

# Epidemic Increase in Childhood Overweight, 1986-1998

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**T**HE PREVALENCE OF OVERweight is increasing dramatically in the United States. Results from the Behavioral Risk Factor Surveillance System suggest that obesity prevalence has increased by more than 50% among adults between 1991-1999.<sup>1,2</sup> The prevalence of childhood overweight is also increasing at an accelerating rate.<sup>3</sup> The most recent data from the 1988-1991 National Health and Nutrition Examination Survey III (NHANES III) demonstrate that the number of overweight children has increased among all age, race, and sex groups since the NHANES II, 1963-1970.<sup>4</sup> Preliminary data from the most recent NHANES study (NHANES IV, 1999) indicate that overweight continues to increase.<sup>5</sup>

Data from the 1988-1991 NHANES III cohort suggest that approximately 14% of US children are overweight.<sup>6</sup> More recent data suggest that overweight is more common among specific population subgroups. The prevalence of overweight in the Practice Partner Research Network, a network of primary care practices across the country, was 18% to 20%, while the prevalence of "at-risk" children was 34% to 36%.<sup>7</sup> Similarly, among third- and sixth-grade children in New York City, the prevalence of overweight was 15% to 22%.<sup>8</sup>

To monitor overweight trends in children from 1986-1998, we analyzed data from the National Longitudinal Survey of Youth (NLSY). The NLSY study design allows for an accurate determination of changes in over-

**Context** Overweight is the most common health problem facing US children. Data for adults suggest that overweight prevalence has increased by more than 50% in the last 10 years. Data for children also suggest that the prevalence of overweight continues to increase rapidly.

**Objective** To investigate recent changes in the prevalence of overweight within a nationally representative sample of children.

**Design, Setting, and Participants** The National Longitudinal Survey of Youth, a prospective cohort study conducted from 1986 to 1998 among 8270 children aged 4 to 12 years (24 174 growth points were analyzed).

**Main Outcome Measures** Prevalence of overweight children, defined as body mass index (BMI) greater than the 95th percentile for age and sex, and prevalence of overweight and at-risk children, defined as BMI greater than the 85th percentile for age and sex. The roles of race/ethnicity, sex, income, and region of residence were also examined.

**Results** Between 1986 and 1998, overweight increased significantly and steadily among African American ( $P < .001$ ), Hispanic ( $P < .001$ ), and white ( $P = .03$ ) children. By 1998, overweight prevalence increased to 21.5% among African Americans, 21.8% among Hispanics, and 12.3% among non-Hispanic whites. In addition, overweight children were heavier in 1998 compared with 1986 ( $P < .001$ ). After adjusting for confounding variables, overweight increased fastest among minorities and southerners, creating large demographic differences in the prevalence of childhood overweight by 1998. The number of children with BMI greater than the 85th percentile increased significantly from 1986 to 1998 among African American and Hispanic children ( $P < .001$  for both) and nonsignificantly among white children ( $P = .77$ ).

**Conclusions** Childhood overweight continues to increase rapidly in the United States, particularly among African Americans and Hispanics. Culturally competent treatment strategies as well as other policy interventions are required to increase physical activity and encourage healthy eating patterns among children.

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weight rates, since a common survey design was followed for the duration of the study.

## METHODS

### Sample

The study population consists of 4- to 12-year-old children born to women enrolled in the NLSY. The NLSY consists of a national sample of young adults who were interviewed yearly or biyearly from 1979-1998, as well as a supplemental sample of Hispanics, African Americans, and poor whites. The NLSY was

originally designed to study variations in labor market behaviors and experiences. However, over time, the study expanded its mission and now provides a comprehensive assessment of factors that

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**Table 1.** Demographics, National Longitudinal Survey of Youth, 1986-1998 (N = 8270)\*

Total No. of observations	24 174
Observations per child, mean (SD), No.	2.92 (1.29)
Sex, No. (%)	
Male	4243 (51.3)
Female	4027 (48.7)
Race, No. (%)	
Hispanic	1698 (20.5)
African American	2535 (30.7)
White	4037 (48.8)
Child age, mean (SD), y	
1986-1990	7.06 (2.27)
1992-1994	7.97 (2.54)
1996-1998	8.26 (2.52)
Maternal age, mean (SD), y	31.2 (4.0)
Region, %	
Northeast	14.4
Central	25.2
South	40.2
West	20.3
Residence, %	
Urban	76.6
Rural	23.4

\*Unweighted data.

