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Which Measures of Obesity Are Related to Depressive Symptoms and in Whom?

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Abstract

The authors asked which obesity measurements were associated with depressive symptoms, whether this relationship differed by gender, and whether controlling for fatigue and response bias affected the relationship. A sample of 129 subjects (66 men, 63 women), with a mean age of 36.9 years and a mean Body Mass Index (BMI) of 26.4 participated in the study. Depressive symptoms, levels of fatigue, response bias, and anthropometrics were assessed. In women, but not men, BMI and percent of ideal body weight were related to depression. However, percent of body fat did not show a relationship with depression after controlling for fatigue and response bias. These findings suggest that women's depressive symptoms are more influenced by body size than body fat composition, whereas men's depressive symptoms seem to be unrelated to obesity.

The prevalence of overweight or obesity in the adult United States population has increased by as much as 60% in the last decade,¹ making it a major health problem. Obesity is associated with depression,^{2,3} but not in a simple or single association;⁴ the relationship between depression and obesity is likely affected by several confounding factors.⁵ A major difficulty in understanding the association between depression and obesity is that some obese persons may not seek treatment when they become depressed. Thus, the nature of depressive symptoms in non-treatment-seeking obese persons is uncertain.

Moreover, some studies have found in their samples that obesity does not relate to depression. In a review of studies in this area, Friedman and Brownell⁶ reported that many studies have failed to find significant differences in depressive symptoms between obese and non-obese individuals. These researchers speculated that underlying this null finding was considerable study heterogeneity. Thus, they proposed a risk-factor model to identify individuals who are most at risk for poor quality of life due to obesity and to understand those areas of functioning most affected. One factor that may influence the relationship between obesity and depression is gender. Istvan et al.⁷ found no significant relationship between obesity and depression in 1,237 men, whereas obesity was significantly associated with increased depression among 1,616 women.

Traditionally, women are believed to be more sensitive to their weight and obesity than men. Faith et al. found a positive relationship between neuroticism and body mass index (BMI) in women, but not in men.⁸ More strikingly, Carpenter et al. reported that obesity in women was

associated with a 37% increase in the prevalence of major depression, whereas, among men, obesity was associated with a decrease in the prevalence of major depression.⁹

Fatigue is also a frequent complaint in obese individuals. Excessive body fat has adverse consequences on the immune system, mediated via increased inflammatory cytokines.^{10,11} Moreover, fatigue in obesity can be caused by increased sleep problems, comorbid medical illness, psychiatric disorders, and unexplored metabolic processes related to obesity per se, beyond inflammatory cytokines.¹²

Fatigue is a common symptom in mood disorders and is one of the key diagnostic symptoms of major depressive disorder, bipolar disorder, and dysthymic disorder.¹³ Investigators have also suggested that fatigue and depression are overlapping conditions that may share similar underlying mechanisms.^{14,15} Moreover, lower vitality or slower bodily activity from overweight might be confused with depression and fatigue. Yancy et al.¹⁶ reported that higher BMI was associated with lower vitality in 1,168 male veterans.

There are different ways to conceptualize obesity; some of which use highly technical methods to assess body fat, whereas others are more related to appearance. By definition, obesity implies excessive body fat, not excessive relative weight.¹⁷ Of course, increased body fat is usually accompanied by increased total body mass, so indices of relative weight are commonly used to diagnose obesity and to track progress in the treatment of the obese person.¹⁸ One of the commonly used indices of relative weight is the BMI (defined as body weight [in kilograms] divided by the square of the height [m²]), which accurately predicts obesity-related morbidity and mortality.¹⁹ In the early 1920s, Metropolitan Life Insurance Company began to publish tables of ideal, desirable, or what might be more appropriately called healthy weights, by virtue of the lower mortality rates associated with those weights.²⁰ Bioelectrical impedance measurements can be used to provide an index of body water; this technique calculates percent of body fat (percent fat) and lean mass by using resistance ohms.²¹

This study examined the link between obesity and depressive symptoms in otherwise healthy subjects. First, we wanted to find out which obesity measurements are linked with such symptoms. Next, we examined whether the relationship between depression and obesity differed between male and female subjects. Because fatigue symptoms influence both depression and obesity, and because self-report of mood is susceptible to socially-desirable responding, we examined the relationship between depression and obesity by gender after controlling for response bias and fatigue symptoms.

METHOD

Subjects

A group of 129 subjects (66 men, 63 women) were recruited through advertisements and word-of-mouth referral. Subjects were studied after we obtained written informed consent that was approved by the University of California, San Diego Institutional Review Board.

