PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Disparities in Peaks, Plateaus, and Declines in Prevalence of High BMI Among Adolescents

Kristine A. Madsen, Ashley E. Weedn and Patricia B. Crawford
Pediatrics published online Aug 16, 2010;
DOI: 10.1542/peds.2009-3411

Disparities in Peaks, Plateaus, and Declines in Prevalence of High BMI Among Adolescents

WHAT'S KNOWN ON THIS SUBJECT: Recent NHANES data demonstrate a leveling off in the prevalence of pediatric obesity. NHANES data do not demonstrate differences by race in trends over time; however, NHANES data are not powered to detect small (<5%) differences in trends over time.

WHAT THIS STUDY ADDS: The authors demonstrate a population-level decline in obesity prevalence for California's white and Asian youth since 2005, continuing increases in prevalence for black and American Indian girls, and a plateau for Latino youth, suggesting that health disparities are increasing.

abstract

FREE

OBJECTIVES: The objective of this study was to investigate trends in prevalence of high BMI from 2001 to 2008 and examine racial/ethnic disparities.

METHODS: Records for a total of 8 283 718 fifth-, seventh-, and ninth-grade students who underwent California's school-based BMI screening between 2001 and 2008 were included. Logistic regression identified trends in prevalence of high BMI (≥85th, ≥95th, ≥97th, and ≥99th percentiles).

RESULTS: For 3 of 4 BMI cut points, prevalence continued to increase for black and American Indian girls through 2008, Hispanic girls plateaued after 2005, non-Hispanic white girls declined to 2001 prevalence levels after peaking in 2005, and Asian girls showed no increases. Non-Hispanic white boys peaked in 2005, then declined to 2001 prevalence levels for all BMI cut points; Hispanic and Asian boys declined after 2005 (for 3 lowest BMI cut points only) but remained above 2001 levels; and American Indian boys peaked later (2007) and declined only for BMI ≥95th. No girls and few boys showed a decline after peaking in prevalence of BMI ≥99th percentile. In 2008, disparities in prevalence were greatest for BMI ≥99th percentile, with prevalence of 4.9% for American Indian girls and 4.6% for black girls versus 1.3% for non-Hispanic white girls.

CONCLUSIONS: On the basis of statewide California data, prevalence of high BMI is declining for some groups but has not declined for American Indian and black girls. These trends portend greater disparities over time, particularly in severe obesity. Interventions and policies that are tailored to the highest risk groups should be pursued. *Pediatrics* 2010;126:434–442

AUTHORS: Kristine A. Madsen, MD, MPH,[a] Ashley E. Weedn, MD,[b] and Patricia B. Crawford, DrPH, RD[c]

[a]Department of Pediatrics, University of California, San Francisco, San Francisco, California; [b]Department of Pediatrics, University of Oklahoma, Oklahoma City, Oklahoma; and [c]Dr Robert C. and Veronica Atkins Center for Weight and Health, University of California, Berkeley, Berkeley, California

KEY WORDS

obesity, disparities, public health, public policy, minority health

ABBREVIATIONS

NHANES—National Health and Nutrition Examination Survey
CDE—California Department of Education
CDC—Centers for Disease Control and Prevention
OR—odds ratio
PE—physical education

www.pediatrics.org/cgi/doi/10.1542/peds.2009-3411

doi:10.1542/peds.2009-3411

Accepted for publication Jun 8, 2010

Address correspondence to Kristine A. Madsen, MD, MPH, University of California, San Francisco, Department of Pediatrics, 3333 California St, Box 0503, San Francisco, CA 94118. E-mail: madsenk@peds.ucsf.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

In the United States, the prevalence of pediatric overweight and obesity tripled from 1970 to 2000.[1] Recent National Health and Nutrition Examination Survey (NHANES) data suggested a leveling off in prevalence from 1999 to 2008,[2] representing the first sign of abatement in the pediatric obesity epidemic. It is unclear whether this leveling off reflects a plateau in prevalence or a peak from which prevalence will decline. This distinction is of significant concern, because obesity is associated with multiple chronic health conditions[3,4] that increase with the severity of obesity.[4,5]

Recent studies indicated racial/ethnic disparities in obesity.[4,6,7] NHANES data from 1999 to 2008 also demonstrated significantly higher prevalence of obesity among Hispanic and black youth compared with non-Hispanic white youth.[2] Differences in trends over time by race, however, were not statistically significant in NHANES data, suggesting that the rate of change in obesity prevalence was similar among the race groups from 1999 to 2008. If, in fact, trends in obesity are similar by race, then disparities would not be expected to worsen; however, although differences did not reach statistical significance, it is difficult to rule out an effect by race, given the relatively large SEs for prevalence of high BMI in the NHANES data set. Thus, to date, the NHANES data have not unequivocally addressed trends in disparities.

California has conducted annual school-based BMI screening among all fifth-, seventh-, and ninth-grade public school students since 2001 as part of a statewide mandate to assess overall student fitness. Almost 13% of US youth who are younger than 18 years reside in California, and Hispanic children, who are at high risk for weight-related comorbidity,[8] make up half of the school population in the state. In addition, California's large BMI screening data set includes a considerable number of Asian youth and sufficient American Indian youth to examine trends in high BMI among these understudied and at-risk groups.[9,10] We sought to use California's school-based BMI screening data to determine prevalence of high BMI in a census-based sample of youth; to determine whether prevalence is increasing, leveling off, or declining; and to identify potential gender and racial/ethnic disparities in high BMI among 5 major racial/ethnic groups.

