Published in final edited form as:
Obesity (Silver Spring). 2012 September ; 20(9): 1922–1928. doi:10.1038/oby.2011.311.

The Relationship Between Symptoms of Depression and Body Weight in Younger Adults

Angela G. Fowler-Brown[1], **Long H. Ngo**[1], and **Christina C. Wee**[1]

[1]Division of General Medicine and Primary Care, Department of Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA

Abstract

A bidirectional relationship between obesity and depression may exist, though previous results are conflicting. The objectives of our study were to determine whether there is a bidirectional relationship between obesity and symptoms of depression in younger adults and whether this relationship varies with sociodemographic factors. We used data from 7,980 participants in the National Longitudinal Survey of Youth 1979 to examine whether baseline depressive symptoms (score ≥ 10 on a seven-item subscale of the CES-D) in 1992, predicted adjusted percent change in BMI between 1992 and 1994. We then examined whether obesity in 1992 predicted the development of symptoms of depression in 1994, after adjustment for confounders. We found that the presence of baseline depressive symptoms was not prospectively associated with increase in percent BMI, except in Hispanic women. Additionally, baseline obesity was not associated with higher risk of future symptoms of depression in the sample overall (adjusted risk ratio (RR) 1.20; 99% CI 0.91–1.60). However, in those of higher socioeconomic status, obesity was associated with almost double the risk of depressive symptoms compared to nonobese (highest income category: adjusted RR 1.97; 99% CI 1.14–3.40). We concluded that although obesity was not associated with risk of depression symptoms in the population overall, obesity was associated with an increased risk of developing depressive symptoms in those of higher socioeconomic status. Sociodemographic factors may be important modifiers of the relationship between obesity and depression.

INTRODUCTION

The high prevalence of obesity is one of the most salient challenges to the health of the US population today. Obesity is known to be associated with increased mortality and substantial medical morbidity, including higher risk of diabetes, cardiovascular disease, stroke, and certain cancers (1–4). In addition to the medical risks, previous work has suggested that obesity may have an important relationship with psychosocial conditions, such as depression.

While both obesity and depression are very prevalent conditions in the adult population, prior studies on the relationship between obesity and depression have not been definitive. A recent systematic review found that there was relatively weak evidence supporting the hypothesis that obesity contributes to the risk of depression, as the majority of relevant studies were cross-sectional (5). A subsequently published meta-analysis including eight longitudinal studies found that obese persons had an increased odds of developing

Correspondence: Angela G. Fowler-Brown (afowler@bidmc.harvard.edu).

DISCLOSURE The authors declared no conflict of interest.

depression; however, they were only able to analyze outcome adjusted for age and sex (6). Further, only half of the included studies were conducted in the United States. While there is a relative paucity of supporting data, there are several potential mechanisms through which obesity could contribute to the development of depression. The societal stigma associated with obesity may have a negative impact on body-image, self-esteem, and social interactions, which could contribute to the development of depression (7). Additionally, obesity is associated with higher risk of health problems and bodily pain, which could potentiate depressive symptoms (8–10). Finally, there may be a physiological factor common to both obesity and depression, such as a genetic variant or altered serotonin levels in the central nervous system, that increases the risk of developing both conditions (11).

Conversely, some have posited that depression could contribute to the development of obesity (12,13). Depression could lead to unfavorable health behaviors, such as physical inactivity, that contribute to obesity (14–16). Depression may also be associated with biochemical changes, such as alteration in the pituitary-adrenal axis that could potentiate the development of obesity (17,18). Though depression could lead to weight gain and obesity through physiological and/or behavioral mechanisms, evidence for this association has been variable (19–21). The above-mentioned meta-analysis found a positive relationship between depression and odds of developing obesity; however as before, the authors were unable to adjust for many important covariates in their analysis.