We limited enrollment to subjects between the ages of 25 and 50 years; participants >200% of ideal body weight were excluded to avoid confounding other medical conditions associated with extreme morbid obesity.²² Subjects were excluded if they had a psychiatric disorder, any medical problems, or were taking prescription medication.

Anthropometric Data Measures

Subjects were instructed to remove their shoes, articles in their pockets, and exterior clothing other than a light shirt and pants. Weight was measured to the nearest 0.1 kg, and height was

assessed to the nearest 0.1 cm. Weight and height were used to compute BMI as Kg/m². Ideal body weight was determined with Metropolitan Life tables.²³

Percent of body fat was measured by the RJL Bio-electrical Impedance System and Cyprus 1.2 Body-Composition Analysis software (Clinton Twp., MI). The reliability of bioelectrical impedance assessment was reported to be from 0.972 to 0.983, depending on the part assessed.²⁴

Formulas using resistance ohms were used to calculate lean mass, and lean mass with body weight was used to calculate percent of body fat.

Psychological Evaluation

Participants completed the Center for Epidemiologic Studies–Depression Scale (CES–D), a frequently-used self-report scale that has been shown to be reliable and valid for assessing depression symptoms.²⁵

Participants completed the short form of Profile of Mood States (POMS–SF).²⁶ We were interested in the POMS–SF Depression/Dejection subscale and Fatigue/ Inertia subscale. The POMS–SF Depression/Dejection subscale measures personal worthlessness, hopelessness, desperation, emotional isolation, sadness, and guilt. The POMS–SF Fatigue/Inertia subscale measures weariness, inertia, and low energy level. The reliability of both two subscales of the POMS–SF is well established; their internal-consistency reliability coefficients range from 0.81 to 0.91.

Participants also completed the Marlowe-Crowne Social Desirability Scale (MCSDS), a commonly used measure of response bias. Elevated scores suggest that a participant may be defensive and understating his or her true experience of psychological symptoms.^{27,28}

Statistical Analysis

In order to examine gender differences in participant characteristics, we analyzed the data with independent *t*- tests. Next, we examined the relationship between obesity measures and scores on the MCSDS, POMS–SF Fatigue, and depressive symptoms with simple correlations and partial correlations.

To investigate the relative importance of the individual variables, we conducted a hierarchical linear-regression analysis in women, with CES–D score as the dependent variable. MCSDS scores were entered on Step 1 of the model in order to control for response bias. POMS–SF Fatigue scores were entered at Step 2, and BMI was entered at Step 3 of the model. Because of the multicollinearity between BMI and other obesity measures, BMI was chosen as the most salient obesity-related measure. The same analysis was repeated with POMS–SF Depression as the dependent variable in order to assess this relationship across multiple measures of depression.

RESULTS

Participant characteristics are presented in Table 1. The range of BMI was 18.3–37.9 for men and 18.0–40.4 for women. There were no significant differences for average systolic or diastolic blood pressure, BMI, CES–D scores, or POMS–SF Depression scores between men and women. However, women showed higher percent fat ($p=0.01$) and higher scores on POMS–SF Fatigue ($p=0.05$).

As can be seen in Table 2, bivariate correlations showed that BMI was positively associated with CES–D ($r=0.221$; $p<0.01$) and POMS Depression ($r=0.258$; $p<0.01$). Percent fat was

unrelated to CES-D or POMS-SF Depression scores. However, percent fat was positively associated with POMS Fatigue scores ($r=0.247$; $p<0.01$). As expected, scores on Social Desirability were negatively correlated with CES-D ($r = -0.264$; $p<0.01$) and POMS-SF Depression ($r = -0.196$; $p<0.05$). Scores on POMS-SF Fatigue were positively associated with BMI ($r=0.184$; $p<0.05$) and percent fat ($r=0.247$; $p<0.01$). Fatigue was also positively associated with both CES-D ($r=0.538$; $p<0.01$) and POMS Depression ($r=0.538$; $p<0.01$).

Table 3 depicts relationships between obesity measures and depressive symptoms after controlling for social desirability in partial correlations. These analyses showed that both obesity measures were significantly associated with CES-D and POMS-SF Depression scores in the total sample (p values <0.05). Associations between the variables were then examined in men and women separately. These analyses revealed that neither of the obesity measures related to depressive symptoms in men. However, the association between the obesity measures and depressive symptoms remained significant in women (p values <0.05).

Partial correlations were also conducted to control for scores on both the MCSDS and POMS-SF Fatigue, because of the significant relationship between POMS-SF Fatigue and all obesity measures. BMI was significantly associated with CES-D ($r=0.235$; $p<0.05$) and POMS-SF Depression ($r=0.305$; $p<0.05$) in the total sample. In contrast, percent fat was no longer related to either CES-D or POMS-SF Depression scores. An examination of the relationship between the variables in men and women separately revealed that there was a significant relationship between obesity and depressive symptoms in women, but not in men. Women with higher BMIs had higher CES-D ($r=0.336$; $p<0.05$) and POMS Depression ($r=0.291$; $p<0.05$) scores (Table 3).

