American Journal of Epidemiology
Copyright © 2003 by the Johns Hopkins Bloomberg School of Public Health
All rights reserved

Vol. 158, No. 12
Printed in U.S.A.
DOI: 10.1093/aje/kwg275

Is Obesity Associated with Major Depression? Results from the Third National Health and Nutrition Examination Survey

Chiadi U. Onyike[1,2], Rosa M. Crum[1,2,3], Hochang B. Lee[1,2], Constantine G. Lyketsos[1,2,3], and William W. Eaton[2]

[1] Department of Psychiatry and Behavioral Sciences, School of Medicine, Johns Hopkins University, Baltimore, MD.
[2] Department of Mental Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD.
[3] Department of Epidemiology, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD.

Received for publication September 11, 2002; accepted for publication June 18, 2003.

Data from the Third National Health and Nutrition Examination Survey (1988–1994) were used to examine the relation between obesity and depression. Past-month depression was defined using criteria from the *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition, and was measured with the Diagnostic Interview Schedule. Obesity was defined as a body mass index (weight (kg)/height $(m)^2$) of 30 or higher. The authors compared risks of depression in obese and normal-weight (body mass index 18.5–24.9) persons. Obesity was associated with past-month depression in women (odds ratio (OR) = 1.82, 95% confidence interval (CI): 1.01, 3.3) but was not significantly associated in men (OR = 1.73, 95% CI: 0.56, 5.37). When obesity was stratified by severity, heterogeneity in the association with depression was observed. Class 3 (severe) obesity (body mass index ≥40) was associated with past-month depression in unadjusted analyses (OR = 4.98, 95% CI: 2.07, 11.99); the association remained strong after results were controlled for age, education, marital status, physician's health rating, dieting for medical reasons, use of psychiatric medicines, cigarette smoking, and use of alcohol, marijuana, and cocaine. These findings suggest that obesity is associated with depression mainly among persons with severe obesity. Prospective studies will be necessary to clarify the obesity-depression relation but await the identification of potential risk factors for depression in the obese.

body mass index; body weight; depression; obesity

Abbreviations: BMI, body mass index; CI, confidence interval; DIS, Diagnostic Interview Schedule; DSM, *Diagnostic and Statistical Manual of Mental Disorders*; NHANES III, Third National Health and Nutritional Examination Survey; OR, odds ratio.

Obesity, an increasingly prevalent public health problem, is strongly predictive of diabetes mellitus, cardiovascular disease, chronic back pain, degenerative joint disease, and other chronic medical conditions (1–4). Whether obesity also predicts psychiatric disorders such as depression has not been established. Since depression is also associated with chronic medical conditions (5, 6), poor treatment compliance, higher utilization of health services, and worse health outcomes (5, 6), the relation between obesity and depression is important to clinicians, researchers, and policy-makers. Thus far, population-based studies of the association between obesity and depression have yielded inconsistent results (7, 8). Some studies found an association (9–14), but others did not (15–17). Some found an association between obesity and *higher* rates of depression in women but not in men (11, 12); others reported *inverse* associations between obesity and depression in both women (18, 19) and men (13, 16, 18, 19).

Methodological differences across studies have contributed to these inconsistent observations. Friedman and Brownell noted in their 1995 review (8) that most population-based studies had not defined depression according to established psychiatric diagnostic criteria. The definition of obesity also varied. Some investigators used body mass index (BMI), defined as weight in kilograms divided by the square of height in meters, as a continuous variable in their analyses; others used cutpoints to define BMI categories. More recent studies have used cutpoints recommended by

Correspondence to Dr. Chiadi U. Onyike, Osler 320, The Johns Hopkins Hospital, 600 North Wolfe Street, Baltimore, MD 21287 (e-mail: conyike1@jhem.jhmi.edu)

the US Public Health Service (the Public Health Service defines obesity as a BMI at or above the 85th percentile) (20) or the National Heart, Lung, and Blood Institute (the Institute defines obesity as a BMI of 30 or higher) (1). The use of cutpoints defined by percentiles is problematic. BMI distributions vary across subpopulations defined by age, gender, race, geography, and time (1). Thus, cutpoints based on percentiles may yield obesity categories that are not comparable across studies.

Since the publication of Friedman and Brownell's review, three population-based studies (9, 10, 13) have defined depression using criteria from the *Diagnostic and Statistical Manual of Mental Disorders* (DSM), Fourth Edition (DSM-IV) (21). Carpenter et al. (13) used data from the 1992 National Longitudinal Alcohol Epidemiologic Survey (22). Among adults aged 18 years or more, high BMI was inversely associated with past-year depression and suicide ideation in men; positive associations were observed in women. Low BMI was associated with past-year depression, suicide attempts, and suicide ideation in men but not in women. When BMI categories were used in the analyses, obesity (BMI ≥30) was associated with past-year depression in women and was inversely associated with it in men.

Roberts et al. (9), in older adults from the Alameda County Study, found that obesity in 1994 (as defined by the US Public Health Service criteria) was associated with past-year depression in 1995, after controlling for age, sex, education, marital status, social support, social isolation, life events, financial strain, chronic medical conditions, and functional disability. Health and functional disability were the most important indicators of risk for depression in that report. Roberts et al. examined whether the definition of obesity affected their results. There was an association between obesity and past-year depression in unadjusted analyses but not in multivariable analyses when obesity was defined using the National Heart, Lung, and Blood Institute criteria (9). These findings were replicated in a 5-year study of the same cohort (10).

