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PAPER

# The relation of gender, race and socioeconomic status to obesity and obesity comorbidities in a sample of US adults

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**OBJECTIVE:** To examine the obesity-related chronic diseases in the US adult population according to gender, race and socioeconomic status.
**METHODS:** Data from the 1994–1996 Continuing Survey of Food Intakes by Individuals (1994–1996 CSFII) conducted by the US Department of Agriculture/Agricultural Research Service (USDA/ARS) were used in the analysis. Relevant data included self-reported weight and height, self-reported physician-diagnosed diabetes mellitus, hypertension, heart disease and high serum cholesterol. Analysis was conducted according to gender, race, income level and education level.
**RESULTS:** There was a graded increase in diabetes, hypertension and high serum cholesterol with increasing body weight in nearly all gender, racial and socioeconomic groups. Among the obese individuals, the prevalence of hypertension was higher in black subjects and the prevalence of diabetes, hypertension and heart disease was higher in individuals with lower education compared to their counterparts. The odds of having diabetes, hypertension, heart disease and high serum cholesterol increased with increasing body weight after adjusting for age, gender, race, income, education and smoking.
**CONCLUSION:** Although cross-sectional in nature, our results suggest that the disease burden associated with obesity in the population may be substantial. This burden increases with increasing severity of obesity. Our findings support the current opinion that, although the nature of obesity-related health risks is similar in all populations, the specific level of risk associated with a given level of obesity may be different depending on gender, race and socioeconomic condition.
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**Keywords:** obesity; body mass index; race; socioeconomic status

## Introduction

There has been a steady increase in the prevalence of obesity in the USA during the past decade, with a trend that varies across population groups.[1,2] With the exception of Asian-Americans, the prevalence of overweight and obesity is higher in racial-ethnic minority populations, especially black people, than in US white people.[3] In addition to gender and race, the prevalence of obesity also varies across socioeconomic classes in most Western countries.[4] However, the relationship between socioeconomic status and obesity is complex and poorly understood.

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Although the nature of obesity-related health risks is similar in all populations, the specific level of risk associated with a given level of obesity may be different depending on gender, race and societal conditions.[3] For example, studies in the South African population showed that black women had a more favorable lipid profile and a lower risk of heart disease than white women regardless of their weight.[5] In the US population, the plasma triglyceride level increased with increasing body weight, but less so in black compared to white people.[6] In contrast, black men and women appear to be at higher risk of type 2 diabetes mellitus and hypertension than whites across all levels of body weight.[7,8] Some studies have shown that obesity is associated with the increased health risk in other ethnic-minority populations as well.[9–11]

The disease burden associated with obesity in the US has been clearly demonstrated. For example, a graded increase in diabetes, high blood pressure, gall bladder disease and osteoarthritis was observed with increasing severity of

obesity.[12] Body mass index (BMI) was positively associated with hypertension and dyslipidemia, and obesity was associated with the increased risk of hypertension-diabetes comorbidity.[13,14] In these studies, both the gender and the racial differences in obesity-related conditions were shown. The socioeconomic difference in these conditions, however, was not examined. Given the observed relationship between socioeconomic status and obesity, it is likely that the obesity comorbidities may also vary across socioeconomic groups. In this study, we examined the association between obesity and obesity comorbidities according to gender, race, income and education in a sample of US adults.

## Methods

The 1994–1996 Continuing Survey of Food Intakes by Individuals (CSFII 1994–1996) was conducted in a nationally representative sample of noninstitutionalized persons in the US using a stratified, multistage, area probability sample design. The details of survey design and methods are available elsewhere.[15] The in-person interview was the method of data collection. The CSFII 1994–1996 did not include anthropometric and clinical measurements, and all of the data were self-reported. A total of 20 126 individuals were initially selected into the sample. Of these, 16 103 individuals (80%) completed the interview. In this study, we focused on 10 164 survey participants 18 y of age and older. Of these, 9643 (95%) provided complete data for analysis.

