

Depression in Association With Severe Obesity

Changes With Weight Loss

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Background: The relationship between depression and severe obesity is unclear. We examined depression before and after surgically induced weight loss.

Methods: Beck Depression Inventory (BDI) questionnaires were completed before and at yearly intervals after gastric-restrictive weight-loss surgery. We used the BDI scores of 487 consecutive patients to identify predictors of depression. Scores from all completed questionnaires were used to follow changes with time. Paired preoperative and 1-year postoperative scores (n=262) were used to identify predictors of change in BDI score.

Results: For the 487 subjects, the mean±SD preoperative BDI score was 17.7±9.5. Higher scores, indicating increased symptoms of depression, were found in younger subjects, women, and those with poorer body image. These factors had independent effects. We found no as-

sociation between BDI and waist circumference or insulin concentrations. High BDI scores correlated with poorer physical and mental quality-of-life measures. Weight loss was associated with a significant and sustained fall in BDI scores, with a mean±SD score of 7.8±6.5 at 1 year and 9.6±7.7 at 4 years after surgery. Greater falls in BDI score at 1 year were seen in women, younger subjects, and those with greater excess weight loss (combined $r^2=0.10$; $P<.001$). Fall in BDI score correlated with improvement in appearance evaluation ($r=-0.31$; $P<.001$).

Conclusions: Severely obese subjects, especially younger women with poor body image, are at high risk for depression. We found sustained improvement with weight loss. These findings also support the hypothesis that severe obesity causes or aggravates depression.

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OBESITY IS the most common chronic physical illness in modern society, and depression is the most prevalent psychological condition. Despite the high prevalence of these conditions, exploration of any association between them has been limited. The nature of the relationship between obesity and depressive illness remains unclear, with data more suggestive of a positive relationship rather than the "fat and jolly" hypothesis.^{1,2} Many studies have shown an increase in the prevalence of depression and psychological illness in obese subjects, including children³⁻¹⁰; however, a causal relationship has not been established.

A number of mechanisms exist through which depression and obesity may be linked or interact. Symptoms of depression correlate significantly with reported body image dissatisfaction.¹¹⁻¹³ The severely obese person certainly suffers stigmatization, discrimination,^{14,15} and major psychosocial disturbance,¹⁶ which may

cause or aggravate a depressive illness. In addition, repeated failed attempts to lose weight are the norm, and this failure may be accompanied by thoughts of guilt, hopelessness, and poor self-esteem.¹⁷ Obesity is associated with a high prevalence of binge eating disorder, which is frequently accompanied by depression and seen more commonly in those attempting to lose weight.^{18,19} Serious health consequences and physical disability often accompany severe obesity, and these in turn may aggravate depression. Alternative hypotheses link the development of obesity to depression. Obesity may develop as a result of reduced interest and enjoyment of physical activity or, in susceptible subjects, increased appetite for energy-rich comfort foods. Depression in children has been positively associated with adult body mass index (BMI; calculated as weight in kilograms divided by the square of height in meters),²⁰ and depression in adolescence tends to exaggerate weight change tendencies, with leaner subjects becoming leaner adults and heavier subjects becoming heavier adults when compared

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with nondepressed controls.²¹ Adolescent pregnant girls with poor self-esteem and symptoms of depression tended to deposit excessive fat during pregnancy.²² Obesity can be associated with secondary gain; eg, subjects who have experienced sexual abuse may feel threatened by appearing physically attractive.^{23,24} Another possibility is that medication used to treat depression may lead to weight gain.²⁵ Finally, all of the above conditions may be genetically related, with first-degree relatives of obese subjects more likely to experience a range of psychiatric conditions, including depression.²⁶

Improvement in depression has been reported after significant weight loss after bariatric surgery²⁷⁻²⁹ and behavioral and dietary interventions.^{30,31} One study also found that patients with symptoms of depression lost more weight after gastroplasty.³² However, study findings have not been universally positive. Waters et al³³ reported the mental health outcomes after gastric bypass surgery and found improvement in the first 6 to 12 months but a return to preoperative levels by 2 years, with note of several late suicides. A small study of 21 subjects reported an increase in depression in subjects who successfully lost weight after gastroplasty. These authors hypothesized that marked weight loss may lead to problems of adaptation that may trigger depressive reactions.³⁴

