Gender differences in the association between body mass index and psychopathology

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Abstract

Objective: to examine gender differences in the relationship between weight group (under-weight to morbidly obese), and Axis I and Axis II psychopathology. Method: data from the National Epidemiologic Study of Alcohol and Related Conditions (NESARC) were analyzed. Logistic regression models examined the past-year likelihood for meeting diagnostic criteria for psychiatric disorders, and interactions between weight group and gender were utilized to determine whether associations were significantly different in men and women after adjusting for demographic characteristics. Results: First, consistent with previous NESARC analyses, the prevalence estimates of psychiatric disorders were higher among people of higher BMI group, regardless of gender. However, these patterns differed across genders. Both morbidly obese women and men, in comparison to normal weight respondents, were much more likely to meet criteria for affective and anxiety disorders, but these associations were significantly (1.5–2 times) stronger among women. For Axis II disorders while there were very few associations between personality disorders and weight in men, among women increases in weight group were associated with increases in the likelihood of meeting criteria for a personality disorder. Conclusions: Weight and psychopathology appear more strongly associated in women than in men. While these data do not allow for identification of underlying mechanisms, they highlight the importance of assessing for psychopathology in overweight and obese patients and suggest that education related to healthy eating and exercise be incorporated into treatment plans for people with psychiatric disorders.

Keywords

obesity; psychopathology; gender differences

INTRODUCTION

Data from the Centers for Disease Control indicate that in 2003–2004 32.2% of the adult US population was obese. Rates are increasing particularly among adult men and adolescents. However, adult women continue to be more likely to be obese (33.2%) than adult men

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(31.1%)[1]. Obesity has negative health consequences, both in increased morbidity and mortality as well as social stigma and limitations to healthy social functioning.

Multiple community studies have examined the association between obesity (as measured by Body Mass Index 30) and Axis I psychiatric disorders[2–8]. However, findings have not always been consistent. Obesity is often associated with affective[7] and anxiety disorders[6], and less frequently with substance use disorders[7]. However, not all studies have found these relationships[9]. In addition, many studies have not observed gender differences, and those that do have found inconsistent results[7,10]. Several studies have examined Axis II disorders, but generally only in selected samples of patients entering treatment for obesity, and most studies have focused on borderline personality disorder. Although frequencies of borderline personality disorder appear to be higher in patient groups than in the general population[11–14], it is not clear whether this association generalizes to community samples, equally in men and women, or to other personality disorders.

A recent study utilized community data collected as part of the National Epidemiologic Survey on Alcohol and Related Conditions to address a number of the gaps in the literature mentioned above[15]. This study examined weight over several weight groups and assessed the association between weight group and a comprehensive number of both Axis I and II disorders in a community sample. They found that obese and morbidly obese respondents were significantly more likely to have any mood, anxiety, or alcohol disorder, and significantly more likely to have any personality disorder. In addition, being moderately overweight was associated with anxiety and some substance use disorders, but not other disorders[15].

These results had important implications for understanding the comorbid risk of obesity and psychiatric disorders. However, one gap that remains in the literature is whether these patterns are similar across gender. Given that there are gender differences in the risk of many psychiatric disorders, as well as differences in risk for obesity, we hypothesized that patterns of comorbidity may differ significantly across gender. The current study also utilizes the NESARC data but adds to the literature by examining the association between weight group and both Axis I and Axis II psychiatric disorders separately in men and women, as well as examining whether observed gender differences were statistically significant.

METHODS

Sample

The data for this analysis come from the National Epidemiologic Study of Alcohol and Related Conditions (NESARC). The NESARC study methodology has been described elsewhere in more detail[16,17]. Conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) and the U.S. Census Bureau, the NESARC sampled a nationally representative group of U.S. residents (citizens and non-citizens) age 18 and over living in non-institutionalized settings. Respondents were identified using multi-stage stratified sampling, where Census sampling units, households, and then members of households were sampled in sequence. The sample was enhanced with members of group living environments such as dormitories, group homes, shelters, and facilities for housing workers. Jails, prisons, and hospitals were not included. The study over-sampled Black and Hispanic households and respondents aged 18 to 24 in order to have sufficient statistical power to examine patterns of alcohol use in minority populations and young people, who may have otherwise been under-represented in a simple random sample. Weights have been calculated to adjust standard errors for these over-samples, the cluster sampling technique and non-response[18]. The final sample consisted of 43,093 respondents, representing an 81% response rate. All

respondents gave written consent to participate, however the current investigation was exempt from IRB review because it utilized the publicly accessible NESARC data, which is stripped of all personal identifiers.

Measures

Diagnostic data derived from the Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM IV version (AUDADIS-IV)[16], a structured diagnostic assessment administered by trained lay interviewers. The instrument was tested for reliability and validity and found to be a good measure for detecting psychiatric disorders in a community sample[16].

