Research

Original Investigation

Prevalence and Trends in Obesity and Severe Obesity Among Children in the United States, 1999-2012

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IMPORTANCE Childhood obesity is the focus of public health efforts and accurate estimates of the prevalence and severity of obesity are needed for policy decisions and directions for future research.

OBJECTIVE To examine the prevalence of obesity and severe obesity over time for 14 years of the continuous National Health and Nutrition Examination Survey, 1999 to 2012, and to examine differences in the trends by age, race/ethnicity, and sex.

DESIGN, SETTING, AND PARTICIPANTS Representative sample (N = 26 690) of children in the United States, ages 2 to 19 years, in repeated cross-sections of the National Health and Nutrition Examination Survey, 1999 to 2012.

MAIN OUTCOMES AND MEASURES Prevalence of overweight (body mass index [BMI] ≥ 85th percentile), obesity (BMI ≥ 95th percentile for age and sex), class 2 obesity (BMI ≥ 120% of the 95th percentile or BMI ≥ 35), and class 3 obesity (BMI ≥ 140% of the 95th percentile or BMI ≥ 40).

RESULTS From 2011 to 2012, 17.3% (95% CI, 15.3-19.3) of children in the United States aged 2 to 19 years were obese. Additionally, 5.9% (95% CI, 4.4-7.4) of children met criteria for class 2 obesity and 2.1% (95% CI, 1.6-2.7) met criteria for class 3 obesity. Although these rates were not significantly different from 2009 to 2010, all classes of obesity have increased over the last 14 years.

CONCLUSIONS AND RELEVANCE Nationally representative data do not show any significant changes in obesity prevalence in the most recently available years, although the prevalence of obesity may be stabilizing. Continuing research is needed to determine which, if any, public health interventions can be credited with this stability. Unfortunately, there is an upward trend of more severe forms of obesity and further investigations into the causes of and solutions to this problem are needed.

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Childhood obesity is the focus of public health efforts and accurate estimates of the prevalence of obesity are needed for policy decisions and the directions for future research. After years of increasing prevalence of childhood obesity, recent studies have indicated a possible decline in certain groups.[1-4] Popular media have touted this as evidence of progress in combating childhood obesity. Unfortunately, these studies focus on low-income preschool-aged children or specific geographic areas, preventing extrapolation to the entire US population. The last nationally representative data[5]—undermining the media's assumptions—showed no change in obesity from 2007-2008 to 2009-2010. The principle concern with these recent reports of stability in the prevalence rates of overweight or obesity is that such stud-

ies may mask meaningful increases in the prevalence of severe obesity. There may be a rightward shift in the body mass index (BMI) distribution of children above the thresholds for overweight or obesity to higher BMIs. Recent studies of the prevalence of obesity have not examined severe obesity.[5] Studies examining trends in severe obesity have shown a marked increase in certain groups but need to be extended to include recent years.[6] This distinction is critical to understanding the health effects of obesity in children because severe obesity is more strongly related to increased cardiometabolic risk than less severe obesity.[7]

Our objective was to examine the prevalence of obesity and severe obesity over time for the 14 years of continuous National Health and Nutrition Examination Survey (NHANES),

Table 1. Distribution of Demographic Characteristics and Obesity Prevalence by Demographic Characteristics for All Participants, 1999 to 2012