METHODS

This study, certified as exempt by the University of California, San Francisco's Committee on Human Research, examined data that were collected as part of California's mandatory school-based fitness assessments. Since 2001, California schools have conducted the multicomponent Fitnessgram assessment,[11] which includes annual height and weight measurements for all fifth-, seventh-, and ninth-grade students. Schools have the option of participating in training and purchasing equipment for the Fitnessgram; however, documentation of school participation in training is not available.

Student-level Fitnessgram data were obtained from the California Department of Education (CDE) for each year from 2001 to 2008 (aggregate-level data are publicly available from the CDE's Web site[12]). Data records include student grade, age (years), gender, height (inches), weight (pounds), and race/ethnicity (African American, American Indian/Alaskan Native, Asian, Filipino, Hispanic/Latino, Pacific Islander, or white not of Hispanic origin). To protect student confidentiality, the CDE included Filipino and Pacific Islander students in the Asian category. The CDE redacted data for any student who, on the basis of gender, grade, and race, would be among a group of ≤10 students in her or his school district. Data on total enrollment in California were obtained from the CDE Web site.[12]

Fitnessgram data records were available for a total of 11 001 223 students for the years 2001 to 2008, representing 91.7% of fifth-, seventh-, and ninth-graders who were enrolled during the study period. A total of 2 477 450 youth were excluded from analysis because of missing or invalid data: 2 279 757 had no height and/or weight data because of data redaction or missing data; 71 341 were missing age or had an implausible value for age (fifth-grader younger than 8 or older than 13 years; seventh-grader younger than 10 or older than 15 years; ninth-grader younger than 12 or older than 17 years); and 126 352 had a biologically implausible height, weight, or BMI (according to the Centers for Disease Control and Prevention [CDC] SAS protocol for biologically implausible values[13]), or an absolute BMI z score >5. Of the remaining 8 523 773 with valid BMI and age data, 240 055 with unknown or "other" race were excluded from the analysis, leaving 8 283 718 youth who were aged 8 to 17 years from 2001 to 2008 (69% of total students enrolled) included in the final analyses.

BMI z scores were calculated in SAS 9.2 (SAS Institute Inc, Cary, NC) using the CDC's program,[14] which is based on the 2000 gender-specific BMI-for-age growth charts. Each student's BMI percentile was calculated from the BMI z score, and a binary indicator was assigned for 4 high BMI-for-age cut points: ≥85th (overweight), ≥95th (obese), ≥97th, and ≥99th (severely obese) percentiles.

Differences in prevalence of high BMI in 2008 by race/ethnicity and age category (8–11 vs 12–17 years, similar to categories used in previous analyses of NHANES data[15]) were assessed with logistic regression. Trends in high BMI for age between 2001 and 2008 were modeled by using logistic regression, accounting for clustering by school district and by using robust SEs. Year was a categorical predictor (reference year 2001), controlling for racial/ethnic group and age category. For clarification of trends in prevalence, the year in which prevalence of high BMI was highest between 2001 and 2008 was set as the reference in a separate model. Because significant interaction in trends over time by gender and by race/ethnicity within gender were seen, trends were modeled separately for all gender/race groups, adjusting for age category. The significance of any increase in prevalence over levels in 2001 was determined on the basis of the adjusted odds ratio (OR) comparing prevalence in peak year with prevalence in 2001. Similarly, the significance of declines in prevalence after peak was determined by adjusted OR comparing prevalence in 2008 with prevalence in peak year. All tests of significance were 2-sided with an α of .05. Statistical analyses were done using StataMP 11 (Stata Corp, College Station, TX).

RESULTS

Among the 8 283 718 students with valid data, 46.4% were Hispanic, 32.8% were non-Hispanic white, 12.6% were Asian, 7.7% were black, and 0.5% were American Indian.

Prevalence in 2008

Among public school students in California in 2008 ($n = 1\ 171\ 708$), 38.0% were overweight (BMI ≥85th percentile), including 19.8% obese (BMI ≥95th percentile) and 3.6% severely obese youth (BMI ≥99th percentile; Table 1). Boys were more likely to have a high BMI-for-age than girls ($P < .001$), as were 8- to 11-year-olds compared with 12- to 17-year-olds ($P < .001$ for all categories except BMI ≥99th, for which $P = .007$).

For black, Hispanic, and American Indian girls, the odds of having high BMI were 2 to 3 times those of non-Hispanic white girls, with ORs increasing as severity of high BMI-for-age increased (Table 2). Similar patterns existed for boys but with lesser disparities.

Peaks in High BMI

With all racial/ethnic groups combined, boys' and girls' prevalence of high BMI peaked in 2005 (Table 3), with the exception of girls with BMI ≥99th percentile, whose prevalence was highest in 2008. (Although no single racial/ethnic subgroup of girls peaked in prevalence of BMI ≥99th percentile in 2008, for all subgroups of girls, prevalence of BMI ≥99th percentile in 2008 was second only to prevalence in peak year.)

American Indian youth demonstrated later peaks and larger increases in prevalence over 2001 than any other group (Table 3). Both black and American Indian girls had the highest prevalence in 2008 for BMI categories ≥85th, ≥95th, and ≥97th percentiles.

American Indian boys peaked in 2007 across BMI categories. Hispanic and non-Hispanic white boys peaked in 2005 across BMI categories, whereas Asian boys demonstrated earlier peaks except for BMI ≥99th percentile. Black boys showed no increase in prevalence from 2001 to 2008 except for BMI ≥99th percentile, which peaked in 2007. The figures show unadjusted trends by racial/ethnic group for BMI ≥99th percentile (Fig 1) and BMI ≥95th percentile (Fig 2).