Results from these studies are somewhat disparate with respect to the risk for depression when obesity is defined using National Heart, Lung, and Blood Institute criteria. This may be due to heterogeneity of the obesity-depression relation across obese persons, as has been suggested in recent reviews (7, 8). One approach to resolving this heterogeneity is to stratify obesity by severity (class 1, BMI 30–34.9; class 2, BMI 35–39.9; class 3, BMI ≥40); this approach has not previously been used. In addition, the first two studies (9, 13) reported associations for *past-year* depression, the third (10) for depression within the past 2 weeks; it is possible that the association between obesity and depression depends on the time frame used to measure depression.

The inconsistency of findings from previous research indicates that obesity and depression do not always co-occur. Therefore, it is necessary to ask: *When* does an association between these conditions occur? Understanding when obesity and depression co-occur in the population is important. First, obesity and depression are common and have important deleterious effects on a wide range of health outcomes (1–6). Second, a subgroup of people may exist in whom both conditions co-occur with a higher frequency than in the general population. Indeed, clinical studies have reported higher rates of depression and psychopathology among persons with severe obesity (23, 24); however, clinical samples represent a select population. It remains unclear whether severely obese persons represent a subgroup of the obese population that is at particular risk for depression.

Identifying which obese persons will also have depression is a useful approach to resolving the heterogeneity of findings from previous research. Finding this subpopulation will also help investigators focus future research on more informative samples. By specifying an "at-risk" population, researchers can use increasingly precise case definitions to investigate underlying mechanisms and to develop and evaluate more effective preventive and therapeutic interventions for both conditions.

In this study, we investigated whether there is any association between obesity and depression; whether the association between obesity and depression depends on the severity of obesity; and whether the definition of obesity and/or depression influences the occurrence of the association. Data from the Third National Health and Nutritional Examination Survey (NHANES III) (25) presented us with the opportunity to address these questions in a population sample, since a structured diagnostic interview was used to ascertain the presence of DSM major depression in the respondents. We assessed several hypotheses. First, we predicted that there would be no association between obesity (BMI ≥30) and depression in the NHANES III sample. Our rationale was that obesity is a heterogeneous condition (26), and inconsistent results from previous studies strongly suggested heterogeneity of relations (with depression) within the obesity category (7, 8). In addition, our population sample was young and healthy; chronic medical conditions and functional disability explain much of the association in older adults (9, 10). On the other hand, we hypothesized that severe obesity (BMI ≥40) would be associated with depression. Severe obesity has been associated with depression in clinical samples (23, 24, 27), and a population-based study of persons aged 20–59 years found a higher prevalence of unhappiness (in men) and sadness (in women) in the highest tertile of relative body weight (28).

We expected the occurrence of an association between obesity and depression to depend on the time frame used to measure depression. The time frame used to measure depression influences the assignment of depression status. For example, many persons with *past-year* depression are excluded from the diagnosis when the *past-month* time frame is used to measure depression; this can lead to error when evaluating associations between obesity and depression. In addition, individuals' recollection of past symptoms can change considerably over time (29); there may be differences in reliability when different time frames are used to diagnose depression.

MATERIALS AND METHODS

Study population

This was an analysis of cross-sectional data collected during NHANES III, a survey of the US population

involving interviews, physical and psychological examinations, and collection of laboratory data. The survey was carried out between 1988 and 1994 by the National Center for Health Statistics. Data were weighted to produce national estimates, with adjustments for oversampling (of young children, the elderly, and ethnic minorities) and nonresponse. The multistage sampling procedure has been described elsewhere (25, 30). This study received approval from the Committee for Human Research of the Johns Hopkins Bloomberg School of Public Health.

A total of 39,695 respondents aged 2 months to ≥90 years were included in NHANES III. The response rates of 82 percent for the household interviews and 73 percent for the examinations (unpublished data from the National Center for Health Statistics) are typical of large surveys. In this study, we focused on the 8,773 persons aged 15–39 years who had been randomly selected for the structured psychiatric interview. A total of 363 respondents (4.1 percent) were excluded from the study analyses: 28 of these (0.3 percent) were missing data on height or weight (precluding calculation of relative body weight), and 338 (3.8 percent) were missing data from the psychiatric interview (precluding ascertainment of depression status). The final sample size for this study was 8,410. Compared with study subjects, persons excluded from the study were more frequently underweight (BMI <18.5) and less frequently obese (χ^2 test: $p > 0.05$; data not shown). Those excluded more frequently had an education of eighth grade or less and had less frequently been educated beyond high school (χ^2 $p < 0.01$). Approximately 71 percent of participants were White, as compared with 44 percent of excluded persons (χ^2 $p < 0.01$); the participation of African-American and Hispanic respondents was comparable. There were no differences by gender, age, or marital status.

Measurements

Diagnostic Interview Schedule. The Diagnostic Interview Schedule (DIS) (31, 32) is a structured interview designed for use by trained lay interviewers. In the NHANES III, only the section required for diagnosis of depressive and bipolar disorders was administered. The DIS allowed diagnoses to be made according to operational criteria in the *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition (DSM-III) (33). The DIS has been well characterized (34) and widely used in epidemiologic field studies (35). The DIS/DSM-III diagnosis of major depression in NHANES III is equivalent to a diagnosis based on the DSM-IV.