Characteristic	Full Population, No. (%)	Overweight		Obesity		Class 2 Obesity		Class 3 Obesity	
		% (95% CI)	P Value[a]	% (95% CI)	P Value[a]	% (95% CI)	P Value[a]	% (95% CI)	P Value[a]
Total No.	26 690	8979		4902		1671		518	
Total prevalence		31.2 (30.1-32.2)		16.4 (15.6-17.2)		5.1 (4.6-5.5)		1.5 (1.3-1.7)	
Population[b]	71 898 377	22 403 078		11 781 596		3 645 60		155 791	
Age, y									
2-5	5963 (21.1)	23.8 (22.2-25.4)		11.1 (9.9-12.2)		2.1 (1.6-2.6)		0.5 (0.2-0.7)	
6-11	7987 (33.5)	33.1 (31.5-34.7)	<.001	17.5 (16.3-18.7)	<.001	5.0 (4.5-5.6)	<.001	1.2 (0.9-1.4)	<.001
12-19	12 740 (45.4)	33.2 (31.8-34.5)		18.0 (16.9-19.1)		6.5 (5.7-7.3)		2.1 (1.8-2.5)	
Sex									
Female	13 154 (48.8)	30.7 (29.4-32.0)	.24	15.6 (14.6-16.6)	.005	4.8 (4.2-5.3)	.10	1.4 (1.1-1.7)	.47
Male	13 536 (51.2)	31.6 (30.3-32.9)		17.1 (16.2-18.1)		5.4 (4.7-6.0)		1.5 (1.3-1.8)	
Race/ethnicity									
White	7317 (58.2)	28.7 (27.1-30.3)		14.3 (13.0-15.6)		3.9 (3.2-4.5)		1.0 (0.7-1.3)	
Black	7733 (14.6)	35.1 (33.8-36.4)	<.001	20.3 (19.3-21.4)	<.001	8.5 (7.7-9.3)	<.001	3.3 (2.8-3.9)	<.001
Hispanic	9875 (19.9)	37.7 (36.5-39.0)		20.9 (19.8-22.0)		6.6 (5.9-7.3)		1.8 (1.4-2.1)	
Other	1765 (7.2)	24.6 (21.9-27.3)		12.7 (10.8-14.6)		3.6 (2.5-4.7)		0.7 (0.1-1.4)	

[a] P values are from adjusted Wald tests of differences by demographics within each obesity definition.

[b] Population refers to the estimated total number of children in each category, extrapolated to the US population.

1999 to 2012. Additionally, we sought to examine changes in the most recent years. Finally, we aimed to identify differences in the trends by age, race/ethnicity, and sex.

Methods

Data Source
In this study, data came from the repeated cross-sections of the NHANES, 1999 to 2012. The NHANES is a stratified, multistage probability sample of the civilian, noninstitutionalized population of the United States. It includes an in-home questionnaire on a variety of demographic and health-related topics, a computer-assisted interview, and an examination component consisting of a thorough physical examination including measured height and weight.[8] In the current continuous NHANES, data are released in pooled 2-year cycles. This allows prevalence estimates that are representative of the US population for each 2-year grouping combined.

Analyses were performed using the survey estimation routines in Stata version 13.0 (StataCorp). This study was deemed exempt from further review by the institutional review board under federal regulation 45 CFR §46.101(b) because it used only deidentified secondary data.

Definitions of Obesity
We used height and weight as measured during the examination component to calculate age- and sex-specific BMI percentile (calculated as weight in kilograms divided by height in meters squared), using an SAS code developed for that purpose.[9] In 2011 to 2012, the NHANES provided age in years for children 2 to 19 years, rather than age in months as in previous releases. To most accurately estimate prevalence rates, we classified children as being at the midpoint for their whole-year age for calculation purposes (eg, an 11-year-old child would

be considered 11.5 years of age). This yielded similar prevalence rates to calculations based on age in months (differences of 1- or 2-tenths of a percentage point). We used this for calculation for all 2-year cycles because consistency in definition across time was considered critically important for our trend analysis.

We defined overweight and obesity using the Centers for Disease Control and Prevention criteria and severe obesity using 2 additional criteria. First, we defined *overweight* as having a BMI greater than or equal to the 85th percentile for age and sex and defined *obesity* as having a BMI greater than or equal to the 95th percentile for age and sex.[10] Second, we used a definition of *severe obesity* recommended by the American Heart Association as a BMI greater than 120% of the 95th percentile for age and sex or a BMI of 35 or greater, whichever is lower.[11] This is used in place of the 99th percentile because it has been shown to demonstrate more stability in estimation.[12] This represents what is considered class 2 obesity in adults,[13] and we refer to it as such throughout this study. Lastly, we used an estimate to represent *class 3 obesity*, which we defined as a BMI greater than 140% of the 95th percentile for age and sex or a BMI greater than or equal to 40, whichever is lower. We chose 140% because this approximated a BMI of 40 at the same age as 120% approximated a BMI of 35. In adults, these ranges of BMI are considered higher risk with early mortality.[14]

Other Variables
Race and ethnicity were categorized as non-Hispanic white, non-Hispanic black, Mexican American, other Hispanic, or other race/ethnicity. In 2011 to 2012, Asian individuals were oversampled. However, owing to small numbers in previous years, we included Asian individuals in the other race/ethnicity category for the trend analysis. We did not examine household income because income data were not released with the 2011 to 2012 demographic data.