Data relevant to this study include the self-reported weight and height, self-reported physician-diagnosed chronic diseases, and sociodemographic data. Data about smoking habits were used where appropriate. Body weight was reported in pounds and height without shoes was reported in feet and inches. From these, BMI was calculated as the weight in kilograms divided by the height in meters squared ($kg/m^2$). The presence of the physician-diagnosed health condition was ascertained in all participants. We chose four obesity-related conditions: diabetes, hypertension, heart disease (all types), and high serum cholesterol. We defined two income categories: lower income and higher income were defined as income of 130% or less, and income of more than 130%, respectively, of the Federal poverty guidelines based on household size and income.[16] Education level was ascertained by the actual number of years of schooling completed. This was classified into two categories: less than high school education and high school education or higher.

We divided the study population into three racial groups: non-Hispanic white ($n=7481$), non-Hispanic black ($n=1112$), and Hispanic ($n=821$). Asians, Pacific Islanders, American Indians, and Alaskan natives ($n=229$) were not represented in adequate numbers for reliable estimate, but were included in the sample for data weighting purpose. We defined four weight categories using the recommended criteria:[3] underweight (BMI of 18.4 $kg/m^2$ or less), normal weight (BMI between 18.5 and 24.9 $g/m^2$), overweight (BMI between 25.0 and 29.9 $kg/m^2$), and obese (BMI of 30.0 $kg/m^2$ or greater). Smoking status was defined as the current smoker and the non-smoker or ex-smoker. We excluded 521 individuals from analysis, 76 pregnant women and 445 persons with missing or incomplete data.

## Statistical analysis

Appropriate sampling weights were used in all analyses to compensate for variable probabilities of selection, differential nonresponse rates, and possible deficiencies in the sampling frame.[15] Crude or age-adjusted estimates were presented. Age adjustment was done using the direct method and the projected year 2000 US resident population. The proportions of individuals classified as underweight, normal weight, overweight and obese were calculated, stratified by gender, race, income, and education level. The proportions of individuals with diabetes, hypertension, heart disease, and high serum cholesterol in different BMI categories were calculated and compared, stratified by gender, race, income and education. Separate analysis was done for each of these diseases. The proportions were compared using chi-square statistic corrected for the survey design.[17] We used a *P*-value of less than 0.01 to indicate statistically significant differences. Multiple logistic regression analysis was used to estimate the odds ratio (OR) of each of the four chronic diseases according to BMI category, with the normal weight as the reference category and simultaneously controlling for age, race, gender, income, education and smoking. All analyses were done using Stata release 7 and SAS version 8.1.[17,18]

## Results

Table 1 shows the age-adjusted prevalence of overweight, obesity, and obesity comorbidities in the study sample. As shown, the rate of overweight was higher in men while the rate of obesity was higher in women. The prevalence of overweight and obesity was higher in black and Hispanic compared to white people. The prevalence of diabetes, hypertension, and high serum cholesterol was similar in

**Table 1** Age-adjusted prevalence of overweight, obesity and obesity comorbidities by gender and race, CSFII 1994–1996[a]

| | *Gender* | | *Race* | | |
|---|---|---|---|---|---|
| | *Male* | *Female* | *White* | *Black* | *Hispanic* |
| Overweight | 42.7 | 27.3 | 34.7 | 36.2 | 40.7 |
| Obesity | 16.8 | 18.6 | 16.5 | 29.0 | 18.7 |
| Diabetes mellitus | 5.7 | 5.6 | 4.7 | 10.1 | 9.4 |
| Hypertension | 20.8 | 20.1 | 19.3 | 32.7 | 17.6 |
| Heart disease | 9.0 | 6.6 | 7.4 | 10.6 | 6.3 |
| High serum cholesterol | 13.8 | 14.8 | 15.5 | 10.1 | 11.5 |

[a]All estimates are weighted estimates. Data are presented as percentages. CSFII denotes the Continuing Survey of Food Intakes by Individuals.

men and women. With the exception of high serum cholesterol, the prevalence of obesity comorbidities was higher in black compared to white people. Hispanics reported lower rates of hypertension and heart disease compared to black or white people.

