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Background: Although obesity is frequently associated with poverty, recent increases in obesity may not occur disproportionately among the poor. Furthermore, the relationship between income and weight status may be changing with time.

Methods: We use nationally representative data from the National Health and Nutrition Examination Surveys (1971-2002) to examine (1) income differentials in body mass index (calculated as weight in kilograms divided by the square of height in meters) and (2) change over time in the prevalence of obesity (body mass index, ≥30) at different levels of income.

Results: Over the course of 3 decades, obesity has increased at all levels of income. Moreover, it is typically not the poor who have experienced the largest gains. For example, among black women, the absolute increase in obesity is 27.0% (1.05% per year) for those at middle incomes, but only 14.5% (0.54% per year) for the near poor and 5.4% (0.50% per year) for the poor. Furthermore, all race-sex groups show income differentials on body mass index, but patterns show substantial variation between groups and consistency and change within groups over time. For example, white women consistently show a strong inverse gradient, while a positive gradient emerges in later waves for black and Mexican American men.

Conclusion: The persistence and emergence of income gradients suggests that disparities in weight status are only partially attributable to poverty and that efforts aimed at reducing disparities need to consider a much broader array of contributing factors.

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Reducing obesity is a national health priority in the United States, where the prevalence of obesity has increased from 23% to 30% during the past decade and 65% of adults are overweight or obese. Recent attention has also centered on a link between obesity and poverty, but it is not known whether recent weight gains have occurred disproportionately among the poor. In addition, there has been relatively less focus on the relationship between weight status and the entire income distribution. Like other health outcomes, weight status may be influenced by a graded relationship with socioeconomic status (SES). Although poverty is a powerful correlate of health, broader gradients suggest that mechanisms linking SES to health are not limited to the more obvious material and social disadvantages imposed by severe impoverishment.

In a review published in 1989, Sobal and Stunkard find that studies on developed societies tend to show a strong inverse relationship between SES and obesity among women. While some studies show a similarly inverse relationship for men, others find a positive relationship or no relationship at all. More recent studies continue to show strong inverse relationships among women and inconsistent associations among men. There are limitations to prior work: few consider racial/ethnic differences, and almost all have either used relatively coarse categories of SES or only tested for a linear relationship. Such approaches can fail to capture nonlinear or complex relationships and, consequently, may contribute to discrepant findings between studies.

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A second potential reason for inconsistent findings is that differentials may be changing with time. Flegal et al examined secular trends in the relationship of body mass index (BMI) (calculated as weight in kilograms divided by the square of height in meters) to income from 1960 to 1980. They found a decreasing inverse association among women and a stable positive association among men. Incorporating more recent data, Zhang and Wang found a decreasing inverse association between obesity and education since the 1970s. While education is indeed a constituent of SES, the social significance and monetary return for set educational cat-
categories (eg, high school graduate) have changed quite markedly with time, limiting the utility of education relative to income in assessing trends over time. Little is known about income trends after 1980, the period when the distribution of BMI has shifted most dramatically.

We examine income differentials on BMI and obesity among US adults during a 3-decade period (1971-2002). We consider whether income gradients vary by race-sex groups and whether such gradients have changed over time. We also examine shifts over time in the prevalence of obesity at different points along the income distribution. While attention is often drawn to the prevalence of obesity among the poor, some data suggest that secular changes have occurred among persons with a higher SES as well.25

RESULTS

Sample characteristics for each of the 4 surveys are given in Table 1. The prevalence of obesity and mean BMI have increased substantially within each race-sex group from NHANES II to the last wave (1999-2002), with little change during the 1970s. Within sex groups, whites tend to have a lower percentage in the obese category than nonwhites, but these racial differences are much larger among women.