influence social, emotional, and cognitive development of children born to mothers enrolled in the NLSY. The weighted sample of children is nationally representative of young children born to mothers who were 23 to 39 years old. Data on NLSY children were collected prospectively every 2 years. Detailed information on region of residence and family income were updated every 1 to 2 years during in-home interviews. Missing demographic data were obtained from the previous response. Complete demographic and socioeconomic data were available in approximately 93% of the eligible cohort.<sup>9-11</sup> Details of NLSY assessment methodology, attrition, and other matters are described in detail elsewhere.<sup>9-11</sup>

### Measurements and Definitions

Growth data were available for 8270 unique children. Because multiple observations of many children were obtained over the 1986-1998 time frame, 24300 growth observations were available for analysis (TABLE 1). Weights and heights were measured by the in-home interviewer using a portable scale and tape measure. Height was measured for 81% of the sample, and weight was measured for 76%. In the remaining subjects, parental reports were used. Body mass index (BMI) z scores were

calculated using the LMS method.<sup>12,13</sup> The BMI z-score measurements 6 or more SDs from the reference median were excluded (n = 126) as likely measurement errors, reporting errors, or signs of extreme medical condition.

Overweight was defined as BMI greater than the 95th percentile for age and sex derived from a fixed reference distribution. We used the most recent Centers for Disease Control and Prevention (CDC) National Center for Health Statistics (NCHS) growth curves.<sup>10</sup> The percentage of children with BMIs above the 85th percentile for age and sex were also analyzed to assess the total number of children who are considered overweight and at risk for overweight. These cutoff values are in accordance with recommendations of an expert panel on childhood obesity<sup>14</sup> as well as previous studies.<sup>4</sup> There was no significant difference in the rate of increase of overweight among children with reported and measured heights and weights ( $P = .85$ ).

### Data Analysis

Because the NLSY oversampled African Americans and Hispanics, we used NLSY sample weights to provide prevalence estimates corresponding to a nationally representative sample. Data were analyzed using STATA 7.0 (Stata Corporation, College Station, Tex). Since obesity is correlated within families, SEs in descriptive statistics were adjusted to account for familial clustering cross-sectionally and over time. Differences in proportions were compared by  $\chi^2$  test. Prevalence results are presented for the weighted sample, while regression results are presented for the unweighted sample, in accordance with NLSY study recommendations.<sup>10</sup>

To assess the relative rate of increase of overweight over the study period, a cross-sectional, time-series multivariate logistic regression was performed. Because the NLSY included repeated measures of the same individuals, a generalized estimating equation specification was used, which included the main effects, year interaction, and confounding variables (ie,

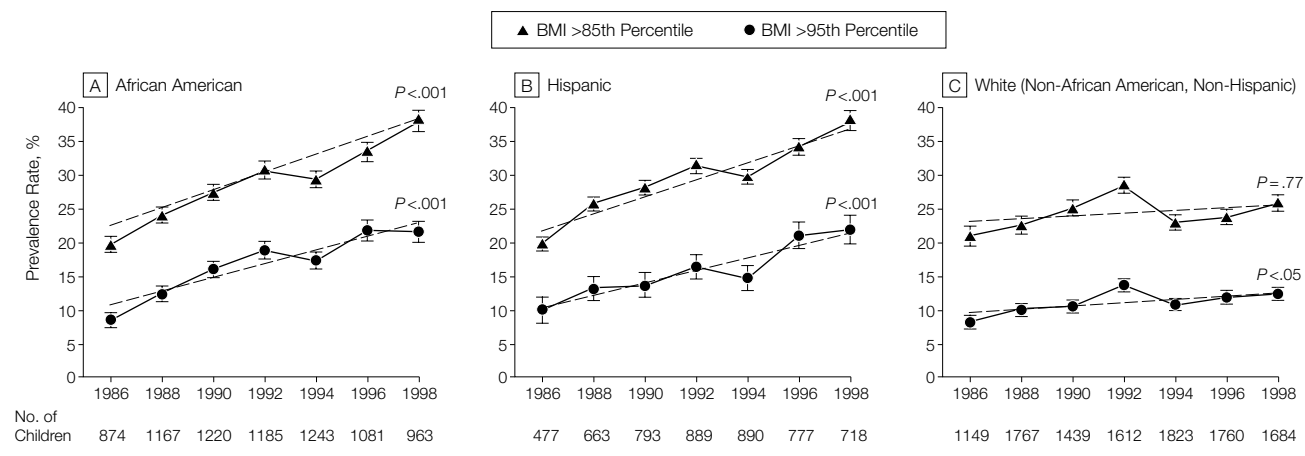
race/ethnicity, sex, urbanicity, region, income, maternal age, and child age). Standard errors of each subgroup were calculated using the delta method, combining the SEs for the estimated group-specific trend and for the base prevalence in each subgroup.