Table 2. Obesity Prevalence for All Children 2 to 19 Years of Age
by National Health and Nutrition Examination Survey Year

Category	% (95% CI)	P Value[a]
Overweight		
1999-2000	28.7 (25.8-31.6)	
2001-2002	29.8 (27.2-32.4)	
2003-2004	33.5 (29.8-37.1)	
2005-2006	30.2 (27.2-33.2)	.07
2007-2008	31.6 (29.3-33.8)	
2009-2010	32.0 (30.2-33.7)	
2011-2012	32.2 (29.6-34.7)	
Obesity		
1999-2000	14.5 (12.6-16.5)	
2001-2002	15.2 (13.2-17.1)	
2003-2004	17.3 (14.9-19.7)	
2005-2006	15.9 (13.3-18.5)	.03
2007-2008	17.3 (14.7-20.0)	
2009-2010	17.0 (15.6-18.4)	
2011-2012	17.3 (15.3-19.3)	
Class 2 obesity		
1999-2000	3.8 (2.7-4.9)	
2001-2002	5.1 (4.1-6.1)	
2003-2004	5.1 (3.8-6.4)	
2005-2006	4.8 (3.5-6.1)	.04
2007-2008	5.0 (3.8-6.2)	
2009-2010	5.7 (4.5-7.0)	
2011-2012	5.9 (4.4-7.4)	
Class 3 obesity		
1999-2000	0.9 (0.6-1.3)	
2001-2002	1.3 (0.9-1.7)	
2003-2004	1.6 (0.9-2.2)	
2005-2006	1.2 (0.6-1.8)	.002
2007-2008	1.5 (1.0-2.0)	
2009-2010	1.6 (1.1-2.1)	
2011-2012	2.1 (1.6-2.7)	

[a] P values represent tests of linear trends across year.

Statistical Analysis

All analyses are adjusted for the weights and complex survey design of the NHANES as recommended by the National Center for Health Statistics.[15,16] We present prevalence estimates for each obesity definition by 2-year NHANES cycles. To test for trends across years, we regressed NHANES years as an ordinal variable on the binary outcome of severe obesity. The resulting coefficient and standard errors represent a test for a linear trend while also permitting complete correction for the probability weights and survey design of the NHANES, which is not available in many other trend tests. Because the prevalence rates for the outcomes we examined were routinely less than 20%, we used logistic regression for this analysis. Therefore, we present prevalence rates with P values that are based on the trend tests.

In addition to trends across the 14-year period, we wanted to examine differences in the most recent years, from the 2009

Figure. Prevalence of Overweight, Obesity, Class 2 Obesity, and Class 3 Obesity Among Children in the United States by Year
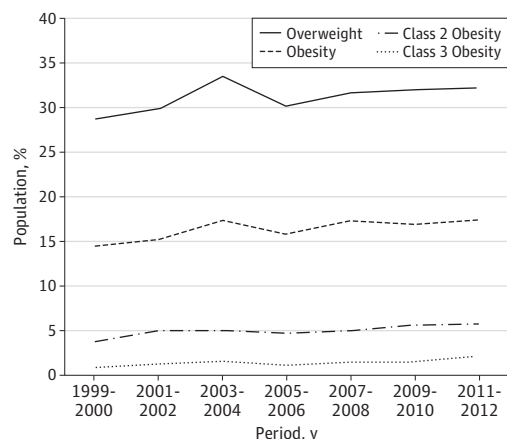
to 2010 cycle to the 2011 to 2012 cycle. For this we used an adjusted Wald test comparing the prevalence rates for these 2 cycles.

Results

A total of 26 690 children aged 2 to 19 years had BMI data in the NHANES 1999 to 2012 and were included in the analysis. **Table 1** presents overall demographic characteristics and prevalence by demographic characteristics. Older children and non-Hispanic black and Hispanic children had higher prevalence rates of overweight and obesity as well as both class 2 and class 3 obesity in the group of all years pooled.

Table 2 shows the prevalence of overweight and obesity by ordinal 2-year cycles. A positive linear trend is significant for obesity (P = .03), class 2 obesity (P = .04), and class 3 obesity (P = .002) (**Figure**). Adjusted Wald tests examining the differences between 2009 to 2010 and 2011 to 2012 only revealed no significant difference in any of the obesity categories.