Notably, the greatest proportional increase in prevalence from 2001 to peak year was seen for BMI ≥99th percentile: from 2001 to 2005 (peak year), boys increased by 0.9% ($P < .001$), representing a proportional increase of 26.0%; girls increased by 0.5% ($P < .001$) from 2001 to 2008 (peak year), representing a 23.9% proportional increase. In comparison, the proportional increase over 2001 for boys and girls, respectively, was 16.7% and 13.7% for BMI ≥97th, 13.4% and 11.3% for BMI ≥95th, and 8.3% and 7.3% for BMI ≥85th percentiles (all significant at $P < .001$). Similarly, within each racial/ethnic subgroup, the proportional increase over 2001 was incrementally larger with each higher category of BMI. American Indian youth demonstrated the greatest proportional increases over 2001: 80.6% for BMI ≥99th ($P = .005$), 65.2% for BMI ≥97th, 53.0% for BMI ≥95th, and 30.2% for BMI ≥85th percentile (all significant at $P < .001$).

Declining Prevalence After Peak

Table 3 shows the adjusted decrease in prevalence from peak year to 2008. With all racial/ethnic groups combined, prevalence across all categories of BMI declined from peak until 2008 but remained above prevalence in 2001 (except for girls' prevalence of BMI ≥99th percentile, which was highest in 2008).

Black and American Indian girls did not decline in prevalence in any BMI category after peaking. Hispanic girls plateaued rather than declined for all categories except BMI ≥85th percentile. In contrast, prevalence among non-Hispanic white girls declined after peaking and reached 2001 levels for all but BMI ≥99th percentile.

Prevalence of high BMI among boys was more likely to decline after peaking than among girls (Table 3); however, American Indian boys plateaued rather than declined for all categories except BMI ≥95th percentile. Whereas Hispanic and Asian boys showed some declines after peak, only non-Hispanic white boys returned to 2001 levels of prevalence, and then only for BMI ≥85th, ≥95th, and ≥97th percentiles.

TABLE 1 Prevalence of High BMI for Age Among California Children in 2008

Parameter	All		Non-Hispanic White		Black		Hispanic		Asian		American Indian	
	N	% (SE)	*N*	% (SE)	*N*	% (SE)	*N*	% (SE)	*N*	% (SE)	*N*	% (SE)
BMI ≥99th percentile of the CDC growth charts												
Age, y												
Both genders												
8–17	1 171 708	3.6[a]	346 950	1.7[a]	83 219	4.5[b]	586 850	5.0[a]	150 486	1.7[a]	4203	5.2 (0.3)
8–11	293 857	3.7[a]	83 252	1.6[a]	20 509	4.5 (0.1)	148 646	5.3[b]	40 577	1.8[b]	873	4.8 (0.7)
12–17	877 851	3.5[a]	263 698	1.7[a]	62 710	4.5[b]	438 204	4.9[a]	109 909	1.7[a]	3330	5.3 (0.4)
Boys												
8–17	597 831	4.3[a]	178 024	2.1[a]	41 989	4.3 (0.1)	297 933	6.2[a]	77 780	2.4[b]	2105	5.6 (0.5)
8–11	143 052	4.3[b]	39 810	1.8[b]	9939	4.2 (0.2)	72 602	6.2[b]	20 298	2.5 (0.1)	403	5.2 (1.1)
12–17	454 779	4.3[a]	138 214	2.1[a]	32 050	4.4 (0.1)	225 331	6.2[b]	57 482	2.4[b]	1702	5.6 (0.6)
Girls												
8–17	573 877	2.8[a]	168 926	1.3[a]	41 230	4.6 (0.1)	288 917	3.8[a]	72 706	1.0[a]	2098	4.9 (0.5)
8–11	150 805	3.1[a]	43 442	1.4[b]	10 570	4.8 (0.2)	76 044	4.4[b]	20 279	1.1[b]	470	4.5 (1.0)
12–17	423 072	2.6[a]	125 484	1.3[a]	30 660	4.5 (0.1)	212 873	3.6[a]	52 427	0.9[a]	1628	5.0 (0.5)
BMI ≥97th percentile of the CDC growth charts												
Age, y												
Both genders												
8–17	1 171 708	13.3[a]	346 950	7.6[a]	83 219	14.4 (0.1)	586 850	18.0[b]	150 486	7.8[b]	4203	17.0 (0.6)
8–11	293 857	15.2[b]	83 252	8.3[b]	20 509	15.9 (0.3)	148 646	20.6 (0.1)	40 577	9.3 (0.1)	873	18.8 (1.3)
12–17	877 851	12.7[a]	263 698	7.3[b]	62 710	13.9 (0.1)	438 204	17.1[b]	109 909	7.2[b]	3330	16.5 (0.6)
Boys												
8–17	597 831	15.6[b]	178 024	8.9[b]	41 989	13.6 (0.2)	297 933	21.2[b]	77 780	10.5 (0.1)	2105	18.2 (0.8)
8–11	143 052	18.1 (0.1)	39 810	9.8 (0.1)	9939	15.3 (0.4)	72 602	24.5 (0.2)	20 298	12.8 (0.2)	403	20.1 (2.0)
12–17	454 779	14.8[b]	138 214	8.6[b]	32 050	13.0 (0.2)	225 331	20.1[b]	57 482	9.7 (0.1)	1702	17.8 (0.9)
Girls												
8–17	573 877	11.0[a]	168 926	6.2[b]	41 230	15.3 (0.2)	288 917	14.7[b]	72 706	4.9[b]	2098	15.8 (0.8)
8–11	150 805	12.5[b]	43 442	6.9 (0.1)	10 570	16.4 (0.4)	76 044	17.0 (0.1)	20 279	5.7 (0.2)	470	17.7 (1.8)
12–17	423 072	10.5[b]	125 484	5.9[b]	30 660	14.9 (0.2)	212 873	13.9[b]	52 427	4.6[b]	1628	15.2 (0.9)
BMI ≥95th percentile of the CDC growth charts												
Age, y												
Both genders												
8–17	1 171 708	19.8[a]	346 950	12.1[b]	83 219	20.7 (0.1)	586 850	26.0[b]	150 486	12.5[b]	4203	24.3 (0.7)
8–11	293 857	22.6[b]	83 252	13.5 (0.1)	20 509	23.0 (0.3)	148 646	29.7 (0.1)	40 577	14.9 (0.2)	873	26.7 (1.5)
12–17	877 851	18.9[a]	263 698	11.7[b]	62 710	19.9 (0.2)	438 204	24.8[b]	109 909	11.6 (0.1)	3330	23.7 (0.7)
Boys												
8–17	597 831	22.5[b]	178 024	13.9[b]	41 989	19.1 (0.2)	297 933	29.7[b]	77 780	16.4 (0.1)	2105	25.6 (1.0)
8–11	143 052	26.2 (0.1)	39 810	15.7 (0.2)	9939	21.9 (0.4)	72 602	34.3 (0.2)	20 298	20.0 (0.3)	403	28.0 (2.2)
12–17	454 779	21.3[b]	138 214	13.4[b]	32 050	18.3 (0.2)	225 331	28.2[b]	57 482	15.2 (0.1)	1702	25.0 (1.0)
Girls												
8–17	573 877	16.9[b]	168 926	10.2[b]	41 230	22.2 (0.2)	288 917	22.2[b]	72 706	8.3 (0.1)	2098	23.1 (0.9)
8–11	150 805	19.1 (0.1)	43 442	11.4 (0.2)	10 570	24.0 (0.4)	76 044	25.2 (0.2)	20 279	9.7 (0.2)	470	25.5 (2.0)
12–17	423 072	16.2[b]	125 484	9.8[b]	30 660	21.6 (0.2)	212 873	21.2[b]	52 427	7.8 (0.1)	1628	22.4 (1.0)
BMI ≥85th percentile of the CDC growth charts												
Age, y												
Both genders												
8–17	1 171 708	38.0[a]	346 950	27.7[b]	83 219	39.4 (0.2)	586 850	46.5[b]	150 486	28.0 (0.1)	4203	42.4 (0.8)
8–11	293 857	41.7[b]	83 252	30.3 (0.2)	20 509	42.0 (0.3)	148 646	50.7 (0.1)	40 577	32.1 (0.2)	873	46.6 (1.7)
12–17	877 851	36.8[b]	263 698	26.9[b]	62 710	38.5 (0.2)	438 204	45.1[b]	109 909	26.4 (0.1)	3330	41.3 (0.9)
Boys												
8–17	597 831	40.5[b]	178 024	29.9 (0.1)	41 989	36.4 (0.2)	297 933	49.3[b]	77 780	33.6 (0.2)	2105	42.3 (1.1)
8–11	143 052	45.8 (0.1)	39 810	33.4 (0.2)	9939	40.4 (0.5)	72 602	55.0 (0.2)	20 298	39.9 (0.3)	403	46.7 (2.5)
12–17	454 779	38.9[b]	138 214	28.8 (0.1)	32 050	35.2 (0.3)	225 331	47.4 (0.1)	57 482	31.4 (0.2)	1702	41.3 (1.2)
Girls												
8–17	573 877	35.4[b]	168 926	25.5 (0.1)	41 230	42.4 (0.2)	288 917	43.6[b]	72 706	21.9 (0.2)	2098	42.4 (1.1)
8–11	150 805	37.9 (0.1)	43 442	27.5 (0.2)	10 570	43.5 (0.5)	76 044	46.5 (0.2)	20 279	24.3 (0.3)	470	46.6 (2.3)
12–17	423 072	34.6[b]	125 484	24.8 (0.1)	30 660	42.0 (0.3)	212 873	42.5 (0.1)	52 427	21.0 (0.2)	1628	41.2 (1.2)