Table 2 shows the percentage of individuals in each weight category stratified by gender, race, income and education. About 35 and 18% of all individuals were classified as overweight and obese, respectively, and 2.7% were classified as underweight. About 16% of the individuals in the sample were classified as having lower income, with similar proportion reported having less than high school education. The prevalence of obesity was significantly higher among black and Hispanic subjects compared to whites, and among the individuals with lower income and lower education compared to their counterparts.

Table 3 shows the prevalence of diabetes, hypertension, heart disease and high serum cholesterol according to the BMI categories and stratified by gender, race, income and education. There was a graded increase in diabetes, hypertension and high serum cholesterol with increasing body weight in nearly all gender, race and socioeconomic groups. The prevalence of diabetes and hypertension was higher in black people compared to white or Hispanic people across all BMI categories, but not all of the differences were statistically significant. Similarly, the prevalence of diabetes, hypertension and heart disease was higher in individuals with lower income and lower education compared to their counterparts. High serum cholesterol was more prevalent in white compared to black or Hispanic people. The association between body weight and heart disease was not clear, with a higher rate observed in the underweight, overweight, and obese individuals compared to the normal weight group.

The OR of diabetes, hypertension, heart disease, and high serum cholesterol according to BMI category are shown in Table 4. These estimates were obtained from the multiple logistic regression model with normal weight as the reference category (OR = 1) and controlling for age, gender, race, income, education and smoking. As shown, the OR of diabetes, hypertension, and high serum cholesterol increased as body weight increased. This incremental increase was not observed for heart disease. The ORs of diabetes, hypertension and high serum cholesterol were all significantly higher in overweight and obese individuals compared to the normal weight group. The OR of heart disease was significantly higher in obese, but not overweight individuals, compared to the normal weight group.

## Discussion

In this study, we examined the disease burden associated with obesity in the US population according to gender, race and socioeconomic status. Our results show that, with a few exceptions, there was a significant increase in prevalence of diabetes, hypertension, heart disease and high serum cholesterol with increasing body weight in all gender, racial and socioeconomic groups. Moreover, there were gender, racial and socioeconomic differences in the obesity-related conditions at a given level of body weight. For example, the obese black subjects reported higher rates of hypertension than obese white or Hispanic subjects and the obese individuals with lower education reported higher rates of diabetes, hypertension and heart disease compared to those with higher education. As mentioned above, although the gender and racial differences in health risks associated with obesity have been demonstrated, the socioeconomic difference in these risks has not been adequately examined.

Socioeconomic factors have been associated with obesity in different populations. However, this relationship is complex because socioeconomic status may influence obesity, obesity may influence socioeconomic status, or common factor(s) may influence both obesity and socioeconomic

**Table 2** Study population classified by gender, race, income, education and weight category[a]

| | | *Weight category* | | | |
|---|---|---|---|---|---|
| | *Sample size (n = 9643)* | *Underweight* | *Normal weight* | *Overweight* | *Obese* |
| Total | 100.0 | 2.7 | 45.0 | 34.7 | 17.6 |
| Gender | | | | | |
| Male | 49.2 | 1.1[a] | 40.0[b] | 42.0[c] | 16.6 |
| Female | 50.8 | 4.2[a] | 50.0[b] | 27.3[c] | 18.5 |
| Race | | | | | |
| White | 79.0 | 2.6 | 46.3[d] | 34.7 | 16.4[e] |
| Black | 12.0 | 2.4 | 33.0[d] | 36.0 | 28.6[e] |
| Hispanic | 9.0 | 2.2 | 40.4[d] | 39.6 | 17.8[e] |
| Income | | | | | |
| Lower | 15.6 | 3.7 | 41.7 | 31.7 | 23.0[f] |
| Higher | 84.4 | 2.5 | 45.6 | 35.3 | 16.6[f] |
| Education | | | | | |
| Lower | 16.0 | 3.1 | 37.7[g] | 36.3 | 23.0[h] |
| Higher | 84.0 | 2.7 | 46.3[g] | 34.5 | 16.5[h] |

[a]All estimates are weighted estimates. Data are presented as percentages. Numbers with the same superscript are significantly different, $P < 0.01$.

