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The Disease Burden Associated With Overweight and Obesity

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Context Overweight and obesity are increasing dramatically in the United States and most likely contribute substantially to the burden of chronic health conditions.

Objective To describe the relationship between weight status and prevalence of health conditions by severity of overweight and obesity in the US population.

Design and Setting Nationally representative cross-sectional survey using data from the Third National Health and Nutrition Examination Survey (NHANES III), which was conducted in 2 phases from 1988 to 1994.

Participants A total of 16 884 adults, 25 years and older, classified as overweight and obese (body mass index [BMI] ≥25 kg/m^2) based on National Institutes of Health recommended guidelines.

Main Outcome Measures Prevalence of type 2 diabetes mellitus, gallbladder disease, coronary heart disease, high blood cholesterol level, high blood pressure, or osteoarthritis.

Results Sixty-three percent of men and 55% of women had a body mass index of 25 kg/m^2 or greater. A graded increase in the prevalence ratio (PR) was observed with increasing severity of overweight and obesity for all of the health outcomes except for coronary heart disease in men and high blood cholesterol level in both men and women. With normal-weight individuals as the reference, for individuals with BMIs of at least 40 kg/m^2 and who were younger than 55 years, PRs were highest for type 2 diabetes for men (PR, 18.1; 95% confidence interval [CI], 6.7-46.8) and women (PR, 12.9; 95% CI, 5.7-28.1) and gallbladder disease for men (PR, 21.1; 95% CI, 4.1-84.2) and women (PR, 5.2; 95% CI, 2.9-8.9). Prevalence ratios generally were greater in younger than in older adults. The prevalence of having 2 or more health conditions increased with weight status category across all racial and ethnic subgroups.

Conclusions Based on these results, more than half of all US adults are considered overweight or obese. The prevalence of obesity-related comorbidities emphasizes the need for concerted efforts to prevent and treat obesity rather than just its associated comorbidities.

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OVERWEIGHT AND OBESITY ARE common health conditions and their prevalence is increasing globally.[1-3] Recent estimates suggest that 1 in 2 adults in the United States is overweight or obese, defined by a body mass index (BMI) of higher than 25, an increase of more than 25% over the past 3 decades.[4] These dramatic increases have occurred among the 3 major racial and ethnic groups and include both sexes.[4]

Excess weight is associated with an increased incidence of cardiovascular disease, type 2 diabetes mellitus (DM), hypertension, stroke, dyslipidemia, osteoarthritis, and some cancers.[5] Associations of excess weight with overweight- and obesity-related mortality may differ among racial and ethnic groups.[6-10]

In 1998, the National Heart, Lung, and Blood Institute of the National Institutes of Health published evidence-based clinical guidelines for the identification, evaluation, and treatment of overweight and obesity in adults.[11] This classification resembles the categories used by the World Health Organization.[1] Based on BMI, calculated as weight in kilograms divided by the square of height in meters, both approaches use 4 classes of increasing severity, consistent with the notion of graded risk in the US Department of Agriculture's *Dietary Guidelines for Americans*.[12,13]

Several recent articles that rely on the Third National Health and Nutrition Examination Survey (NHANES III) data[14-18] largely focus on single-health outcomes[15,16] and population subgroups.[17,18] This study was undertaken to provide estimates of the prevalence of morbid conditions associated with obesity by severity, race and ethnicity, and age, as well as by the frequency of multiple obesity-related comorbidities in the US population.

METHODS

Population for Study

Conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention, NHANES III was designed to provide nationally representative data to estimate the prevalence

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Table 1. Weight Classification by Body Mass Index (BMI)*

NHLBI Terminology[11]	BMI, kg/m^2, Range	WHO Classification[1]
Underweight	<18.5	Underweight
Normal	18.5-24.9	Normal range
Overweight	25.0-29.9	Preobese
Obesity class 1	30.0-34.9	Obese class 1
Obesity class 2	35.0-39.9	Obese class 2
Obesity class 3	≥40.0	Obese class 3

*NHLBI indicates National Heart, Lung, and Blood Institute and WHO, World Health Organization.

of major diseases, nutritional disorders, and potential risk factors. In NHANES III, 2 waves of data were collected in 2 phases from 1988 to 1994. The total sample included 33 199 persons; 16 884 were at least 25 years old. The sampling plan followed a complex, stratified, multistage, probability cluster design to produce estimates representative of the noninstitutionalized civilian US population. To improve the reliability of estimates for non-Hispanic blacks and Mexican Americans as well as young children and the elderly, NHANES III oversampled these groups. Further details of the design and operation of the survey are available elsewhere.[19,20]

Overweight and Obesity Criteria

The survey protocol included a home interview and a standardized physical examination in a mobile examination center or a limited examination in the subject's home for subjects unable to travel. In both settings, body weight and height were measured by trained technicians with standardized equipment and procedures.

