Trends in the Association between Obesity and Socioeconomic Status in U.S. Adults: 1971 to 2000

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Abstract

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Objective: To study the secular trends in the disparity of obesity across socioeconomic status (SES) groups among U.S. adults.

Research Methods and Procedures: We used national representative data collected in the National Health and Nutrition Examination Surveys conducted in 1971 to 1974, 1976 to 1980, 1988 to 1994, and 1999 to 2000 from 28,543 adults 20 to 60 years old. Obesity was defined based on BMI calculated using measured weight and height. Trends in the relationship between obesity and education levels were analyzed controlling for age, gender, and ethnicity.

Results: The disparity in obesity across SES (less than high school, high school, and college or above to indicate low, medium, and high SES, respectively) has decreased over the past 3 decades. In National Health and Nutrition Examination Surveys I (1971 to 1974), there was as much as a 50% relative difference in the obesity prevalence across the three groups, but by 1999 to 2000, it decreased to 14%. This trend was more pronounced in women. The trends of diminishing disparities in obesity were also revealed by our logistic and linear regression analyses. The odds ratio converged to 1 from the 1970s to 2000. In most sociodemographic groups, the relationship between BMI and SES (coefficients) has been weakened over time.

Discussion: The association between SES and obesity has been weakened over the past 3 decades, when the prevalence of obesity increased dramatically. There are considerable variations in the changes in the associations across gender and ethnic groups. Our findings suggest that individual characteristics are not likely the main cause of the current obesity epidemic in the U.S., whereas social-environmental factors play an important role. Strategies for obesity prevention and management should target all SES groups from a societal perspective.

Key words: BMI, education, NHANES, socioeconomic status, trends

Introduction

National survey data show that the prevalence of obesity has doubled over the past 3 decades, and it continues to increase in the United States (1–3). Currently, approximately two-thirds of American adults are overweight or obese (3). Obesity increases the risks of a number of diseases and health conditions, such as cardiovascular disease, hypertension, type 2 diabetes, and certain types of cancer (4,5). A recent study suggests that an estimated 300,000 deaths in the U.S. are related to the condition (6). The total direct and indirect costs associated with obesity have been estimated at $117 billion in 2000 (7).

Socioeconomic status (SES)[1] has, in the past, been an important factor associated with obesity, particularly in women, because SES influences individuals' energy intake and energy expenditure and, as a result, affects their body fat storage (8). Previous studies have shown that the association between SES and obesity may vary by populations, by gender, and by age (8–10). In general, in industrialized countries, low-SES groups are more likely to be obese than their high-SES counterparts, whereas in developing coun-

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[1] Nonstandard abbreviations: SES, socioeconomic status; NHANES, National Health and Nutrition Examination Surveys; OR, odds ratio; CI, confidence interval.

tries, high-SES groups are more likely to be obese (11–13). Numerous studies conducted in the U.S. have shown that low-SES and minority groups have a higher prevalence of obesity (14–16). However, to our knowledge, few studies have systematically examined whether the relationship between obesity and SES has changed over time; in other words, whether the disparity in obesity across SES groups has changed. If the relationship has changed, are there differences across sociodemographic (e.g., gender and ethnic) groups? The present study attempts to answer these questions.

Research on the secular trend in the disparity of obesity across different SES groups is of special importance for several reasons. First, it can help increase our understanding of the underlying causes of the rising obesity epidemic in the U.S. Second, it can help predict future trends in obesity prevalence across SES groups. Finally, such research findings can guide the development of effective programs and policies for the prevention and management of obesity in different SES groups. It can help set priorities for future research and interventions, and for government policy to reduce obesity. In the present study, using successive national representative survey data that were collected over the past 4 decades in the National Health and Nutrition Examination Surveys (NHANES), we examined the secular changes in the relationship between obesity and SES in the U.S. We also examined whether the changes in the associations varied across gender and ethnic groups.

Research Methods and Procedures

Data

The NHANES include a series of cross-sectional surveys that have provided nationally representative information on the nutrition and health status of the U.S. civilian population. The National Center for Health Statistics conducted the first and second NHANES (I and II) in 1971 to 1975 and 1976 to 1980, respectively; NHANES III was conducted during 1988 to 1994. Since 1999, NHANES has been a continuous survey, and the data are now available for the first 2 years of that period (1999 to 2000). All of the four rounds of NHANES used a stratified, multistage probability cluster sampling design. Detailed descriptions of the sample design, interviewing procedures, and physical examinations conducted have been published elsewhere (17–20).