**Table 3** Obesity comorbidities according to gender, race, income, education and weight category*

| | Weight category | | | | |
|---|---|---|---|---|---|
| | *Underweight* | *Normal weight* | *Overweight* | *Obese* | P† |
| *Diabetes mellitus* | | | | | |
| Male | 3.0 | 3.6 | 5.6 | 8.3[a] | <0.001 |
| Female | 1.6 | 2.8 | 6.8 | 13.0[a] | <0.001 |
| White | 1.5 | 2.8 | 5.6 | 10.0 | <0.001 |
| Black | 7.3 | 5.3 | 8.1 | 15.0 | 0.001 |
| Hispanic | 1.8 | 4.8 | 7.8 | 7.3 | 0.2 |
| Lower income | 2.5 | 5.0[b] | 9.7[c] | 18.0[d] | <0.001 |
| Higher income | 1.8 | 2.9[b] | 5.4[c] | 9.0[d] | <0.001 |
| Lower education | 6.1 | 6.5[e] | 11.8[f] | 19.3[g] | <0.001 |
| Higher education | 1.1 | 2.7[e] | 4.7[f] | 8.5[g] | <0.001 |
| *Hypertension* | | | | | |
| Male | 11.4 | 11.5 | 20.7[a] | 35.4 | <0.001 |
| Female | 7.1 | 13.3 | 25.0[a] | 36.0 | <0.001 |
| White | 7.5 | 13.0[b] | 22.0[c] | 35.2[d] | <0.001 |
| Black | 18.2 | 18.1[b] | 32.1[c] | 44.0[d] | <0.001 |
| Hispanic | 5.5 | 5.0[b] | 15.1[c] | 24.4[d] | <0.001 |
| Lower income | 8.7 | 14.6 | 27.5[e] | 39.0 | <0.001 |
| Higher income | 7.8 | 12.1 | 21.5[e] | 35.0 | <0.001 |
| Lower education | 18.4[f] | 22.1[g] | 35.8[h] | 46.0[i] | <0.001 |
| Higher education | 5.8[f] | 11.0[g] | 19.5[h] | 33.1[i] | <0.001 |
| *Heart disease* | | | | | |
| Male | 11.3 | 7.3[a] | 8.4 | 8.2 | 0.5 |
| Female | 6.7 | 5.7[a] | 6.8 | 9.8 | 0.004 |
| White | 7.7 | 7.0 | 8.0 | 8.8[b] | 0.2 |
| Black | 15.8 | 6.4 | 9.6 | 12.8[b] | 0.1 |
| Hispanic | 7.5 | 2.4 | 4.3 | 2.0[b] | 0.2 |
| Lower income | 10.6 | 8.2 | 11.0 | 16.0[c] | 0.004 |
| Higher income | 7.0 | 6.1 | 7.2 | 7.2[c] | 0.3 |
| Lower education | 21.1[d] | 15.6[e] | 15.5[f] | 18.2[g] | 0.5 |
| Higher education | 4.8[d] | 4.8[e] | 6.0[f] | 6.8[g] | 0.08 |
| *High serum cholesterol* | | | | | |
| Male | 6.0 | 8.5[a] | 15.0 | 19.1 | <0.001 |
| Female | 5.3 | 11.5[a] | 18.7 | 21.1 | <0.001 |
| White | 6.7 | 11.5[b] | 18.6[c] | 22.5[d] | <0.001 |
| Black | 6.1 | 5.0[b] | 7.8[c] | 16.6[d] | <0.001 |
| Hispanic | 0 | 3.8[b] | 11.3[c] | 10.2[d] | N/A |
| Lower income | 4.6 | 7.5 | 14.1 | 18.4 | <0.001 |
| Higher income | 5.7 | 10.6 | 16.8 | 20.6 | <0.001 |
| Lower education | 11.4 | 12.1 | 16.8 | 17.1 | <0.08 |
| Higher education | 4.2 | 10.0 | 16.4 | 21.2 | <0.001 |