We used the National Heart, Lung, and Blood Institute's definitions for the cutoff points between overweight and obesity and between obese and its class levels.[11] Using a reference category of BMI 18.5 to 24.9 kg/m^2 (termed *normal weight*), the 4 classes as shown in TABLE 1, which also lists the World Health Organization's cutoff points.[1] Both organizations use the same categories with the exception of the BMI range of 25.0 to 29.9 kg/m^2 category: WHO calls it *preobese* and the National Heart, Lung, and Blood Institute calls it *overweight*. Both organizations consider persons with a BMI of between 25.0 and 29.9 kg/m^2 to be overweight.

Among the 16 884 subjects at least 25 years old, we excluded pregnant women (n = 164) and persons who did not have height or weight measurements (n = 1719).

Health Outcomes

On the basis of previous research, we selected for study health conditions for which excess weight is an established risk factor and for which sample sizes were adequate. These conditions included high blood pressure, type 2 DM, high blood cholesterol level, coronary heart disease (CHD), and gallbladder disease. In addition, for analyses that considered the number of comorbidities, osteoarthritis was included.

High blood pressure was deemed present if subjects reported that a physician had ever told them that they had hypertension or high blood pressure, or if the mean of at least 3 blood pressure readings (measured by NHANES technicians) exceeded 140 mm Hg systolic or 90 mm Hg diastolic. The specific details of the blood pressure measurements are published elsewhere.[20] The average of all available blood pressure measurements was used.

Ideally, type 2 DM should be defined based on self-report of physician diagnosis and fasting plasma glucose levels. However, fasting plasma glucose levels were unavailable for 44% of the sample. Therefore, type 2 DM was defined only by self-report of diagnosed disease. Because the structured interview item for physician-diagnosed DM did not distinguish type 1 from type 2 DM, we identified subjects with type 2 DM on the basis of the information provided in the questionnaire. We started with all those who responded affirmatively to the question: "Has a physician ever told you have diabetes?" We then excluded those who reported having DM only during pregnancy. Of those who remained, we excluded those with type 1 DM (diagnosis before age 30 years and number of years of insulin use equal to within 1 year of duration of disease). Those who remained were considered to have type 2 DM. This approach may misclassify a small number of persons with type 2 DM as having type 1 DM, and an even smaller number of persons with late-onset type 1 DM as having type 2 DM.

Subjects were classified as having high blood cholesterol levels if they reported that a physician had told them such or if measured serum cholesterol levels exceeded 6.2 mmol/L (240 mg/dL). Levels were determined by contract laboratories using reference analytical methods.[21]

A diagnosis of CHD was based on a history of having had a "heart attack," congestive heart failure, or angina. Heart attack and congestive heart failure were based on self-report of physician diagnosis. The location of chest pain as described by self-report was used for classification of angina based on established criteria.[22]

Gallbladder disease or osteoarthritis were considered present for subjects who had ever been told by their physician that they had either condition.

Data Analysis

All analyses were conducted using specialized software that adjusts for complex sample designs.[23] Sample weights were applied to produce nationally representative estimates. Prevalence estimates were calculated by cross-tabulation. Race- and ethnicity-specific estimates were calculated for non-Hispanic whites, non-Hispanic blacks, and Mexican Americans. Other racial and ethnic groups were not represented in adequate numbers for reliable estimates for these subgroups but were included in population-based estimates. All analyses were stratified by sex.