In each survey, standardized protocols were used for all interviews and examinations. Data on weight and height were collected for each individual through direct physical examination in a mobile examination center. In NHANES I and II, race-ethnic group was classified as white, black, and "other" based on observation. In NHANES III, subjects were classified as non-Hispanic white, non-Hispanic black, Mexican American, and other ethnic groups, based on self-reported race and ethnicity. In NHANES 1999 to 2000, subjects were classified into non-Hispanic white, non-Hispanic black, Mexican American, other race (including multiracial), and other Hispanic.

Measures

Definitions of Overweight and Obesity. BMI [weight (kilograms)/height (meters squared)] was calculated for each individual based on measured weight and height. According to the World Health Organization's recommendation, individuals with a BMI $\geq$30 were considered obese (5). Pregnant women were excluded from our analysis.

SES. Most commonly used variables to measure SES were education, income, and occupational status. Each SES measure had its own strengths and limitations when the relationship between SES and health outcomes was studied. Many researchers suggested that education is the most stable and robust indicator of SES (21–23).

We selected education level of the subjects as the primary measure of SES because: education is the only available SES variable in NHANES 1999 to 2000; education is less likely to be affected by a subject's body weight status, whereas people's income might be affected; and education is more comparable across time than income or occupation. In addition, education had little missing data, compared with income. We coded the education level as follows: low education (less than high school, meaning ninth grade or less), medium education (high school, meaning 10th to 12th grades), and high education (college or higher) to indicate low, medium, and high SES. Note that our findings regarding the trends in the association between SES and obesity were similar if income was used as the indicator of SES in analysis using the NHANES I to III data (data not shown).

Confounding Variables. Previous studies suggest that obesity is associated with demographic characteristics such as gender, age, and race/ethnicity (24,25). Meanwhile, SES may also be correlated with gender, age, and ethnicity. Thus, these variables are potential confounders, and it is necessary to control for them when studying the relationship between SES and obesity. When studying the difference across ethnic groups, because of small sample sizes and limited information about subjects with Hispanic origin available in NHANES I and II, we recoded race/ethnicity into three groups (white, black, and other) to make the analysis comparable across surveys. In this report, we focused on the comparison between white and black.

Because there were two gender groups, three ethnic groups, and three SES levels, 18 gender-race-education groups were created in our analysis. If we would have stratified the subjects further into four age groups, the sample size for each gender-race-age-SES group would have been too small. Therefore, we reported prevalence

Table 1. Sociodemographic characteristics and anthropometric measures of U.S. adults 20 to 60 years old: 1971 to 2000

	NHANES I (1971 to 1974) (n = 6622)		NHANES II (1976 to 1980) (n = 7731)		NHANES III (1988 to 1994) (n = 11,533)		NHANES (1999 to 2000) (n = 2657)	
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Both genders								
Age (years)	35.3	0.28	37.7	0.19	37.5	0.21	38.7	0.38
White (%)	87.9	0.93	86.8	1.60	74.1	1.37	68.9	2.34
Black (%)	10.9	0.94	10.6	1.30	11.7	0.67	11.6	0.43
Other (%)	1.2	0.20	2.6	0.86	14.3	1.06	19.5	2.46
Low education (less than high school) (%)	17.4	0.94	11.6	0.70	11.8	0.71	21.5	1.15
Medium education (high school)	49.7	1.27	50.6	1.07	43.3	1.00	25.7	2.30
High education (%) (college or higher)	33.0	1.34	37.9	1.21	44.9	1.29	52.9	2.63
Women								
Weight (kg)	64.4	0.33	65.5	0.32	69.7	0.48	75.0	0.88
Height (cm)	162.4	0.14	162.4	0.11	162.8	0.14	162.9	0.18
BMI (kg/m^2)	24.4	0.13	24.9	0.12	26.3	0.19	28.2	0.33
Men								
Weight (kg)	78.5	0.43	79.0	0.22	82.6	0.41	86.0	0.83
Height (cm)	176.1	0.24	176.1	0.16	176.2	0.16	176.2	0.22
BMI (kg/m^2)	25.3	0.12	25.5	0.08	26.5	0.12	27.6	0.22

only in gender-ethnic-SES groups. However, we did control for age in our regression analysis.