The publicly accessible data from the NESARC contains diagnostic variables that have synthesized self-report data from the AUDADIS-IV into diagnostic categories based upon DSM-IV criteria. The data contain diagnostic variables for major depression, dysthymia, mania, and hypomania, panic disorder with and without agoraphobia, social phobia, simple phobia, generalized anxiety disorder, alcohol abuse, alcohol dependence, drug abuse, drug dependence, and nicotine dependence[18]. The instrument provides the ability to distinguish past-year diagnoses, prior to past-year diagnoses, and lifetime diagnoses, and includes exclusions for illness and substance-induced symptoms where appropriate. We utilized the past-year diagnoses with illness and substance exclusions, thereby making the diagnoses 'primary' or independent diagnoses as defined by the DSM[19].

The instrument also assesses seven Axis II personality disorders: antisocial, avoidant, dependent, histrionic, obsessive-compulsive, paranoid, and schizoid. Not every DSM-IV personality disorder was assessed due to subject burden and time constraints[20]. It is particularly important to note that borderline personality disorder was not assessed, since much of the previous literature on personality disorders and obesity has focused on this disorder. Since the Axis II disorders were assumed to be temporally stable constructs, no time periods were applied. Respondents were asked about how they felt or acted most of the time, throughout their lives, and regardless of situation. The assessments followed DSM-IV diagnostic criteria. To meet criteria, respondents had to endorse the required number of symptoms as well as report that at least one of the symptoms had caused significant social dysfunction[20].

Before the analysis of individual disorders, and in order to reduce the problem of multiple comparisons, we first examined a number of clusters of disorders—any Axis I disorder, any mood disorder, and anxiety disorder, any substance use disorder, any Axis II disorder, and Axis II clusters A, B, and C. If the clusters showed evidence for significant gender by weight group interactions, individual disorders within the cluster were also analyzed.

The primary independent variable of interest in the present analyses was based on self-reported height and weight, which were transformed into a measure of Body Mass Index (BMI) and then categorized into BMI's of 18.5 (underweight), between 18.5 and 24.9 (normal weight), between 25 and 29.9 (overweight), between 30 and 34.9 (obese), and over 35 (morbidly obese)[21].

Other variables utilized in the analyses include self-reported gender, age in years, race/ethnicity (African-American, Hispanic, and Caucasian), education, current employment, marital status and household income in dollars. Race categories were non-mutually exclusive because, in keeping with current Federal regulations regarding the measurement of race, respondents could endorse more than one racial category.

Data analyses

The primary research questions concerned gender differences in the association between BMI group and psychiatric disorders. To investigate, we first examined the association between gender, BMI group and other socio-demographic variables in order to identify socio-demographic variables potentially influencing the relationship between gender, BMI group, and psychiatric disorders. Next, we calculated unadjusted weighted rates of psychiatric disorders, stratified by both gender and BMI group. Finally, we fit a series of logistic regression models where psychiatric and substance abuse variables were the dependent variables of interest and the BMI group variable, gender, and an interaction between gender and BMI group were the independent variables of interest, adjusting for previously identified socio-demographic variables.

Due to the design elements of the study sample we analyzed data using SUDAAN software[22] and the NESARC-calculated weights.

RESULTS

The survey sample consisted of 18,518 men and 24,575 women. Gender differences in demographic characteristics in the NESARC sample have been reported previously, with differences identified in age, education, employment, marital status, and race/ethnicity.[23] In comparison to men, women appeared to be older, have lower household incomes, and be more likely to have some college education and less likely to have a college degree, less likely to be currently working, more likely to be previously married, and more likely to be African-American. Table 1 presents associations between BMI group and socio-demographic variables. Obesity was significantly associated with education and employment. Overweight and obese respondents were more likely to be married than normal weight respondents, but morbidly obese respondents were less likely to be married. Obese respondents were also less likely to report their race as White and more likely to report race as Black or ethnicity as Hispanic compared to normal weight respondents. Finally, obese respondents were older and had in general lower household incomes. As each tabulated socio-demographic variable distinguished the BMI groups, all were included in multivariable models.

Baseline rates of psychiatric disorders by gender in the NESARC data have been presented previously[23]. Consistent with data from the National Comorbidity Study Replication, female respondents in the NESARC sample had higher estimates of most affective and anxiety disorders and lower estimates of substance use disorders than male respondents[24]. They were also more likely to meet criteria for avoidant, dependent, and paranoid personality disorder, and less likely to meet criteria for antisocial personality disorder than were men.

The unadjusted associations between psychiatric disorders and BMI group, stratified by gender, reveal several important observations (Table 2). First, Axis I and Axis II disorders show a significant association with BMI group status in both men and women. Second, with the exception of anxiety disorders in men, each cluster of Axis I and Axis II disorders is associated with BMI group status in men and women. Third, there are several disorders where the prevalence estimates appear higher among under-weight than normal weight respondents (major depression, dysthymia, and mania as well as schizoid and histrionic personality disorder). Fourth, in general, prevalence estimates of disorders increased with increasing weight severity from normal weight respondents to morbidly obese ones. However, this pattern differs across genders. For example, for all of the anxiety disorders, there is a significant association with BMI in women but not in men. Conversely, for drug abuse/dependence and nicotine dependence, there is a significant association with BMI in men but not in women. For avoidant, dependent, and obsessive-compulsive personality

disorder there is a significant association with BMI in women but not in men. Conversely, histrionic personality disorder is significantly associated with BMI in men but not in women.