Is depression a comorbidity of obesity? The American Obesity Association defines a comorbidity as any condition associated with obesity that usually worsens as the degree of obesity increases and that often improves as the condition is treated.^{35,36} Although there would appear to be good evidence of a positive relationship between obesity and depression, it is unclear what impact weight loss has on depression. It is also unclear which obese subjects are at greatest risk for depression. If depression is a true comorbidity of obesity, then we hypothesize that a positive association exists between obesity and depression and that sustained weight loss should produce a sustained reduction in measures of depression. In addition, we hypothesize that greater falls in measures of depression should occur in those with greater weight loss and in groups with greater risk for obesity-associated depression. The aim of our study was to explore these hypotheses.

We have used the 21-item Beck Depression Inventory (BDI) as a measure of the characteristic attitudes and symptoms of depression in severely obese subjects presenting for the Bioenterics Lap-Band System of gastric-restrictive weight-loss surgery (Inamed Health Corporation, Santa Barbara, Calif; hereafter referred to as Lap-Band surgery). We have used the BDI to help assess the risk for depression within groups, not to diagnose depression in any given patient. The BDI was completed in a self-reported, written manner. In addition, subjects have completed the same instrument at yearly intervals after Lap-Band surgery. The BDI³⁷ has been used for longer than 40 years as a measure of depression. It has been validated and used in different ethnic groups, subjects with coexistent medical conditions, and obese subjects.^{6,38-41}

Our study had the following 3 aims:

1. To look for predictors of depression, as measured by the BDI, in consecutive severely obese subjects presenting for Lap-Band surgery.

2. To assess for any change in BDI score with weight loss after Lap-Band surgery.

3. To look for predictors of any change in the BDI after Lap-Band surgery.

METHODS

Patients with a BMI of greater than 35 and significant medical, physical, and/or psychosocial disabilities and in whom significant attempted weight reduction by other means had failed for at least 5 years were considered for surgery. In all cases, a physician referred the patient for consideration of obesity surgery. Fewer than 10% of those referred specifically for obesity surgery decided not to proceed. We did not survey those who chose not to proceed with surgery. Preoperative assessment included medical assessment, documentation of comorbidity, anthropometric measurements, biochemical tests, and completion of standardized questionnaires, including the BDI. The same assessment has been made at yearly intervals after surgery as part of a comprehensive follow-up program. Informed written consent was obtained from all patients before surgery. The study has been performed in accordance with the Declaration of Helsinki.

The Lap-Band system consists of a band of silicone elastomer with an inflatable inner shell and a buckle closure connected by tubing to an access port placed outside the abdominal cavity. The inner diameter of the band can be readily adjusted by the addition or removal of isotonic sodium chloride solution through the access port. The band is placed laparoscopically around the upper stomach, approximately 1 cm below the esophagogastric junction. The procedure has been shown to be very safe, effective, and minimally invasive. The adjustability provides a unique ability to alter the degree of restriction for a gentle, progressive, and durable weight loss.⁴²

PATIENT SELECTION

The use of BDI was commenced in January 1999, and since then, 487 patients admitted to the surgical weight-loss program have completed the BDI in addition to the other measures. The data from these patients have been used to look for predictors of depression in obese patients (aim 1).

When we commenced the comprehensive preoperative assessment, including the BDI questionnaire, we also began administering the questionnaire to subjects attending for annual follow-up review. Thus, not all subjects who completed yearly follow-up questionnaires completed the preoperative questionnaire. The responses to preoperative and yearly follow-up questionnaires have been used to evaluate the mean BDI scores in groups based on the time the questionnaire was completed after Lap-Band surgery (aim 2).

We used paired preoperative and 1-year data from the 262 available patients who have completed the preoperative and 1-year postoperative questionnaires to identify predictors of change in BDI score with weight loss (aim 3).