Statistical Analysis

Our analysis of the NHANES I, II, and III data was conducted using Stata (version 7; Stata Press, College Station, TX). Analysis of the 1999 to 2000 data was conducted using SUDAAN. All analyses took into account the complex survey design and unequal probabilities of sample selection in NHANES. First, we examined the absolute and relative differences in the prevalence of overweight and obesity among the low-, medium-, and high-SES groups in different gender-ethnic groups over time. Next, we conducted logistic regression to examine the association between obesity and SES (two dummy variables to code low and high SES were used; the medium-SES group was used as the reference) and overweight and SES. Odds ratios (ORs) and the 95% confidence intervals (CIs) were estimated. The results for overweight were similar to those for obesity; thus, they were not presented. Finally, using multiple linear regression analysis, we examined the relationship between BMI and SES. All regression analyses were conducted separately for men and women, and age was controlled. Race/ethnicity was also controlled when analysis was conducted for combined ethnic groups in men and women. Statistical tests were conducted at the $p = 0.05$ significance level.

Results

Social Demographic Characteristics and Anthropometric Measures

The social-demographic characteristics and anthropometric measures of adults across NHANES are presented in Table 1. During the period of 1971 to 2000, the population became slightly older; mean age increased 3.4 years. There was also a remarkable change in the population composition: The proportion of white people continued to decrease, and the proportion of "other race" adults, including Hispanic, increased significantly after NHANES II. Proportions of individuals in different education categories also changed across surveys. More people had a high educational level (college or higher), and fewer people had a medium educational level (high school). In NHANES I and II, ~50% of the individuals were in the medium educational level, but by the time of the NHANES III and again in 1999 to 2000, ~50% were in the higher education level. With more minority individuals moving into the high-education group, the association between SES and obesity in the whole population was likely to be weakened because minority groups tended to have a higher prevalence of obesity than whites. Neither men's nor women's height changed over the period, but their weight increased considerably: Men's mean weight increased by 7.5 kg (or, in relative terms, 9.5%), whereas women's mean weight increased by 10.6 kg

(a relative change of 16.4%). Consistently, men's and women's mean BMI increased: approximately by 2 points among men and 4 points among women.

Secular Trends in the Disparity of Obesity across SES Groups: The Absolute and Relative Differences in the Prevalence across SES Groups

To examine the secular trends in the disparity of obesity across SES groups, we calculated the absolute and relative difference in prevalence among the three SES groups in each survey period for each sex-ethnic group (Tables 2 and 3). Similar to what other researchers have reported previously, our analysis showed that the prevalence of obesity increased significantly over the last 4 decades in all gender-ethnic-SES groups. Among the three SES groups, the high-education group had the highest rate of increase in the prevalence of obesity. For example, the prevalence of obesity in black men with high education increased by a striking 6 times between NHANES I and NHANES 1999 to 2000, whereas the prevalence of obesity in black men with medium education increased only 40% during the same period. In white women, the prevalence of obesity in the high-education group quadrupled, whereas the rate in the low-education group had only a 66% increase. The same pattern can be found also in white men and black women. Prevalence of obesity in low-educated black women was quite stable across time, but the rate among the more highly educated almost tripled.

Clearly, the difference in the prevalence between the low- and high-SES groups became smaller over time, more dramatically so among women than men. For example, among women, the absolute difference in obesity prevalence between the low- and high-SES groups dropped from 18 to 8 percentage points, or, in relative terms, 71% to 21%. Among men, it dropped from ~5 to 3 percentage points, or, in relative terms, from 38% to 12%.

We also observed remarkable ethnic differences in the trends. In white women, the absolute difference in prevalence of obesity between those with low education and those with medium education was reduced 44%, whereas the relative difference was reduced 62%, between NHANES I and NHANES 1999 to 2000. In NHANES 1999 to 2000, no significant difference existed among SES groups, except for the difference between the low- and high-SES groups in white women. In black women, the magnitude of the relative and absolute differences in the prevalence declined compared with the three previous waves of NHANES, but the direction of the association was changed. In NHANES I to III, African-American women with lower SES had a higher prevalence of obesity, but in 1999 to 2000, the medium-SES group had the highest prevalence.

The trends in disparity among men were mixed. In white men, the absolute difference between the prevalence of obesity in two SES groups was stable across surveys, whereas the relative difference decreased. In black men, the disparity in obesity between the medium- and the high-SES groups tended to decline across time, whereas the disparity between the low-to-medium and the low-to-high SES groups had no clear pattern.