The Figure presents the results of polynomial models of the relationship between BMI and PIR. The y-axis ranges from a BMI of 24 to 30 for all groups except black women, for whom the range is 26 to 33, and Mexican Americans, for whom the range is 26 to 32. For whites and blacks, the curves show increasingly high BMI values across the entire income spectrum in the later 2 surveys, NHANES III and the continuous NHANES. In all but 4 of the 20 race-sex-survey models, a single 3 df test of the income terms is significant (P < .05), indicating a significant association between PIR and BMI. The 4 models in which the income terms are not significant are as follows: black men in NHANES I, Mexican American men in NHANES III, and Mexican American men and women in the continuous NHANES. Last, were income modeled as a single linear term, it would seem to be unassociated with BMI in several of the models in which a more flexible approach has revealed a significant relationship. For example, the P values for the single linear income term in NHANES II are .15 for black women and .93 for black men.

White women show a consistent inverse association between income and BMI in all periods, with a slight inverted U shape appearing around the poverty level in the continuous NHANES. Although the slope seems roughly similar, the intercept shifts upward with each wave. Women near the top of the income distribution (PIR, 3-4) in the continuous NHANES actually have a higher mean BMI than poor women at the bottom in NHANES I and II. For white men, the curves are generally flatter, but a slight inverse gradient emerges among incomes above poverty in the later waves, with curvature at the lower end of the income distribution.

Black women also show an inverse association between income and BMI, although there seems to be a positive gradient at levels below poverty in NHANES II and the continuous NHANES. Despite the presence of an inverse relationship among much of the income distribution in each wave, black women at the top of the income...
distribution in the continuous NHANES have a higher mean BMI than women at all levels of income in all previous surveys. In black men, the shape of the relationship may be changing over time, with an increasingly positive gradient emerging in the later waves. In fact, the changing nature of the gradient suggests that black men at the higher end of the income distribution may have experienced greater increases over time than those at the lower end. Among Mexican Americans, women show a modest inverse gradient in NHANES III and a weaker and nonsignificant ($P=.31$) relationship in the continuous NHANES. Mexican American men show a modest positive gradient; although the income terms are nonsignificant for the polynomial model in NHANES III ($P=.26$) and the continuous NHANES ($P=.15$), a single linear term is significant ($P=.02$) in the last wave.

Table 2 and Table 3 show the age-standardized prevalence of obesity by categories of income for women and men, respectively, and results are broadly consistent with patterns observed in the graphs on BMI. With the exception of near-poor (PIR, >1-2) black men, tests for trend over time within income groups are all significant among whites and blacks. For white women, the estimated prevalence of obesity decreases in monotonic fashion with increasing income within all waves except the last. With respect to change, the near poor show the largest, and those at the highest income (PIR, >4) show the lowest, absolute increase in obesity (near poor vs highest income, 22.6% vs 13.0%; $P=.02$). Among black women, estimates also decrease when going from the lowest to highest incomes within survey year, but not in monotonic fashion. As for change, the middle income (PIR, 2-4) group shows the largest estimated increase in obesity over time (absolute shift, 27.0%; trend, 1.05% per year), and the trend is significantly greater than that of the poor (PIR, 0-1) group (0.54% per year; $P=.02$) and the near poor (0.53% per year; $P=.03$). For Mexican American women, the poor also show the lowest estimated slope for trend, but this does not differ significantly ($P=.05$) from those of other income groups.

Among white men, the prevalence of obesity decreases in nonmonotonic fashion moving from the lowest to the highest income group, and the contrasts are more modest than those observed for white women. The poor show the largest absolute and trend increase with time, but these changes are not significantly different.

Table 1. Characteristics of Study Subjects*

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<td>PIR</td>
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<td>35.6</td>
<td>25.4</td>
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</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); NA, data not available; NHANES, National Health and Nutrition Examination Survey; PIR, poverty-income ratio.

*Data are given as means, except for sample sizes and percentage of obesity. Sample sizes reflect examined persons, excluding pregnant women; means and percentages are adjusted for survey weighting and design. Subjects were aged 18 to 64 years. The period for NHANES I was from 1971 to 1974; II, 1976 to 1980; III, 1988 to 1994; and continuous NHANES, 1999 to 2002.
Among black men, it seems that the highest income group transitions during the 32-year period from having less obesity (relative to the 2 lower-income groups) to having more obesity. Accordingly, the highest income group shows the largest increase over time in terms of absolute shift (21.1%) as well as trend (0.77% per year), and these changes are significantly different from those of the near poor (shift, 4.5%; trend, 0.06% per year; \( P < .01 \)). In units of relative change, obesity has increased by more than 296% for the highest income group compared with only 29% for the near poor. For Mexican American men, there seems to be a monotonic positive gradient in the continuous NHANES. As for change, the middle income group is the only group showing a statistically significant increase, although the trend differs significantly only from that of the poor (\( P = .01 \)).