Self-administered questionnaires included the following. The BDI was used to assess characteristic attitudes and symptoms of depression and, therefore, the risk for depression within a population. We have not made a clinical diagnosis of depression, using the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV)* criteria,⁴³ in individual cases, and therefore we have used the BDI to measure the characteristic attitudes and symptoms of depression within groups. The full 21-item version was used and total scores were calculated. There was no secondary analysis or subanalysis of specific items or groups of items. We have chosen to use the following cutoff values for grouping total BDI scores: reference group, 0 to 9; mild depressive symptoms, 10 to 15; moderate depressive symp-

Table 1. Consecutive Severely Obese Subjects (N = 487) Grouped by Their Preoperative BDI Score*

	Depression Symptoms (BDI Score)				P Value†	Whole Group
	Reference (0-9)	Mild (10-15)	Moderate (16-22)	Major (≥23)		
No. of subjects	105	122	118	142		487
Age, y	42.7 ± 10 ^b	43 ± 9 ^b	41.4 ± 10 ^b	38.2 ± 9.5 ^a	<.001	41.2 ± 9.7
% Male‡	27	13	14	10	.003	15
BMI	44.3 ± 7	43.3 ± 8	44.7 ± 7	44.2 ± 7	.52	44.1 ± 7.4
Appearance evaluation	1.90 ± 0.6 ^b	1.71 ± 0.5 ^b	1.67 ± 0.5	1.40 ± 0.5 ^a	<.001	1.65 ± 0.9
ESS	6.0 ± 4.7 ^a	7.4 ± 5.1	8.2 ± 5.2 ^b	8.5 ± 5.1 ^b	.002	7.6 ± 5.1
Poor sleep quality, %‡	9	15	22	33	<.001	21
SF-36 MCS§	53.1 ± 6	48.4 ± 8	43.9 ± 6	38.1 ± 6	<.001	45.3 ± 8.6
% Taking antidepressant medication‡	7	16	27	31	<.001	21

Abbreviations: ANOVA, analysis of variance; BDI, Beck Depression Inventory; BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); ESS, Epworth Sleepiness Scale; MCS, mental component summary.

*Unless otherwise indicated, data are expressed as mean ± SD.

†Unless otherwise indicated, calculated using ANOVA with the Tukey method of post hoc analysis. Differences between values marked with superscript a and b were significant.

‡P value was calculated using the χ^2 method.

§All scores were significantly different from one another.

toms, 16 to 22; and major depressive symptoms, 23 to 63. Several minor variations have been used previously.^{6,38,44} The BDI contains questions to assess all 9 characteristic attitudes and symptoms listed in the *DSM-IV* criteria for a major depressive episode.

The Medical Outcomes Trust's SF-36 Health Survey (SF-36) questionnaire (modified Australian version)^{45,46} was completed to assess health-related quality of life. The health survey was scored in a standard manner into 8 multi-item scaled scores, or domains.⁴⁶ The domain-scaled scores (0-100) are physical function, physical role, pain, general health, vitality, social functioning, emotional role, and mental health. The scores from the 8 domains were individually weighted into physical and mental components, then combined to calculate the SF-36 physical and mental health summary scales.⁴⁷ These 2 health summary scales were adjusted to achieve a community mean value of 50 with an SD of 10.

Appearance orientation (AO) and appearance evaluation (AE) sections of the Multidimensional Body-Self Relations Questionnaire were completed.⁴⁸ The AO score⁴⁹ is a measure of the investment in one's appearance. The AE score⁴⁹ is a measure of one's self-evaluated attractiveness and satisfaction with one's looks. These are scored in a standard manner of 1 to 5, with higher scores indicating greater investment in or satisfaction with appearance.

The Epworth Sleepiness Scale (ESS), a validated instrument that measures daytime sleepiness, was also completed.^{50,51} The normal community mean ± SD score is 4.0 ± 3.0, with excessive daytime sleepiness defined as an ESS score greater than 10.

We used results of detailed clinical evaluation, including questionnaires and serial interviews, to obtain demographic details, medical and psychiatric history, and history of smoking and alcohol consumption. In addition, standard anthropometric measures of height, weight, waist, hip, and neck were taken, along with biochemical measures to assess metabolic risk and nutritional status.

Preoperative excess weight is calculated as the weight in kilograms at the time of surgery less the ideal weight in kilograms as measured by the Metropolitan Height and Weight Tables (1983).⁵² Percentage of excess weight loss (EWL) is calculated by dividing the weight loss by the preoperative excess weight, and by multiplying the result by 100.

All patients are asked to complete a weight history questionnaire preoperatively to indicate their weight at different stages in their life. The stage at which they first indicate they were above average weight is taken as an indication of the stage in their life when a weight problem was first recognized.