Multivariate logistic models were developed to estimate prevalence odds ratios (PORs) by obesity class (compared

with the normal weight [BMI, 18.5-24.9 kg/m^2]), adjusted for smoking status, age, and race and ethnicity. Age was modeled as a continuous variable. Smoking status was defined by indicator variables for never, former, and current smoking; never smoking was the referent category. To test for interactions between race and ethnicity and the categories of overweight and obesity, we evaluated the significance of interaction terms for 3 racial and ethnic groups and 5 weight classes (normal, overweight, and obesity classes 1, 2, and 3) by a likelihood ratio test comparing the logistic model with and without the interaction terms. The race and ethnicity interaction was not significant. Similarly, we tested age and weight class interaction terms. This interaction was significant, so age-specific analyses, stratified into 2 broad categories of younger than 55 years and 55 years or older, are presented. To test for linear trend, we included BMI as a continuous variable in the logistic models and tested for its statistical significance. For common outcomes, the POR does not well approximate the prevalence ratio (PR). We corrected the PORs using the method of Zhang and Yu.[24] Using our logistic regression models, we estimated the baseline prevalence of each condition for normal weight individuals, of modal race or ethnicity and modal smoking status. These baseline-adjusted prevalences were used to convert the PORs to adjusted PRs and are presented with the PRs to aid in the interpretation of the ratios.[25]

Statistical significance was set at $P<.05$ and the stability of the estimates reflected by 95% confidence intervals (CIs). In describing patterns, we considered PRs to be similar when the CI for one estimate included the point estimate of the other and when the trend tests for a pair of models were both significant or both nonsignificant.

To evaluate multiple morbidities, we used cross-tabulation to evaluate the proportion of persons who had 0, 1, 2, or more comorbidities by weight status category within strata of sex and racial and ethnic group. To be conservative for these analyses, we calculated crude prevalences only for type 2 DM, gallbladder disease, high cholesterol levels, high blood pressure, and osteoarthritis as obesity-related comorbidities. Coronary heart disease was not included in these analyses because hypertension, high cholesterol levels, and type 2 DM may be in the causal pathway for heart disease. If these conditions are intermediate events in the development of CHD, it would not be correct to count them as 2 separate health conditions.

RESULTS

Based on the NHANES III sample, approximately 63% of men and 55% of women aged 25 years or older in the US population were overweight or obese (TABLE 2). Specifically, 42% of men and 28% of women were overweight, and

Table 2. Sociodemographic and Other Selected Characteristics of Persons 25 Years or Older, by National Heart, Lung, and Blood Institute Recommended Weight Categories[11]*

Characteristic	Sample Size	Weighted Size	Underweight	Normal	Overweight	Obesity Class 1	Obesity Class 2	Obesity Class 3
Men								
Race and ethnicity								
Mexican American	1893	3 719 433	0.86	29.49	46.04	18.19	4.16	1.26
Non-Hispanic black	1860	7 395 180	1.98	39.82	36.94	14.73	4.23	2.30
Non-Hispanic white	3099	58 312 466	0.87	35.85	42.44	15.23	3.55	2.05
Other	249	5 525 736	0.40	48.13	36.65	11.60	2.68	0.53
Cigarette smoking status								
Current smoker	2161	23 501 410	1.65	45.47	38.16	11.28	1.99	1.45
Former smoker	2607	25 861 363	0.64	29.71	42.94	20.25	4.35	2.11
Never smoked	2333	25 590 041	0.62	36.10	43.54	13.29	4.29	2.17
Age, y								
25-54.9	3929	52 590 201	0.74	39.08	40.77	13.69	3.34	2.40
≥55	3172	22 362 613	1.44	31.56	43.72	18.29	4.17	0.82
Women								
Race and ethnicity								
Mexican American	1821	3 297 415	1.35	30.04	32.29	22.36	8.57	5.38
Non-Hispanic black	2199	9 089 748	2.47	28.59	29.99	19.77	11.01	8.17
Non-Hispanic white	3546	62 504 053	3.49	46.78	25.96	13.73	6.50	3.55
Other	330	5 938 132	2.45	44.11	25.50	19.33	5.74	2.86
Cigarette smoking status								
Current smoker	1670	19 903 966	5.21	48.06	23.33	14.76	5.33	3.31
Former smoker	1474	17 517 319	1.70	42.65	28.19	14.90	7.73	4.83
Never smoked	4752	43 408 063	2.90	42.42	27.52	15.47	7.53	4.16
Age, y								
25-54.9	4471	52 404 501	3.32	47.92	23.17	14.08	7.06	4.45
≥55	3425	28 424 847	3.00	36.36	33.02	17.19	6.99	3.43

*Weight categories are delineated in Table 1. Data are are presented as percentages unless otherwise indicated.

21% of men and 27% of women were obese. The crude prevalence estimates showed a generally similar magnitude and pattern across racial and ethnic groups by sex with 2 exceptions: among non-Hispanic white women the prevalence of BMI of 25 kg/m^2 or higher (overweight or obesity) was lower and among Mexican American men prevalence was higher compared with other racial or ethnic sex groups.

