Weight Gain Trends Across Sociodemographic Groups in the United States

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Objectives. To better understand health disparities, we compared US weight gain trends across sociodemographic groups between 1986 and 2002.

Methods. We analyzed mean and 80th-percentile body mass index (BMI), calculated from self-reported weight and height, for subpopulations defined by education, relative income, race/ethnicity, and gender. Data were from the Behavioral Risk Factor Surveillance System, a random-digit-dialed telephone survey (total sample = 1.88 million adult respondents).

Results. Each sociodemographic group experienced generally similar weight gains. We found no statistically significant difference in increase in mean BMI by educational attainment, except that individuals with a college degree gained less weight than did others. The lowest-income group gained as much weight on average as the highest-income group, but lowest-income heavier individuals (80th percentile of BMI) gained weight faster than highest-income heavier individuals. We found no differences across racial/ethnic groups except that non-Hispanic Blacks gained more weight than other groups. Women gained more weight than men.

Conclusions. We found fewer differences, especially by relative income and education, in weight gain across subpopulations than we had expected. Women and non-Hispanic Blacks gained weight faster than other groups. (*Am J Public Health.* 2005;95:1602–1606. doi:10.2105/AJPH.2004.043935)

While large segments of the American population are either overweight (body mass index [BMI]>25) or obese (BMI≥30), disparities exist in the prevalence of overweight and obesity across population subgroups defined by race/ethnicity, gender, age, or socioeconomic status.[1–3] A larger proportion of individuals are overweight or obese among lower-educated groups, Blacks, and Mexican Americans than among other sociodemographic groups, and socioeconomic differences in obesity rates tend to be larger for women than for men.[1–3]

Although sociodemographic differences in the prevalence of unhealthy weight contribute to health disparities, it is not clear how the current obesity epidemic has contributed to these disparities. The National Health and Nutrition Examination Survey (NHANES), the benchmark for objectively measured national trends, shows no statistically significant differences in increasing obesity rates among racial/ethnic groups for men.[2] This finding, however, may be primarily a consequence of insufficient statistical power for subgroup comparison; although a highly significant increase in severe obesity has occurred for the full population, this increase is not statistically significant for most individual subpopulations. Data from the Behavioral Risk Factor Surveillance System (BRFSS) show significant differences across racial/ethnic groups. However, the direction (widening or narrowing) of the disparities seen depends on the cutpoint used to define unhealthy weight (BMI=25, 27, or 30) and the type of changes (i.e., absolute vs relative) being considered.[1,4]

Plausible hypotheses have been developed to explain trends of widening or narrowing health disparities related to unhealthy weight. One intriguing theory focuses on the economics of food supply, taking into consideration that individuals with limited financial resources must choose energy-dense foods, which in turn is likely to encourage excessive energy intake.[5,6] This process could result in widened disparities across income groups, given that the prices of less energy-dense products, such as fresh produce, have increased more rapidly than the consumer price index over the past 2 decades, whereas the prices of more energy-dense products, such as fats and sweets, have increased slower than the consumer price index.[7,8] If the differential costs of diets constitute a primary pathway to disparities in weight gain, differential weight gain would be expected to occur across income groups, but not necessarily by education or race/ethnicity, after adjustment for income.

Another possible explanation for increasing disparities is that higher-educated groups tend to make health-improving behavior changes in response to new knowledge more quickly than do lower-educated groups, as has occurred in the case of smoking.[9] Arguments also have been made supporting a narrowing of weight-related disparities over time. Suburban sprawl has been associated with higher rates of obesity, less walking, and chronic conditions related to obesity, after control for individual sociodemographic characteristics, but neighborhoods with characteristics of suburban sprawl (low population density, poorly connected streets, single-mode land use) tend to be characterized by higher income and fewer minorities than are urban neighborhoods (high population density, better connected streets, mixed land use).[10–13] It is also possible that factors leading to differential weight gain across population subgroups are less important than secular changes that affect all groups, such as motorization, suburbanization, and increased food availability. If that is so, weight would be expected to increase similarly across groups.