Major depression. The diagnosis of DIS/DSM-III major depression requires the persistence of depressed mood or anhedonia for at least 2 weeks. An additional four out of eight other possible depressive symptom groups are required to have been clustered with depressed mood or anhedonia during those 2 weeks. The diagnosis is not made if the respondent attributes the symptoms to another illness, medicines, or bereavement or if there is no social or occupational impairment. In this study, the primary measure of depression was past-month DSM-III major depression. Respondents were also assigned a diagnosis of past-year and/or lifetime (ever having met the criteria) major depression. Respondents were assigned a diagnosis of recurrent major depression if they had ever had more than one episode of depression. All depression measures were binary (0 = no depression, 1 = depression).

Relative body weight. Body mass index was calculated from height and weight, which were measured by trained technicians. Participants were grouped into four or six BMI categories based on criteria from the National Heart, Lung, and Blood Institute (1). For the four-category definition, these groups were "normal weight" (BMI 18.5–24.9; the reference category), "underweight" (BMI <18.5), "overweight" (BMI 25.0–29.9), and "obese" (BMI ≥30). For the six-category definition, the obese category was subdivided into "obesity class 1" (BMI 30.0–34.9), "obesity class 2" (BMI 35.0–39.9), and "obesity class 3" (BMI ≥40). We also used BMI as a continuous variable to investigate associations over the entire range of relative body weight.

Covariates. Selection of covariates was based on the published literature (36–44), and bivariable logistic regression analyses were performed to identify potentially confounding factors. The potential confounders considered were: age (15–19 (referent), 20–24, 25–29, 30–34, or 35–39 years); race/ethnicity (non-Hispanic White (referent), non-Hispanic Black, Hispanic, or other); education (≤8 (referent), 9–11, 12, or >12 years); marital status (married (referent), divorced/widowed/separated, or never married); physician's rating of health (excellent, good, or fair/poor); dieting for medical reasons (0 = no, 1 = yes); use of psychiatric medicines in the past month (0 = no, 1 = yes); cigarette smoking (never, former, or current); use of alcohol (no use, former use, moderate use, or abuse); and ever use of marijuana (0 = no, 1 = yes) or cocaine (0 = no, 1 = yes).

Statistical analysis

Stata software (45) was used for all statistical analyses. Stata uses weights and sampling data to provide corrected standard error estimates and statistical tests. There was sufficient statistical power to test the study hypotheses (table 1). Most analyses were stratified by gender. The primary analytical method was estimation of the relative odds for depression in each obesity class. The multivariable logistic regression model included the potential confounders. Logistic regression analyses were performed for each definition of DSM-III major depression (past-month, past-year, lifetime, and recurrent) and for each measure of relative body weight (continuous BMI, four BMI categories, and six BMI categories).

RESULTS

The demographic characteristics of the respondents are shown in table 2. Men and women did not differ significantly in terms of age, race/ethnicity, education status, or area of residence (urban vs. rural). Equal proportions of men and women were currently married. Greater than twofold more women than men were separated, widowed, or divorced (χ^2 $p < 0.0001$); more men than women had never been married ($\chi^2 p < 0.0001$). The sample was 53.9 percent normal weight, 3.7 percent underweight, 26.1 percent overweight, and 16.3

TABLE 1. Sample sizes and power calculations for the study hypotheses ($\alpha = 0.05$) in a study of the relation between obesity and depression, Third National Health and Nutrition Examination Survey, 1988–1994

Hypothesis and sample	n_1*	n_2†	p_1‡	p_2§	n_2/n_1	β
Hypothesis A: Obesity (body mass index¶ ≥30) is associated with depression.						
All respondents	4,154	1,658	0.028	0.051	0.40	0.982
Females	2,180	1,084	0.038	0.067	0.50	0.933
Males	1,974	574	0.017	0.029	0.29	0.389
Hypothesis B: Class 3 (severe) obesity (body mass index ≥40) is associated with depression.						
All respondents	4,154	267	0.028	0.125	0.06	0.999
Females	2,180	202	0.038	0.130	0.09	0.993
Males	1,974	65	0.017	0.115	0.03	0.922

* No. of normal-weight respondents in the sample (reference group).
† No. of obese (or obesity class 3) respondents.
‡ Proportion of normal-weight respondents with depression.
§ Proportion of obese (or obesity class 3) respondents with depression.
¶ Weight (kg)/height $(m)^2$.

TABLE 2. Baseline characteristics of the study population in a study of the relation between obesity and depression, Third National Health and Nutrition Examination Survey, 1988–1994

Characteristic	Females (n = 4,745)		Males (n = 4,028)	
	%	SE†	%	SE
Gender	50.7	0.6	49.3	0.6
Age (years)				
15–19	17.2	1.2	17.8	0.9
20–24	20.3	1.2	19.2	1
25–29	19.6	1.1	21.0	1
30–34	21.5	1.4	22.3	1.2
35–39	21.4	1.1	19.7	1.1
Race/ethnicity				
White	70	1.6	71.2	1.7
Black	14	1	12.1	0.7
Hispanic	12	1.2	12.4	1.1
Other	4.1	0.6	4.3	0.6
Education (years)				
0–8	6.8	0.8	7.4	0.6
9–11	19.7	1.1	22.3	1.2
12	33.6	1.1	31.4	1.2
≥12	39.9	1.7	38.8	1.6
Marital status*				
Married	52.2	1.4	51.0	1.6
Separated/divorced/widowed	11.5	0.7	4.8	0.5
Never married	36.3	1.5	44.2	1.7
Area of residence				
Urban	49.6	5.0	50.4	4.9
Rural	50.4	5.0	49.6	4.9

* $p < 0.0001$ (χ^2 test) for the difference between females and males.
† SE, standard error.

percent obese (data not shown). A higher proportion of women than of men were in obesity classes 2 and 3, and more men than women were overweight ($\chi^2 p < 0.0001$).