Secular Trends in the Association between Obesity and SES

Our logistic regression analysis indicated that the association between SES and obesity was attenuated over time, especially among women. ORs tended to converge to 1 across surveys in most gender-race groups (see Figure 1 and Table 4, in which medium SES was the reference group). In white women, ORs for obesity in those with low education decreased from 1.40 to 1.15 between NHANES I and 1999 to 2000, whereas ORs for obesity in those with high education increased from 0.45 to 0.78 during the same period. It is worth noting the reducing statistical significance of ORs across time, especially in women. For example, in white women, ORs for obesity in high- or low-education groups were all statistically significantly different from 1 in NHANES I and II but became insignificant in NHANES III and 1999 to 2000.

There were remarkable differences between men and women and across ethnic groups. In black women, the OR for the low-SES group was reducing to 1 across surveys. However, no clear reducing trend was observed for the high-SES group. In men, the reference group had a higher risk of obesity than the other two SES groups. There was a rising trend for ORs in low- and high-education groups across surveys. In white men, the OR in those with low education increased from 0.66 to 0.91, whereas the OR in those with high education rose from 0.53 to 0.78. In NHANES I and II, the ORs in white men with high education were significantly less than 1. But in NHANES III and 1999 to 2000, the ORs in the same group became not significantly different from 1. A similar pattern was observed in black men, but with less statistical power.

Secular Trends in the Relationship between BMI and SES

In general, the findings of our multiple linear regressions (Table 5) were consistent with those of the logistic regression analysis. We observed mixed patterns in the association for men but a clearly weakened one for women. For women, the overall association between SES and BMI changed from significant in the 1970s (a reverse association) to insignificant in 1999 to 2000. In NHANES I, compared with medium-SES women, low-SES women's BMI was 1.5 points higher ($p < 0.05$), whereas that of the high-SES group was 1.2 points lower ($p < 0.05$). The figures were

Table 2. Trends in the disparity of obesity by ethnicity and education among U.S. women 20 to 60 years old: 1971 to 2000

	NHANES I (1971 to 1974)	NHANES II (1976 to 1980)	NHANES III (1988 to 1994)	NHANES, (1999 to 2000)
Women				
Prevalence				
Low education	24.9	28.9	31.9	37.8
Medium education	14.8	17.3	28.3	34.5
High education	7.3	8.8	18.0	29.9
Absolute difference in prevalence				
Low to medium	10.1	11.6	3.6	3.3
Medium to high	7.5	8.5	10.3	4.6
Low to high	17.6	20.1	13.9	7.9
Relative difference in prevalence				
(Low to medium)/low (%)	40.6	40.1	11.3	8.7
(Medium to high)/medium (%)	50.7	49.1	36.4	13.3
(Low to high)/low (%)	70.7	69.6	43.6	20.9
White women				
Prevalence				
Low education	21.9	26.5	26.6	36.3
Medium education	14.1	15.7	26.2	31.9
High education	6.4	7.9	16.4	26.6
Absolute difference in prevalence				
Low to medium	7.8	10.8	0.4	4.4
Medium to high	7.7	7.8	9.8	5.3
Low to high	15.5	18.6	10.2	9.7
Relative difference in prevalence				
(Low to medium)/low (%)	35.6	40.8	1.5	12.1
(Medium to high)/medium (%)	54.6	49.7	37.4	16.6
(Low to high)/low (%)	70.8	70.2	38.3	26.7
Black women				
Prevalence				
Low education	38.1	42.2	42.6	44.3
Medium education	20.7	29.0	37.4	54.4
High education	18.7	18.9	28.8	51.5
Absolute difference in prevalence				
Low to medium	17.4	13.2	5.2	−10.1
Medium to high	2.0	10.1	8.6	2.9
Low to high	19.4	23.3	13.8	−7.2
Relative difference in prevalence				
(Low to medium)/low (%)	45.7	31.3	12.2	−22.8
(Medium to high)/medium (%)	9.7	34.8	23.0	5.3
(Low to high)/low (%)	50.9	55.2	32.4	−16.3

similar in NHANES II, whereas by 1999 to 2000, none of the differences was significant. In fact, the change had already started in NHANES III for the low-SES group when the difference between the low- and medium-SES groups became insignificant ($p > 0.05$). The patterns were similar for white and black women.