To investigate the relative importance of these predictors of depressive symptoms, we conducted a hierarchical linear-regression analysis using CES-D as the dependent variable. Since there was no relationship between obesity and depression in men, these analyses were conducted in women only. The overall model explained 35.4% of the variance in depressive symptoms significantly ($p<0.001$). At Step 1, MCSDS accounted for 11.6% of the variance in CES-D scores ($p=0.007$). At the second step, the POMS-SF Fatigue variable accounted for an additional 19.7% of the CES-D variance ($p<0.001$). After we controlled for fatigue and social desirability, BMI accounted for 7.4% of the variance in CES-D scores ($p=0.011$). However, when BMI was replaced with Fatigue at Step 3, percent fat was not significantly related to CES-D scores.

When we repeated the hierarchical linear-regression using POMS-SF Depression as a dependent variable, we obtained similar findings. The overall model explained 31.8% of the variance in depressive symptoms ($p<0.001$), and BMI accounted for an additional 8.3% of the variance in POMS-SF Depression ($p=0.008$) after controlling for response bias and fatigue symptoms.

DISCUSSION

Obesity is a major health problem, and it has been linked to greater depression in previous studies.^{2,3} Also, gender differences have been observed in the relationship between anthropometric measures and depressive symptoms.⁷⁻⁹ We asked which obesity measures would be associated with depression scores and whether these relationships would differ for men and women after we controlled for response bias and fatigue symptoms.

We found that BMI was related to depressive symptoms, as measured with the CES-D and the POMS-SF Depression scale. This finding emerged even after controlling for social desirability and fatigue. Interestingly, however, percent fat was unrelated to depressive symptoms after fatigue symptoms were taken into account. Fat composition was highly correlated with fatigue

symptoms. Thus, after controlling for fatigue, the relationship between percent fat and depressive symptoms was no longer significant.

When we examined the relationship between obesity and depressive symptoms in each gender separately, we found that obesity was related to depressive symptoms in women, but not in men. Next, we re-ran the analyses, controlling for both MCSDS and POMS–SF Fatigue subscale scores. In women, the relationships between BMI and depressive symptoms remained; however, the relationship between percent fat and depressive scores disappeared. There was no significant relationship between obesity measures and subjective feelings of depression in men.

Our results suggest that depressive symptoms in women may be more influenced by body size than actual amount of body fat and that men's depression scores are relatively unrelated to diverse measures of obesity. This supports other studies that have reported female-gender specificity in the association between obesity and neuroticism/depression.^{8,9}

The current finding that women's body size is related to depression contrasts with previous reports where no such correlations were observed.⁶ This discrepancy may stem from a few factors, including differences in subject characteristics and the use of social desirability as a covariate. Since women are prone to social pressure regarding their physical fitness, controlling for social desirability may have enabled us to detect relationships between variables that would likely be concealed by response bias.

Interestingly, percent of fat was more strongly associated with fatigue than with depression in our sample. Individuals with higher percent of fat were more likely to report experiencing fatigue. Percent of body fat is associated with increased inflammatory cytokines, sleep problems, and comorbid medical and psychiatric disorders that are known to cause fatigue. Furthermore, research suggests that physical inactivity is associated with greater reports of fatigue.²⁹ Thus, these factors may be underlying mechanisms that explain high levels of fatigue among individuals with higher percent of fat in our study.

When all pertinent variables were considered together in a regression model, even after controlling for response bias and fatigue, BMI explained a significant portion of the variance in depression. This suggests that obesity is related to depressive symptoms beyond the relationship explained by response bias and fatigue.

It is estimated that over 60% of men and 50% of women in the United States are currently overweight.³⁰ In the general population, being overweight is significantly associated with reduced satisfaction with general health, physical functioning, and vitality.³¹ However, regardless of health issues, weight-related perceptions are influenced by social norms and the standards of the culture.³² For instance, during the growth-spurt period, boys experience positive feelings toward body change in muscularity, whereas girls become more dissatisfied with their body owing to a perception of body-fat accumulation.³³ This may explain why obesity was related to depression in women but not men in our study.

Because of the cross-sectional nature of this study, we could not determine the direction of causality between anthropometric measures and depression. Negative self-perception, teasing, or psychosocial stigmatization, disordered eating, and stress in obese people might increase depressive feelings in women. Although the inverse is also possible, it may be uncommon in the general population. Roberts et al.² reported that obesity at baseline was associated with increased risk of depression after 5 years, even after controlling for confounding variables. On the contrary, depression did not increase the risk of future obesity in their study.