[a] SE <0.05%.
[b] SE <0.1%.

TABLE 2 Logistic Regression of High BMI for Age in Children and Adolescents, 2008

Parameter	OR (95% CI)							
	≥99th Percentile of the CDC Growth Chart		≥97th Percentile of the CDC Growth Charts		≥95th Percentile of the CDC Growth Charts		≥85th Percentile of the CDC Growth Charts	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Age, y								
8–11	1.0 (0.9–1.0)	1.2 (1.1–1.3)	1.3 (1.2–1.3)	1.2 (1.2–1.3)	1.3 (1.3–1.3)	1.2 (1.2–1.3)	1.3 (1.3–1.4)	1.2 (1.1–1.2)
12–17	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)
Race/ethnicity								
Black	2.2 (2.0–2.4)	3.6 (3.2–3.9)	1.6 (1.5–1.7)	2.7 (2.6–2.9)	1.5 (1.4–1.6)	2.5 (2.4–2.7)	1.3 (1.3–1.4)	2.2 (2.0–2.3)
Hispanic	3.1 (2.9–3.4)	2.9 (2.7–3.2)	2.8 (2.6–2.9)	2.6 (2.5–2.8)	2.6 (2.5–2.7)	2.5 (2.4–2.7)	2.3 (2.2–2.4)	2.3 (2.1–2.4)
Asian	1.2 (1.1–1.3)	0.7 (0.7–0.9)	1.2 (1.1–1.3)	0.8 (0.7–0.9)	1.2 (1.1–1.3)	0.8 (0.7–0.9)	1.2 (1.1–1.2)	0.8 (0.8–0.9)
American Indian	2.8 (2.2–3.6)	3.8 (3.0–4.8)	2.3 (2.0–2.7)	2.9 (2.5–3.4)	2.1 (1.9–2.4)	2.7 (2.4–3.0)	1.7 (1.6–1.9)	2.2 (1.9–2.5)
Non-Hispanic white	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)

CI indicates confidence interval.