The relationship between depression and body weight may vary and be influenced by sociodemographic factors. Mechanisms related to coping with depressive symptoms, as well as the stigma associated with obesity is likely to vary in different sociocultural environments. For instance, obesity is especially prevalent among black women. Additionally, obese black women have been found to have higher satisfaction with body size than their white counterparts (22). Therefore, we hypothesize that obesity would be less stigmatizing in this group and thus, more weakly associated with development of depressive symptoms in black women compared to white women. Furthermore, it is well known that the prevalence of obesity is inversely associated with socioeconomic status (23); therefore, obesity would be less prevalent in communities of greater wealth compared to poorer communities. Thus, obesity may be less accepted and more stigmatizing in communities of higher socioeconomic status and may be more likely to be associated with depression symptoms.

Understanding the relationship between obesity and depression in different populations is necessary to fully recognize the wider public health impact of these two very common conditions. More definitive knowledge of the interrelationship between obesity and depression will inform the development of strategies to identify and treat substantial morbidities of these conditions. The objectives of our study are to determine in a nationally representative, longitudinal cohort of younger men and women: (i) how symptoms of depression are related to future weight gain, (ii) how weight status influences the development of future symptoms of depression, and (iii) how these relationships may vary by race, sex, and socioeconomic factors.

METHODS AND PROCEDURES

Study population

We used the National Longitudinal Survey of Youth 1979 (NLSY79), a longitudinal cohort sponsored by the U.S. Bureau of Labor Statistics, for our analysis. The NLSY79 was initiated in 1979 to gain information on youth transition to the work force, labor experiences, and educational experiences. The NLSY79 is comprised of a (i) a cross-sectional sample of 6,111 respondents designed to be representative of the non-

institutionalized civilian segment of youth living in the United States in 1979 and born between 1 January 1957 and 31 December 1964 (aged 14–22 years in 1979); (ii) a supplemental sample of 5,295, similarly aged respondents designed to oversample Hispanics, blacks, and economically disadvantaged white youth living in the United States born during the same time frame as the primary sample; and (iii) a sample of 1,280 respondents designed to represent the population born between 1 January 1957 and 31 December 1961 who were enlisted in one of the four branches of the military. The military subsample was not interviewed after 1984 and is not included in our study.

We included in this analysis only participants with available data on weight and depressive symptoms in 1992 and 1994, who were not pregnant at either time point (7,980 of 8,771 eligible participants).

Depressive symptoms

One of our primary factors of interest was symptoms of depression. The NLSY79 utilized the Center for Epidemiological Studies—Depression questionnaire (CES-D) to assess depressive symptoms. The CES-D was developed by the National Institutes of Health as a tool to screen for depression and is one of the most widely used questionnaires of its type (24). The full survey consists of 20 questions. Respondents to the CES-D questions rate the frequency of depressive and nondepressive symptoms on a scale of 0–3, where “0” indicates rarely or none of the time, and “3” indicates most or all of the time. Whereas all 20 items from the CES-D were administered to the NYSLY79 in 1992, a shortened version containing seven questions was used in 1994. Shortened versions of the CES-D have been used extensively in the research literature (25,26). To allow for consistency of comparison at the two time points, we used only the seven items from the CES-D common to both time points. The seven CES-D items common to both the 1992 and 1994 surveys were items that asked at what frequency the participant experienced poor appetite, restless sleep, sadness, poor concentration, depressed feelings, difficulty with motivation and whether tasks seemed to take extra effort. These items were summed to generate a scale with values ranging from 0 to 21. We observed high degree of correlation between the full 20-item CES-D and the seven-item CES-D in 1992 ($r = 0.90$). Cronbach alpha coefficient for the seven-item scale in 1992 and 1994 was 0.77 and 0.81, respectively.

In previous studies, scores of 16–26 (of possible 60) on the 20-item CES-D are considered to be an indicator of mild depression and scores of 27 or higher to suggest major depressive symptoms (24,27). Prior work has suggested the more stringent cutoff score of 27 to be more useful for screening than the cutoff score of 16, thus we elected to use the higher cut-point (28). To adjust this cut-point for the shortened length of the survey, we used the technique recommended by Shrout and Yager, who advised multiplying the cut-point for the 20-item CES-D by the number of items in the shortened scale and then divide by 20 (29). We therefore dichotomized the CES-D into those with “high levels of depressive symptoms,” defined by CES-D scores of 10 or greater, and those without high levels of depressive symptoms (CES-D <10). This approach has been used in previous analyses (30). In our analyses which tested a possible bidirectional relationship between obesity and depression, the depressive symptom variable was treated as the predictor in the first set of models, and the outcome other models.