Odds ratios from multivariable models investigating the adjusted strength of associations between psychiatric disorders and BMI group are presented for each gender, using respondents with BMI within the normal range as the reference group (Table 3). Interaction terms tested whether the odds ratios for women are significantly different from those for men. These models indicate that, adjusting for socio-demographic characteristics related to both BMI and psychiatric disorders, overweight and obese women are significantly more likely than similar weight men to be diagnosed with major depression, mania, social phobia, simple phobia and nicotine dependence, as well as all of the personality disorders assessed.

DISCUSSION

To our knowledge, this is the first national epidemiologic examination of the association between obesity and a wide range of both Axis I and Axis II psychiatric disorders that also utilizes dimensional weight groups ranging from underweight to morbidly obese and performs gender comparisons. The data support several conclusions. First, as reported from other NESARC analyses[15], the prevalence of psychiatric disorders in these data was consistently higher among people of higher BMI group, regardless of gender. However, these patterns were inconsistent across gender. In particular, both morbidly obese women and men, in comparison to normal weight respondents, were much more likely to meet criteria for affective and anxiety disorders, but these associations were significantly (1.5–2 times) stronger among women. For Axis II disorders the gender differences were evident across the BMI spectrum; while there were very few associations between personality disorders and BMI in men, among women increases in BMI group were associated with strong increases in the likelihood of meeting criteria for a personality disorder.

Obesity and Axis I disorders

The patterns of comorbidity between obesity and Axis I disorders suggest that obese individuals are more likely to suffer from internalizing disorders such as depression and anxiety than externalizing disorders such as substance abuse, and this finding is consistent with some previous research[7,15]. Because these data are cross-sectional it is not possible to tell which disorder pre-dates the other, or whether an etiologic relationship exists between obesity and internalizing disorders. There may be multiple contributing mechanisms. For example, respondents who are obese may as a result suffer from depression and anxiety due to the social stigma and restrictions in social functioning that result from being obese. Conversely, disordered eating may be a behavior used to 'medicate' or soothe feelings of depression or anxiety, and such behavior coupled with lower physical activity, social activity, or psychotropic medication use associated with depression and anxiety may make individuals more vulnerable to obesity. It is also possible that lifestyle factors associated with both psychiatric illness and obesity (e.g. smoking, lower physical activity, poor diet, alcohol use and low socio-economic status) contribute to patterns of comorbidity. Finally, there may be shared genetic and neurobiological mechanisms that put people, particularly women, at higher risk for both types of disorders. Both obesity and depression, for example, may share common characteristics related to dopamine systems, stress-related cortisol responses governed by the hypothalamic-pituitary-adrenal axis[25], and energy homeostasis involving the hormone leptin[26].

While the associations between obesity and internalizing disorders are significant in these data, no significant associations were observed for either gender group between BMI alcohol abuse/dependence, drug abuse/dependence or nicotine dependence. This is also consistent

with previous reports, which found that though there were some significant associations between higher weight groups and lifetime histories of substance use disorders, there were no significant associations with past-year disorders[15]. Some eating disorder literature has suggested that people with eating disorders use food as a drug, and thus become 'addicted' to food either when eaten in large quantities, or with high fat, sugar or salt content[13,27,28]. These findings suggest that obesity and substance use disorders might operate by different mechanisms, or if they operate by similar mechanisms, that they may do so competitively (e.g., the mechanisms underlying the motivational drives for excessive eating may be specifically directed towards food and not substances of abuse, and vice-versa). During active drug addictions, individuals may neglect other areas of life, including eating regularly. Different substances of abuse also influence appetite differently, with nicotine, cocaine and other stimulants tending to suppress hunger and cannabis tending to increase hunger, and these properties may influence associations between substance use disorders and elevated BMI. These and other possibilities warrant further examination. For example, obesity, particularly in women, may share more common elements, either functionally or biologically, with internalizing rather than externalizing disorders and future research should investigate how and why obesity is related to internalizing disorders and related constructs such as emotional regulation.

Obesity and Axis II Disorders

The personality disorder that arguably has elicited the most interest with respect to its relationship with obesity is borderline personality disorder, and virtually all of the research in this area was conducted with women. In both women entering treatment for obesity-related conditions (e.g. gastric surgery clinics) and obese women being seen in primary care settings, the prevalence of borderline personality is significantly higher than in the general population[11–14]. Clinically, this has been suggested as a probable intersection of several factors: a genetic vulnerability to obesity, which may be coupled with a genetic vulnerability to personality disorders; personality traits characterized by significant self-regulatory deficits that result in disordered eating and, ultimately, obesity; and environment or lifestyle factors such as poor diet in childhood, low socio-economic status, or early exposure to child abuse, all of which have been associated with obesity in adults, particularly women[11–14].