For both men and women, high blood pressure was the most common overweight- and obesity-related health condition and its prevalence showed a strong increase with increasing weight status category (TABLE 3). The prevalence of type 2 DM, gallbladder disease, and osteoarthritis increased sharply among both overweight and obese men and women corresponding with the increasing weight classes. High blood cholesterol level was very prevalent in both sexes but showed no increase in prevalence with increasing weight category. However, men and women with BMIs of 25 kg/m^2 or more, were more likely than persons of normal weight to have high blood cholesterol levels. Because these estimates are not adjusted for age or smoking status, they reflect the presence of these health conditions in the US population.

Sex-specific PRs by weight class for the health conditions considered showed no evidence of race and ethnicity–weight class interactions for either sex. (Racial- and ethnic-specific PRs are available from A.M.) Significant interactions between weight status category and age group (<55 years, ≥55 years) were observed for all health outcomes examined, except for CHD (TABLE 4).

Type 2 DM showed a strong increase in prevalence with increasing overweight class among both younger and older subjects. The PR associated with elevated weight was 3- to 4-fold greater among younger overweight men and women. Among those in the most obese group, the PR for younger men was 18.1 (95% CI, 6.7-46.8) and 12.9 (95% CI, 5.7-28.1) for younger women. Among older men and women, PRs were more moderate but still substantially elevated, with a PR of 3.4 (95% CI, 1.1-8.3) for the most obese men, and 5.8 (95% CI, 4.2-7.4) for the most obese women.

The PRs for gallbladder disease differed substantially by sex. Men younger than 55 years exhibited a marked increase in PRs for gallbladder disease with increasing weight status, with a PR of 21.1 (95% CI, 4.1-84.2) observed in the highest obesity class. Among older men, a weaker gradient of PRs was observed. For women, for whom the condition is more than twice as prevalent as it is among men, a steady increase in the PRs for gallbladder disease with increasing weight status category was observed in both age groups, with a PR of 1.9 (95% CI, 1.3-3.0) for overweight women younger than 55 years.

Unlike the other comorbidities examined, the PRs for CHD did not differ by age group. Prevalence ratios were not elevated among the overweight but were significantly elevated in obesity class 1 for men and in all 3 obesity classes for women. Among these obese classes, PRs ranged from 1.6 among obesity class 1 women (95% CI, 1.2-2.1) to 3.0 among obesity class 3 women (95% CI, 2.1-4.2). The linear trend of BMI was statistically significant for both sexes.

The PRs for high cholesterol level exhibited a different pattern than that observed for the other overweight- and obesity-related comorbidities. Among younger men and for women, PRs for most classes of overweight and obesity were elevated compared with the reference group (BMI, 18.5-24.9 kg/m^2), but there was no evidence of a gradient of PRs with increasing weight status category. Among older subjects, PRs were significantly increased only for overweight individuals.

A steeply graded association between weight class and high blood pressure was observed in men and women younger than 55 years, with elevations observed even among those in the overweight class, for which PRs were almost doubled compared with normal weight individuals. Among older men and women, statistically significant elevations in this highly prevalent condition were observed, beginning with the overweight category and increasing across weight categories.

The FIGURE shows the number of comorbidities by overweight class for each race and ethnicity–sex group (not age adjusted). From left (normal weight) to right (greater degree of overweight and obesity) the percentage of persons with at least 2 comorbidities in-

Table 3. Prevalence of Comorbidity by Obesity Class and Sex

	Weight Status Category*					
Health Condition	Underweight	Normal	Overweight	Obesity Class 1	Obesity Class 2	Obesity Class 3
Men (n = 6987)						
Type 2 diabetes mellitus	4.69	2.03	4.93	10.10	12.30	10.65
Gallbladder disease	6.96	1.93	3.39	5.38	5.80	10.17
Coronary heart disease	12.45	8.84	9.60	16.01	10.21	13.97
High blood cholesterol level	6.66	26.63	35.68	39.17	34.01	35.63
High blood pressure	23.38	23.47	34.16	48.95	65.48	64.53
Osteoarthritis	0.39	2.59	4.55	4.66	5.46	10.04
Women (n = 7689)						
Type 2 diabetes mellitus	4.76	2.38	7.12	7.24	13.16	19.89
Gallbladder disease	6.42	6.29	11.84	15.99	19.15	23.45
Coronary heart disease	12.07	6.87	11.13	12.56	12.31	19.22
High blood cholesterol level	13.36	26.89	45.59	40.37	40.96	36.39
High blood pressure	19.81	23.26	38.77	47.95	54.51	63.16
Osteoarthritis	7.79	5.22	8.51	9.94	10.39	17.19