Table 3. Trends in the disparity of obesity by ethnicity and education among U.S. men 20 to 60 years old: 1971 to 2000

	NHANES I (1971 to 1974)	NHANES II (1976 to 1980)	NHANES III (1988 to 1994)	NHANES (1999 to 2000)
Men				
Prevalence				
Low education	12.0	13.8	24.1	26.7
Medium education	14.4	14.4	19.6	29.4
High education	7.4	8.6	17.1	23.6
Absolute difference in prevalence				
Low to medium	−2.4	−0.6	4.5	−2.7
Medium to high	7.0	5.8	2.5	5.8
Low to high	4.6	5.2	7.0	3.1
Relative difference in prevalence				
(Low to medium)/low (%)	−20.0	−4.3	18.7	−10.1
(Medium to high)/medium (%)	48.6	40.3	12.8	19.7
(Low to high)/low (%)	38.3	37.7	29.0	11.6
White men				
Prevalence				
Low education	11.4	13.4	30.6	27.7
Medium education	14.2	14.0	20.1	28.3
High education	7.7	8.7	17.0	23.9
Absolute difference in prevalence				
Low to medium	−2.8	−0.6	10.5	−0.6
Medium to high	6.5	5.3	3.1	4.4
Low to high	3.7	4.7	13.6	3.8
Relative difference in prevalence				
(Low to medium)/low (%)	−24.6	−4.5	34.3	−2.2
(Medium to high)/medium (%)	45.8	37.9	15.4	15.5
(Low to high)/low (%)	32.5	35.1	44.4	13.7
Black men				
Prevalence				
Low education	13.6	15.5	20.1	32.8
Medium education	16.1	16.1	19.4	22.6
High education	4.3	10.1	21.6	24.8
Absolute difference in prevalence				
Low to medium	−2.5	−0.6	0.7	10.2
Medium to high	11.8	6.0	−2.2	−2.2
Low to high	9.3	5.4	−1.5	8.0
Relative difference in prevalence				
(Low to medium)/low (%)	−18.4	−3.9	3.5	31.1
(Medium to high)/medium (%)	73.3	37.3	−11.3	−9.7
(Low to high)/low (%)	68.4	34.8	−7.5	24.4

In men, the trends were mixed. Overall there was a slightly increased protective effect in the high-SES group compared with the medium-SES group over time. High-SES had a protective effect in white men but not in black men. In white men, the β coefficient changed from −0.34 in 1971 to 1974 to −0.84 in 1999 to 2000. For black men in NHANES I to III, none of the β coefficients was significant, but by 1999 to 2000, high-SES black men had signif-

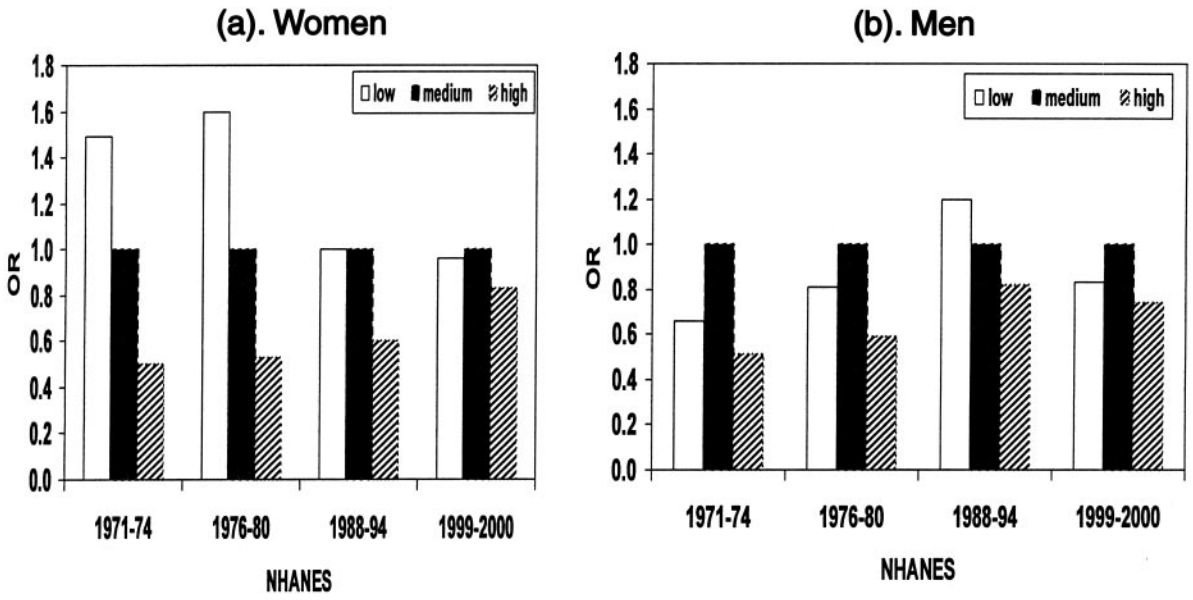

Figure 1: Secular trends in the association between SES and obesity among U.S. adults 1971 to 2000: ORs.

icantly higher BMI ($\beta = 2.53$, $p < 0.05$) than the medium-SES group.