Weight status

We calculated BMI for years 1992 and 1994 using self-reported weight for those years, and adult height reported in 1985 (aged 21–28 years). To examine how depression may influence weight change, we calculated 2 year, percent change in BMI by subtracting BMI in 1992 from BMI in 1994 and dividing by the BMI in 1992. To examine how weight status

could influence future depression, we analyzed weight in three categories, normal weight (BMI < 25 kg/m^2), overweight (BMI 25–29.9 kg/m^2), and obese (BMI ≥ 30 kg/m^2).

Other variables of interest

The NLSY79 also collects information on other factors that may confound the relationship between symptoms of depression and weight status including: age, sex, race (white, black, Hispanic), family income-to-poverty ratio (four categories), highest educational year completed (less than high school, high school degree, and some advanced education), ever a smoker (yes, no), current smoking (none, occasional, and daily), presence of physical/health issues that limits ability to work (yes, no), and days of alcohol use (none, less than 1 day/ week, 1–2 days/ week, 3–4 days/week, 5–6 days/week, and every day)

Statistical analysis

We used descriptive statistics to characterize participant's demographic and clinical characteristics at baseline. We then used linear regression to estimate how depressive symptoms at baseline were associated with change in BMI over the subsequent 2 years. We conducted sex- and race-stratified models to determine the possible differential impact of the exposure on outcome. All fully adjusted models controlled for baseline BMI, age, sex, smoking status, education, family income-to-poverty ratio, marital status, race, alcohol use, and presence of health limitations. Using β-coefficients from the multivariable regression models, we estimated the mean-adjusted 2-year change in BMI in those with high levels of depressive symptoms and in those without.

We then used multivariable generalized linear equations (Poisson distribution, log link) to estimate the adjusted probability of having high levels of depressive symptoms at follow-up in those with obesity at baseline compared to those without. Fully adjusted models controlled for baseline symptoms of depression, age, sex, smoking status, education, family income-to-poverty ratio, marital status, race/ethnicity, alcohol use, and presence of health limitations. Because previous work suggests that the effects of obesity and depression could vary by sex (5), we conducted analysis stratified by sex. We were also interested in exploring how the relationships of interest may vary by race/ethnicity and socioeconomic status, thus we conducted analyses stratified by race, race/sex, and by category of family income-to-poverty ratio, based on the distribution of income-to-poverty ratio (upper class 10% and above; upper middle class 10–20%, middle class 20–50%, working/lower class 50% and lower). We also constructed models including interaction terms of the predictors with sex, race, and income to test for effect modification.

The NLSY79 was assembled using a complex sampling strategy, thus all analyses were weighted to adjust for unequal sampling fractions. However, in our analyses, we could not account for the clustering induced by survey design. Design effects induced by clustering do not bias estimates of coefficients and prevalence ratios, but rather would inappropriately narrow variance estimators and confidence intervals. Therefore, to approximately compensate for this limitation, we considered only significance levels of 0.01 or less as statistically significant (99% CI) (31). All analyses were conducted using STATA statistical software (version 10, College Station, TX) (32).

RESULTS

The baseline characteristics of our sample are described in Table 1. At baseline, the mean age was 31 years, 48% were women, and 16% were obese. While 8% of nonobese participants were categorized as having high levels of depressive symptoms at baseline, the prevalence was significantly higher in obese participants (13%) ($P < 0.005$). The average

percent change in BMI between 1992 and 1994 was 2.2%; however, there were large differences by weight category; obese participants gained significantly less weight over time than nonobese participants.