The prevalence of past-month DSM-III major depression, by relative body weight, is shown in table 3. As expected, women had an approximately 2.5-fold higher prevalence of past-month depression than men; this is consistent with results from other population-based prevalence studies that used the DIS and DSM-III criteria to identify cases, as well as with results from studies that used other measurement methods (46). The prevalence of past-month depression was higher in obese subjects than in normal-weight subjects. There was heterogeneity in the prevalence rates across the subclasses of obesity, with the highest rates of depression occurring in obesity class 3. Prevalence rates for depression in the underweight and overweight were not different from those in the normal-weight. Results were similar for past-year, lifetime, and recurrent depression (data not shown). Among women, the prevalence of depression was higher with increasing levels of obesity. Among men, prevalence rates were lowest in obesity class 2 and highest in obesity class 3.

Unadjusted odds ratios for the association between relative body weight and measures of depression are shown in table 4. Analyses were stratified by gender. Obesity (BMI ≥30) was associated with past-month depression in women (odds ratio (OR) = 1.82, 95 percent confidence interval (CI): 1.01, 3.3) but not in men (OR = 1.73, 95 percent CI: 0.56, 5.37). There was an association between obesity class 3 (BMI ≥40) and past-month depression in both women (OR = 3.78, 95 percent CI: 1.64, 8.68) and men (OR = 7.68, 95 percent CI: 1.03, 57.26). There was also an association between obesity class 3 and lifetime depression in women (OR = 2.15, 95 percent CI: 1.17, 3.92). The odds ratios for risk of past-year (and recurrent) depression in obesity class 3 were not statistically significant. In women, we observed a trend of higher

TABLE 3. Prevalence of DIS†/DSM-III† major depression in the past month, by relative body weight, in a study of the relation between obesity and depression, Third National Health and Nutrition Examination Survey, 1988–1994

Relative body weight‡	No. of participants	% with DIS/DSM-III depression§		
		All respondents	Females	Males
Normal weight (BMI† 18.5–24.9)¶	4,154	2.79	3.82	1.67
Underweight (BMI <18.5)	301	3.24	3.82	1.82
Overweight (BMI 25.0–29.9)	2,297	2.42	4.01	1.37
Obese (BMI ≥30)*	1,658	5.12	6.74	2.85
Obesity class 1 (BMI 30–34.9)	910	3.55	4.97	1.88
Obesity class 2 (BMI 35–39.9)	410	4.8	6.79	0.83
Obesity class 3 (BMI ≥40)**	267	12.51	13.03	11.54

* $p < 0.00001$ (χ^2 test) for the risk of past-month major depression in the obese (body mass index ≥30) relative to those of normal weight when the four-category definition of relative body weight was used.

** $p < 0.00001$ (χ^2 test) for the risk of past-month major depression in persons with class 3 obesity (body mass index ≥40) relative to those of normal weight when the six-category definition of relative body weight was used.

† DIS, Diagnostic Interview Schedule; DSM-III, *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition; BMI, body mass index.

‡ Based on body mass index (weight (kg)/height $(m)^2$) and National Heart, Lung, and Blood Institute cutpoints.

§ Depression was assessed by means of the Diagnostic Interview Schedule, using the criteria for major depression outlined in the *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition (33).

¶ Reference category.

odds ratios with increasing levels of obesity for past-month, past-year, and lifetime depression.

Adjusted odds ratios for the association between relative body weight and past-month depression are shown in table 5. Data presented are for the total population and include estimates of association with depression for all covariates in the model. Obesity class 3 was associated with depression (OR = 4.63, 95 percent CI: 2.06, 10.42). Similar results were observed for women (data not shown); there were too few obesity class 3 men with depression for meaningful multivariable analyses. Female gender, current smoking, and use of psychiatric medicines were also associated with depression in these analyses. In post-hoc analyses, there was no evidence of interaction between gender or age and obesity (or any obesity class) in the association with depression.

DISCUSSION

In this study, we investigated severity of obesity (as defined by National Heart, Lung, and Blood Institute criteria) as a potential discriminator between obese persons with depression and those without depression. We also examined how definitions of obesity and depression may affect the occurrence of an association between these conditions in epidemiologic studies. Early population-based studies showed an inconsistent relation between obesity and major depression, with the preponderance of the evidence suggesting that no association existed between obesity and depression (see Friedman and Brownell's review (8)). These studies typically treated obesity as a unitary construct, an approach that potentially obscures any heterogeneity of relations with depression (7, 8). More recent studies have shown an association between obesity and depression (9, 10, 13). Data from clinic samples also support the presence of an association (8, 23, 24, 27). In the most recent reviews, Faith et al. (7) and Friedman and Brownell (8) concluded that there are probably multiple relations between obesity and depression. They have proposed a "second generation" of research that would focus on identifying potential risk factors for depression *within* the obese population (in preparation for future prospective multivariable studies). We implemented that approach in this study by investigating severe obesity as a potential risk factor for depression.

We found that the association between obesity and depression depends on the severity of the obesity. Obese persons had an approximately 1.5-fold higher prevalence of past-month depression than their normal-weight counterparts. Among women, obesity was associated with 82 percent higher odds of past-month depression; the estimate of 73 percent higher odds in men was not statistically significant. These data were inconsistent with our first hypothesis, which predicted null results. However, among the obese, there was heterogeneity in rates of the prevalence of past-month depression. The prevalence of depression was highest in persons with severe obesity (BMI ≥40). Consistent with our second hypothesis, there was a strong association between severe obesity and depression in logistic regression analyses; when we adjusted for potential confounders to assess whether obesity was independently associated with depression, the association remained strong.