In addition, we examined the trends regarding how much of the variation in BMI could be explained by SES by calculating partial R^2 due to SES (change in R^2) when including and excluding low- and high-SES in the models (Figure 2). In women, a clear declining trend was observed, which indicates that SES had become a less powerful predictor of BMI. In men, the partial R^2 decreased in the first three waves of NHANES, but picked up in 1999 to 2000, in particular, due to the increase in black men's partial R^2.

Discussion

To our knowledge, this is the first study that has systematically examined the trends in the association between SES and obesity among U.S. adults between the 1970s and 2000 using national representative data with measured anthropometric measures. Overall, our findings show a disproportionate increase in the prevalence of obesity in the high-SES group and a weakened association between SES and obesity in most gender and ethnic groups. There are considerable variations in the changes in the associations across gender and ethnic groups. The trend is clearer for women than for men. These findings provide a new perspective to understand the causes of the dramatic increase in obesity in the U.S. Although a positive energy balance (i.e., energy intake > energy expenditure) over a prolonged period must be the fundamental biological basis for the development of obesity, it is crucial to understand how individual factors and social-environmental factors may lead to an energy imbalance. SES is an important individual characteristic that influences an individual's access to resources, knowledge of nutrition and health, food choices, and physical activity at work and in leisure time (26). Extensive literature has documented the higher rates of obesity and overweight among low-SES groups (3,4,9), but we have noticed a significant "catch-up" in the prevalence of obesity in the high-SES group.

The timing of the changes in the relationship between SES and obesity coincided with the increase in the prevalence of obesity. Before NHANES III, the relationship between SES and obesity was relatively stable, which was consistent with findings from previous studies (27,28). However, distinct changes in the relationship between SES and obesity were observed between NHANES II and III. During this period, the prevalence of obesity increased dramatically.

The declining disparity of obesity across SES groups and a weakened relationship between SES and BMI indicate that individual characteristics may not be the dominant factor that has contributed to the dramatic increase in obesity over the past 2 decades. The trends we observed suggest that some social-environmental factors might have a more profound effect in influencing an individual's body weight status than an individual's characteristics such as SES. We suspect that some societal environmental changes affecting all SES groups have contributed to a gradual positive energy balance and weight gain among American adults; thus, the association between obesity and an individual's SES is weakened. However, different gender and ethnic groups may have different susceptibilities and may have adopted

Table 4. Logistic regression models: secular trends in the relationship between SES and obesity (OR and 95% CI) among U.S. adults, by gender and ethnicity: 1971 to 2000

	NHANES I (1971 to 1974)	NHANES II (1976 to 1980)	NHANES III (1988 to 1994)	NHANES (1999 to 2000)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
White women				
Low education	1.40 (1.03 to 1.91)	1.67 (1.28 to 2.18)	0.93 (0.60 to 1.46)	1.15 (0.68 to 1.94)
High education	0.45 (0.31 to 0.65)	0.51 (0.38 to 0.69)	0.58 (0.43 to 1.78)	0.78 (0.51 to 1.19)
Black women				
Low education	1.96 (1.06 to 3.61)	1.34 (0.70 to 2.55)	0.98 (0.71 to 1.34)	0.64 (0.27 to 1.51)
High education	0.89 (0.43 to 1.84)	0.64 (0.39 to 1.07)	0.69 (0.53 to 0.91)	0.92 (0.54 to 1.56)
White men				
Low education	0.66 (0.39 to 1.12)	0.83 (0.51 to 1.32)	1.50 (0.93 to 2.41)	0.91 (0.50 to 1.65)
High education	0.53 (0.36 to 0.78)	0.62 (0.48 to 0.82)	0.78 (0.56 to 1.09)	0.78 (0.49 to 1.24)
Black men				
Low education	0.38 (0.13 to 1.07)	0.56 (0.29 to 1.06)	0.99 (0.66 to 1.49)	1.65 (0.70 to 3.91)
High education	0.24 (0.05 to 1.26)	0.61 (0.25 to 1.46)	1.15 (0.88 to 1.50)	1.12 (0.42 to 3.01)

* Medium education group was the reference group. Age was controlled in logistic regression.

different behaviors to face these changes, which helps explain the differences in the trends we observed among different population groups.