We studied trends in weight gain through analysis of BRFSS data for 1986 through 2002. We focused on changes in BMI (mean and 80th percentile) among different sociodemographic groups. We tried to determine whether population differences are primarily related to education, race/ethnicity, relative income, or gender.

TABLE 1—Sample Characteristics: Behavioral Risk Factor Surveillance System, 1986–2002

	% in Sample (SD), 1986–2002 (N = 1 879 862)	BMI, 1986–1990		BMI, 1991–1995		BMI, 1996–2002	
		Mean (SD)	80th Percentile (95% CI)	Mean (SD)	80th Percentile (95% CI)	Mean (SD)	80th Percentile (95% CI)
Education							
No high school diploma	14.4 (35.1)	25.7 (4.9)	29.2 (29.1, 29.2)	26.2 (5.1)	29.9 (29.8, 30.0)	27.1 (5.7)	31.2 (31.1, 31.2)
High school diploma	32.7 (46.9)	24.8 (4.4)	27.9 (27.9, 28.0)	25.5 (4.7)	28.9 (28.8, 28.9)	26.5 (5.3)	30.2 (30.1, 30.2)
Some college	26.9 (44.3)	24.4 (4.2)	27.4 (27.3, 27.4)	25.2 (4.7)	28.3 (28.3, 28.3)	26.2 (5.2)	29.9 (29.8, 29.9)
College graduation	25.9 (43.8)	24.2 (3.8)	26.7 (26.6, 26.9)	24.8 (4.1)	27.5 (27.5, 27.5)	25.6 (4.6)	28.8 (28.7, 28.8)
Race/ethnicity							
Non-Hispanic White	76.6 (42.3)	24.6 (4.2)	27.5 (27.4, 27.5)	25.2 (4.6)	28.3 (28.3, 28.3)	26 (5.0)	29.5 (29.5, 29.5)
Non-Hispanic Black	9.3 (29.1)	25.8 (5.0)	29.6 (29.5, 29.8)	26.7 (5.3)	30.7 (30.5, 30.7)	27.8 (5.9)	32.2 (32.1, 32.3)
Hispanic	9.8 (29.7)	25 (4.3)	28.1 (27.9, 28.2)	25.7 (4.6)	28.9 (28.7, 29.0)	26.8 (5.2)	30.2 (30.1, 30.2)
Other	4 (19.6)	23.5 (4.0)	27.1 (26.8, 27.3)	24.2 (4.4)	28 (27.8, 28.2)	25.1 (4.9)	29.4 (29.3, 29.6)
Gender							
Female	51 (50.0)	24 (4.7)	27.4 (27.4, 27.4)	24.7 (5.1)	28.3 (28.3, 28.3)	25.7 (5.6)	29.8 (29.8, 29.8)
Male	49 (50.0)	25.4 (3.8)	28.1 (28.0, 28.1)	26 (4.1)	28.7 (28.7, 28.8)	26.8 (4.6)	29.9 (29.8, 30.0)
Income[a]							
Lowest	31.6 (46.5)	25 (5.1)	28.8 (28.7, 29.0)	25.8 (5.5)	29.5 (29.5, 29.6)	26.8 (6.1)	31.2 (31.2, 31.2)
Highest	68.4 (46.5)	24.5 (4.2)	27.4 (27.4, 27.5)	25.1 (4.2)	28.1 (28.0, 28.1)	26 (4.6)	29.3 (29.2, 29.3)
Age, mean	44.4 (17.6)	43.3 (17.8)	...	43.9 (17.6)	...	45.2 (17.5)	...
Married, %	62.4 (48.4)	63.2 (48.2)	...	62.9 (48.3)	...	61.8 (48.6)	...
Working, %	63 (48.3)	63.2 (48.2)	...	62.6 (48.4)	...	63.2 (48.2)	...
Smoking, %	20.3 (40.2)	24.7 (43.1)	...	21.1 (40.8)	...	17.9 (38.4)	...