For females of all ages combined, class 2 obesity and class 3 obesity have increased significantly over time (**Table 3** and eTable 1 in Supplement). This is also significant among girls aged 6 to 11 years. For males of all ages combined, a positive linear trend is seen but is not significant for overweight, obesity (P = .06), class 2 obesity (P = .16), or class 3 obesity (P = .09). In contrast to females, the prevalence rates of obesity and class 3 obesity have increased among adolescent boys aged 12 to 19 years. Adjusted Wald tests examining the differences between 2009 to 2010 and 2011 to 2012 revealed that the only significant differences were obesity among boys aged 2 to 5 years (P = .02) and class 2 obesity among boys aged 2 to 5 years (P = .04).

Prevalence rates of overweight, obesity, and class 2 obesity are increasing significantly among Hispanic females and black males (**Table 4** and eTable 2 in Supplement). The linear trend for class 3 obesity is most prominent for white

Table 3. Obesity Prevalence by Age for Females and Males 2 to 19 Years of Age by National Health and Nutrition Examination Survey 2-Year Cycle[a]

	Overweight				Obesity				Class 2 Obesity				Class 3 Obesity			
	2-18 y	2-5 y	6-11 y	12-19 y	2-18 y	2-5 y	6-11 y	12-19 y	2-18 y	2-5 y	6-11 y	12-19 y	2-18 y	2-5 y	6-11 y	12-19 y
Females																
1999-2000	27.4	21.8	27.3	30.1	14.5	11.1	15.5	15.4	3.8	2.2	3.3	5.1	0.9	0.0	0.6	1.6
2001-2002	29.5	22.4	31.6	31.1	14.0	10.4	14.2	15.4	4.3	2.4	3.3	5.9	1.0	0.3	0.6	1.6
2003-2004	32.8	25.8	37.8	32.3	16.3	13.2	17.8	16.7	4.9	1.7	5.3	6.1	1.6	0.1	1.3	2.4
2005-2006	30.0	21.4	27.9	35.4	15.4	11.5	14.4	17.8	4.5	1.4	3.1	6.9	1.2	0.2	0.2	2.3
2007-2008	31.6	21.0	35.2	34.3	16.3	10.7	19.1	17.0	4.6	2.0	5.1	5.5	1.3	1.2	0.6	1.9
2009-2010	30.7	24.9	32.0	32.6	15.2	10.6	16.0	16.9	5.0	1.5	4.6	7.0	1.5	0.3	1.8	1.9
2011-2012	32.4	22.9	36.3	34.2	17.4	8.0	19.7	20.4	6.0	1.6	6.9	7.7	2.3	0.4	1.8	3.7
P trend test[b]	.01	.85	.09	.20	.01	.37	.01	.04	.04	.50	.02	.15	.003	.04	.01	.11
Males																
1999-2000	29.9	22.3	33.3	30.8	14.6	10.0	16.3	15.3	3.8	1.4	3.2	5.4	1.0	0.4	0.8	1.4
2001-2002	30.1	23.6	31.9	31.1	16.4	10.9	17.2	17.7	5.8	2.8	7.3	5.9	1.6	0.9	2.1	1.5
2003-2004	34.2	27.7	35.4	36.2	18.2	14.8	18.9	19.1	5.2	3.7	5.1	6.0	1.6	1.3	1.4	1.9
2005-2006	30.3	24.5	31.1	32.3	16.4	10.3	17.6	18.3	5.1	1.6	4.3	7.1	1.2	0.4	0.7	2.0
2007-2008	31.5	21.7	35.6	33.6	18.3	10.4	21.4	20.0	5.4	1.4	6.0	6.8	1.6	0.4	1.3	2.4
2009-2010	33.2	28.9	34.6	34.2	18.7	14.8	20.1	19.7	6.3	3.5	5.5	8.4	1.7	0.3	1.0	2.9
2011-2012	32.0	23.6	33.0	35.3	17.2	8.8	17.2	21.4	5.7	1.8	6.8	6.8	2.0	0.6	2.2	2.4
P trend test[b]	.32	.59	.77	.19	.06	.93	.30	.03	.16	.96	.23	.21	.09	.43	.51	.02

[a] eTable 1 in Supplement provides the complete Table including sample sizes and confidence intervals.