*All estimates are weighted estimates. Data are presented as percentages. For each disease, the numbers with same superscript are significantly different, $P < 0.01$

†*P*-value for the difference in row percentages across four weight categories. N/A = not applicable because one cell was empty.

status.[19] In addition, whether the obesity comorbidities may also vary according to the socioeconomic status is not known. Our results show that low income and low education may be associated with both obesity and obesity comorbidities. These findings support the current opinion that although the nature of obesity-related health risks is similar in all populations, the specific level of risk at a given level of obesity may be different depending on gender, race, and societal conditions.[3]

Our results show that there was a graded increase in diabetes, hypertension and high serum cholesterol across all levels of body weight. However, this incremental increase

**Table 4** Odds ratio (OR) of obesity comorbidities according to weight category[a]

| *Weight category* | *Odds ratio* | *95% confidence interval* | P |
|---|---|---|---|
| Diabetes | | | |
| Underweight | 0.6 | (0.2–1.3) | 0.2 |
| Normal weight | 1.0 | — | — |
| Overweight | 1.7 | (1.3–2.2) | <0.001 |
| Obese | 3.4 | (2.6–4.4) | <0.001 |
| Hypertension | | | |
| Underweight | 0.5 | (0.3–0.7) | 0.001 |
| Normal weight | 1.0 | — | — |
| Overweight | 1.9 | (1.6–2.2) | <0.001 |
| Obese | 4.1 | (3.4–5.0) | <0.001 |
| Heart disease | | | |
| Underweight | 1.1 | (0.7–2.0) | 0.6 |
| Normal weight | 1.0 | — | — |
| Overweight | 1.0 | (0.8–1.3) | 0.7 |
| Obese | 1.4 | (1.1–1.8) | 0.003 |
| High serum cholesterol | | | |
| Underweight | 0.5 | (0.3–0.9) | 0.03 |
| Normal weight | 1.0 | — | — |
| Overweight | 1.7 | (1.4–2.1) | <0.001 |
| Obese | 2.3 | (1.9–3.0) | <0.001 |

[a]Weighted estimates and adjusted for age, race, gender, income, education, and smoking. Normal weight is the reference category (OR = 1).

was not observed for heart disease, where the rate was also higher in the underweight compared to the normal weight group, especially among women and individuals with lower income. Similarly, the results from multivariate analysis show that there was an incremental increase in the OR of diabetes, hypertension, and high serum cholesterol with increasing body weight after adjusting for age, race, gender, income, education and smoking. Both the overweight and the obese individuals were at significantly higher risk of diabetes, hypertension and high serum cholesterol compared to the normal weight individuals. The OR for heart disease was higher among the obese, but not underweight or overweight individuals, compared to the normal weight group.

The major limitation of this study is the use of self-reported weight and height. The accuracy of self-reported weight and height has been studied extensively, and it was concluded that the self-reported weight and height is sufficiently accurate in situations where the measured weight and height is not available.[20–22] In addition, although the CSFII emphasized the physician-diagnosed chronic illnesses, the self-reporting of these conditions is also subject to error. Other limitations include the cross-sectional study design, which does not provide evidence for the causal relationship between obesity and obesity comorbidities. However, prospective studies have shown that overweight and obesity usually precede the onset of obesity-related illnesses,[23–25] and given the consistency of these findings, the cross-sectional relationship between obesity and chronic diseases in the population is likely to reflect true association.[12] Finally, the use of BMI as a measure of body weight does not take into account the body fatness and body fat distribution which are known to be associated with obesity comorbidities independently of BMI. Despite these limitations, our results showed that the disease burden associated with obesity in the population may be substantial, and that such burden may vary significantly depending on gender, race and socioeconomic condition.

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