Note. CI = confidence interval; BMI = body mass index. Except for the 80th-percentile BMI, all other statistics are weighted and nationally representative.
[a]Descriptive statistics of the 2 relative income groups were based on a subsample of data with 676 830 observations. See “Independent Variables” subsection of “Methods” section for explanation of how these income groups were derived.

METHODS

Data

We used data from the 1986–2002 BRFSS, a cross-sectional telephone survey of noninstitutionalized adults. The BRFSS is a standard data set for tracking obesity and diabetes rates, as well as other health behaviors, over time[1,4,14]; study details are available at the Centers for Disease Control and Prevention Web site.[15] Table 1 presents descriptive statistics from the data sets used for our analyses, which included 17 years of the BRFSS and 1 879 862 observations. To allow a comparison with the effect of relative income, we also generated a subsample of lowest-income vs highest-income households.

Dependent Variable

The primary dependent variable was individual BMI, defined as weight in kilograms divided by the square of height in meters. BMI was calculated from self-reported weight and height and is therefore subject to the well-known biases of self-report data.[16–18] Because the level of underreporting tends to increase with actual weight and the weight of the total population has increased, this bias may lead to underestimation of increases in BMI across all groups. In addition to mean BMI, 80th-percentile BMI was included in the analysis because weight gain in this heavier subgroup may differ from mean weight gain. On the basis of 2000–2002 BRFSS data, the 80th percentile corresponds to a BMI of 30.13.

Independent Variables

Explanatory variables included calendar year, education (no high school diploma, high school diploma, some college, and college graduation), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and other), gender, marital status (married or member of an unmarried couple vs other), employment status (working for wages or self-employed vs other), smoking status (current smokers [those who smoke every day and have smoked at least 100 cigarettes in their lives] vs other), age group (in 5-year intervals), and state of residence (to control for changing survey participation by states over time).

Time trend was measured by calendar year. To allow for nonlinear changes in weight gain over time, we used linear spline with knots at 1991 and 1996 (different amounts of weight gain for the periods 1986–1990, 1991–1995, and 1996–2002). To estimate the BMI trend by education, race/ethnicity, and gender, we included in the model terms to capture interactions between year and education, year and race/ethnicity, and year and gender. These interaction terms were the key independent variables that predicted differential increases in BMI over time across the study groups.

Ideally, we would have included income in testing the separate effects of income, education, race/ethnicity, and gender. However, the BRFSS includes only 7 broad categories based on nominal income. Because the meaning of these categories changes over time, and they cannot be adjusted for inflation, we could not include income in the model that predicts BMI trends by education, race/ethnicity, and gender. The exclusion of income from the model probably produces an overestimation of educational effects on BMI gains because of the positive relationship between income and education and the negative relationship between income and BMI (evidenced by our BRFSS data). Similarly, this exclusion could increase the gap between minority groups and non-Hispanic Whites by attributing an economic factor to the race/ethnicity effects.

To test the relevance of income, we focused on a subsample of the data representing the lowest- and highest-income groups for each year. BRFSS data provide income categories, not actual income, for each respondent. The percentage of people in each of the 7 income categories in BRFSS data varies from one year to another, substantially so in some years. To generate a subsample of data containing the lowest and highest income groups with the percentages roughly constant over the study years, it was sometimes necessary to combine BRFSS income categories. For instance, the 2 highest income categories for 1986 (13.83% and 7.29%) were combined to produce the new highest income group of 21.12%, roughly comparable to the lowest income category for 1986 (19.97%). Income categories from BRFSS data were combined for the years where there were considerable differences in the percentages. As a result, there are 676 830 observations in this subsample. This reclassification allowed us to obtain a crude estimate of the effects of relative income. The results for BMI trends across the 2 relative-income groups were based on this subsample.