Depression and future weight change

Our initial analyses were to determine whether symptoms of depression measured at baseline were prospectively associated with weight change over the subsequent two years in men and women. In the sample overall, depressive symptoms at baseline did not seem to predict weight change over a 2-year period (Table 2). Whites with high levels of depressive symptoms tended to have less BMI gain than those without, although this relationship was not statistically significant. Analyses stratified by both sex and race, suggest possible differences by race. While white women with high depressive symptoms, tended to gain less weight than their less depressed counterparts, in non-white women, depressive symptoms tended to have the opposite effect. Both black and Hispanic women with depressive symptoms gained more weight than those without high depressive symptoms, but this relationship approached statistical significance only in Hispanic women ($P = 0.025$); interaction terms for race × depression interaction among women were statistically significant for the comparison of white with Hispanic women ($P = 0.006$). Among men, white and Hispanic men with depressive symptoms showed a tendency to gain less weight than their counterparts, but this was not statistically significant. In contrast, black men with depressive symptoms were tended to gain more weight than black men without these symptoms but this was not statistically significant, and interaction terms of race and high depressive symptoms were similarly not significant in men. We found no significant variation of the impact of depression on BMI change by income level. (data not shown)

Obesity and future depressive symptoms

We then conducted analyses to determine whether obesity status at baseline was prospectively associated with the likelihood of developing high levels of depressive symptoms. Analysis of the entire sample suggests that on average, those with over-weight and obesity tended to have a higher adjusted risk of future depressive symptoms than those with normal weight; however, this relationship was not statistically significant (Table 3). This effect seems to be most pronounced in Hispanic women. On the other hand, overweight or obese black men seemed less likely than normal weight counterparts to develop high levels of depressive symptoms.

In subsequent analyses, we found that the association of obesity with future depressive symptoms varied by income (Table 4). While obesity was not associated with risk of depressive symptoms in those in the lower-income categories, obese adults in the upper category had a greater likelihood of future depressive symptoms ($P < 0.005$ for obesity × highest income level interaction term). In sex-stratified analyses, obese women in the upper income category were significantly more likely to have depressive symptoms compared to normal weight women in that income category. In further analyses, this effect in women did not appear to vary significantly by race (data not shown). Although the point estimates of association of obesity with increased risk of future depressive symptoms was elevated in men in the upper income category, this relationship was not statistically significant (Table 4).

DISCUSSION

The aim of our study was to understand the relationship between weight status and depressive symptoms in a young to middle-aged adult population and to understand how this relationship may vary with sex, race, and socioeconomic status. We found that depression is

not associated with statistically significant increases in BMI over time, except in Hispanic women. Thus, depression may not be expected to contribute to weight gain or obesity in much of the population in this age range. We also explored whether there was a reciprocal relationship, whereby obesity is associated with the development of depressive symptoms. Our analysis suggests that obesity is differentially associated with depressive symptoms according to ethnicity/sex and socioeconomic status. Obese and overweight Hispanic women were more likely to develop high levels of depressive symptoms, as were obese women of greater socioeconomic status. Obesity was generally not associated with increased risk of depressive symptoms in men and women with less income.

Our study adds to the relatively small number of prospective studies examining the relationship between weight status and depression symptoms, one of few that examine racial and socioeconomic variability in this association. Previous work related to whether depression could lead to obesity has been conflicting. A recent meta-analysis of longitudinal studies concluded that depression was associated with higher likelihood of future obesity, particularly, depression in adolescent girls (33). For example, a study of by Goodwin and Whitaker found that depressed adolescents are at increased risk for the development and persistence of obesity during adolescence (34). In contrast, we found that high levels of depressive symptoms did not predict increasing weight for most of our sample. Possibly, depression has a stronger impact on weight change in adolescence, as this developmental stage is one of substantial physical, mental, emotional, and social changes, and may be a period in which both obesity and depression are initiated. Similar to our findings, Roberts *et al.* used data from a middle-aged to older cohort of adults and found that depression did not predict subsequent obesity (35). But our data suggest there may be subsets of people in whom depressive symptoms are associated with weight gain, for example Hispanic women. Why weight gain may be associated with depression in some, but not others, is not clear. We suggest that the strategies that individuals choose to cope with depressive symptoms may be influenced by sociocultural context. Further work should be done to determine which factors modify how depression is associated with future weight change.