**COMMENT**

Obesity has increased at all levels of income during the past 3 decades, but there are notable discrepancies between income groups in the magnitude of such change.
### Table 2. Age-Standardized Prevalence of Obesity by PIR for Women

<table>
<thead>
<tr>
<th>Variable</th>
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<td></td>
<td></td>
<td></td>
<td>I</td>
<td>0-1</td>
<td>&gt;1-2</td>
<td>&gt;2-4</td>
<td>&gt;4</td>
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<td></td>
<td></td>
<td></td>
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<td>23.4 (2.3)</td>
<td>18.2 (1.5)</td>
<td>13.1 (0.9)</td>
<td>9.5 (1.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>III</td>
<td>33.6 (4.0)</td>
<td>26.0 (2.5)</td>
<td>21.2 (1.6)</td>
<td>19.0 (1.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Continuous</td>
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<td>41.4 (3.0)</td>
<td>31.3 (2.8)</td>
<td>23.1 (1.9)</td>
<td></td>
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<tr>
<td>Change from NHANES I to the continuous NHANES</td>
<td>18.6 (4.6)†</td>
<td>22.6 (3.4)†</td>
<td>18.3 (2.9)†</td>
<td>13.0 (2.3)†</td>
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<tr>
<td>Trend slope, %/y</td>
<td>0.68 (0.15)†</td>
<td>0.71 (0.11)†</td>
<td>0.56 (0.08)†</td>
<td>0.51 (0.07)†</td>
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<td></td>
<td>Non-Hispanic Blacks</td>
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<td>32.4 (3.7)</td>
<td>21.8 (3.8)</td>
<td>14.9 (4.4)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>II</td>
<td>33.0 (3.2)</td>
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<td>21.5 (3.7)</td>
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<td>21.3 (5.6)†</td>
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<td>0.53 (0.17)†</td>
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<td>Mexican Americans</td>
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<td>III</td>
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Abbreviations: See Table 1.

*Data are given as percentage (SE) of women who were obese unless otherwise indicated, and are age standardized by the direct method to the 2000 US standard population, using age groups of 18 to 24, 25 to 44, and 45 to 64 years. The period for NHANES I was from 1971 to 1974; II, 1976 to 1980; III, 1988 to 1994; and continuous NHANES, 1999 to 2002.

†P<.01.

### Table 3. Age-Standardized Prevalence of Obesity by PIR for Men

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<td>19.0 (2.3)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Continuous</td>
<td>19.3 (3.0)</td>
<td>24.7 (3.4)</td>
<td>33.1 (3.9)</td>
<td>36.2 (3.7)</td>
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<tr>
<td>Change from NHANES III to the continuous NHANES</td>
<td>-3.1 (3.5)</td>
<td>4.1 (4.1)</td>
<td>11.1 (4.4‡)</td>
<td>3.8 (5.6)</td>
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<tr>
<td>Trend slope, %/y</td>
<td>-0.32 (0.37)</td>
<td>0.43 (0.43)</td>
<td>1.17 (0.46)‡</td>
<td>0.40 (0.69)</td>
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</table>

Abbreviations: See Table 1.

*Data are given as percentage (SE) of men who were obese unless otherwise indicated, and are age standardized by the direct method to the 2000 US standard population, using the age groups of 18 to 24, 25 to 44, and 45 to 64 years. The period for NHANES I was from 1971 to 1974; II, 1976 to 1980; III, 1988 to 1994; and continuous NHANES, 1999 to 2002.

†P<.01.
‡P<.05.
For example, among black women, those at middle incomes have experienced the largest increase, and among black men, those at the highest incomes have experienced the largest increase. While attention is often focused on poverty as a risk factor for obesity, these findings suggest that those living below federal poverty levels may not be the group at highest risk in the years to come.

