92 (0.83,1.03)  | 3.9                   | 2.4  | −38.9                        | 0.90 (0.80,1.01)  |
| 6–<12                          | 7.4                   | 6.5  | −12.1                        | 0.94 (0.86,1.02)  | 9.7                   | 6.7  | −30.4                        | 0.92 (0.85,0.98) <sup>d</sup>                           |
| 12–<24                         | 10.0                  | 8.7  | −13.4                        | 0.96 (0.89,1.02)  | 9.8                   | 7.5  | −23.6                        | 0.92 (0.86,0.98) <sup>d</sup>                           |
| 24–<36                         | 6.7                   | 6.0  | −11.6                        | 0.90 (0.82,0.99) <sup>d</sup>                           | 5.6                   | 4.1  | −26.3                        | 0.92 (0.84,1.01)  |
| 36–<72                         | 11.0                  | 12.3 | 11.7                         | 1.02 (0.96,1.07)  | 14.7                  | 10.0 | −31.9                        | 0.92 (0.87,0.97) <sup>d</sup>                           |
| Stratified by race/ethnicity   |                       |      |                              |   |                       |      |                              |   |
| Non-Hispanic white             | 6.9                   | 6.3  | −8.3                         | 0.98 (0.93,1.02)  | 8.0                   | 6.2  | −23.1                        | 0.96 (0.92,1.00)  |
| Non-Hispanic African American  | 11.7                  | 12.2 | 3.8                          | 0.98 (0.91,1.05)  | 13.7                  | 8.9  | −34.9                        | 0.87 (0.81,0.93) <sup>d</sup>                           |
| Hispanic                       | 13.7                  | 13.5 | −1.8                         | 0.98 (0.87,1.11)  | 12.9                  | 11.8 | −8.6                         | 0.99 (0.90,1.09)  |
| Asian                          | 5.7                   | 6.0  | 5.0                          | 0.98 (0.83,1.15)  | 6.2                   | 3.3  | −46.5                        | 0.87 (0.75,1.00)  |
| Others                         | 9.6                   | 6.3  | −33.9                        | 0.96 (0.85,1.08)  | 8.6                   | 5.1  | −40.6                        | 0.84 (0.75,0.93) <sup>d</sup>                           |
| Stratified by health insurance |                       |      |                              |   |                       |      |                              |   |
| Medicaid                       | — <sup>e</sup>        | 10.8 | —                            | 0.85 (0.71,1.01)  | 12.7                  | 10.0 | −21.3                        | 0.96 (0.90,1.03)  |
| Non-Medicaid                   | 8.2                   | 7.1  | −14.2                        | 0.98 (0.94,1.01)  | 8.3                   | 5.6  | −32.3                        | 0.91 (0.88,0.95) <sup>d</sup>                           |

<sup>a</sup> Relative change = 100% \* (Prevalence in 2003 − Prevalence in 1999) / Prevalence in 1999.

<sup>b</sup> Adjusted for age group, race/ethnicity, health insurance, and pediatric practice site in all sample; adjusted for other socio-demographics and pediatric practice site in stratified samples.

<sup>c</sup> Relative change = 100% \* (Prevalence in 2008 − Prevalence in 2004) / Prevalence in 2004.

<sup>d</sup> Significant adjusted OR.

<sup>e</sup> No sample with Medicaid in 1999.

**TABLE 4** Comparison of Prevalence and Changes in Prevalence of Obesity Among Children Aged <6 Years in CENTURY Study with NHANES and PedNSS, Across 3 Biannual Periods

|                                     | CENTURY     |                 | NHANES      |                 | PedNSS      |                         |
|-------------------------------------|-------------|-----------------|-------------|-----------------|-------------|-------------------------|
|                                     | Sample Size | Obesity (SE), % | Sample Size | Obesity (SE), % | Sample Size | Obesity, <sup>a</sup> % |
| Age 0–<24 mo                        |             |                 |             |                 |             |                         |
| 1999–2000 <sup>b</sup>              | 11 258      | 8.8 (0.3)       | 671         | 10.4 (1.6)      | 2 685 454   | 12.5                    |
| 2003–2004                           | 10 722      | 8.2 (0.3)       | 766         | 9.5 (1.3)       | 7 195 699   | 13.4                    |
| 2007–2008                           | 19 977      | 6.8 (0.2)       | 719         | 9.5 (1.1)       | 8 505 588   | 13.1                    |
| Absolute change                     |             |                 |             |                 |             |                         |
| 1999–2000 to 2003–2004              |             | –0.5            |             | –0.9            |             | 0.9                     |
| 2003–2004 to 2007–2008              |             | –1.4            |             | 0.0             |             | –0.3                    |
| Relative change, %                  |             |                 |             |                 |             |                         |
| 1999–2000 to 2003–2004 <sup>c</sup> |             | –6.2            |             | –8.7            |             | 7.5                     |
| 2003–2004 to 2007–2008 <sup>d</sup> |             | –17.2           |             | 0.0             |             | –2.2                    |
| Age 24–<72 mo <sup>e</sup>          |             |                 |             |                 |             |                         |
| 1999–2000 <sup>b</sup>              | 8322        | 10.2 (0.3)      | 739         | 10.3 (1.7)      | 1 932 131   | 13.2                    |
| 2003–2004                           | 7495        | 11.2 (0.4)      | 818         | 13.9 (1.6)      | 5 391 066   | 14.8                    |
| 2007–2008                           | 12 551      | 8.9 (0.3)       | 885         | 10.4 (1.4)      | 5 865 254   | 14.8                    |
| Absolute change                     |             |                 |             |                 |             |                         |
| 1999–2000 to 2003–2004              |             | 1.0             |             | 3.6             |             | 1.6                     |
| 2003–2004 to 2007–2008              |             | –2.3            |             | –3.5            |             | 0.0                     |
| Relative change, %                  |             |                 |             |                 |             |                         |
| 1999–2000 to 2003–2004 <sup>c</sup> |             | 9.7             |             | 35.0            |             | 11.8                    |
| 2003–2004 to 2007–2008 <sup>d</sup> |             | –20.2           |             | –25.2           |             | 0.0                     |