Others have also suggested that obesity could lead to increased risk of depression. Using an ethnically homogeneous US cohort, Roberts *et al.* found that obesity at baseline was associated with higher likelihood of future depression (35). The authors of that study recommended further research on which subgroups of obese people are at the most risk for psychological dysfunction associated with obesity. We found that obesity was not associated with future risk of depressive symptoms in our sample overall. However, our findings extend the current scientific knowledge by pointing to the possibility that differences in the socioenvironmental context could be a significant modifier of the effect of obesity on future depression. Those in the highest income category had increased risk of depressive symptoms associated with obesity, whereas this relationship was not observed in other income groups. There may be several reasons why socioeconomic status is an important modifier of the impact of obesity on depressive symptoms. We postulate this observation is largely related to the likelihood that social acceptance of obesity varies with socioeconomic status, and lack of social acceptance is likely to be a relevant factor in the development of depression associated with obesity. Further work is warranted to better define who might be at greatest risk of depression associated with obesity.

The strengths of our study design include a large, nationally representative sample, and longitudinal study design. However, there are several limitations that should be considered. The weight and height data used were self-reported rather than measured which may introduce bias, as those who are overweight tend to report values lower than their actual weight, and those who are shorter tend to report higher values for height; however, previous work suggests that this bias does not vary by the level of depression (36). Thus, this

measurement bias might blunt the observed measures of association between weight status and depressive symptoms. Although the scale we used to measure depressive symptoms is extensively used in epidemiologic studies and has been shown to correlate well with depression diagnoses, clinical assessments of depression may be a more informative outcome. Finally, we had measurements of depressive symptoms at only two time points. More assessments of depressive symptoms over time would be beneficial in understanding the dynamics of the relationship between obesity and depression.

In conclusion, while we did not find evidence that depression leads to weight gain in most populations, obesity is associated with increased risk of future depressive symptoms in men and women of higher socioeconomic status. Thus, in addition to the well-known associated physical health impairments, obesity could contribute to mental health morbidity in certain groups. Awareness of this relationship should provide consideration for screening obese people in this age group for depressive symptoms. Our study also underscores the importance of assessing potential factors that could modify the relationship between body weight and depression, such as income and race, in future studies. Previous conflicting results in the literature may be in part related to demographic differences in the populations studied. Future research with diverse populations and high-quality measures should better define the mechanisms through which obesity increases risk of depression in some. Future work should also better define the factors that modify susceptibility to depression related to obesity and the propensity to gain weight in association with depression.

Acknowledgments

Dr Wee is supported by a grant from the National Institutes of Health (R01 DK071083). Dr Fowler-Brown had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

REFERENCES

1. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med. 2003; 348:1625–1638. [PubMed: 12711737]
2. Colditz GA, Willett WC, Stampfer MJ, et al. Weight as a risk factor for clinical diabetes in women. Am J Epidemiol. 1990; 132:501–513. [PubMed: 2389754]
3. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. JAMA. 2005; 293:1861–1867. [PubMed: 15840860]
4. Bray GA. Medical consequences of obesity. J Clin Endocrinol Metab. 2004; 89:2583–2589. [PubMed: 15181027]
5. Atlantis E, Baker M. Obesity effects on depression: systematic review of epidemiological studies. Int J Obes (Lond). 2008; 32:881–891. [PubMed: 18414420]
6. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. Arch Gen Psychiatry. 2010; 67:220–229. [PubMed: 20194822]
7. Puhl RM, Heuer CA. The stigma of obesity: a review and update. Obesity (Silver Spring). 2009; 17:941–964. [PubMed: 19165161]
8. Janke EA, Collins A, Kozak AT. Overview of the relationship between pain and obesity: What do we know? Where do we go next? J Rehabil Res Dev. 2007; 44:245–262. [PubMed: 17551876]
9. Rejeski WJ, Ip EH, Marsh AP, Zhang Q, Miller ME. Obesity influences transitional states of disability in older adults with knee pain. Arch Phys Med Rehabil. 2008; 89:2102–2107. [PubMed: 18996238]
10. Verbrugge LM, Gates DM, Ike RW. Risk factors for disability among U.S. adults with arthritis. J Clin Epidemiol. 1991; 44:167–182. [PubMed: 1825325]