STATISTICAL ANALYSIS

The BDI scores were normally distributed, with mean ± SD reported. We used the independent 2-tailed *t* test to assess for differences in BDI scores between 2 groups. With the Tukey method of post hoc analysis, we used analysis of variance to assess more than 2 groups. Raw correlation coefficients were calculated using Pearson or Spearman methods as appropriate. Linear regression analysis was used with forward and backward modeling to find independent predictors of actual values of normally distributed continuous variables, preoperative BDI scores, and the change in BDI scores at 1 year. Regression analysis was performed in the following series of blocks: (1) age, sex and BMI; (2) anthropometric measures and markers of insulin resistance; (3) history of medical illness (hypertension, diabetes mellitus, depression, etc); and finally (4) specific questionnaire results (the physical function domain of SF-36 as a measure of physical ability, AE as a measure of satisfaction with appearance, and ESS as a measure of daytime sleepiness). The percentage of EWL at 1 year was added to the regression analysis for change in BDI at 1 year. We reported β coefficients and combined r^2 statistics. The following 3 sets of data were analyzed: (1) data from the 487 consecutive patients preoperatively; (2) scores obtained preoperatively and at 1- through 4-year follow-ups; and (3) paired preoperative and 1-year postoperative BDI questionnaires completed by 262 patients. All analyses were performed using SPSS for Windows, Version 10.⁵³

RESULTS

At present, 487 consecutive patients have completed the BDI preoperatively. Characteristics of the group are shown in **Table 1**. These patients had a BMI range from 35 to 74. The mean preoperative BDI score was 17.7 ± 9.5. Thus, the mean score for these subjects is within the moderate range of symptoms of depression. The characteristics of

Table 2. Predictors of Higher Preoperative BDI Score (N = 487) Using Linear Regression Analysis*

Factor Groups	Factor Group			
	General†	Patient History of Illness‡	Questionnaires§	Combined Effect of Factors
Significant factors	Younger age, $r = 0.18$; women, $r = 0.17$	History of depression, $r = 0.36$	Poor physical function, $r = -0.36$; poor AE, $r = -0.32$; higher ESS, $r = 0.15$	Younger age, $\beta = -.15$; women, $\beta = .10$; history of depression, $\beta = .28$; poor PF, $\beta = -.30$; poor AE, $\beta = -.23$
Combined r for variables in column	$r^2 = 0.05$	$r^2 = 0.13$	$r^2 = 0.21$	$r^2 = 0.32$

Abbreviations: AE, appearance evaluation; BDI, Beck Depression Inventory; BMI, body mass index; ESS, Epworth Sleepiness Scale; PF, physical function. *The r values for individual items are calculated from the linear regression with the item modelled alone ($r > 0.10$, then $P < .05$; $r > 0.13$ then $P < .01$; and $r > 0.15$, then $P < .001$). The r^2 values indicate the combined effect of variables within the column. Anthropometric measures and indicators of insulin resistance did not have a significant effect. All listed β coefficients are statistically significant and corrected for other significant factors listed.

†Block includes age in years, BMI, and sex.

‡Block includes hypertension, diabetes mellitus, arthritis, asthma, depression, etc.

§Block includes PF, AE, and ESS.

||All listed factors had a significant independent effect.

patients grouped by BDI scores, indicating the reference group and mild, moderate, and major symptoms of depression, are shown in Table 1. Younger age, female sex, a history of depressive illness, poor physical function, and poor appearance evaluation were all independently associated with higher BDI scores (**Table 2**). More than 50% of women younger than 35 years with an AE score below the mean (< 1.6) had a BDI score of 23 or greater (mean BDI score, 23.1 ± 10), indicating major symptoms of depression. A history of depression was reported at the preoperative interviews by 185 patients (38%). Their mean BDI scores were significantly higher than those not reporting a history of depression (22.0 ± 9 vs 15.1 ± 8 ; $P < .001$).

The BDI scores in these obese patients correlated very well with the mental health domain scores ($r = -0.74$; $P < .001$) and mental component summary scores ($r = -0.67$; $P < .001$) of the SF-36. Low scores in each of the 8 quality-of-life domains of the SF-36 were associated with higher BDI scores (**Table 3**). There was a positive correlation between higher BDI scores and the ESS scores ($r = 0.15$; $P = .001$) and poor sleep quality (Table 1). Of the 487 patients, 99 had been referred for overnight polysomnography, as obstructive sleep apnea was suspected. In this group, there was no correlation between sleep apnea and BDI scores after controlling for age and sex.