Statistical Methods

We used ordinary least squares regression to estimate the conditional mean BMI and least absolute deviation regression to estimate the 80th-percentile BMI across sociodemographic groups. Regressions were weighted to control for differential sampling probabilities across years, states, and sociodemographic groups that may not be fully accounted for by the included independent variables.

For the analysis of education, race/ethnicity, and gender, the independent variables include the linear time spline, education and its interactions with time, race/ethnicity and its interactions with time, gender and its interactions with time, marital status, smoking status, employment status, age group, and state dummy variables. For the analysis of relative income, we used the subsample of the highest- and lowest-income groups and added relative income and its interactions with time to the same model specification for education, race/ethnicity, and gender.

Tests were based on the individual-level regression model for the null hypothesis of no differences in BMI gain across sociodemographic groups. Because the time trend was specified as a linear spline with 2 knots, 3 time variables were used to represent the 3 periods. The number of interaction terms between any sociodemographic variable and time is thus 3. Joint tests for these interaction terms were conducted. The following example may help to clarify our hypothesis testing. Assume that gender is a dummy variable. Year 1, year 2, and year 3 are time variables representing the 3 periods divided by the 2 knots. The 3 interaction terms are thus gender with year 1, gender with year 2, and gender with year 3. If male gender was the reference group and if all 3 interaction terms simultaneously equaled 0, this would indicate that, in each and every period, weight gain was the same for men and women, which would confirm the null hypothesis.

Because of numerous comparisons, we restricted our analysis to results that were statistically significant at $P < .001$. Even at this statistical significance level, there could be statistically significant findings that are unimportant because the sample size is large and high statistical power is able to detect even minute differences. To plot the weight gain trends after adjustment for changes in other confounding factors, we used population characteristics for the year 2002 as follows. First, we estimated the model coefficients, using the full sample for the model without income and the subsample for the model with relative income. Second, we predicted the conditional mean BMI for every respondent in 2002. Third, we used all covariates of the respondents for 2002 except for the time value to predict the conditional mean BMI for the respondents from the other years. For instance, to predict conditional mean BMI for the respondents from 1986, we retained the observations for 2002 but replaced the year value with 1986. Last, after the prediction, we estimated the weighted yearly average BMI for every year from 1986 to 2002. Except for the first step, this process was repeated for each sociodemographic group. We performed the same estimation for 80th-percentile BMI (data not shown).

RESULTS

Body Mass Index Trend Across Education Groups

Figure 1 shows the mean BMI across education groups for each year. For any year, lower educational achievement was associated with higher BMI, but the curves were essentially parallel in the no-high-school-diploma group, the high-school-diploma group, and the some-college group. Only in the college-graduation group was weight gain statistically significantly smaller, although the total difference in weight gain among the groups over the study period was not large: 1.74 BMI units for the college group vs 2.09 BMI units for the no-high-school-diploma group. The average person in the high-school-diploma group, the some-college group, and the college-graduation group passed from normal to overweight status (BMI=25) in 1988, 1990, and 1997, respectively. We can extrapolate that the average person in the no-high-school-diploma group became overweight in 1982. The BMI gap between the lowest-education and the highest-education group was about 14 years; that is, unless trends change, the average BMI of the college-graduation group will reach the level of the current average BMI of the no-high-school-diploma group in 14 years. For 80th-percentile BMI, the no-high-school-diploma group gained less weight than the high-school-diploma group or the some-college

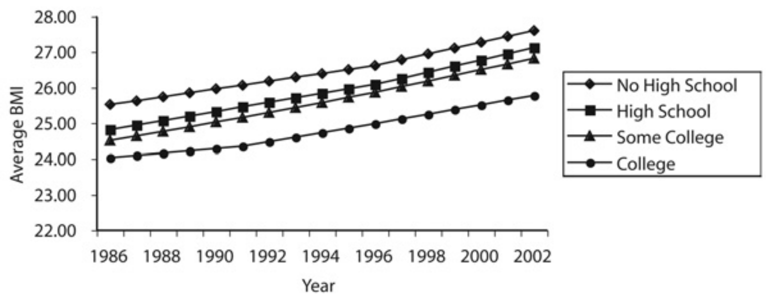

FIGURE 1—Trends in average body mass index (BMI), by education: Behavioral Risk Factor Surveillance System, 1986–2002.