TABLE 3 Prevalence of High BMI in 2001 With Increase to and Decline From Prevalence in Peak Year

Ethnicity	Boys						Girls					
	Prevalence in 2001, %	Increase 2001 to Peak, %[a]	*P*	Peak Year	Decrease, Peak to 2008, %[b]	*P*	Prevalence in 2001	Increase 2001 to Peak, %[a]	*P*	Peak Year	Decrease, Peak to 2008, %[b]	*P*
BMI ≥99th percentile												
All	3.5	0.9	c	2005	0.1	.029	2.2	0.5	c	2008	—	—
Black	3.6	0.8	c	2007	0.0	NS	3.8	0.8	c	2007	0.0	NS
Hispanic	5.3	1.1	c	2005	0.2	NS	3.2	0.6	c	2005	0.0	NS
Asian	2.2	0.4	c	2006	0.2	.009	0.9	0.2	.002	2002	0.2	.034
American Indian	3.4	3.0	c	2007	0.8	NS	2.4	2.5	.013	2006	0.0	NS
Non-Hispanic white	1.9	0.4	c	2005	0.3	c	1.2	0.2	c	2005	0.1	NS
BMI ≥97th percentile												
All	13.7	2.3	c	2005	0.3	c	9.7	1.3	c	2005	0.0	.049
Black	13.0	—	—	—	—	—	13.5	1.8	c	2008	—	—
Hispanic	19.2	2.7	c	2005	0.7	c	13.6	1.4	c	2005	0.2	NS
Asian	9.8	1.3	c	2003	0.7	c	5.0	—	—	—	—	—
American Indian	11.7	8.0	c	2007	1.5	NS	9.4	6.4	c	2008	—	—
Non-Hispanic white	8.9	1.0	c	2005	1.0	c	5.8	0.7	c	2005	0.3	.020
BMI ≥95th percentile			c									
All	20.3	2.7	c	2005	0.5	c	15.3	1.7	c	2005	0.1	.014
Black	18.8	—	—	—	—	—	20.0	2.2	c	2008	—	—
Hispanic	27.4	3.2	c	2005	0.9	c	20.8	1.8	c	2005	0.3	NS
Asian	15.7	1.7	c	2003	0.9	c	8.6	—	—	—	—	—
American Indian	17.8	10.3	c	2007	2.6	.042	15.1	8.1	c	2008	—	—
Non-Hispanic white	14.2	1.1	c	2005	1.4	c	9.9	1.0	c	2005	0.6	.004
BMI ≥85th percentile												
All	38.3	3.2	c	2005	0.9	c	33.1	2.4	c	2005	0.1	.007
Black	36.4	—	—	—	—	—	39.8	2.6	.002	2008	—	—
Hispanic	47.4	3.4	c	2005	1.5	c	42.0	2.1	c	2005	0.5	.018
Asian	32.3	2.4	c	2003	1.1	.002	21.7	—	—	—	—	—
American Indian	33.5	11.1	c	2007	2.3	NS	32.8	9.6	.008	2008	—	—
Non-Hispanic white	30.5	1.4	c	2005	2.0	c	25.0	1.5	c	2005	1.0	.006

NS indicates not significant at $P > .05$.

[a] Significance levels for increase in prevalence given for OR comparing prevalence in 2001 with prevalence in peak year.

[b] Significance levels for decrease in prevalence given for OR comparing prevalence in peak year with prevalence in 2008.

[c] $P \leq .001$.

Within each gender/race subgroup, prevalence of BMI ≥99th percentile did not decline after peaking, except among Asian and non-Hispanic white boys (Table 3).

To demonstrate changes in BMI at the population level over time, Fig 3 shows the smoothed distribution of BMI by race in years 2001, 2005, and 2008. Compared with 2001, distributions in 2005 and 2008 are shifted right for Hispanic, black, and American Indian groups. Non-Hispanic white youth are the only group for which the distributions in 2001 and 2008 are nearly identical.

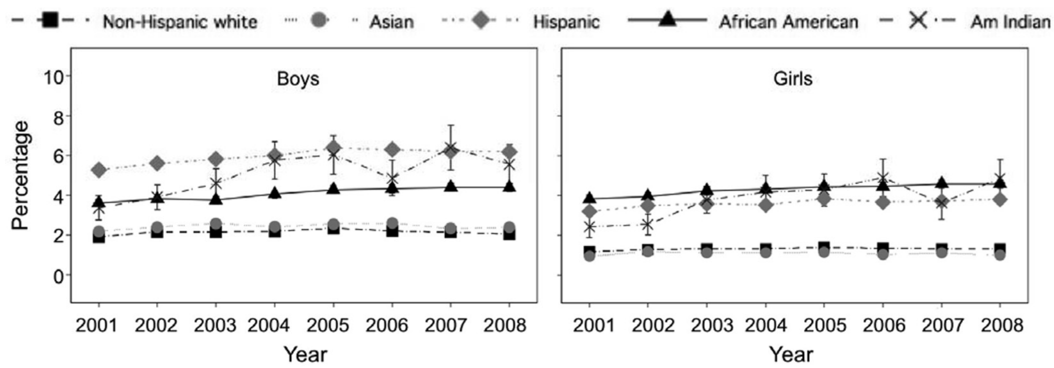

FIGURE 1
BMI for age ≥99th percentile by race/ethnicity in 2001–2008. Error bars indicate 95% confidence intervals and are visualized only for American Indian youth; all other ethnicities had negligible SE. Students were in fifth, seventh, and ninth grades.