In these obese subjects, anthropometric measures, including BMI, weight, waist, hip, and neck circumference, and waist-hip ratio, did not predict higher BDI scores. Measures of fasting plasma glucose and insulin levels and calculated insulin resistance index were not predictive of BDI score. Obesity comorbid conditions of diabetes, hypertension, and osteoarthritis were not associated with higher BDI scores. Socioeconomic status as indicated by residential address and the time in life that a weight problem was first noted did not influence BDI scores.

Severely obese women had significantly higher BDI scores than severely obese men (**Table 4**). They also had significantly lower SF-36 mental health summary scale

Table 3. Correlation Between BDI Scores and Quality of Life as Measured by the 8 SF-36 Domain Scores and Summary Scores

SF-36 Scores	r Value*
Physical function	-0.36
Physical role	-0.38
Pain	-0.37
General health	-0.44
Energy	-0.55
Social functioning	-0.60
Emotional role	-0.61
Mental health	-0.74
Physical component summary†	-0.24
Mental component summary†	-0.67

Abbreviations: BDI, Beck Depression Inventory; SF-36, Medical Outcomes Trust Short-Form 36-Item Health Survey.

*Calculated as Spearman correlation coefficients. $P < .001$ for all.

†Calculated in a standard way from the 8 domain scores.

scores and a greater discrepancy between AO and AE (Table 4).

BDI ACROSS 4 YEARS

The BDI scores for all patients who completed the questionnaire preoperatively and at yearly follow-up are shown in **Table 5**. Eighty-five percent of patients to reach the 1-year follow-up after Lap-Band surgery completed the questionnaires. The completion rate for patients reaching the annual milestones beyond 1 year is 77%. The mean preoperative BDI scores for subjects not completing postoperative follow-up questionnaires was 17.8 ± 9.0 , no different from that for the whole group (17.7 ± 9.5). The lower numbers in the latter years simply reflect fewer patients to have reached these follow-up milestones. This table also details the mean BMI and percentage of EWL at yearly follow-up. When compared with preoperative scores, significantly lower mean BDI scores were reported at each of the yearly review periods. There was

no significant difference between the scores at 1 to 4 years of follow-up.

INFLUENCES ON THE CHANGE IN BDI SCORE AT 1 YEAR AFTER LAP-BAND SURGERY

For 262 subjects (45 men and 217 women) with paired preoperative and 1-year postoperative BDI scores, mean weight and BDI score changes are shown in **Table 6**. The percentage of subjects in each depression symptom category, as assessed preoperatively and at 1 year, is shown in the **Figure**. This group did not differ in any way when compared with the whole group of preoperative patients. Predictors of the change in BDI scores at 1 year were sought. Greater falls in BDI score were seen in women, younger subjects, those with a greater percentage of EWL, and those with a poorer preoperative appearance evaluation. These factors had independent effects (**Table 7**). Preoperative physical disease associated with obesity was not predictive of change in BDI score. However, a history of depression (n=79 [30%]) was associated with a greater mean fall in BDI score at 1 year (Tables 6 and 7).

Table 4. SF-36 Summary Scores, BDI, and Appearance Evaluation and Orientation Scores for 487 Severely Obese Subjects Grouped by Sex*

	Men (n = 75)	Women (n = 412)	P Value†
Age, y	42.5 ± 8.5	41.0 ± 9.9	.20
BMI	46.2 ± 8.2	43.7 ± 7.2	.006
BDI score	14.3 ± 9	18.4 ± 9	.001
Mental component summary of SF-36	47.1 ± 9	45.0 ± 9	.05
Physical component summary of SF-36	37.6 ± 9	36.6 ± 9	.38
AO	3.41 ± 1.1	3.75 ± 0.4	<.001
AE	1.66 ± 0.65	1.64 ± 0.94	.90
Orientation evaluation discrepancy	1.75 ± 0.9	2.10 ± 1.1	.013

Abbreviations: AE, appearance evaluation; AO, appearance orientation; BDI, Beck Depression Inventory; BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); SF-36, Medical Outcomes Trust Short-Form 36-Item Health Survey.