Borderline personality disorder was not assessed in the NESARC. However, our results indicate similar patterns of association between all three clusters of personality disorders and obesity in women, while similar patterns are not seen for men. The disorders with the strongest associations in women (avoidant, antisocial, and paranoid) share characteristics of removal from social interactions that may either be exacerbated by the stigma associated with obesity, or predispose an individual to engage in uninhibited eating behavior that may result in obesity. Future research is needed to examine the specific factors underlying the associations between obesity and personality disorders seen in women. As the presence of personality disorders has been found to complicate treatment outcome for obesity and psychiatric disorders, the findings highlight the need to screen for a broad range of personality disorders in overweight and obese women entering treatment, so that therapies can be appropriately tailored to their needs.

Strengths and Limitations

The study's strengths include its methodologically rigorous survey design, a large nationally representative sample, the inclusion of a wide range of DSM-IV Axis I and II disorders, the conception of BMI as a dimensional rather than a binary variable, and a high response rate (81%). This study also has several important limitations. First, the cross-sectional nature of the data precludes our ability to establish temporal patterns between obesity and psychiatric disorders. It is therefore possible to suggest several competing, although not necessarily

mutually exclusive, explanations, all of which are consistent with the data. Further clinical and longitudinal research will be needed to better understand these relationships. Second, BMI was calculated using self-reported height and weight. Self report may be inaccurate, and the inaccuracy may vary according to weight status or psychiatric illness in unknown ways. Additionally, although BMI is widely used as a measure of obesity, it is insensitive to weight from fat as opposed to weight from muscle. Thus, in men in particular, BMI may be over-estimated in those with higher muscle mass. Some other measures (e.g., waist circumference, fasting lipid profiles) have been found to track closely with measures of morbidity and mortality associated with obesity. Additional measures such as these would be helpful in future investigations to understand more precisely the nature of the observed associations in the present study.

Clinical Implications

These results have important clinical implications for both the prevention and treatment of obesity as well as the prevention, identification and treatment of psychiatric disorders. First, effective interventions involving screening for mental health disorders among overweight/ obese individuals, particularly women, should be employed, and screening for obesity in mental health care settings should be performed. Patients presenting in general medical settings with obesity, particularly morbid obesity, should be screened for the presence of psychiatric disorders. While this may be routine practice for some treatments, particularly gastric surgery procedures, such screening may not be uniformly employed in the primary care of overweight or obese patients. The presence of either Axis I or Axis II disorders could increase the risk for obesity by influencing the ability of affected patients to control their food intake. When treating individuals (particularly women) with psychotropic medications, particular consideration should be given with respect to associations with medications' influences on metabolism and potential weight gain. Psychiatric disorders might also have a significant impact on the likelihood of an individual entering into a weight control treatment plan and the likelihood of success on such a plan.

The second clinical implication is that weight management and the development of healthy eating behaviors should be an important part of the management and treatment of psychiatric disorders. While some weight problems in patients with psychiatric disorders may be in part attributable to medications or to genetic predispositions, the influence of lifestyle factors such as poor eating and exercise habits may be substantial. Therefore, education regarding healthy shopping and cooking, recognizing the role of food in the regulation of mood, and setting weight management goals should be considered as an important part of a treatment plan for an individual with a psychiatric disorder. Some recent work shows promise for the development of weight management programs for people with psychiatric disorders[29]. Public health interventions involving screening for mental health disorders among overweight/obese individuals, particularly women, should be developed and validated, as well as screening for obesity in mental health care settings.

Literature Cited

1. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. Jama. 2006 Apr 5; 295(13):1549–1555. [PubMed: 16595758]

2. Herva A, Laitinen J, Miettunen J, et al. Obesity and depression: results from the longitudinal Northern Finland 1966 Birth Cohort Study. Int J Obes (Lond). 2006 Mar; 30(3):520–527. [PubMed: 16302014]

3. Moreira RO, Marca KF, Appolinario JC, Coutinho WF. Increased waist circumference is associated with an increased prevalence of mood disorders and depressive symptoms in obese women. Eat Weight Disord. 2007 Mar; 12(1):35–40. [PubMed: 17384528]

4. Newcomer JW. Metabolic syndrome and mental illness. Am J Manag Care. 2007 Nov; 13(7 Suppl):S170–177. [PubMed: 18041878]

5. Scott KM, Bruffaerts R, Simon GE, et al. Obesity and mental disorders in the general population: results from the world mental health surveys. Int J Obes (Lond). 2008 Jan; 32(1):192–200. [PubMed: 17712309]

6. Scott KM, McGee MA, Wells JE, Oakley Browne MA. Obesity and mental disorders in the adult general population. J Psychosom Res. 2008 Jan; 64(1):97–105. [PubMed: 18158005]

7. Simon GE, Von Korff M, Saunders K, et al. Association between obesity and psychiatric disorders in the US adult population. Arch Gen Psychiatry. 2006 Jul; 63(7):824–830. [PubMed: 16818872]

8. Vila G, Zipper E, Dabbas M, et al. Mental disorders in obese children and adolescents. Psychosom Med. 2004 May-Jun;66(3):387–394. [PubMed: 15184702]