The association between obesity and depression is sensitive to the definition of obesity. This is hardly surprising,

TABLE 4. Unadjusted odds ratios (from logistic regression) for the association between relative body weight and different definitions of DIS*/DSM-III* major depression, by gender, Third National Health and Nutrition Examination Survey, 1988–1994†

Population and BMI*,‡ category	No. of participants	Past-month major depression		Past-year major depression		Lifetime major depression		Recurrent major depression	
		OR*	95% CI*	OR	95% CI	OR	95% CI	OR	95% CI
All respondents									
BMI (continuous variable)	8,410	1.05	1.01, 1.09	1.03	0.99, 1.06	1.02	0.99, 1.05	1.01	0.97, 1.05
Normal weight (BMI 18.5–24.9)	4,154	1.00§		1.00§		1.00§		1.00§	
Underweight (BMI <18.5)	301	1.17	0.49, 2.80	1.39	0.66, 2.95	1.35	0.73, 2.48	1.21	0.54, 2.70
Overweight (BMI 25.0–29.9)	2,297	0.86	0.53, 1.41	0.84	0.53, 1.34	0.93	0.65, 1.35	0.84	0.54, 1.29
Obese (BMI ≥30)	1,658	1.88	1.02, 3.46	1.41	0.85, 2.36	1.22	0.81, 1.82	1.13	0.72, 1.78
Obesity class 1 (BMI 30–34.9)	981	1.28	0.64, 2.56	1.01	0.54, 1.86	0.87	0.54, 1.4	0.78	0.46, 1.31
Obesity class 2 (BMI 35–39.9)	410	1.76	0.78, 3.95	1.67	0.91, 3.09	1.39	0.77, 2.49	1.41	0.71, 2.81
Obesity class 3 (BMI ≥40)	267	4.98	2.07, 11.99	2.92	1.28, 6.67	2.60	1.38, 4.91	2.28	0.93, 5.60
Females									
BMI (continuous variable)	4,561	1.05	1.01, 1.09	1.02	0.99, 1.06	1.02	1.03, 1.06	1.00	0.97, 1.03
Normal weight (BMI 18.5–24.9)	2,180	1.00§		1.00§		1.00§		1.00§	
Underweight (BMI <18.5)	202	1.0	0.38, 2.64	1.36	0.60, 3.05	1.2	0.59, 2.46	1.03	0.41, 2.60
Overweight (BMI 25.0–29.9)	1,095	1.05	0.64, 1.74	0.81	0.54, 1.22	0.94	0.65, 1.35	0.71	0.45, 1.13
Obese (BMI ≥30)	1,084	1.82	1.01, 3.3	1.29	0.8, 2.09	1.12	0.77, 1.62	0.97	0.63, 1.51
Obesity class 1 (BMI 30–34.9)	597	1.28	0.60, 2.87	0.9	0.44, 1.81	0.74	0.42, 1.29	0.68	0.36, 1.27
Obesity class 2 (BMI 35–39.9)	285	1.75	0.71, 4.73	1.66	0.78, 3.5	1.41	0.73, 2.74	1.40	0.66, 2.98
Obesity class 3 (BMI ≥40)	202	3.78	1.64, 8.68	2.19	0.97, 4.94	2.15	1.17, 3.92	1.36	0.59, 3.15
Males									
BMI (continuous variable)	3,849	1.06	0.98, 1.15	1.04	0.98, 1.1	1.02	0.97, 1.07	1.03	0.96, 1.10
Normal weight (BMI 18.5–24.9)	1,974	1.00§		1.00§		1.00§		1.00§	
Underweight (BMI <18.5)	99	1.09	0.21, 5.61	0.57	0.11, 2.98	1.06	0.27, 4.15	1.12	0.17, 7.36
Overweight (BMI 25.0–29.9)	1,202	0.82	0.34, 1.96	1.08	0.56, 2.1	1.16	0.64, 2.09	1.25	0.63, 2.48
Obese (BMI ≥30)	574	1.73	0.56, 5.37	1.54	0.70, 3.38	1.28	0.66, 2.5	1.4	0.57, 3.45
Obesity class 1 (BMI 30–34.9)	384	1.13	0.40, 3.17	1.22	0.58, 2.57	1.14	0.61, 2.16	1.0	0.40, 2.47
Obesity class 2 (BMI 35–39.9)	125	0.49	0.06, 3.89	0.99	0.22, 4.45	0.66	0.14, 2.95	0.71	0.09, 5.8
Obesity class 3 (BMI ≥40)	65	7.68	1.03, 57.26	4.53	0.83, 24.68	3.26	0.66, 16.12	5.15	0.96, 27.62

* DIS, Diagnostic Interview Schedule; DSM-III, *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition; BMI, body mass index; OR, odds ratio; CI, confidence interval.

† For past-year, past-month, and recurrent major depression, noncases included persons with lifetime major depression.

‡ Weight (kg)/height (m)^2.

§ Reference category.

since specific conditions exist for the association (severe obesity, in this study). The time frame used to define cases of DIS/DSM-III major depression had only a small effect on the presence of association, especially when obesity was stratified by severity. When depression is defined using DSM criteria, the presence of an association may not be sensitive to the time frame used to measure depression. This may be partly explained by depression's being a chronic condition, and it is of value to researchers in this field in that it suggests that DSM depression *within the past year* is a reliable measure. Thus, the definition of obesity is the more important determinant of the occurrence of an association with depression. We did not observe any associations when BMI was used as a continuous measure. BMI is an unsatisfactory measure when used as a continuous variable—which requires the assumption that the relation between obesity and depression is linear across the entire range of relative body weights. Empirical research suggests that health risks are not linearly distributed across the entire range of relative body weights; health risks are dramatically higher in the obese (1, 3, 4), particularly the severely obese (1). As we noted above, when BMI was categorized, heterogeneity in depression risk was observed and severe obesity was associated with depression.