[b] P values represent tests of linear trends across years.

females (P = .02) and black males (P = .06). The changes from 2009-2010 to 2011-2012 were not significant for any of the race/sex subgroups in any of the obesity categories.

Table 5 shows the results of year trends controlling for race/ethnicity, sex, and age. The linear trend analysis demonstrates a significant positive trend for obesity (P = .02), class 2 obesity (P = .03), and class 3 obesity (P = .002). Although the trends are positive overall, the most recent years (2011-2012) are greater than but not significantly different from the previous 2-year cycle (2009-2010) for all levels of obesity. The increase over time is particularly marked for class 3 obesity.

Discussion

Nationally representative data do not show any significant changes in obesity prevalence in the most recently available years (2011-2012). This is in contrast to state-specific findings among low-income preschoolers in the same time frame demonstrating declines.[1-4] Trends across 1999 to 2012 are positive overall and within certain subgroups. Prevalence rates for all categories of obesity increased among most groups from 2009 to 2010 and 2011 to 2012, although these differences are not statistically significant.

Our findings reflect those of earlier work using the NHANES where younger children and nonwhite participants were at greater risk for obesity and severe obesity.[6,17] The greater prevalence rates of class 2 and class 3 obesity are particularly no-

table in adolescents and non-Hispanic black individuals. Additionally, overweight and obesity at all levels of severity are increasing significantly among Hispanic girls and non-Hispanic black boys. Future research should determine whether there are specific factors that can be addressed in these high-risk groups.

Addressing severe obesity is critical to the long-term health of children in the United States. Studies[18] predict that obesity and severe obesity among adults in the United States will increase significantly through 2030. We also know that obesity in adolescence is significantly related to incident severe obesity in adulthood.[19] Although overweight (BMI ≥ 85th percentile) and obesity (BMI ≥ 95th percentile) are somewhat related to increased cardiovascular risk, more severe levels of obesity have much stronger associations to the number and severity of cardiometabolic risk factors.[11]

One important limitation to our study was that we were unable to examine state-specific trends in obesity prevalence. Many obesity-related policies are developed and implemented at the state and local levels, so understanding which of these policies are most effective is not possible with the national data we used in this study. Second, although we have a sufficiently large sample for overall prevalence estimates, we do not have an adequate sample to examine trends in very specific age, race/ethnicity, and sex groups, particularly in the class 3 obesity category. Finally, we were unable to examine recent trends in obesity by income because income was not available in the most recent NHANES public release.

Table 4. Obesity Prevalence by Race/Ethnicity for Males and Females by National Health and Nutrition Examination Survey 2-Year Cycle[a]

	Overweight				Obesity				Class 2 Obesity				Class 3 Obesity			
	White	Black	Hispanic	Other Race/ Ethnicity	White	Black	Hispanic	Other Race/ Ethnicity	White	Black	Hispanic	Other Race/ Ethnicity	White	Black	Hispanic	Other Race/ Ethnicity
Females																
1999-2000	23.4	37.2	31.7	25.1	11.6	21.7	15.7	18.1	3.0	7.5	3.2	4.9	0.4	2.8	1.0	1.1
2001-2002	26.9	35.9	34.9	25.3	12.1	19.8	17.4	8.7	3.3	7.6	6.2	1.9	0.5	2.5	1.9	0.0
2003-2004	31.6	40.7	34.8	18.4	15.5	23.7	16.6	5.3	3.9	10.2	5.1	0.9	1.0	4.5	1.4	0.0
2005-2006	27.8	38.7	35.7	17.4	12.7	24.7	20.4	5.6	2.9	10.3	6.2	1.2	0.4	4.6	1.2	0.0
2007-2008	30.1	38.9	35.7	16.9	15.4	22.9	17.7	5.7	3.8	8.0	5.6	0.7	1.2	2.4	1.4	0.0
2009-2010	26.6	40.7	38.5	21.7	11.8	24.6	19.2	12.0	4.2	9.2	5.4	2.9	1.0	4.5	1.6	0.0
2011-2012	30.1	36.1	38.3	24.3	16.1	20.4	20.4	11.9	4.8	10.1	7.3	3.5	2.5	5.4	0.6	0.0
P trend test[b]	.23	.79	.02	0.81	.29	.73	.05	.71	.29	.36	.05	.90	.02	.15	.43	
Males																
1999-2000	27.9	30.7	36.6	22.8	10.8	17.0	23.0	12.6	2.4	6.1	5.3	5.4	0.6	2.1	1.3	0.6
2001-2002	27.9	27.1	39.1	34.7	15.1	14.9	21.7	18.0	5.4	5.8	8.6	3.4	1.3	2.0	2.2	1.7
2003-2004	34.4	31.3	41.6	19.5	17.8	15.9	22.1	16.9	4.6	7.4	5.7	4.9	1.2	2.7	2.2	1.1
2005-2006	27.8	31.3	39.9	26.2	14.3	18.0	24.5	11.4	3.3	8.1	9.1	3.9	0.7	3.1	2.0	0.0
2007-2008	28.8	32.5	39.6	29.0	16.1	18.1	24.9	17.7	4.2	6.7	7.9	5.3	1.0	2.0	3.0	2.0
2009-2010	30.3	36.7	39.5	30.9	16.2	23.9	23.5	15.2	4.6	12.0	8.1	4.2	1.2	4.8	1.7	0.0
2011-2012	27.5	34.3	41.3	30.3	13.8	19.8	23.8	16.7	3.3	10.1	7.9	6.8	0.9	3.4	3.0	3.6
P trend test[b]	.90	.02	.28	.36	.43	.002	.48	.73	.99	.05	.22	.65	.94	.06	.15	.44