<sup>a</sup> SE of prevalence were not calculated for PedNSS because PedNSS can be viewed as a census sample.

<sup>b</sup> Only the year 2000 in PedNSS.

<sup>c</sup> Relative change = 100% \* (Prevalence in 2003–2004 – Prevalence in 1999–2000) / Prevalence in 1999–2000.

<sup>d</sup> Relative change = 100% \* (Prevalence in 2007–2008 – Prevalence in 2003–2004) / Prevalence in 2003–2004.

<sup>e</sup> Age 24 to <60 mo in PedNSS.

with a leveling off in PedNSS, suggest that the epidemic of obesity may have peaked among young children around 2003–2004. The reasons for this downturn are not known with certainty, but possible contributors include reduced maternal smoking during pregnancy,<sup>25</sup> increased breastfeeding,<sup>26</sup> limiting television advertisements of some packaged foods (eg, sweets, beverage, snacks) targeted to young children,<sup>27</sup> and increased screening and counseling for childhood obesity,<sup>28,29</sup> in the context of increased awareness of the childhood obesity epidemic among US families, society, and governments.<sup>30–32</sup> In addition, birth weight in US children has unexpectedly declined since 2000.<sup>33</sup> Counteracting these changes is increased consumption of sugar-sweetened beverages.<sup>34</sup>

### Differences by Sex, Age, Race/Ethnicity, and Insurance Type

Despite the substantial demographic disparities in absolute prevalence of

obesity, the overall trends or changes in obesity prevalence were fairly consistent between boys and girls and across age and racial/ethnic groups in our sample. However, as we suspected, the decline in obesity prevalence was greater among children insured by non-Medicaid health plans than among those insured by Medicaid. These findings suggest that programs and policies that have resulted in declines in childhood obesity have had more impact in higher than lower socioeconomic strata. Children from households with higher socioeconomic status tend to have more favorable maternal nutrition and behavior (eg, appropriate weight gain and nonsmoking) during pregnancy and breastfeeding practices; healthy family norms, lifestyle, and home environment; and positive parenting practices.<sup>35,36</sup> They are also more likely to receive obesity-related diet and exercise counseling than their counterparts from lower socioeconomic households.<sup>37</sup> Moreover,

children from low socioeconomic households more often live in disadvantaged communities with high density of convenience stores and fast-food restaurants but fewer supermarkets, large grocery stores, sidewalks, and greens.<sup>38,39</sup> The smaller decrease in obesity prevalence in Medicaid-insured children portends widening of socioeconomic disparities in childhood obesity and suggests that more aggressive interventions are needed for disadvantaged children. A recent review<sup>40</sup> on published studies during 1999–2010 also concluded that the overall leveling off of global obesity epidemic among older children and adults was less evident in the lower socioeconomic status groups.

### Strengths and Limitations

There are several strengths in this analysis. Our large sample size produced precise estimates for obesity prevalence and trends. Availability of well-stored electronic data from 1980 to

2008 allowed us to examine trends in childhood obesity over the past 3 decades (in this and previous analyses) when there have been shifts in obesity noted in national studies. Although we did not have additional information on socioeconomic status beyond health insurance type, our study sample contained relatively large subsamples of nonwhite race/ethnicity including Asians who are not specifically analyzed in NHANES. In addition, we used GEEs to account for correlation between different visits of the same child, and we used multivariable logistic regression to account for changes in demographics and practice sites over time. One limitation of this analysis is the quality of the clinical length/height measures. Although we have used statistical regression to partially correct the systematic errors in measuring infants' length based on the paper-and-pencil protocol, these measurement

errors cannot be eliminated. This limitation might bias our estimated prevalence of obesity for each year but is less likely to impact the trends across 1999–2008 because the clinical practices consistently used the paper-and-pencil method throughout the period. In addition, in any pediatric practice, it is possible that demographic distributions change over time, given self-selection into practice. However, our results suggest that demographics of analyzed well-child visits were fairly stable during 1999–2008. It should be noted that all included HVMA pediatric offices were located in eastern Massachusetts. Therefore, our main finding of decreasing obesity prevalence after 2004 may be generalizable to young insured children living in the northeastern United States, but caution is appropriate for broader generalization.

## CONCLUSIONS

In this analysis, we found a substantial decline in obesity prevalence among young children during 2004–2008. However, the smaller decrease in obesity prevalence in Medicaid-insured children suggests that the coming years may see a widening of socioeconomic disparities in childhood obesity. Continued routine surveillance by using well-child visit records will be 1 important method to gauge the success of ongoing policies and programs to decrease obesity rates overall and among young disadvantaged and minority children, among whom the prevalence of obesity remains especially high.

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