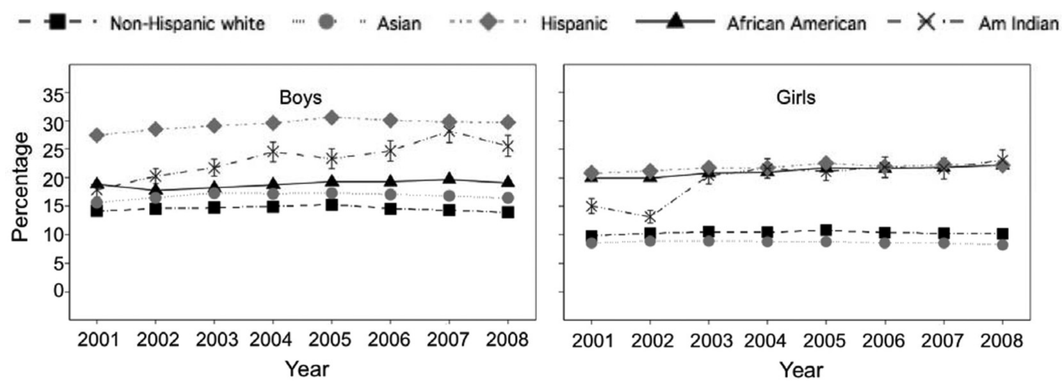

FIGURE 2
BMI for age ≥95th percentile by race/ethnicity in 2001–2008. Error bars indicate 95% confidence intervals and are visualized only for American Indian youth; all other ethnicities had negligible SE. Students were in fifth, seventh, and ninth grades.

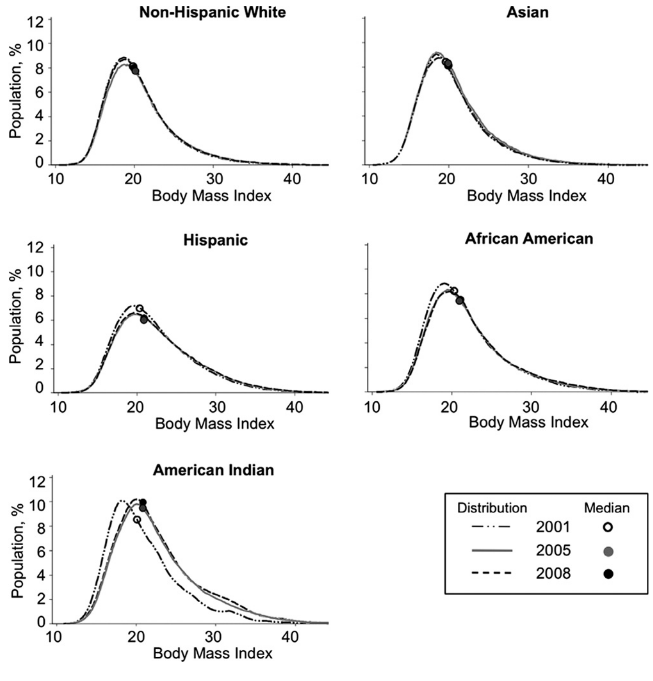

FIGURE 3
Change in distribution of BMI by race: 2001, 2005, and 2008.

DISCUSSION

This study takes advantage of California's mandated school-based BMI screening to examine trends in prevalence of high BMI from 2001 to 2008. The large sample size of this data set is a unique strength, providing ample power to identify significant trends over time and disparities in trends. To our knowledge, this is the first study to document a population-based decline in prevalence of high BMI after 2005, among most boys and for white girls. Even Hispanic boys, long leading in prevalence of obesity, declined in prevalence after peaking; however, Hispanic girls demonstrate no decline after peaking, and black and American Indian girls had the highest prevalence across BMI categories in 2008, the last year for which data were available. Differing patterns of plateau versus decline by race/ethnicity suggest that the alarming disparities in prevalence of high BMI in 2008 are expected to widen.

Overall prevalence of high BMI in 2008 in California's data set was similar to or slightly higher than prevalence among NHANES youth who were aged 6 to 19 years in 2007–2008: 13.3% had BMI ≥97th percentile in both data sets; 19.8% in California and 18.7% in NHANES had BMI ≥95th percentile; and 38.0% of California youth versus 34.7% of NHANES youth had BMI ≥85th percentile.[2] Across BMI categories, we demonstrate a larger magnitude of disparities than those seen in NHANES data,[2] largely because California's non-Hispanic white youth had lower prevalence of high BMI. This pattern replicates regional differences in obesity seen among adults in the CDC Behavioral Risk Factor Surveillance System data,[16] with non-Hispanic white adults in the West having lower prevalence of obesity than white adults in any other region, whereas Hispanic adults in the West have higher obesity prevalence than that seen nationally.[16] Thus, higher prevalence in California is expected given a higher proportion of individuals of Hispanic ethnicity in California relative to the US population as a whole. Although this study is limited to California, it represents a large proportion of US children: current census data reveal that 1 in 8 children in the United States lives in California.