[a] eTable 2 in Supplement provides the complete Table including sample sizes and confidence intervals.

[b] P values represent tests of linear trends across years.

Table 5. Multivariate Analysis of Obesity Trends Controlling for Age, Sex, and Race/Ethnicity[a]

	Overweight		Obesity		Class 2 Obesity		Class 3 Obesity	
Period	OR (95% CI)	P Value	OR (95% CI)	P Value	OR (95% CI)	P Value	OR (95% CI)	P Value
1999-2000	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
2001-2002	1.06 (0.87-1.29)	.57	1.06 (0.86-1.32)	.57	1.37 (0.95-1.96)	.09	1.40 (0.87-2.25)	.16
2003-2004	1.27 (1.01-1.61)	.04	1.26 (0.99-1.60)	.06	1.37 (0.92-2.04)	.12	1.73 (1.02-2.93)	.04
2005-2006	1.09 (0.88-1.35)	.42	1.14 (0.89-1.46)	.31	1.29 (0.87-1.92)	.20	1.31 (0.75-2.28)	.34
2007-2008	1.16 (0.96-1.41)	.12	1.25 (0.98-1.60)	.08	1.34 (0.90-1.99)	.15	1.59 (0.95-2.68)	.08
2009-2010	1.18 (0.99-1.42)	.06	1.23 (1.01-1.49)	.04	1.56 (1.06-2.30)	.02	1.78 (1.09-2.90)	.02
2011-2012	1.18 (0.97-1.44)	.09	1.24 (1.00-1.53)	.05	1.57 (1.07-2.33)	.02	2.31 (1.46-3.67)	.000
Continuous (trend)	1.02 (1.00-1.05)	.08	1.03 (1.00-1.06)	.02	1.06 (1.01-1.11)	.03	1.11 (1.04-1.18)	.002

Abbreviations: NHANES, National Health and Nutrition Examination Survey; OR, odds ratio.

[a] Results represent logistic regression of the NHANES cycle with the referent of 1999 to 2000, as well as results of logistic regression, examining the NHANES cycle as an ordinal variable.

Conclusions

In 2011 to 2012, 32.2% of children in the United States aged 2 to 19 years were overweight and 17.3% were obese. Additionally, 5.9% of children met criteria for class 2 obesity and 2.1% met criteria for class 3 obesity. Although these rates were not significantly different from 2009 to 2010, all classes of obesity have increased over the last 14 years. Examining only the total prevalence of overweight and obesity among chil-

dren masks upward trends of class 2 and class 3 obesity across time. Although our results suggest that the prevalence of obesity is continuing to level off, research is needed to determine which, if any, public health interventions can be credited with this stability. Unfortunately, the high prevalence and upward trend of more severe forms of obesity will likely require more intensive interventions than can be done through widespread public health efforts.

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