*Data are expressed as mean ± SD.

†Calculated by independent *t* tests.

Fifty (19%) of the 262 patients were taking antidepressant medications preoperatively. The mean BDI score fell significantly at 1-year follow-up (Table 6). The mean fall (8.3±9.0) was not significantly different from that in subjects not taking antidepressants preoperatively (9.6±9.0). Significantly fewer of these 28 (11%; *P* = .006) were taking antidepressants at the 1-year follow-up. Five new patients (2%) had commenced antidepressant therapy in the year after surgery. The total number using antidepressants decreased in the year after surgery (*P* = .04, by χ^2 test). Decisions to cease antidepressant medication therapy were in all cases made by the patient's primary care physician.

We found a significant correlation between the fall in BDI score and the improvements in AE (*r* = -0.31; *P* < .001) and mental (*r* = -0.52; *P* < .001) and physical component summary scores (*r* = -0.25; *P* < .001) of the SF-36. We also found a significant positive relationship between the falls in BDI and ESS scores (*r* = 0.14; *P* = .03).

Twenty-eight patients had a rise in BDI at 1 year. However, this group had lower mean preoperative BDI scores (9.2±6.0) compared with the remainder (18.2±9.0). Of these patients, most had a trivial rise within the reference range or the range of mild depression. Ten patients had a rise in BDI score of greater than 5 points, and of these, scores of greater than 16 points developed in 6. Factors associated with a clinically relevant rise in BDI score were mixed. Eight of the 10 patients had a history of depressive illness, despite normal preoperative BDI scores in 4. Three had significant postoperative complications, ie, liver toxic effects, tubing disconnection, and band erosion. Other contributing causes included menopause, postnatal depression, and employment difficulties. In no case was weight loss itself likely to have contributed to the development of depressive illness.

DEPRESSION AND WEIGHT LOSS

We previously reported that a history of depressive illness has no influence on weight loss after Lap-Band surgery.⁵⁴ In the present study, we have found no relationship between preoperative BDI score and percentage of EWL at 1 and 2 years after surgery. In addition, the percentage of EWL for the 50 patients taking antidepressants preoperatively was the same (46.1%±20.0%) as for those not taking them (45.9%±18.0%).

Table 5. BDI Scores Preoperatively and at 1 to 4 Years After Surgery*

	BDI Scores†					P Value†
	Preoperative (n = 487)	Postoperative				
		1 Year (n = 373)	2 Years (n = 249)	3 Years (n = 148)	≥4 Years (n = 134)	
BMI	44.1 ± 7.4 ^a	35.7 ± 6 ^{bc}	34.3 ± 6 ^{bd}	33.8 ± 6 ^{bd}	32.3 ± 5 ^{bd}	<.001
% EWL	NA	45.8 ± 18 ^a	50.8 ± 19 ^b	51.0 ± 23 ^b	53.7 ± 23 ^b	<.001
BDI score	17.7 ± 9.5 ^a	7.8 ± 6.5 ^b	8.0 ± 8 ^b	9.0 ± 9 ^b	9.6 ± 7.7 ^b	<.001

Abbreviations: BDI, Beck Depression Inventory; BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); EWL, excess weight loss; NA, not applicable.

*Data are expressed as mean ± SD.

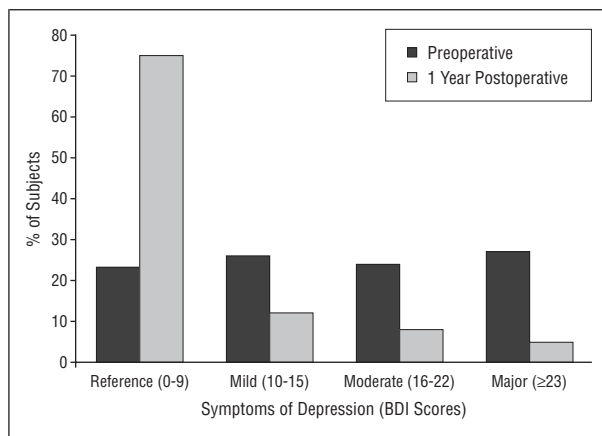
†Significant differences (*P* < .05) were assessed using analysis of variance, with the Tukey method used for post hoc analysis. Differences between values marked superscript a and b were significant, as were those marked superscript c and d.