9. Lamertz CM, Jacobi C, Yassouridis A, Arnold K, Henkel AW. Are obese adolescents and young adults at higher risk for mental disorders? A community survey. Obes Res. 2002 Nov; 10(11):1152–1160. [PubMed: 12429879]

10. Anderson SE, Cohen P, Naumova EN, Jacques PF, Must A. Adolescent obesity and risk for subsequent major depressive disorder and anxiety disorder: prospective evidence. Psychosom Med. 2007 Nov; 69(8):740–747. [PubMed: 17942847]

11. Sansone RA, Sansone LA, Weiderman MW. The comorbidity, relationship and treatment implications of borderline personality and obesity. Journal of Psychosomatic Research. 1997; 43(5):541–543. [PubMed: 9394271]

12. Frankenburg FR, Zanarini MC. Obesity and obesity-related illnesses in borderline patients. Journal of Personality Disorders. 2006; 20(1):71–80. [PubMed: 16563080]

13. van Hanswijck de Jonge P, Vvan Furth EF, Lacey JH, Waller G. The prevalence of DSM-IV personality pathology among individuals with bulimia nervosa, binge eating disorder and obesity. Psychological Medicine. 2003; 33(7):1311–1317. [PubMed: 14580084]

14. Sansone RA, Wiederman MW, Sansone LA. The prevalence of borderline personality disorder among individuals with obesity: a critical review of the literature. Eating Behaviors. 2000; 1(1):93–104. [PubMed: 15001070]

15. Petry NM, Barry DT, Pietrzak RH, Wagner JA. Overweight and obesity are associated with psychiatric disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Psychosomatic Medicine. 2008; 70:288–297. [PubMed: 18378873]

16. Grant BF, Dawson DA, Stinson FS, S Chou P, Kay W, Pickering R. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. Drug & Alcohol Dependence. 2003; 71:7–16. [PubMed: 12821201]

17. Grant BF, Stinson FS, Dawson DA, et al. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders. Arch Gen Psychiatry. 2004; 61:807–816. [PubMed: 15289279]

18. Grant, BF.; Kaplan, K.; Shepard, J.; Moore, T. Source and Acuracy Statement for Wave 1 of the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2003.

19. American Psychiatric Association Committee on Nomenclature and Statistics. Diagnostic and Statistical Manual of Mental Disorders. 4. Washington, DC: American Psychiatric Association; 2000.

20. Grant BF, Hasin DS, Stinson FS, et al. Co-occurrence of 12-month mood and anxiety disorders and personality disorders in the US: results from the national epidemiologic survey on alcohol and related conditions. Journal of Psychiatric Research. 2005; 39:1–9. [PubMed: 15504418]

21. NIH. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report: National Heart, Lung, and Blood Institute in cooperation with the National Institute of Diabetes and Digestive and Kidney Diseases. Sep. 1998 1998Report No.: 98–4083

22. Research Triangle Institute. SUDAAN Software. 8.0.0. Research Triangle Park, NC: Research Triangle Institute; 2001.

23. Desai RA, Potenza MN. Gender differences in the associations between past-year gambling problems and psychiatric disorders. Soc Psychiatry Psychiatr Epidemiol. 2008 Mar; 43(3):173–183. [PubMed: 18080792]

24. Kendler KS, Prescott CA, Neale MC. The structure of genetic and environmental risk factors for common psychiatric and substance use disorders in women and men. Arch Gen Psychiatry. 2003; 60:929–937. [PubMed: 12963675]

25. Bornstein SR, Schuppenies A, Wong ML, Licinio J. Approaching the shared biology of obesity and depression: the stress axis as the locus of gene-environment interactions. Molecular Psychiatry. 2006; 11(10):892–902. [PubMed: 16880826]

26. Lu XY. The leptin hypothesis of depression: a potential link between mood disorders and obesity? Curr Opin Pharmacol. 2007 Dec; 7(6):648–652. [PubMed: 18032111]

27. Barry DT, Grilo CM, Masheb RM. Comparison of patients with bulimia nervosa, obese patients with binge eating disorder, and nonobese patients with binge eating disorder. J Nerv Ment Dis. 2003 Sep; 191(9):589–594. [PubMed: 14504568]

28. Bulik CM, Sullivan PF, Kendler KS. Medical and psychiatric morbidity in obese women with and without binge eating. Int J Eat Disord. 2002 Jul; 32(1):72–78. [PubMed: 12183948]

29. Melamed Y, Stein-Reisner O, Gelkopf M, et al. Multi-modal weight control intervention for people with persistent mental disorders. Psychiatr Rehabil J. 2008 Winter;31(3):194–200. [PubMed: 18194946]

Table 1

Associations between weight group and demographic characteristics stratified by gender