TABLE 5. Adjusted odds ratios (from logistic regression) for the association between obesity and past-month DSM-III* major depression in all study participants, Third National Health and Nutrition Examination Survey, 1988–1994

Covariate	OR†	95% CI†	*t* ‡	*p* value
BMI†,§ category				
Normal weight	1.00¶			
Underweight	1.13	0.43, 3.01	0.25	0.801
Overweight	0.96	0.57, 1.64	–0.14	0.893
Obese	1.84	0.95, 3.55	1.86	0.068
Class 1	1.33	0.57, 3.13	0.68	0.502
Class 2	1.90	0.79, 4.6	1.47	0.149
Class 3	4.63	2.06, 10.42	3.80	<0.001
Gender				
Male	1.00¶			
Female	2.62	1.76, 3.92	4.83	<0.001
Age (years)				
15–19	1.00¶			
20–24	0.80	0.36, 1.76	–0.57	0.573
25–29	0.61	0.22, 1.69	–0.97	0.335
30–34	0.64	0.3, 1.39	–1.13	0.265
35–39	0.72	0.31, 1.89	–0.70	0.490
Race/ethnicity				
White	1.00¶			
African-American	0.8	0.48, 1.32	–0.90	0.373
Hispanic/other	1.02	0.53, 1.94	0.05	0.961
Education (years)				
0–8	1.00¶			
9–11	0.8	0.40, 1.57	–0.67	0.505
12	0.59	0.3, 1.12	–1.66	0.104
≥12	0.69	0.32, 1.51	–0.95	0.348
Marital status				
Married	1.00¶			
Separated/divorced/ widowed	1.71	0.92, 3.17	1.75	0.087
Never married	1.19	0.69, 2.06	0.64	0.522
Physician's health rating				
Excellent	1.00¶			
Good	0.74	0.49, 1.11	–1.48	0.144
Fair/poor	1.55	0.43, 5.65	0.69	0.496
Medical dieting				
No	1.00¶			
Yes	1.62	0.85, 3.06	1.51	0.137
Use of psychiatric medicines				
No	1.00¶			
Yes	7.41	3.01, 18.24	4.47	<0.001
Smoking				
Never smoker	1.00¶			
Former smoker	0.97	0.58, 1.62	–0.12	0.901
Current smoker	2.24	1.32, 3.81	3.06	0.004
Alcohol use				
None	1.00¶			
Moderate	0.97	0.62, 1.54	–0.12	0.904
Abuse	1.53	0.78, 3.02	1.27	0.211
Marijuana use				
None	1.00¶			
Ever	1.58	0.99, 2.53	1.95	0.056
Cocaine use				
None	1.00¶			
Ever	1.22	0.72, 2.05	0.76	0.455

Table continues

* DSM-III, *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition.
† OR, odds ratio; CI, confidence interval; BMI, body mass index.
‡ Wald statistic.
§ Weight (kg)/height $(m)^2$. For category cutpoints, see table 4.
¶ Reference category.

Our results complement findings from other population-based studies that investigated the relation between obesity and DSM major depression. Carpenter et al. (13) found an association between obesity and depression in women; their inverse association in men may correspond to our finding of a relatively low prevalence of depression in obesity class 2 men (which was not statistically significant in logistic regression analyses). Roberts et al. (9, 10) found associations between obesity and depression among older adults with a relatively high prevalence of chronic medical conditions and functional disability—the principal indicators of risk for depression in their studies. In contrast, we sampled young adults in whom chronic medical conditions and functional disability were of very low prevalence and were not associated with depression. Palinkas et al. (16) also studied older adults but did not find any association between obesity and depression (defined by scores on the Beck Depression Inventory (47)). These studies did not examine associations across levels of obesity. In another study, Britz et al. (27) compared a clinic sample of severely obese adolescents with obese and normal-weight adolescents from the population and found higher rates of DSM-IV psychiatric disorders in the clinic-based case adolescents. Since the clinic-based case children were considerably more obese than the population-based case children, the investigators could not determine whether the higher rates of psychiatric disorders were related to severe obesity or to treatment-seeking behavior.

This study had several strengths. First, the sample was drawn from the general household population of the United States, thereby minimizing the selection biases of clinical samples. Second, DSM-III diagnostic criteria were applied using data from a structured psychiatric lay interview method (the DIS); the DIS/DSM-III diagnosis of major depression was equivalent to a DSM-IV diagnosis. Third, we stratified the analyses by gender, which allowed us to identify gender-specific patterns of association. Fourth, we were able to examine the association between obesity and depression within subclasses of obesity. Finally, to our knowledge, this is the only study that has assessed the impact on the

association between the two conditions of using different time frames to ascertain depression.