### RESULTS

The FIGURE indicates 1986-1998 trends in overweight children. As shown, the prevalence of overweight increased significantly and steadily among African Americans, Hispanics, and non-Hispanic whites. By 1998, overweight prevalence had increased by more than 120% among African Americans and Hispanics, and by more than 50% among whites. By 1998, 21.5% of African American children and 21.8% of Hispanic children were overweight. In contrast, 12.3% of white children were overweight. The relative weight of overweight children also increased from 1986 to 1998 (% median [SD] BMI/age, sex: 144% [1%] in 1986 vs 155% [1%] in 1998;  $P < .001$ ), suggesting that the severity as well as the prevalence of overweight increased over the period.

TABLE 2 shows group-specific increases for overweight. Overall, large differences in overweight prevalence emerged between groups over the study period. To take one example, 1986 overweight prevalence was virtually identical among upper-income white girls and among lower-income African American and Hispanic boys (6.6% vs 6.5%,  $P = .95$ ). Yet by 1998, overweight prevalence had only slightly increased to 8.7% among upper-income white girls ( $P = .45$  compared with 1986), while overweight prevalence had increased to 27.4% among lower-income African American and Hispanic boys ( $P < .001$  compared with 1986). Overall, high income was protective of overweight among whites (odds ratio [OR] for high vs low income, 0.78 [95% confidence interval (CI), 0.67-0.90]), equivocal among Hispanics (OR, 0.88 [95% CI, 0.57-1.34]), and associated with increased rates of overweight among African Americans (OR, 1.39 [95% CI, 1.03-1.90]).

**Figure.** Prevalence Rates of BMIs Greater Than the 95th Percentile and 85th Percentile, National Longitudinal Survey of Youth, 1986-1998, Weighted Sample



In each graph, the dashed line and significance value represents linearized trends for each subgroup after adjusting for child's age. By 1998, prevalence rates of overweight among African Americans, Hispanics, and whites were 21.5%, 21.8%, and 12.3%, respectively. By 1998, prevalence rates for children with body mass indexes (BMIs) greater than the 85th percentile among African Americans, Hispanics, and whites were 38.4%, 37.9%, and 25.8%, respectively. Error bars indicate SEs.

Regional differences also emerged over the study period. For example, 1986 child overweight prevalence was quite similar in southern and western states (7.6% vs 9.4%,  $P = .39$ ). By 1998, the overall prevalence of overweight had increased to 10.8% in western states, and to 17.1% in southern states ( $P < .005$ ).

The same general trends occur by applying a cutoff at the 85th percentile of BMI (Figure, Table 2). Over the course of the study, the percentage of white children with BMIs above the 85th percentile did not significantly increase (Figure, Table 2). However, racial/ethnic, regional, and economic disparities among children with BMIs above the 85th percentile increased from 1986 to 1998.

**COMMENT**

The prevalence of childhood overweight is rapidly increasing, with the sharpest observed increases among boys, African Americans, Hispanics, and those living in southern states. By 1998, more than 21% of African American and Hispanic NLSY children were classified as overweight. These race/ethnic trend disparities remained large and statistically significant after controlling for family income and for other confounders. In-

**Table 2.** Rate of Increase in Overweight and "At Risk" of Overweight: National Longitudinal Survey of Youth (NLSY), 1986-1998\*