Because of the possibility of confounding by other conditions associated with extreme morbid obesity, this study was limited to participants with $\leq 200\%$ of ideal body weight. However, it is possible that the risk of depression is greater among individuals who are morbidly obese. Onyike et al.³⁴ reported that obesity was associated with depression mainly among persons with severe obesity.

The subjects of this study were healthy volunteers, and only 29.2% of the total of subjects reported CES-D scores that exceed the cutoff score of 16, suggesting a diagnosable mood disorder. Therefore, further studies may find it useful to include subjects who have been diagnosed with depression and/or morbidly obese subjects.

This study examined relationships between body size/fat composition and negative affect. We found gender differences in these relationships, such that BMI and percent fat were associated with more depression in women, but not in men. This suggests that higher rates of depressive symptoms among women with a larger body size may be driven by increasing social pressure to be “thin” and an obsession for physical fitness. It is also noteworthy that the association between percent of fat and depression was no longer significant after we controlled for fatigue. Analyses revealed that percent fat was more closely related to fatigue than to depression. This suggests that physiological factors associated with increasing fat composition may explain the positive relationship between percent fat and fatigue, whereas body-image concerns in individuals with higher BMIs may explain the association between BMI and depression. More research should be conducted to identify the distinct mechanisms underlying the increased depressive symptoms in individuals with larger body size and greater fatigue symptoms in those with higher fat composition.

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TABLE 1**Demographic and Clinical Characteristics of Study Subjects**

Characteristic	Men (N = 66)	Women (N = 63)
Age, years	37.7 ± 7.4	36.9 ± 8.1
Average systolic blood pressure, mmHg	131.5 ± 12.7	121.1 ± 14.9
Average diastolic blood pressure, mmHg	77.5 ± 9.3	73.3 ± 10.5
Body Mass Index (Kg/m ²)	27.0 ± 5.7	26.9 ± 6.3
Ideal Body Weight, proportion	1.17 ± 0.25	1.17 ± 0.27
Body fat, % ^{**}	20.8 ± 7.8	37.7 ± 10.6
CES-D	11.3 ± 10.5	11.3 ± 9.6
POMS-SF Depression	3.7 ± 5.4	3.7 ± 5.0
POMS-SF Fatigue [*]	3.7 ± 3.6	4.8 ± 4.1

CES-D: Center for Epidemiologic Studies-Depression Scale; POMS-SF: Profile of Mood States-Short Form.

* p < 0.05, independent *t*-test.

** p < 0.01, independent *t*-test.

Univariate Relationships (*r*) Between Obesity Indices, Scores on the M-C Social Desirability Scale, POMS-SF Fatigue scale, and Depressive Symptoms in Total Subject Group (N = 129)

	BMI	% Fat	CES-D	POMS-SF Depression	MC-Social Desirability	POMS-SF Fatigue
BMI						
% Fat	0.619**					
CES-D	0.221**	0.126				
POMS-SF Depression	0.258**	0.107	0.747**			
M-C Social Desirability	0.136	0.084	-0.264**	-0.196*		
POMS-SF Fatigue	0.184*	0.247**	0.538**	0.538**	-0.167	

BMI: Body Mass Index; % Fat: percent body fat; CES-D: Center for Epidemiologic Studies–Depression Scale; POMS-SF: Profile of Mood States–Short Form; MC Social Desirability: Marlowe-Crowne Social Desirability Scale score.

* *p* <0.05, univariate correlation.

** *p* <0.01, univariate correlation.

Partial Correlations (*r*) Between Obesity Indices and Depressive Symptoms in All Participants, Controlling for Scores on the Marlowe-Crowne Social Desirability Scale (MCSDS) and Profile of Mood States (POMS) Fatigue Scores

TABLE 3

	CES-D			POMS-SF Depression		
	All	Men	Women	All	Men	Women
After controlling for scores on the MCSDS:						
BMI	0.305**	0.142	0.459**	0.306**	0.160	0.446**
% Fat	0.204*	0.114	0.333*	0.144	0.057	0.281*
After controlling for scores on the MCSDS and POMS Fatigue scores:						
BMI	0.235*	0.193	0.336*	0.233*	0.209	0.291*
% Fat	0.086	0.176	0.203	0.006	0.108	0.106

BMI: Body Mass Index; % Fat: percent body fat; CES-D: Center for Epidemiologic Studies–Depression Scale; POMS-SF Profile of Mood States–Short Form.

* *p* <0.05, partial correlations.

** *p* <0.05, partial correlations.