Our study also had limitations. First, the design was cross-sectional; a temporal relation between obesity and depression could not be inferred. Second, we had data only on persons aged 15–39 years. Thus, the study was limited to that age group. Third, the size of the male subpopulation was too small for us to test for an independent association of severe obesity with depression. However, the sample size was adequate for our primary hypotheses. Fourth, lay interviewers may collect clinical data of limited quality, since they are not trained to probe responses; thus, the validity of diagnoses based on lay interviews can be questioned (48, 49). In addition, problems with the accuracy of the DIS for diagnosing depression (and other psychiatric disorders) have been reported (50, 51), and diagnostic agreement between the DIS and a psychiatrist's interview is higher in clinical samples than in community samples (34). Furthermore, nonspecific symptoms such as change in appetite, fatigue, insomnia, and loss of libido are included in the DSM-III diagnostic criteria for depression. These symptoms may be more common in the severely obese (because of a higher prevalence of chronic medical conditions), making careful attribution of symptoms (which requires clinical training) a critical factor in the diagnostic process. However, use of the DIS is a tremendous improvement over use of continuous scales (such as the Beck Depression Inventory (47), the Center for Epidemiologic Studies Depression Scale (52), and the scale of Zung et al. (53)), and our results are consistent with findings from clinical studies. In addition, it is prohibitively expensive to use clinically trained interviewers to ascertain diagnoses in large community surveys.

Our findings indicate that informative approaches to the study of the association between obesity and psychiatric outcomes include the stratification of obesity by severity and the use of DSM definitions of psychiatric disorder. Persons with severe obesity may represent an "at-risk" population in which mechanisms linking obesity to depression can be profitably investigated. This association between severe obesity and depression is also of interest to clinicians, since depression is associated with poorer treatment outcomes. It is important to evaluate and treat depression in persons who seek medical treatment for severe obesity, and it may be that routine screening for depression should be formulated as the standard of care for these patients.

More research is needed to clarify the relation between severe obesity and depression. For instance, the association may be bidirectional (7). In addition, it remains unclear whether gender, age, race, and socioeconomic status influence this association. The use of DSM criteria for the diagnosis of depression in population-based studies has been an important step forward, but research measures will have enhanced construct validity when interviewers are clinically trained. Clinic-based samples will be useful for identifying other potential risk factors for depression in the obese, since they often represent the extreme of disease or syndrome presentations and thus may minimize ambiguity in case definitions and heterogeneity in research samples. Prospective studies will ultimately be required in order to clarify the temporal relation between obesity and depression, but these studies must await the identification of potential risk factors for depression in the obese. These studies will require active collaboration between investigators to surmount the challenges involved, which include high costs, the need for large study samples, lengthy follow-up, and repeated assessments, and the problem of censorship in studies of long duration.

ACKNOWLEDGMENTS

This research was supported by psychiatric epidemiology training grant T32-MH14592, awarded by the National Institute of Mental Health to the Department of Mental Health, Johns Hopkins Bloomberg School of Public Health.

REFERENCES

1. National Heart, Lung, and Blood Institute. Clinical guidelines for the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report. Bethesda, MD: National Heart, Lung, and Blood Institute, 1998.
2. Visscher TL, Seidell JC. The public health impact of obesity. Annu Rev Public Health 2001;22:355–75.
3. Pi-Sunyer FX. Medical hazards of obesity. Ann Intern Med 1993;119:655–60.
4. Khaodhiar L, McCowen KC, Blackburn GL. Obesity and its comorbid conditions. Clin Cornerstone 1999;2:17–31.
5. Katon W, Sullivan MD. Depression and chronic medical illness. J Clin Psychiatry 1990;51(suppl):3–11.
6. Katon W, Ciechanowski P. Impact of major depression on chronic medical illness. J Psychosom Res 2002;53:859–63.
7. Faith MS, Matz PE, Jorge MA. Obesity-depression associations in the population. J Psychosom Res 2002;53:935–42.
8. Friedman MA, Brownell KD. Psychological correlates of obesity: moving to the next research generation. Psychol Bull 1995;117:3–20.
9. Roberts RE, Kaplan GA, Shema SJ, et al. Are the obese at greater risk for depression? Am J Epidemiol 2000;152:163–70.
10. Roberts RE, Strawbridge WJ, Deleger S, et al. Are the fat more jolly? Ann Behav Med 2002;24:169–80.
11. Noppa H, Hallstrom T. Weight gain in adulthood in relation to socioeconomic factors, mental illness and personality traits: a prospective study of middle-aged women. J Psychosom Res 1981;25:83–9.
12. Istvan J, Zavela K, Weidner G. Body weight and psychological distress in NHANES I. Int J Obes Relat Metab Disord 1992;16:999–1003.
13. Carpenter KM, Hasin DS, Allison DB, et al. Relationships between obesity and DSM-IV major depressive disorder, suicide ideation, and suicide attempts: results from a general population study. Am J Public Health 2000;90:251–7.
14. Sullivan M, Karlsson J, Sjostrom L, et al. Swedish Obese Subjects (SOS)—an intervention study of obesity. Baseline evaluation of health and psychosocial functioning in the first 1743 subjects examined. Int J Obes Relat Metab Disord 1993;17:503–12.
15. Hallstrom T, Noppa H. Obesity in women in relation to mental illness, social factors and personality traits. J Psychosom Res 1981;25:75–82.
16. Palinkas LA, Wingard DL, Barrett-Connor E. Depressive symptoms in overweight and obese older adults: a test of the "jolly fat" hypothesis. J Psychosom Res 1996;40:59–66.