11. Wurtman JJ. Depression and weight gain: the serotonin connection. J Affect Disord. 1993; 29:183–192. [PubMed: 8300977]
12. Katon WJ. Clinical and health services relationships between major depression, depressive symptoms, and general medical illness. Biol Psychiatry. 2003; 54:216–226. [PubMed: 12893098]
13. Davidson K, Jonas BS, Dixon KE, Markovitz JH. Do depression symptoms predict early hypertension incidence in young adults in the CARDIA study? Coronary Artery Risk Development in Young Adults. Arch Intern Med. 2000; 160:1495–1500. [PubMed: 10826464]
14. Brown WJ, Ford JH, Burton NW, Marshall AL, Dobson AJ. Prospective study of physical activity and depressive symptoms in middle-aged women. Am J Prev Med. 2005; 29:265–272. [PubMed: 16242588]
15. Farmer ME, Locke BZ, Moscicki EK, et al. Physical activity and depressive symptoms: the NHANES I Epidemiologic Follow-up Study. Am J Epidemiol. 1988; 128:1340–1351. [PubMed: 3264110]
16. Wassertheil-Smoller S, Shumaker S, Ockene J, et al. Depression and cardiovascular sequelae in postmenopausal women. The Women's Health Initiative (WHI). Arch Intern Med. 2004; 164:289–298. [PubMed: 14769624]
17. Gold PW, Goodwin FK, Chrousos GP. Clinical and biochemical manifestations of depression. Relation to the neurobiology of stress (2). N Engl J Med. 1988; 319:413–420. [PubMed: 3041279]
18. Gold PW, Goodwin FK, Chrousos GP. Clinical and biochemical manifestations of depression. Relation to the neurobiology of stress (1). N Engl J Med. 1988; 319:348–353. [PubMed: 3292920]
19. Barefoot JC, Heitmann BL, Helms MJ, et al. Symptoms of depression and changes in body weight from adolescence to mid-life. Int J Obes Relat Metab Disord. 1998; 22:688–694. [PubMed: 9705031]
20. Pine DS, Cohen P, Brook J, Coplan JD. Psychiatric symptoms in adolescence as predictors of obesity in early adulthood: a longitudinal study. Am J Public Health. 1997; 87:1303–1310. [PubMed: 9279265]
21. Pine DS, Goldstein RB, Wolk S, Weissman MM. The association between childhood depression and adulthood body mass index. Pediatrics. 2001; 107:1049–1056. [PubMed: 11331685]
22. Stevens J, Kumanyika SK, Keil JE. Attitudes toward body size and dieting: differences between elderly black and white women. Am J Public Health. 1994; 84:1322–1325. [PubMed: 8059896]
23. Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. Psychol Bull. 1989; 105:260–275. [PubMed: 2648443]
24. Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. Applied Psychological Measurment. 1977; 1:385–401.
25. Santor DA, Coyne JC. Shortening the CES-D to improve its ability to detect cases of depression. Psychological Assessment. 1997; 9:233–243.
26. Kohout FJ, Berkman LF, Evans DA, Cornoni-Huntley J. Two shorter forms of the CES-D (Center for Epidemiological Studies Depression) depression symptoms index. J Aging Health. 1993; 5:179–193. [PubMed: 10125443]
27. Jacoby R. Center for Epidemiologic Studies Depression Scale had high sensitivity and specificity for major depression in older adults. Evid Based Ment Health. 1998; 1:57.
28. Zich JM, Attkisson CC, Greenfield TK. Screening for depression in primary care clinics: the CES-D and the BDI. Int J Psychiatry Med. 1990; 20:259–277. [PubMed: 2265888]
29. Shrout PE, Yager TJ. Reliability and validity of screening scales: effect of reducing scale length. J Clin Epidemiol. 1989; 42:69–78. [PubMed: 2913189]
30. Prause J, Dooley D, Huh J. Income volatility and psychological depression. Am J Community Psychol. 2009; 43:57–70. [PubMed: 19130213]
31. Gortmaker SL, Must A, Perrin JM, Sobol AM, Dietz WH. Social and economic consequences of overweight in adolescence and young adulthood. N Engl J Med. 1993; 329:1008–1012. [PubMed: 8366901]
32. StataCorp. Stata Statistical software: Release 10. Stata Corp College Station; TX: 2007.
33. Blaine B. Does depression cause obesity?: A meta-analysis of longitudinal studies of depression and weight control. J Health Psychol. 2008; 13:1190–1197. [PubMed: 18987092]