These findings are a call to action for policies and interventions that are tailored for use in high-risk populations. School- and after-school–based programs have demonstrated improvements in weight status among black[17–19] and Hispanic youth.[20,21] More such interventions are needed and more work must be done to address weight status in understudied American Indian youth, who demonstrated the greatest increases in prevalence of high BMI in this study and are at high risk for weight-related comorbidities.[9,22] Future interventions should build on the work done and lessons learned in the National Heart, Lung, and Blood Institute–funded Pathways study.[23,24] Interventions in early childhood will also be critical because national data demonstrate increasing obesity prevalence among low-income American Indian preschool children as well.[25]

We demonstrate that disparities increase with increasing severity of obesity; however, although disparities are greatest for BMI ≥99th percentile, concerns around severe obesity apply to all youth. All racial/ethnic subgroups experienced the greatest proportional increase in prevalence for BMI ≥99th percentile. This has also been demonstrated in NHANES data for black, Hispanic, and non-Hispanic white youth.[4] In this study, no subgroups except white and Asian boys showed a decline after peaking in prevalence of severe obesity. This is of significant consequence because the adverse effects of high BMI worsen as severity of obesity increases, with respect to risk for future complications and economic impacts,[3,5,26] as well as risk for morbidity in adolescence.[27–31]

Reversing childhood obesity will require concerted public health efforts, similar to the multifaceted approach taken to reduce smoking.[32–34] Interventions to be considered might include restricting advertising of unhealthy products both in schools and during television programming targeted at children[35,36]; taxing sugar-sweetened beverages, which have been causally linked to obesity[37]; banning the sale of sugar-sweetened beverages and snacks that are high in fat or sugar during the school day (such policies in California may be related to declines in obesity seen after 2005)[38]; and increasing the quality and quantity of physical education (PE).[39–42] Policy levers that benefit low-income communities first and foremost may address disparities.

Although school-based BMI screening provides objective data on a vast number of youth, data quality is unknown. There is no surveillance of Fitnessgram test administration, and data collection methods and integrity likely vary (which will decrease precision of prevalence estimates) and may vary by school (which might bias estimates of prevalence, although less likely to bias estimates of trends over time). In addition, not all students who are enrolled in a school complete the Fitnessgram. The test, most often administered during PE, is more likely to miss students who are not taking PE. Because greater participation in PE has been associated with improved BMI,[39] missing data might have resulted in an underestimation of prevalence in this study.

Examining 4 BMI cut points could be considered multiple hypothesis testing. Applying Bonferroni adjustments with $P = .0125$ (.05 divided by 4) would suggest greater disparities: among girls, only non-Hispanic white girls would demonstrate a decline post peak; non-Hispanic white boys would remain the only group to decline across BMI cut points, and American Indian boys would show no decline at any cut point. Finally, using a cut point of BMI at the 99th percentile is problematic because percentiles >97th are beyond the range of the data from which parameters for estimating BMI *z* scores (as based on CDC growth charts) were derived; therefore, "extrapolation beyond this range should be done with caution."[43] Given the potential public health impact of increasing rates of severe obesity, however, highlighting this problem is critical.

CONCLUSIONS

The encouraging first signs of a decline in the obesity epidemic demonstrated in this study are tempered by concerns about increasing disparities.

The groups of greatest concern are, first, black and American Indian girls, who have not demonstrated any reduction in prevalence of high BMI; second, American Indian boys and Hispanic girls, whose rates plateaued rather than declined after peaking; and, finally, Hispanic boys, who showed only very small declines and not for the most severe obesity. Clinicians' support of policy approaches that focus on preventing and reducing prevalence of high BMI among these groups will be critical in reversing childhood obesity.

ACKNOWLEDGMENTS

This study was supported by Robert Wood Johnson Foundation grant 65715, Eunice Kennedy Shriver National Institute of Child Health and Human Development grant K23HD054470-01A1, and American Heart Association grant 0865005F. No funders were involved in any aspect of the analyses contained herein or in the preparation of this article.