Variable	Males						Females					
	Under-weight n (%)	Normal weight n (%)	Over-weight n (%)	Obese n (%)	Morbidly obese n (%)	p	Under-weight n (%)	Normal weight n (%)	Over-weight n (%)	Obese n (%)	Morbidly obese n (%)	p
Education												
Less than high school	50 (27.95)	1,098 (15.99)	1,354 (14.92)	560 (16.61)	224 (17.58)	< 0.0001	138 (17.71)	1,487 (11.97)	1,388 (17.29)	798 (20.58)	485 (19.17)	< 0.0001
High school graduate	47 (32.39)	1,636 (27.34)	2,187 (28.21)	887 (30.15)	388 (34.87)		205 (30.39)	2,835 (27.62)	2,027 (30.30)	1,083 (32.01)	804 (35.53)	
Some college	41 (22.73)	1,683 (28.74)	2,201 (28.39)	891 (31.01)	352 (30.76)		191 (27.73)	3,140 (31.50)	2,015 (31.04)	1,017 (31.16)	729 (32.54)	
College or higher	27 (16.93)	1,568 (27.93)	2,143 (28.48)	616 (22.23)	206 (16.79)		165 (24.17)	2,797 (28.91)	1,352 (21.37)	535 (16.24)	304 (12.76)	
Employment												
Full time	73 (51.76)	3,455 (59.87)	5,174 (67.70)	1,915 (66.78)	754 (68.50)	< 0.0001	238 (34.35)	4,505 (43.63)	2,927 (42.33)	1,511 (44.13)	1,001 (42.21)	< 0.0001
Part time	14 (8.36)	525 (8.95)	484 (6.15)	160 (5.68)	58 (4.98)		94 (15.34)	1,382 (15.02)	775 (12.83)	388 (12.39)	228 (11.37)	
Not working	78 (39.88)	2,005 (31.18)	2,227 (26.15)	879 (27.54)	358 (26.51)		367 (50.31)	4,372 (41.35)	3,080 (44.85)	1,534 (43.48)	1,093 (46.42)	
Marital Status												
Married	50 (35.37)	2,810 (54.53)	4,833 (69.82)	1,868 (71.65)	674 (68.05)	< 0.0001	274 (49.51)	4,981 (58.96)	3,400 (61.99)	1,583 (58.76)	962 (54.04)	< 0.0001
Previously married	40 (17.97)	1,080 (11.64)	1,474 (12.09)	513 (11.67)	208 (11.13)		241 (26.02)	2,987 (20.68)	2,216 (23.48)	1,216 (26.09)	791 (25.76)	
Never married	75 (46.66)	2,095 (33.82)	1,578 (18.09)	573 (16.68)	288 (20.83)		184 (24.47)	2,291 (20.36)	1,166 (14.53)	634 (15.14)	569 (20.20)	
White race	125 (80.86)	4,617 (81.80)	6,387 (86.07)	2,306 (84.64)	875 (84.69)	0.0039	535 (79.13)	8,242 (85.23)	4,964 (82.37)	2,288 (78.29)	1,420 (74.55)	< 0.0001
Black race	27 (10.05)	1,005 (10.45)	1,230 (9.68)	578 (12.12)	280 (14.04)	0.0024	109 (8.90)	1,481 (7.98)	1,607 (13.74)	1,065 (18.43)	869 (22.89)	< 0.0001
Hispanic ethnicity	33 (14.34)	1,102 (11.61)	1,646 (12.53)	648 (12.50)	215 (11.43)	0.5816	81 (6.28)	1,811 (9.63)	1,438 (13.28)	697 (12.25)	399 (10.85)	0.0016
	mean (s.e.)	mean (s.e.)	mean (s.e.)	mean (s.e.)	mean (s.e.)	p	mean (s.e.)	mean (s.e.)	mean (s.e.)	mean (s.e.)	mean (s.e.)	p
Age in years	42.95 (2.01)	41.98 (0.30)	45.64 (0.27)	45.75 (0.34)	43.95 (0.45)	< 0.0001	44.70 (0.95)	44.15 (0.27)	48.21 (0.33)	48.33 (0.38)	46.37 (0.42)	< 0.0001
Income	39,683 (4,566)	54,141 (1,178)	61,553 (1,396)	57,087 (1,652)	54,519 (1,555)	< 0.0001	39,863 (4,566)	54,141 (1,178)	61,553 (1,396)	57,087 (1,652)	54,519 (1,555)	< 0.0001

Table 2

Prevalence of psychiatric disorders by gender and weight group.