	Estimated Yearly Rate of Increase in Those With BMI >95th Percentile, % (95% CI)	P Value	Estimated Yearly Rate of Increase in Those With BMI >85th Percentile, % (95% CI)	P Value
<b>Race</b>				
Non-Hispanic white	3.23 (0.83 to 5.64)	Reference	1.41 (-0.15 to 2.97)	Reference
African American	5.85 (3.52 to 8.18)	<.003	3.34 (1.80 to 4.88)	<.001
Hispanic	4.30 (1.73 to 6.90)	.24	3.60 (1.86 to 5.34)	<.001
<b>Sex</b>				
Female	3.78 (1.48 to 6.09)	.05	2.13 (0.62 to 3.66)	.12
Male	5.27 (2.96 to 7.57)		3.09 (1.55 to 4.61)	
<b>Region</b>				
South	6.20 (3.88 to 8.53)	Reference	3.02 (1.52 to 4.52)	Reference
Northeast	3.65 (0.70 to 6.59)	<.05	1.93 (-0.03 to 3.90)	.15
Central	1.86 (0.51 to 3.21)	<.001	1.06 (0.15 to 1.97)	<.001
West	2.25 (-0.61 to 5.11)	<.001	2.75 (0.85 to 4.64)	.55
<b>Residence</b>				
Rural	3.87 (1.31 to 6.45)	.36	2.05 (0.38 to 3.73)	.25
Urban	4.81 (2.63 to 6.99)		2.82 (1.37 to 4.26)	
<b>Family income</b>				
<150% poverty level	5.45 (3.09 to 7.81)	.08	3.00 (1.42 to 4.53)	.50
150%-399% poverty level	4.15 (1.84 to 6.46)	Reference	2.52 (0.99 to 4.05)	Reference
≥400% poverty level	4.22 (1.40 to 7.06)	.83	2.59 (0.72 to 4.47)	.49

\*Rates of increase and 95% confidence intervals (CIs) were computed using multiple logistic regression analysis. Generalized estimation equations were used to account for repeated observations. Because of the repeated measures design, these analyses were calculated on the unweighted NLSY sample. The models included all main effects (race/ethnicity, sex, region of residence, family income, year of survey, as well as child age and maternal age), and also included year and main effects interaction terms for the specific variable. An urbanized area was defined as a town or city and its adjacent closely settled areas with a combined population of 50000 or more based on the 1980 census. BMI indicates body mass index.

creasing race/ethnic differences in prevalence of childhood overweight are particularly disturbing, since these may widen economic disparities<sup>15</sup> and may

increase long-term race/ethnicity disparities in health outcomes.<sup>16</sup>

Although overweight increased rapidly among African Americans and His-

panics, overweight prevalence increased by approximately 50% between 1986 and 1998 among non-Hispanic white children. This increase only appears modest when compared with the triple-digit percentage increase in overweight in minority children.

The NLSY provides the most recent available data based on a single, high-quality, nationally representative sample. Other studies documenting the increase in childhood obesity have relied on comparisons of separate studies that used diverse sampling techniques.<sup>3-6</sup> The NLSY study design allows for accurate determination of changes in overweight prevalence, since a single sampling strategy and family sample frame was used for the duration of the study.

A repeated cross-sectional sample over the same study period would be preferable to the current NLSY cohort. Nevertheless, controlling for respondent and maternal age effects had only small effects on estimated overweight prevalence. In addition, the observed prevalence of overweight among NLSY children is similar to that found in NHANES cohort data over periods

when overlapping prevalence estimates are available, supporting the validity of the NLSY estimates.

In this analysis, we defined overweight based on BMI from the new growth curves released by the NCHS and the CDC. Because BMI cutoff levels with the new growth curves are slightly higher than previous reference values, use of previous standards would have produced even higher estimated prevalence of overweight in this sample. For instance, the widely cited reference BMI levels from the NHANES I study for 6- to 12-year-old children<sup>17</sup> would have resulted in a net increase in estimated 1998 overweight prevalence to 15.6% instead of the 13.3% we observed using the new NCHS/CDC standards.

Like many other preventable adverse health states, childhood overweight reflects the convergence of many biological, economic, and social factors. Overweight arises from multiple causes, some as intimate as the family dinner table, others as seductive as television or the latest children's video game. Provision of high-fat meals and snacks in school settings is both a pow-

erful temptation and a clear signal of accepted nutritional norms. Innovative strategies have been evaluated to address each of these concerns.<sup>18-20</sup> No one intervention, by itself, is likely to produce large reductions in the prevalence of obese or overweight children. Like adolescent smoking, teen pregnancy, and youth violence, childhood overweight is prevalent because it arises from deeply rooted behaviors and from social practices that are hardly confined to children. Given the profound consequences of childhood inactivity, poor nutrition, and overweight throughout the lifespan,<sup>21</sup> urgency is warranted in responding to this epidemic.

**Author Contributions:** Study concept and design: Strauss.

Acquisition of data: Strauss.

Analysis and interpretation of data: Strauss, Pollack.

Drafting of the manuscript: Strauss, Pollack.

Critical revision of the manuscript for important intellectual content: Strauss, Pollack.

Statistical expertise: Strauss, Pollack.

Administrative, technical, or material support: Strauss.

Study supervision: Strauss.

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