*Estimates are weighted to account for the sample design. All data are percentages. Weight categories are based on the National Heart, Lung, and Blood Institute classification[11] and are delineated in Table 1. BMI indicates body mass index.

creases. A comparison of race and ethnicity–sex subgroups suggests that these associations were consistently and directly related across racial and ethnic groups. An appreciable increase in prevalence was evident even for the overweight class in every racial and ethnic–sex group.

COMMENT

In this study, we estimated the cross-sectional relationship between overweight and obesity class levels and morbidity in a contemporary, nationally representative sample of adults. We observed a substantial prevalence of chronic health conditions in association with elevated BMI for both age groups and across racial and ethnic groups. Associations of weight status and health outcomes did not differ between the 3 major racial and ethnic groups. The PRs generally increased with increasing severity and, for many comorbidities, the PRs were significantly elevated even for the overweight class (BMI, 25.0-29.9 kg/m^2). Because the sample is cross-sectional, the data reflect the burden of disease associated with overweight and obesity in the US population aged 25 years and older from 1988 to 1994.

We observed particularly strong cross-sectional associations for overweight and obesity with type 2 DM and hypertension, consistent with the findings of several large cohort studies based on nonrepresentative populations.[26,27] Furthermore, we found a significant increase in PRs of both of these conditions even among persons in the overweight class. This finding is striking given that individuals with the mildest degree of overweight comprise more than 42% of men and 28% of women in the United States. For the majority of health conditions studied, based on overweight status and age, PRs are increased. Our analyses incorporate the newly adopted definitions of overweight and obesity.[1,11] The previous BMI cutoff points of 27.8 (men) and 27.3 (women) kg/m^2 were based on a purely statistical definition (85th percentile from NHANES II). The new cutoff point of 25 kg/m^2 is based on research evidence that links an elevated BMI with adverse health consequences,[13] including type 2 DM, hypertension, cardiovascular disease,[28-30] and death.[31] The prevalence es-

Table 4. Estimated Prevalence Ratios for Selected Overweight- and Obesity-Related Morbidity in Relation to Weight Status Category, by Age*

	Adjusted Prevalence Among Normal-Weight Individuals†	Overweight	Obesity Class 1	Obesity Class 2	Obesity Class 3
		Men			
Type 2 diabetes mellitus					
<55 y	0.2	3.27 (1.17-9.05)	10.14 (4.03-25.08)	7.95 (2.44-25.23)	18.08‡ (6.71-46.84)
≥55 y	5.3	1.77 (1.26-2.47)	2.56 (1.71-3.74)	4.23 (2.09-7.59)	3.44‡ (1.11-8.32)
Gallbladder disease					
<55 y	0.4	1.43 (0.50-4.02)	4.08 (1.33-12.21)	6.84 (0.98-41.83)	21.11‡ (4.12-84.15)
≥55 y	8.6	1.45 (0.95-2.16)	1.82 (1.15-2.79)	1.70 (0.70-3.67)	2.55‡ (0.56-7.11)
Coronary heart disease§	1.3	0.97 (0.76-1.24)	1.59 (1.17-2.11)	1.14 (0.73-1.75)	2.22‡ (0.92-4.22)
High blood cholesterol level					
<55 y	22.3	1.28 (1.02-1.57)	1.34 (0.98-1.76)	1.37 (0.94-1.90)	1.45‡ (0.93-2.09)
≥55 y	36.6	1.18 (1.01-1.35)	1.17 (0.92-1.44)	0.85 (0.53-1.25)	0.88 (0.38-1.59)
High blood pressure					
<55 y	12.1	1.62 (1.25-2.05)	2.52 (2.02-3.08)	4.50 (3.34-5.60)	4.60‡ (3.00-6.07)
≥55 y	54.4	1.11 (0.96-1.25)	1.35 (1.15-1.51)	1.47 (1.18-1.66)	1.66‡ (1.21-1.80)
		Women‖			
Type 2 diabetes mellitus					
<55 y	0.4	3.82 (1.75-8.21)	2.49 (1.01-6.12)	10.67 (4.02-27.11)	12.87‡ (5.69-28.05)
≥55 y	7.9	1.81 (1.41-2.31)	2.19 (1.56-3.01)	3.24 (2.13-4.67)	5.76‡ (4.17-7.42)
Gallbladder disease					
<55 y	2.0	1.94 (1.25-3.00)	2.56 (1.62-4.02)	4.33 (2.20-8.12)	5.20‡ (2.92-8.92)
≥55 y	14.0	1.34 (1.04-1.70)	2.02 (1.58-2.53)	2.29 (1.69-3.00)	3.04‡ (2.10-4.07)
Coronary heart disease§	5.6	1.30 (0.97-1.71)	1.58 (1.19-2.10)	1.74 (1.24-2.42)	2.98‡ (2.07-4.20)
High blood cholesterol level					
<55 y	16.4	1.90 (1.58-2.25)	1.67 (1.34-2.04)	1.71 (1.29-2.20)	1.68‡ (1.11-2.40)
≥55 y	43.2	1.23 (1.11-1.35)	1.10 (0.95-1.25)	1.19 (0.95-1.43)	0.91 (0.57-1.31)
High blood pressure					
<55 y	8.5	1.65 (1.23-2.18)	3.22 (2.56-3.98)	3.90 (2.94-4.99)	5.45‡ (4.16-6.78)
≥55 y	61.7	1.16 (1.06-1.25)	1.24 (1.15-1.32)	1.42 (1.34-1.48)	1.41‡ (1.26-1.50)