Diagnosis	Males						Females					
	Under-weight n (%)	Normal weight n (%)	Over-weight n (%)	Obese n (%)	Morbidly obese n (%)	p	Under-weight n (%)	Normal weight n (%)	Over-weight n (%)	Obese n (%)	Morbidly obese n (%)	p
Any Axis I Disorder	43 (22.44)	1,454 (24.70)	1,685 (21.52)	691 (24.07)	307 (25.02)	.01	187 (26.32)	2,268 (22.70)	1,467 (22.66)	905 (27.37)	741 (33.95)	P<.001
Any Mood Disorder	23 (12.31)	482 (7.90)	472 (5.95)	235 (8.24)	122 (9.38)	P<.001	95 (13.45)	1,025 (10.00)	678 (10.13)	458 (13.56)	394 (17.75)	P<.001
Major Depression	16 (7.30)	341 (5.49)	312 (3.95)	162 (5.64)	91 (6.47)	P<.001	75 (10.63)	838 (8.28)	550 (8.31)	355 (10.75)	314 (14.57)	P<.001
Dysthymia	5 (3.00)	86 (1.20)	73 (0.85)	53 (1.84)	26 (2.08)	.02	20 (2.92)	184 (1.80)	149 (2.16)	102 (2.97)	122 (5.34)	P<.001
Mania	7 (5.33)	102 (1.75)	105 (1.31)	44 (1.48)	18 (1.58)	.21	19 (2.60)	147 (1.36)	109 (1.53)	70 (2.13)	88 (4.07)	P<.001
Hypomania	2 (0.98)	87 (1.59)	72 (1.05)	33 (1.26)	14 (1.13)	.45	6 (0.95)	105 (1.04)	68 (1.03)	55 (1.46)	32 (1.23)	.62
Any Anxiety Disorder	16 (8.03)	438 (7.12)	576 (7.45)	255 (8.87)	109 (9.06)	.07	109 (15.16)	1,227 (12.28)	883 (14.15)	550 (17.55)	468 (21.80)	P<.001
Panic Disorder[1]	3 (1.26)	74 (1.04)	108 (1.33)	38 (1.37)	24 (1.85)	.36	17 (2.40)	231 (2.33)	170 (2.93)	100 (2.97)	116 (5.65)	P<.001
Social phobia	6 (2.66)	131 (2.20)	152 (1.91)	76 (2.63)	28 (2.24)	.38	18 (1.92)	266 (2.76)	202 (3.51)	119 (3.74)	121 (6.38)	P<.001
Simple phobia	10 (4.04)	259 (4.34)	347 (4.43)	162 (5.47)	58 (5.12)	.29	77 (11.33)	795 (7.96)	603 (9.54)	382 (12.53)	285 (12.92)	P<.001
Generalized anxiety	4 (1.60)	77 (1.07)	92 (1.33)	36 (1.31)	21 (1.81)	.51	25 (3.21)	228 (2.23)	168 (2.64)	117 (3.90)	105 (4.78)	P<.001
Any SUD	20 (11.32)	910 (16.07)	990 (12.84)	347 (12.04)	140 (11.27)	P<.001	47 (6.58)	631 (6.68)	304 (4.98)	152 (4.50)	104 (4.64)	P<.001
Alcohol ab/dep[2]	17 (9.57)	818 (14.51)	923 (11.93)	323 (11.24)	126 (10.15)	P<.001	39 (5.55)	572 (6.05)	265 (4.27)	131 (3.68)	84 (3.88)	P<.001
Drug ab/dep	6 (3.05)	233 (4.13)	168 (2.33)	66 (2.11)	22 (1.89)	P<.001	15 (2.22)	131 (1.34)	69 (1.15)	33 (1.19)	28 (1.16)	.46
Nicotine dependence	29 (18.32)	963 (17.32)	891 (12.40)	363 (13.85)	138 (13.35)	P<.001	110 (15.47)	1,098 (11.50)	698 (11.80)	342 (11.31)	253 (11.34)	.24
Any Axis II Disorder	25 (14.00)	944 (16.21)	1,112 (14.11)	514 (17.56)	225 (20.12)	P<.001	111 (15.77)	1,271 (12.37)	943 (13.91)	575 (17.40)	475 (21.17)	P<.001
Any Cluster A	11 (6.78)	398 (6.54)	411 (4.77)	215 (6.47)	100 (8.96)	P<.001	59 (7.03)	579 (5.08)	501 (6.69)	306 (8.89)	272 (11.51)	P<.001
Paranoid	7 (4.22)	276 (4.63)	265 (3.01)	142 (3.98)	62 (5.27)	P<.001	45 (5.03)	439 (3.75)	379 (5.02)	234 (6.91)	209 (8.70)	P<.001
Schizoid	6 (5.20)	211 (3.36)	224 (2.70)	103 (3.47)	56 (5.27)	.02	29 (3.99)	258 (2.23)	237 (3.16)	146 (4.08)	130 (5.80)	P<.001
Any Cluster B	12 (5.81)	428 (7.82)	424 (5.51)	217 (7.71)	106 (9.22)	P<.001	31 (4.13)	299 (2.85)	253 (3.95)	122 (3.37)	125 (5.37)	0.0017
Histrionic	6 (3.09)	141 (2.42)	109 (1.42)	63 (1.76)	35 (2.75)	.01	21 (2.63)	179 (1.68)	120 (1.84)	62 (1.66)	62 (2.65)	.19
Antisocial	9 (4.04)	332 (6.29)	353 (4.60)	171 (6.42)	82 (7.15)	P<.001	16 (2.31)	152 (1.39)	150 (2.40)	67 (1.90)	78 (3.33)	P<.001
Any Cluster C	13 (7.19)	453 (7.93)	601 (7.83)	260 (8.91)	104 (9.18)	.37	54 (9.17)	752 (7.73)	503 (7.76)	312 (9.87)	262 (11.72)	0.0011
Avoidant	9 (2.94)	123 (2.25)	116 (1.55)	67 (2.38)	24 (1.92)	.06	14 (1.31)	215 (2.14)	173 (2.64)	119 (3.82)	120 (5.93)	P<.001
Dependent	2 (0.53)	25 (0.55)	17 (0.23)	11 (0.26)	6 (0.66)	.14	7 (0.98)	41 (0.39)	38 (0.59)	26 (0.72)	30 (1.46)	.01
Obsessive-compulsive	12 (7.04)	447 (7.73)	594 (7.77)	257 (8.84)	99 (8.63)	.43	50 (8.67)	730 (7.49)	482 (7.41)	299 (9.49)	245 (10.92)	P<.001

[1] With or without agoraphobia

[2] ab/dep = abuse or dependence

Table 3

Associations between psychiatric disorders and weight group, by gender.