Environmental changes/factors could increase people's energy intake and decrease people's energy expenditure. First, with regard to energy intake, the revolution in the mass preparation of food could be a key factor that leads to significant increase in food consumption in the United States (29). The average time of food consumption has been lowered so that people have more food options and can eat more frequently. Because "people who have had the most ability to take advantage of the technical changes should have had the biggest gains in weight," women could be most significantly affected by the revolution in food preparation. This may help explain why the disparity of obesity across SES was more weakened in women than in men because the revolution reduces the differences between rich and poor women in food preparation and consumption.

Second, it is argued that the U.S. government's agriculture policy, which subsidizes farmers to produce grains and meats and provide them to the domestic market at low prices, has contributed to people's excessive intake of food and to the current obesity epidemic (30). Another factor that recently has drawn much attention because it affects almost everyone is the increase in portion sizes of food served in restaurants and of processed food packages. For example, the portion sizes of fast foods such as French fries and burgers and sugar-sweetened soft drinks all have increased dramatically. Take soda as an example: Coca-Cola moved from the svelte 8-ounce bottle of soda in the 1970s to the 20-ounce bottle of today. Because the prices of raw materials are so low, many food industry companies are able to provide larger portion sizes without increasing the price per unit of food; in fact, this helps them increase their profit (30). However, the increase in portion sizes has promoted overconsumption of energy (31,32). Moreover, ubiquitous advertisements for energy-dense foods, low prices of unhealthy foods, large portion sizes, and food preparation practices at home can affect all SES groups and, thus, promote weight gain (33).

The other side of the energy equation is energy expenditure. Over the past 2 to 3 decades, many social, economic,

Table 5. Linear regression models: secular trends in the association between BMI and SES among U.S. adults: 1971 to 2000

	NHANES I (1971 to 1974)	NHANES II (1976 to 1980)	NHANES III (1988 to 1994)	NHANES IV (1999 to 2000)
	β (SE)	β (SE)	β (SE)	β (SE)
Women				
Low education	1.45***	1.59***	−0.26	−0.29
	(0.33)	(0.42)	(0.33)	(0.61)
High education	−1.23***	−1.39***	−1.63***	−0.51
	(0.19)	(0.18)	(0.31)	(0.54)
White women				
Low education	1.46***	1.56***	−0.64	0.51
	(0.34)	(0.43)	(0.57)	(1.13)
High education	−1.21***	−1.41***	−1.58***	−0.33
	(0.22)	(0.19)	(0.38)	(0.72)
Black women				
Low education	1.35	2.15	−0.69	−1.57
	(0.79)	(1.43)	(0.61)	(1.61)
High education	−1.49*	−1.43***	−1.26***	−0.07
	(0.69)	(0.51)	(0.37)	(1.01)
Men				
Low education	−0.71*	−0.38	0.14	−0.36
	(0.36)	(0.27)	(0.30)	(0.60)
High education	−0.40	−0.46**	−0.45**	−0.90**
	(0.21)	(0.16)	(0.20)	(0.41)
White men				
Low education	*p*	−0.36	0.60	−0.86
	(0.38)	(0.28)	(0.55)	(0.98)
High education	−0.34	−0.46**	−0.54*	−0.84
	(0.23)	(0.16)	(0.26)	(0.55)
Black men				
Low education	−1.11	−0.88	−0.70	1.42
	(0.80)	(0.61)	(0.41)	(1.07)
High education	−1.25	0.11	0.51	2.53**
	(0.75)	(0.65)	(0.33)	(1.19)

* Medium education group was the reference group.
† Age was controlled for in all models, and ethnicity was also controlled for in the model for all women and men, respectively.
‡ ***, p value < 0.001; **, p value < 0.01; *, p value < 0.05.

and environmental changes probably have contributed to the decline of people's physical activity and energy expenditure (34). Technological development and the expansion of global trade have facilitated more sedentary lifestyles in all SES groups in the U.S. (35). One good example that demonstrates the many impacts of new technologies on people's daily lives is the development of personal computers and the booming of the information technology industry. The information technology advances influence people's occupations and their daily activities by fostering more sedentary activities and reducing job- and leisure-related energy expenditure. Meanwhile, the transfer of labor-intensive industries to developing countries no doubt has reduced the number of workers who are employed in these high-energy-expending