Our study also finds that weight status varies along a wide range of incomes, with considerable variation by race and sex in the pattern, strength, and consistency of the relationship over time. White and black women consistently show a strong inverse association between income and BMI throughout all waves, although the overall relationship seems more linear at some points than others. In comparison, Mexican American women show a weaker and nonsignificant (in the last wave) gradient, consistent with previous work on Hispanics. Among white men, there seems to be a weaker inverse association for incomes above poverty in more recent waves. In contrast to white men, and in contrast to all groups of women, black and Mexican American men currently exhibit a positive relationship between income and weight status. Among black men, this represents a shift in the shape and direction of the gradient, a shift that is to some degree driven by the fact that higher-income black men have experienced a greater increase in weight status during this period than lower-income men.

Despite large secular increases in weight status among white and black women at all incomes, those at higher incomes maintain a distinct health advantage in terms of weight status in each time period. In graphical terms, the slope remains fairly stable relative to an intercept that exhibits considerable upward shifting after 1980. Hence, even though women at the top of the income distribution today have higher levels of obesity than low-income women in the 1970s, they continue to have lower levels of obesity than contemporaneous low-income women. As Link and Phelan have argued, social conditions such as SES can be thought of as “fundamental causes of disease” that maintain persistent and tenacious associations with health—despite changing contexts over time—because they determine access to important resources, resources that ultimately modulate exposures to a changing constellation of risk and protective factors.

Diverse environmental factors have been suggested as contributors to the “epidemic” of obesity, such as the transition to a more sedentary service sector economy, the uptake of labor-saving devices and sedentary entertainment, a decrease in the relative price of food, and a surge in food advertising and portion sizes. Despite these and other changes, women with a higher SES may be more resistant to their effects or more able to take compensatory action, thereby maintaining their relative advantage with time. This may be driven, in part, by variation across SES groups in aesthetic norms or cultural expectations with respect to weight standards.

A cross-sectional relationship between SES and weight status may not derive solely from the effects of SES on weight status. It is also possible that weight status, particularly obesity, affects SES, and that common factors influence both outcomes. With respect to the influence of weight status on SES, there is evidence that obesity may have a negative effect on wages, educational achievement, occupational opportunities, and marital mobility among women. Given the sex differences found in this and prior studies, however, any substantive contribution from genetic mechanisms would have to be sex specific. Moreover, changes to the association between SES and weight status over just a few decades point away from strong genetic effects.

The reasons for differences between men and women are far from clear, but a few points are worth noting. First, it is possible that low-income men engage in more manual occupational labor, thereby experiencing higher levels of physical activity. This could create a positive gradient or mitigate the effect of factors that would otherwise produce a stronger negative association. Second, the influence of obesity on SES is generally much weaker or absent among men. Third, the association between income and weight-related ideals, which is often cited as an explanation for the inverse association observed among white women, may vary across groups. Last, the positive gradient observed among nonwhite men could, to some extent, reflect a higher proportion of unhealthy or underweight men at lower incomes. However, within low-income groups, the prevalence of obesity itself has nevertheless increased over time.

There are limitations to these data. The cross-sectional nature of each wave precludes direct exploration of causal directions in the relationship between income and weight status. This study is also limited by the fact that we cannot distinguish secular from cohort effects. Changes between waves may be due, in part, to the movement of age cohorts bearing different associations into and out of the survey with time. A strength of these data is that they include measured rather than self-reported height and weight. Self-reports are well-known to be biased, and bias in reporting may be correlated with SES.

In sum, we find that the association between income and weight status shows consistency and change within race-sex groups over time, and that increases in the prevalence of obesity are neither limited to nor typically highest among the poor. Although income gradients in health are well established, herein we see that gradients in weight status are highly dependent on sex and race. Indeed, the sex and race differences suggest that the material benefits of income are not the only factors at stake. Furthermore, racial/ethnic discrepancies in weight status persist at broadly equivalent levels of income, suggesting that race discrepancies are not reducible to income effects. Last, the graded income relationships suggest that disparities in weight status are only partially attributable to poverty and that public health efforts aimed at reducing disparities need to consider a much broader array of contributing factors.