REFERENCES

1. Jolliffe D. Extent of overweight among US children and adolescents from 1971 to 2000. *Int J Obes Relat Metab Disord*. 2004; 28(1):4–9
2. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007–2008. *JAMA*. 2010;303(3):242–249
3. Bibbins-Domingo K, Coxson P, Pletcher MJ, Lightwood J, Goldman L. Adolescent overweight and future adult coronary heart disease. *N Engl J Med*. 2007;357(23):2371–2379
4. Skelton JA, Cook SR, Auinger P, Klein JD, Barlow SE. Prevalence and trends of severe obesity among US children and adolescents. *Acad Pediatr*. 2009;9(5):322–329
5. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. *Pediatrics*. 2005; 115(1):22–27
6. Anderson SE, Whitaker RC. Prevalence of obesity among US preschool children in different racial and ethnic groups. *Arch Pediatr Adolesc Med*. 2009;163(4):344–348
7. Freedman DS, Khan LK, Serdula MK, Ogden CL, Dietz WH. Racial and ethnic differences in secular trends for childhood BMI, weight, and height. *Obesity (Silver Spring)*. 2006; 14(2):301–308
8. Centers for Disease Control and Prevention. Diabetes At a Glance 2010. Available at: www.cdc.gov/chronicdisease/resources/publications/aag/pdf/2010/diabetes_aag.pdf. Accessed July 1, 2010
9. Story M, Stevens J, Himes J, et al. Obesity in American-Indian children: prevalence, consequences, and prevention. *Prev Med*. 2003; 37(6 pt 2):S3–S12
10. Harrison GG, Kagawa-Singer M, Foerster SB, et al. Seizing the moment: California's opportunity to prevent nutrition-related health disparities in low-income Asian American population. *Cancer*. 2005;104(12 suppl):2962–2968
11. Eisenmann JC, Bartee RT, Smith DT, Welk GJ, Fu Q. Combined influence of physical activity and television viewing on the risk of overweight in US youth. *Int J Obes (Lond)*. 2008; 32(4):613–618
12. DataQuest. Available at: http://data1.cde.ca.gov/dataquest. Accessed June 2009
13. BIV cutoffs documentation. Atlanta, GA: Division of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion; 2007. Available at: www.cdc.gov/nccdphp/dnpa/growthcharts/resources/BIV-cutoffs.pdf. Accessed July 1, 2010
14. A SAS program for the CDC growth charts. Atlanta, GA: Division of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion; 2007. Available at: www.cdc.gov/nccdphp/dnpa/growthcharts/resources/sas.htm. Accessed November 2, 2009
15. Ogden CL, Carroll MD, Flegal KM. High body mass index for age among US children and adolescents, 2003–2006. *JAMA*. 2008; 299(20):2401–2405
16. Centers for Disease Control and Prevention (CDC). Differences in prevalence of obesity among black, white, and Hispanic adults—United States, 2006–2008. *MMWR Morb Mortal Wkly Rep*. 2009;58(27):740–744
17. Weintraub DL, Tirumalai EC, Haydel KF, Fujimoto M, Fulton JE, Robinson TN. Team sports for overweight children: the Stanford Sports to Prevent Obesity Randomized Trial (SPORT). *Arch Pediatr Adolesc Med*. 2008;162(3):232–237
18. Flores R. Dance for health: improving fitness in African American and Hispanic adolescents. *Public Health Rep*. 1995;110(2): 189–193
19. Robinson TN, Killen JD, Kraemer HC, et al. Dance and reducing television viewing to prevent weight gain in African-American girls: the Stanford GEMS pilot study. *Ethn Dis*. 2003;13(1 suppl 1):S65–S77
20. Madsen KA, Thompson HR, Wlasiuk L, Queliza E, Schmidt C, Newman TB. After-school program to reduce obesity in minority children: a pilot study. *J Child Health Care*. 2009; 13(4):333–346
21. Johnston CA, Tyler C, McFarlin BK, et al. Weight loss in overweight Mexican American children: a randomized, controlled trial. *Pediatrics*. 2007;120(6) Available at: www.pediatrics.org/cgi/content/full/120/6/e1450
22. KE L, Brock KE, Cant RV, Li Y, Morrell SL. The relationship between obesity and blood pressure differs by ethnicity in Sydney school children. *Am J Hypertens*. 2009; 22(1):52–58
23. Caballero B, Clay T, Davis SM, et al. Pathways: a school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren. *Am J Clin Nutr*. 2003;78(5):1030–1038
24. Gittelsohn J, Davis SM, Steckler A, et al. Pathways: lessons learned and future directions for school-based interventions among American Indians. *Prev Med*. 2003;37(6 pt 2):S107–S112
25. Centers for Disease Control and Prevention (CDC). Obesity prevalence among low-income, preschool-aged children—United States, 1998–2008. *MMWR Morb Mortal Wkly Rep*. 2009;58(28):769–773
26. Lightwood J, Bibbins-Domingo K, Coxson P, Wang YC, Goldman LG. Forecasting the future economic impact of current adolescent overweight: an estimate of the coronary heart disease policy model. *Am J Public Health*. 2009;99(12):2230–2237
27. Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979–1999. *Pediatrics*. 2002;109(5) Available at: www.pediatrics.org/cgi/content/full/109/5/e81
28. Must A, Anderson SE. Effects of obesity on morbidity in children and adolescents. *Nutr Clin Care*. 2003;6(1):4–12
29. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. *Pediatrics*. 1999;103(6 pt 1):1175–1182
30. Mallory GB Jr, Fiser DH, Jackson R. Sleep-associated breathing disorders in morbidly

obese children and adolescents. *J Pediatr*. 1989;115(6):892–897

31. Bloomgarden ZT. Type 2 diabetes in the young: the evolving epidemic. *Diabetes Care*. 2004;27(4):998–1010
32. Brownell KD, Warner KE. The perils of ignoring history: Big Tobacco played dirty and millions died. How similar is Big Food? *Milbank Q*. 2009;87(1):259–294
33. Mercer SL, Green LW, Rosenthal AC, Husten CG, Khan LK, Dietz WH. Possible lessons from the tobacco experience for obesity control. *Am J Clin Nutr*. 2003;77(4 suppl): 1073S–1082S
34. Yach D, Hawkes C, Epping-Jordan JE, Galbraith S. The World Health Organization's Framework Convention on Tobacco Control: implications for global epidemics of food-related deaths and disease. *J Public Health Policy*. 2003;24(3–4):274–290
35. Yancey AK, Cole BL, Brown R, et al. A cross-sectional prevalence study of ethnically targeted and general audience outdoor obesity-related advertising. *Milbank Q*. 2009;87(1):155–184
36. Powell LM, Szczypka G, Chaloupka FJ. Adolescent exposure to food advertising on television. *Am J Prev Med*. 2007;33(4 suppl): S251–S256
37. Brownell KD, Farley T, Willett WC, et al. The public health and economic benefits of taxing sugar-sweetened beverages. *N Engl J Med*. 2009;361(16):1599–1605
38. Sanchez-Vaznaugh EV, Sanchez BN, Baek J, Crawford PB. 'Competitive' food and beverage policies: are they influencing childhood overweight trends? *Health Aff (Millwood)*. 2010;29(3):436–446
39. Madsen KA, Gosliner W, Woodward-Lopez G, Crawford PB. Physical activity opportunities associated with fitness and weight status among adolescents in low-income communities. *Arch Pediatr Adolesc Med*. 2009; 163(11):1014–1021
40. Datar A, Sturm R. Physical education in elementary school and body mass index: evidence from the early childhood longitudinal study. *Am J Public Health*. 2004;94(9): 1501–1506
41. Sollerhed AC, Ejlertsson G. Physical benefits of expanded physical education in primary school: findings from a 3-year intervention study in Sweden. *Scand J Med Sci Sports*. 2008;18(1):102–107
42. Wardle J, Brodersen NH, Boniface D. School-based physical activity and changes in adiposity. *Int J Obes (Lond)*. 2007;31(9): 1464–1468
43. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC growth charts for the United States: methods and development. *Vital Health Stat 11*. 2002;(246):1–190