Diagnosis	Male				Females				Interactions with gender (females vs males)			
	OR for underweight vs. normal weight	OR for overweight vs normal weight	OR for obese vs normal weight	OR for morbidly obese vs normal weight	OR for underweight vs. normal weight	OR for overweight vs normal weight	OR for obese vs normal weight	OR for morbidly obese vs normal weight	underweight	overweight	obese	morbidly obese
Any Axis I Disorder	0.84	1.07	1.27*	1.26*	1.19	1.18*	1.55*	2.02*	1.37	1.15	1.26*	1.65*
Any Mood Disorder	1.53	0.96	1.39*	1.53*	1.3	1.20*	1.68*	2.18*	0.82	1.27*	1.23	1.45*
Major Depression	1.23	0.90	1.32*	1.47*	1.22	1.19*	1.61*	2.16*	0.94	1.33*	1.21	1.46*
Dysthymia	2.09	0.88	1.91	2.04	1.39	1.23	1.68*	2.89*	0.61	1.47	0.93	1.50
Mania	3.06*	1.01	1.13	1.14	1.52	1.26	1.73*	3.04*	0.53	1.22	1.53	2.7*
Hypomania	0.56	0.99	1.30	1.05	0.81	1.26	1.8*	1.40	1.50	1.37	1.53	1.49
Any Anxiety Disorder	1.14	1.18*	1.43*	1.43*	1.24	1.28*	1.67*	2.13*	1.05	1.1	1.18	1.51*
Panic Disorder[1]	1.19	1.55*	1.59	2.2*	0.87	1.34*	1.36	2.53*	0.73	0.87	0.88	1.23
Social phobia	1.17	1.03	1.43	1.16	0.65	1.42*	1.53*	2.59*	0.54	1.41	1.09	2.3*
Simple phobia	0.95	1.14	1.41*	1.29	1.44*	1.3*	1.77*	1.79*	1.48	1.18	1.30	1.43*
Generalized anxiety	1.45	1.44	1.40	1.85*	1.35	1.31*	1.96*	2.31*	0.90	0.91	1.38	1.22
Any SUD	0.61	1.02	0.98	0.84	0.98	1.04	0.96	0.94	1.57	0.93	0.87	0.99
Alcohol ab/dep[2]	0.58	1.05	1.02	0.84	0.92	0.99	0.87	0.88	1.57	0.86	0.76	0.92
Drug ab/dep	1.01	.78*	0.86	.75*	1.28	1.19*	1.08	0.99	1.27	1.49*	1.22	1.31
Nicotine dependence	0.60	0.90	0.83	0.65	1.41	1.22	1.28	1.09	2.34	1.31	1.47	1.61
Any Axis II Disorder	0.83	0.98	1.26*	1.43*	1.29	1.28*	1.65*	2.00*	1.55	1.28*	1.28*	1.37*
Any Cluster A	0.94	0.85	1.13	1.50*	1.24	1.40*	1.81*	2.21*	1.35	1.59*	1.53*	1.42*
Paranoid	0.79	.77*	0.99	1.20	1.17	1.42*	1.88*	2.2*	1.49	1.76*	1.79*	1.72*
Schizoid	1.53	0.93	1.17	1.74*	1.65*	1.45*	1.8*	2.38*	1.11	1.52*	1.53*	1.40
Any Cluster B	0.67	0.86	1.24	1.41*	1.28	1.72*	1.41*	2.09*	1.98	1.87*	1.07	1.44
Histrionic	1.16	0.79	0.97	1.41	1.45	1.33	1.17	1.69*	1.22	1.65*	1.17	1.18
Antisocial	0.57	0.89	1.27	1.33	1.35	2.16*	1.65*	2.68*	2.57	2.23*	1.21	1.93*
Any Cluster C	0.98	1.06	1.22*	1.25*	1.26	1.13	1.50*	1.78*	1.28	1.06	1.21	1.40*
Avoidant	1.14	0.91	1.41	1.05	.51*	1.43*	2.09*	3.06*	0.44	1.57*	1.47	2.95*
Dependent	0.80	0.66	0.66	1.62	1.77	1.55	1.87*	3.32*	2.12	2.41	2.79*	2.14
Obsessive-compulsive	0.98	1.07	1.23*	1.19	1.24	1.11	1.48*	1.71*	1.23	1.03	1.19	1.41*

[**] logistic regression models are adjusted for age, race/ethnicity, income, education, marital status, and employment