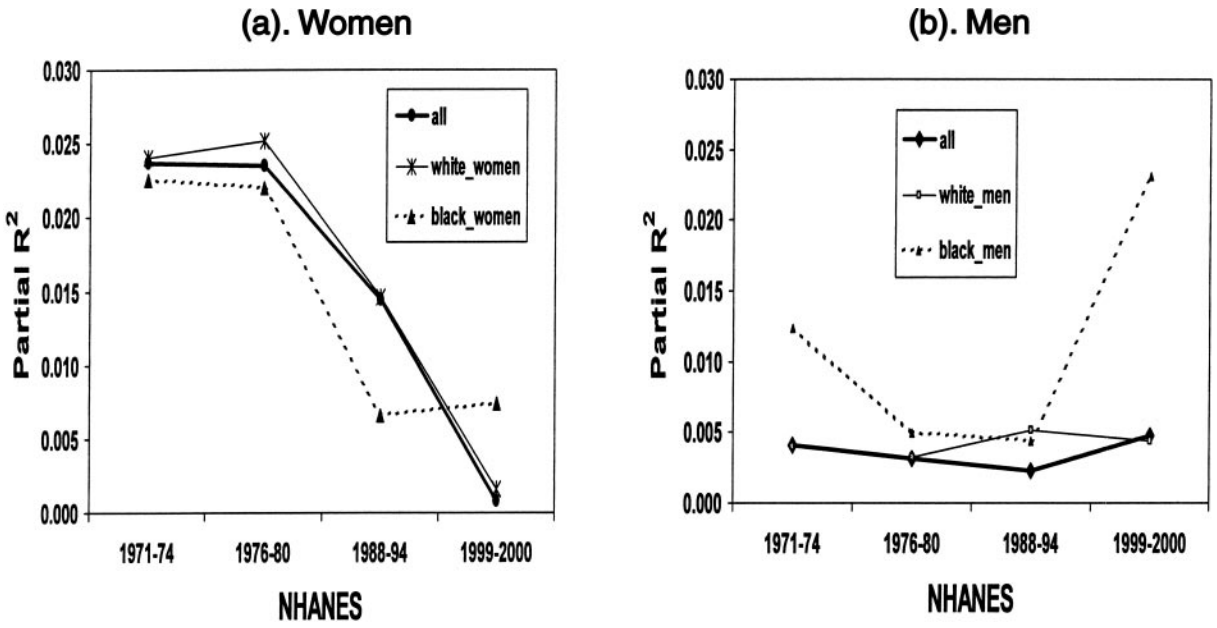

Figure 2: Changes in the variation of BMI explained by SES (partial R^2) among U.S. adults: 1971 to 2000.

sectors of employment in the U.S. In addition, compared with the past, Americans more often drive to work than walk or take public transportation, and there are more elevators in working sites, residential apartments, shopping malls, and other public buildings. Finally, people are less likely to engage in outdoor activities due to concerns about crime or due to the lack of sidewalks and recreation facilities in the communities, and they spend more time on sedentary activities such as watching TV and playing video games.

All of these changes may be playing a more dominant role in influencing people's weight status than individual-level characteristics such as SES (although broad social-environmental factors related to obesity still need to work through an individual's behaviors). Thus, the association between SES and obesity has been diminishing in an "obesogenic" environment.

Our findings suggest that population-based and environmental approaches should be developed for the prevention and management of obesity, whereas individually based approaches, as suggested by many previous studies, probably will not be very effective. Not only low-SES groups but also higher SES groups should be targeted in these efforts (36). Despite previous calls for action and large amounts of resources spent by individuals to reduce weight (37), the prevalence of obesity and overweight has increased in all SES groups. The disproportionate increase in the prevalence of obesity and overweight in high-SES groups indicates that even if people are aware of the importance of maintaining a healthy body weight, having a healthy diet, and engaging in regular physical activity, they are still gaining weight. It is societal changes that have contributed to the increase in obesity. Without developing effective strategies to modify the current obesogenic environment in the U.S., it is likely that the obesity epidemic will continue, which implies that there will be a greater burden of obesity-associated chronic disease such as cardiovascular disease and type 2 diabetes to contend with in the future.

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