*Referent category is individuals with a body mass index (BMI) of 18.5-24.9 kg/m^2; models are adjusted for race and ethnicity, age, and smoking status. 95% Confidence interval in parenthesis. Weight categories are based on the National Heart, Lung, and Blood Institute classification[11] and are delineated in Table 1.
†Prevalence among white, current smokers (<55 y and for CHD) and former smokers (≥55 y), adjusted for age (see "Methods" section of the text).
‡*P* value for trend in logistic model, with BMI as a continuous variable, <.05.
§No significant interactions were observed; age-adjusted models are presented.
‖Prevalence among white, never smokers, adjusted for age (see "Methods" section).

timates based on these definitions differ slightly from those published by Flegal and colleagues.[4] Their report was based on adults 20 years or older, whereas our report includes adults aged 25 years or older.

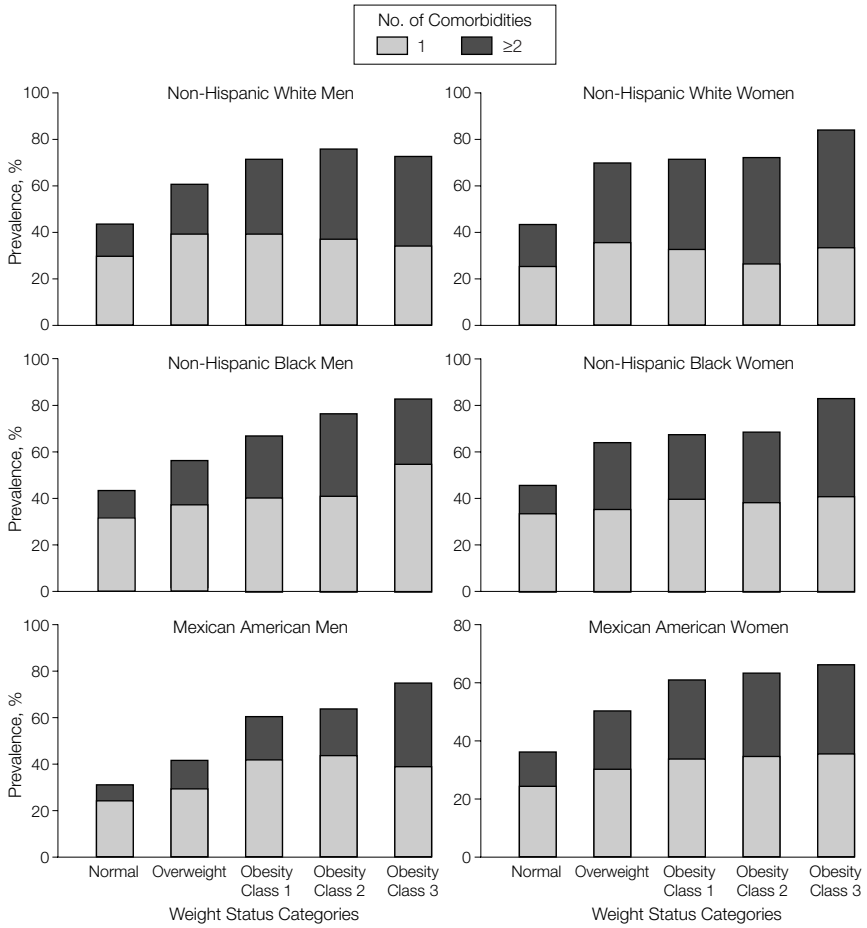
Although the relationship of BMI with body fatness may differ by race and ethnicity,[32-34] whether the relationship between weight status (based on BMI) and adverse health outcomes differs by race and ethnicity is less clear. The pattern of the PRs in relation to weight class was consistent across all 3 racial and ethnic groups for all of the health outcomes we examined, despite differences in the distribution of BMI by race and ethnicity.