34. Goodman E, Whitaker RC. A prospective study of the role of depression in the development and persistence of adolescent obesity. Pediatrics. 2002; 110:497–504. [PubMed: 12205250]

35. Roberts RE, Deleger S, Strawbridge WJ, Kaplan GA. Prospective association between obesity and depression: evidence from the Alameda County Study. Int J Obes Relat Metab Disord. 2003; 27:514–521. [PubMed: 12664085]

36. Jeffery RW, Finch EA, Linde JA, et al. Does clinical depression affect the accuracy of self-reported height and weight in obese women? Obesity (Silver Spring). 2008; 16:473–475. [PubMed: 18239662]

Table 1

Baseline characteristics

	Total *N* = 7,980	Normal weight *N* = 3,780	Overweight *N* = 2,723	Obese *N* = 1,477	*P* value
Age in years (s.e.)	31.1 (0.031)	31.1 (0.045)	31.1 (0.054)	31.2(0.073)	0.136
Female	48%	58%	33%	47%	<0.005
Race					
White	80%	84%	78%	70%	<0.005
Black	14%	11%	15%	21%	–
Hispanic	6%	5%	7%	9%	–
Education					
<HS	11%	10%	11%	17%	<0.005
HS	43%	41%	44%	48%	–
>HS	46%	49%	45%	35%	–
Marital status					
Never married	24%	24%	23%	29%	<0.005
Married/partnered	60%	58%	62%	57%	–
Other	16%	18%	14%	13%	–
Smoked 100 cigarettes in lifetime	51%	54%	49%	47%	<0.005
Current smoking status					
Daily	28%	31%	26%	24%	<0.005
Occasional	5%	5%	5%	5%	–
None	67%	64%	69%	71%	–
Alcohol use					
none	32%	30%	30%	44%	<0.005
less than 1 day/week	2%	2%	2%	1%	–
1–2 days/week	4%	5%	5%	2%	–
3–4 days/week	12%	11%	14%	9%	–
5–6 days/week	26%	26%	27%	24%	–
Every day	24%	26%	22%	20%	–
Health limitations	6.50%	6.10%	5.80%	10.00%	<0.005
Family income-to-poverty ratio (s.e.)	11.8 (0.048)	11.5 (0.067)	11.9 (0.086)	12.3 (0.118)	<0.005
Percent change in BMI over 2 years	2.20%	2.90%	1.60%	0.10%	<0.005
Depressive symptoms	9%	8%	8%	13%	<0.005

Data are given as weighted percentages unless otherwise noted.

HS, high school.