17. Faubel M. Body image and depression in women with early and late onset obesity. J Psychol 1989;123:385–95.
18. Crisp AH, McGuiness B. Jolly fat: relation between obesity and psychoneurosis in general population. BMJ 1976;1:7–9.
19. Crisp AH, Queenan M, Sittampaln Y, et al. "Jolly fat" revisited. J Psychosom Res 1980;24:233–41.
20. Najjar MF, Rowland M. Anthropometric reference data and prevalence of overweight, United States, 1976–80. Vital Health Stat 11 1987:1–73.
21. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Fourth Edition. Washington, DC: American Psychiatric Association, 1994.
22. Grant BF, Harford TC, Dawson DA, et al. Prevalence of DSM-IV alcohol abuse and dependence: United States, 1992. Alcohol Health Res World 1994;18:243–8.
23. Hopkinson G, Bland RC. Depressive syndromes in grossly obese women. Can J Psychiatry 1982;27:213–15.
24. Black DW, Goldstein RB, Mason EE. Prevalence of mental disorder in 88 morbidly obese bariatric clinic patients. Am J Psychiatry 1992;149:227–34.
25. National Center for Health Statistics. Plan and operation of the Third National Health and Nutrition Examination Survey, 1988–94. Series 1: programs and collection procedures. Vital Health Stat 1 1994:1–407.
26. Brownell KD, Wadden TA. Etiology and treatment of obesity: understanding a serious, prevalent, and refractory disorder. J Consult Clin Psychol 1992;60:505–17.
27. Britz B, Siegfried W, Ziegler A, et al. Rates of psychiatric disorders in a clinical study group of adolescents with extreme obesity and in obese adolescents ascertained via a population based study. Int J Obes Relat Metab Disord 2000;24:1707–14.
28. Han TS, Tijhuis MA, Lean ME, et al. Quality of life in relation to overweight and body fat distribution. Am J Public Health 1998;88:1814–20.
29. Barsky AJ. Forgetting, fabricating, and telescoping: the instability of the medical history. Arch Intern Med 2002;162:981–4.
30. Ezzati TM, Massey JT, Waksberg J, et al. Sample design: Third National Health and Nutrition Examination Survey. Vital Health Stat 2 1992:1–35.
31. Robins LN, Helzer JE, Croughan J, et al. National Institute of Mental Health Diagnostic Interview Schedule: its history, characteristics, and validity. Arch Gen Psychiatry 1981;38:381–9.
32. Helzer JE, Robins LN. The Diagnostic Interview Schedule: its development, evolution, and use. Soc Psychiatry Psychiatr Epidemiol 1988;23:6–16.
33. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Third Edition. Washington, DC: American Psychiatric Association, 1980.
34. Helzer JE, Robins LN, McEvoy LT, et al. A comparison of clinical and Diagnostic Interview Schedule diagnoses: physician reexamination of lay-interviewed cases in the general population. Arch Gen Psychiatry 1985;42:657–66.
35. Murphy JM. Diagnostic schedules and rating scales in adult psychiatry. In: Tsuang MT, Tohen M, Zahner GE, eds. Textbook in psychiatric epidemiology. New York, NY: John Wiley and Sons, Inc, 1995.
36. Lianantonakis E, Kotroutsos E, Zacharakopoulou E. Obesity related to the use of psychotropic drugs, considered in its organic aspect. Behav Neuropsychiatry 1976;8:36–8.
37. Bernstein JG. Induction of obesity by psychotropic drugs. Ann N Y Acad Sci 1987;499:203–15.
38. Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. Psychol Bull 1989;105:260–75.
39. Kumanyika SK. Special issues regarding obesity in minority populations. Ann Intern Med 1993;119:650–4.
40. Ross CE. Overweight and depression. J Health Soc Behav 1994;35:63–79.
41. Moore ME, Stunkard A, Srole L. Obesity, social class, and mental illness. 1962. Obes Res 1997;5:503–8.
42. Cheskin LJ, Bartlett SJ, Zayas R, et al. Prescription medications: a modifiable contributor to obesity. South Med J 1999; 92:898–904.
43. Malhi GS, Mitchell PB, Caterson I. "Why getting fat, Doc?" Weight gain and psychotropic medications. Aust N Z J Psychiatry 2001;35:315–21.
44. Friedman KE, Reichmann SK, Costanzo PR, et al. Body image partially mediates the relationship between obesity and psychological distress. Obes Res 2002;10:33–41.
45. Stata Corporation. Stata statistical software. College Station, TX: Stata Corporation, 2002.
46. Horwath E, Weissman MM. Epidemiology of depression and anxiety disorders. In: Tsuang MT, Tohen M, Zahner GE, eds. Textbook in psychiatric epidemiology. New York, NY: John Wiley and Sons, Inc, 1995.
47. Beck AT, Ward CH, Mendelson M, et al. An inventory for measuring depression. Arch Gen Psychiatry 1961;4:561–71.
48. Endicott J. Good diagnoses require good diagnosticians: collecting and integrating the data. Am J Med Genet 2001;105: 48–9.
49. Weissman MM. Phenotype definitions: some hidden issues in psychiatry. Am J Med Genet 2001;105:45–7.
50. Eaton WW, Neufeld K, Chen LS, et al. A comparison of self-report and clinical diagnostic interviews for depression: Diagnostic Interview Schedule and Schedules for Clinical Assessment in Neuropsychiatry in the Baltimore Epidemiologic Catchment Area follow-up. Arch Gen Psychiatry 2000;57:217–22.
51. Parker G. Are the lifetime prevalence estimates in the ECA Study accurate? Psychol Med 1987;17:275–82.
52. Radloff LS. The CES-D Scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1977;1: 385–401.
53. Zung WW, Richards CB, Short MJ. Self-rating depression scale in an outpatient clinic: further validation of the SDS. Arch Gen Psychiatry 1965;13:508–15.