The influence of age on the relationship of BMI to morbidity and mortality has been the subject of some debate, especially for prospective studies of mortality.[35-37] For both hypertension[28] and CHD,[38] the relative risk associated with overweight declines with age. We observed that the cross-sectional relationship of obesity class to the comorbidities studied was generally strongest among the younger age groups. Nonetheless, the PRs were significantly elevated in the older age group except for gallbladder disease in men and high cholesterol level in both sexes.

Our analysis of multiple comorbidities did not include CHD, because of the potential for "double-counting" of CHD with known cardiovascular risk factors such as hypertension, type 2 DM, and high blood cholesterol level. Our consideration of only the most common obesity-related comorbidities and avoidance of double counting suggests that we have likely underestimated the disease burden associated with overweight in the population. The burden to the individual is increased for those with more severe obesity because they are more likely to develop a second or even a third morbidity.

Our approach has several limitations. Foremost, a cross-sectional approach to evaluate the relationship of obesity to the morbidities that we examined does not provide evidence for causality. In some individuals, weight loss may accompany some of these conditions, particularly CHD. Because persons in the higher obesity classes were at increased risk of death, we may have underestimated the impact of weight on adverse health, particularly among older individuals. Reliance on self-report of physician-diagnosed disease underestimates disease burden. For example, a definition based on self-report of diagnosed disease underestimates DM prevalence by more than 50%.[15] The known association between overweight and chronic health conditions increases the likelihood of diagnosis in heavier people and represents an additional source of bias. In addition, using BMI as a weight measure provides an indirect measure of fatness and does not reflect fat distribution, which may affect the risk of comorbidity independent of BMI. Moreover, BMI does not distinguish between fat mass and lean tissue mass and may underestimate fatness in older adults who have greater amount of body fat at a given BMI than younger ones, due to age-related declines in muscle mass.[39] Furthermore, we did not adjust our cross-sectional statistical models for variables often included in models that estimate

Figure. Prevalence of 1 and 2 or More Overweight- and Obesity-Related Morbidities by Weight Status Category for Sex and Race and Ethnic Subgroups



Comorbidities considered included type 2 diabetes, gallbladder disease, high blood cholesterol level, high blood pressure, and osteoarthritis. Normal weight indicates body mass index of 18.5 to 24.9 kg/m^2; overweight, 25.0 to 29.9 kg/m^2; obesity class 1, 30.0 to 34.9 kg/m^2; obesity class 2, 35.0 to 39.9 kg/m^2; and obesity class 3, greater than 40.0 kg/m^2. Data are based on the Third National Health and Nutrition Examination Survey.

incidence (rather than prevalence) of obesity-related comorbidities such as fat distribution, diet, or exercise, because the temporal sequence in cross-sectional data is not established. Our results might have changed if these variables had been included. However, the consistency of our cross-sectional findings with incident chronic disease in several large prospective studies[26-29] suggests that the cross-sectional associations we observed are likely to reflect true associations. The aforementioned misclassification and biases would likely have a minor impact on the magnitude of these estimates.

In conclusion, these national data suggest that clinicians are likely to encounter morbidity more frequently among their patients with elevated BMI, even those patients in the overweight category. A general pattern of increasing prevalence with increasing severity of overweight and obesity is consistent across racial and ethnic groups for all of the health conditions considered, with the exception of high blood cholesterol level. Without concerted initiatives to prevent and treat overweight in adults, the health care system will increasingly be overwhelmed with individuals who require treatment for obesity-related health conditions.

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