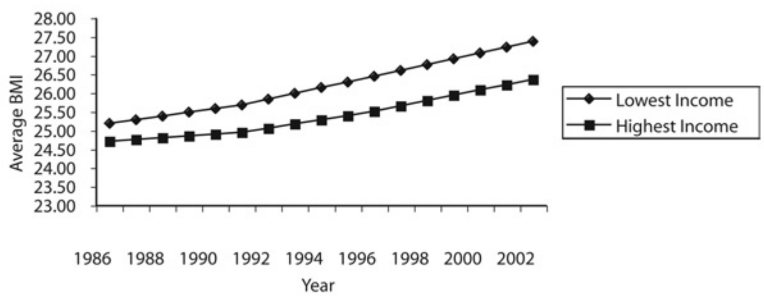

FIGURE 2—Trends in average body mass index (BMI), by relative income: Behavioral Risk Factor Surveillance System, 1986–2002.

TABLE 2—Increase in Body Mass Index (BMI) by Sociodemographic Group: Behavioral Risk Factor Surveillance System, 1986–2002

	Total Increase in BMI, 1986–2002	
Sociodemographic Group	Mean BMI	80th-Percentile BMI
Education		
No high school diploma	2.09	2.79*
High school diploma (reference)	2.31	3.17
Some college	2.30	3.21
College graduation	1.74*	2.46*
Income[a]		
Lowest	2.19*	3.38*
Highest (reference)	1.66	2.24
Race/ethnicity		
Non-Hispanic White (reference)	2.00	2.84
Non-Hispanic Black	2.79*	3.51*
Hispanic	2.17	2.86
Other	2.26	3.14
Gender		
Female	2.40*	3.34*
Male (reference)	1.82	2.5

[a] For explanation of income groups, see "Independent Variables" subsection of "Methods" section.
*$P<.001$.

group and about the same amount of weight as the college-education group.

Body Mass Index Trend Across Relative-Income Groups

Figure 2 confirms that for every year, BMIs were higher for the lowest-income group than for the highest-income group. From 1986 to 1991, the highest-income group gained slightly less weight than the lowest-income group, but the 2 groups exhibited parallel trends from 1992 to 2002, and we found no statistically significant difference in increased BMI between the 2 groups. The BMI gap between the lowest-income and highest-income groups is approximately 7 years; that is, the average BMI of the highest-income group will reach the current average BMI of the lowest-income group in 7 years.

The 80th-percentile BMI curves of the lowest- and highest-income groups were parallel from 1986 to 1991, but from 1992 to 2002 there was a statistically significant divergence, with the lowest-income group gaining more weight than the highest-income group.

Body Mass Index Trends Across Racial/Ethnic and Gender Groups

BMI trends among non-Hispanic Whites, Hispanics, and individuals of "other" race/ethnicity are essentially parallel, but non-Hispanic Blacks gained weight faster: 2.79 BMI units over 16 years, compared with 2.0 BMI units for non-Hispanic Whites, 2.17 BMI units for Hispanics, and 2.26 BMI units for persons of "other" race/ethnicity ($P<.001$), as shown in Table 2. BMIs for non-Hispanic Blacks, which were already high in 1986, became higher over time in both absolute terms and in terms relative to other racial/ethnic groups. Excluding income in the model that predicts BMI gain across racial/ethnic groups may overestimate this differential weight gain, but probably not dramatically, because we found no significant income effect on mean weight gain in the 2 periods 1991–1995 and 1996–2002.