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REFERENCES

1. US Department of Health and Human Services. Healthy People 2010: Under-

standing and Improving Health. 2nd ed. Washington, DC: US Government Print-

ing Office; 2000.

2. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity

3. Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM. Preva-


5. Drewnowski A, Spector SE. Poverty and obesity: the role of energy density and

6. Adler NE, Boyce T, Chesney MA, et al. Socioeconomic status and health: the chal-


7. Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature.

8. Jeffery RW, French SA, Forster JL, Spyr VM. Socioeconomic status differences in
health behaviors related to obesity: the Healthy Worker Project. Int J Obes.

9. Leigh JP, Fries JF, Hubert HB. Gender and race differences in the correlation be-

tween body mass and education in the 1971-1975 NHANES I. J Epidemiol Com-


10. Croft JB, Strogatz DS, James SA, et al. Socioeconomic and behavioral corre-
1992;82:821-826.

central obesity and the metabolic syndrome: evidence from the Whitehall II study.

12. Winkleby MA, Kraemer HC, Amon CK, Varady AN. Ethnic and socioeconomic dif-

and lifestyle on body mass index in a longitudinal study. Int J Epidemiol. 1998;
27:57-63.

14. Sarlio-Lähteenkorva S, Lahelma E. The association of body mass index with so-
28:445-449.

15. Galobardes B, Morabia A, Bernstein MS. The differential effect of education and

16. Lauderdale DS, Rathouz PJ. Body mass index in a US national sample of Asian
Americans: effects of nativity, years since immigration and socioeconomic sta-


17. Mollarius A, Seidell JC, Sans S, Tuomilehto J, Kuulaasma K. Educational level,
relative body weight, and changes in their association over 10 years: an inter-
90:1260-1268.

18. Wardle J, Waller J, Jarvis MJ. Sex differences in the association of socioeco-


19. Freedman DS, Khan LK, Serdula MK, Galuska DA, Dietz WH. Trends and corre-
lates of class 3 obesity in the United States from 1990 through 2000. JAMA. 2002;
286:1758-1761.


at different levels of socioeconomic status. Am J Public Health. 2004;94:
468-472.

22. Zhang Q, Wang Y. Trends in the association between obesity and socioeco-

23. Flegal KM, Harlan WR, Landis JR. Secular trends in body mass index and skin-

24. Flegal KM, Harlan WR, Landis JR. Secular trends in body mass index and skin-

25. Mokdad AH, Serdula MK, Dietz WH, Bowman BA, Marks JS, Koplan JP. The spread
1519-1522.

26. Greenland S. Dose-response and trend analysis in epidemiology: alternatives to

27. Klein RJ, Schoenborn CA. Age Adjustment Using the 2000 Projected US Popu-
lation: Healthy People Statistical Notes No. 20. Hyattsville, Md: National Center

Corp; 2003.

29. Khan LK, Sobal J, Martorell R. Acculturation, socioeconomic status, and obe-

sity in Mexican Americans, Cuban Americans, and Puerto Ricans. Int J Obes Relat

30. Link BG, Phelan J. Social conditions as fundamental causes of disease. J Health


32. French SA, Story M, Jeffery RW. Environmental influences on eating and physi-


33. Jeffery RW, French SA. Socioeconomic status and weight control practices among

34. Chang VW, Christakis NA. Self-perception of weight appropriateness in the United


36. Sorensen TI. Socio-economic aspects of obesity: causes or effects? Int J Obes Relat

37. Register CA, Williams DR. Wage effects of obesity among young workers. Soc

38. Sargent JD, Blanchflower DG. Obesity and stature in adolescence and earnings


40. Gortmaker SL, Must A, Perrin JM, Sobal AM, Dietz WH. Social and economic con-
1993;329:1008-1012.

41. Goldblatt PB, Moore ME, Stunkard AJ. Social factors in obesity. JAMA. 1965;192:
1039-1044.


43. Nawaz H, Chan W, Abdulrahman M, Larson D, Katz DL. Self-reported weight and

44. Stewart AW, Jackson RT, Ford MA, Beaglehole R. Underestimation of relative
weight by use of self-reported height and weight. Am J Epidemiol. 1987;125:
122-126.