Table 2

Adjusted 2-year mean percent change in BMI by prevalence of depressive symptoms

	High depressive symptoms					
	Women and men		Women		Men	
	Yes %change in BMI (99% CI)	No %change in BMI (99% CI)	Yes %change in BMI (99% CI)	No %change in BMI (99% CI)	Yes %change in BMI (99% CI)	No %change in BMI (99% CI)
Race/ethnicity						
All races/ethnicities	2.05 (1.08, 3.03)	2.25 (0.32–0.94)	2.27 (0.99, 3.55)	2.55 (2.06, 3.03)	2.09 (0.60, 3.57)	2.18 (1.74, 2.61)
White	1.42 (0.20, 2.65)	2.02 (1.73, 2.61)	1.31 (−0.27, 2.89)	2.13 (1.56, 2.70)	1.70 (−0.22, 3.63)	1.91 (1.44, 2.38)
Hispanic	3.58 (1.52, 5.64)	2.29 (1.47, 3.11)	4.97 (2.43, 7.50)	2.57 (1.53, 3.61)	1.05 (−2.31, 4.42)	1.97 (0.76, 3.18)
Black	3.30 (1.41, 5.19)	2.49 (1.85, 3.13)	3.81 (1.15, 6.46)	2.96 (1.87, 4.04)	2.89 (0.23, 5.55)	2.00 (1.31, 2.69)

Models adjusted for age, baseline BMI, sex (in analyses not stratified by sex), ever-smoked, current smoking, race/ethnicity (in analyses not stratified by race/ethnicity), education, marital status, alcohol use, health limitations, and family income-to-poverty ratio.

CI, confidence interval.

Table 3

Adjusted relative risk of future depressive symptoms associated with obesity

	Risk ratio (99% CI)		
	Women and men	**Women**	**Men**
Race/ethnicity			
All races/ethnicities			
Normal weight	1	1	1
Overweight	1.14 (0.88–1.50)	1.25 (0.91–1.72)	0.99 (0.65–1.51)
Obese	1.20 (0.91–1.60)	1.22 (0.90–1.67)	1.01 (0.58–1.76)
White			
Normal weight	1	1	1
Overweight	1.24 (0.89–1.72)	1.26 (0.84–1.87)	1.19 (0.69–2.06)
Obese	1.20 (0.82–1.77)	1.15 (0.76–1.74)	1.18 (0.56–2.47)
Hispanic			
Normal weight	1	1	1
Overweight	1.45 (0.81–2.59)	1.92 (1.06–3.51) *	0.84 (0.37–1.90)
Obese	1.73 (0.97–3.08)	1.81 (0.97–3.40)	0.93 (0.35–2.49)
Black			
Normal weight	1	1	1
Overweight	0.81 (0.55–1.19)	1.05 (0.65–1.70)	0.51 (0.27–0.95) *
Obese	1.09 (0.75–1.57)	1.30 (0.83–2.05)	0.67 (0.33–1.37)

Models adjusted for age, baseline depressive symptoms, sex (in analyses not stratified by sex), ever-smoked, current smoking, race/ethnicity (in analyses not stratified by race/ethnicity), education, marital status, alcohol use, health limitations, and family income-to-poverty ratio.

CI, confidence interval.

* $P < 0.01$.

Table 4

Adjusted relative risk of future depression associated with obesity by income level

	Risk ratio (99% CI)		
	Women and men	**Women**	**Men**
Income category			
Upper class			
Normal weight	1	1	1
Overweight	1.04 (0.56–1.94)	1.39 (0.67–2.92)	0.62 (0.0.21–1.82)
Obese	1.97 (1.14–3.40) **	2.23 (1.16–4.25) **	1.61 (0.61–4.22)
Upper middle class			
Normal weight	1	1	1
Overweight	1.05 (0.59–1.87)	1.20 (0.63–2.28)	0.77 (0.24–2.44)
Obese	1.06 (0.60–1.87)	1.06 (0.54–2.08)	1.05 (0.34–3.25)
Middle class			
Normal weight	1	1	1
Overweight	1.11 (0.68–1.82)	1.17 (0.64–2.16)	1.20 (0.52–2.77)
Obese	1.05 (0.56–2.00)	1.18 (0.59–2.37)	0.86 (0.23–3.23)
Working class			
Normal weight	1	1	1
Overweight	1.21 (0.78–1.88)	1.37 (0.77–2.45)	1.20 (0.63–2.30)
Obese	0.82 (0.46–1.48)	0.92 (0.48–1.75)	0.89 (0.29–2.72)

Models adjusted for age, baseline depressive symptoms, sex (in analyses not stratified by sex), ever-smoked, current smoking, race/ethnicity, education, marital status, and alcohol use.

CI, confidence interval.

** $P < 0.01$.