On average, women have lower BMIs than men, but they gained weight faster. The BMI gap between women and men is about 6 years; that is, in 6 years, women can be expected to attain the BMI now current among men. However, women's and men's BMIs are converging. From 1986 to 2002, women gained 2.4 BMI units and men gained 1.82 BMI units. If that differential weight gain trend continues, women's average BMI would match men's average BMI in 26 years.

The trend of increasing weight gain among both non-Hispanic Blacks and women was exacerbated at the 80th percentile of BMI. At that percentile, the BMI gap between women and men is only about 2 years, and women's average BMI could match men's average BMI in about 15 years.

DISCUSSION

Weight gain among Americans is more uniform than one might expect on the basis of cross-sectional differences in the prevalence of obesity among subpopulations. Our findings confirm previous studies[1–3] showing that average BMI is always higher for lower-education, lower-income groups and for non-Hispanic Blacks. However, our study also shows that, for the past decade and even longer, average weight gain has not varied by educational level, although a college degree was a protective factor. Few differences exist in average weight gain between lowest- and highest-income individuals after control for other characteristics, although heavier individuals (80th percentile of BMI) in the lowest-income group gain more weight than do heavier individuals in the highest-income group.

Increases in BMI were similar for most racial/ethnic groups, except for non-Hispanic Blacks, whose mean weight increased the fastest. In 2002, the difference in average BMI in our study was 1.83 units between non-Hispanic Blacks and non-Hispanic Whites, 1.01 units between the lowest- and highest-income groups, and 1.83 units between the no-high-school-diploma group and the college-graduation group. As Table 2 shows, BMI gain from 1986 to 2002 differed by 0.79 units between non-Hispanic Blacks and non-Hispanic Whites, by 0.35 units between the no-high-school-diploma group and the college-graduation group, and by 0.53 units between the lowest- and highest-income groups. The difference in BMI between non-Hispanic Blacks and the other racial/ethnic groups is the clearest and most important evidence of widening disparities among subpopulations.

Although mean BMIs are lower for women than for men, women are gaining weight faster than men. If this trend continues, women will eventually overtake men at the 80th percentile of BMI—the level that entails the highest risk for chronic disease—and assume an increasing burden of obesity-related health problems. In fact, whereas the latest estimates of obesity rates based on *self-reported* height and weight still show lower obesity rates for women than for men,[1,4,13,14] this difference no longer exists for rates based on *objectively measured* height and weight.[2]

Two groups of factors affect weight trends. The first group is factors common to all sociodemographic groups, such as motorization, suburbanization, and increased food availability. The effects of these common factors, however, can vary by characteristics such as education, relative income, and race/ethnicity. Motorization and suburbanization, for example, are common to the whole population, but their adverse effects might be larger for higher-income communities and smaller for minority neighborhoods.[10–13] The second group is factors that may affect some subpopulations but not others. For instance, women's increasing participation in the workforce may have a differential effect on their weight trend relative to that of men. The pattern of weight gain we found captures the *net effect* of all factors, and probably the interaction of these factors. In-depth studies are needed to quantify the differential effects of specific factors and the numerous changes in the living environment. Interventions need to take into account the mechanisms by which various factors affect the weight gain of each sociodemographic group.

Nevertheless, our most striking finding is probably the similarity in weight gain across groups, which indicates that hypotheses successful in explaining weight differences across sociodemographic groups may be less successful in generating policies to stem the obesity epidemic. However, we found noticeable differences in weight gain that indicate the need for strategies targeted at certain subgroups, particularly women and Blacks. ■

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Contributors

K.D. Truong conducted the analyses and wrote the article. R. Sturm originated the study and supervised and helped with all aspects of its implementation.

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Human Participation Protection

Because this study relied on nonidentifiable secondary data, no institutional review board approval was needed.

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