Table 6. Preoperative and 1-Year Postoperative Paired Weight, BMI, and BDI Scores for 262 Subjects

	Preoperative	1 Year Postoperative
Age, y	40.6 ± 10	
Weight, kg	122.6 ± 26	97.5 ± 22
BMI	44.4 ± 7	35.2 ± 7
BDI score (n = 262)	17.2 ± 9	7.8 ± 7
BDI in women (n = 216)	17.9 ± 9	7.8 ± 7
BDI in men (n = 45)	13.6 ± 8	7.9 ± 7
Preoperative BDI <16 (n = 130)	9.8 ± 4	5.8 ± 5
Preoperative BDI ≥16 (n = 132)	24.56 ± 7	9.8 ± 4
BDI using antidepressants (n = 50)	21.5 ± 8	13.2 ± 8
BDI with preoperative history of depression (n = 79)	21.9 ± 9	10.9 ± 8

Abbreviations: BDI, Beck Depression Inventory; BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters).

*Data are expressed as mean ± SD. All comparisons for preoperative vs postoperative values were significant ($P < .001$).



Percentage of subjects in each depression symptom category as assessed by the Beck Depression Inventory (BDI), for 262 subjects with paired preoperative and 1-year scores.

Table 7. Linear Regression Analysis of Predictors of Greater Decline in BDI Score at 1 Year After Surgery (n = 262)*

Factor Groups	Factor Group			
	General†	Patient History of Illness (0 or 1)‡	Preoperative Questionnaires§	Combined Effect of Factors
Significant factors	Younger age, $r = 0.19$; women, $r = -0.18$; % of EWL, $r = -0.19$	History of depression, $r = -0.13$	Poor preoperative physical function, $r = 0.21$; poor preoperative AE, $r = 0.31$	Younger age, $\beta = .14$; women, $\beta = -.16$; % of EWL, $\beta = -.17$; poor preoperative physical function $\beta = .17$; poor preoperative AE, $\beta = .27$
Combined effect factors in column	$r^2 = 0.10$	$r^2 = 0.01$	$r^2 = 0.12$	$r^2 = 0.21$

Abbreviations: AE, appearance evaluation; BDI, Beck Depression Inventory; BMI, body mass index; EWL, excess weight loss.

*The r values for individual items are calculated from the linear regression with the item modeled alone (if $r > 0.12$, then $P < 0.05$; $r > 0.13$, then $P < .01$; and $r > 0.15$, then $P < .001$). The r^2 values indicate the combined effect of variables within the column. All listed β coefficients are statistically significant and adjusted for other significant factors.

†Includes age in years, BMI, sex, and percentage of EWL.

‡Includes hypertension, diabetes, arthritis, asthma, depression, etc.

§Includes physical function and AE.

||All listed had a significant independent effect.

COMMENT

Our findings support the hypothesis that depression is a significant comorbidity of severe obesity. We have found that the majority of patients (53%) presented with BDI scores of 16 or greater, indicating a high prevalence of characteristic attitudes and symptoms of depression. Although affecting severely obese subjects generally, younger subjects, women, and those with a poor body image experience the greatest burden, with these factors having an additive effect. These findings are consistent with the results of previous studies.^{11,12} We have previously shown very poor measures of quality of life in severely obese subjects, with the impairment greatest in the physical rather than the mental component measures.⁵⁵ Symptoms of depression in these obese subjects, indicated by high BDI scores, were strongly associated with poor quality-of-life scores for all 8 SF-36 domain scores, especially those related to social functioning, emotional role, and mental health.

We found no association between BDI scores and measures of weight distribution, fasting insulin level, insulin resistance, or diseases associated with the metabolic syndrome, such as type 2 diabetes mellitus and hypertension. It would not appear that factors associated with the metabolic syndrome or the increased risk for serious disease associated with this syndrome are driving the tendency to depression. This is an important negative finding, as it has been hypothesized that the psychological stress would stimulate the hypothalamic-pituitary-adrenocortical axis and contribute to illness of the metabolic syndrome.⁵⁶

The significant and sustained fall in mean BDI scores with weight loss supports the hypothesis that severe obesity and/or associated conditions cause or aggravate depression. Our findings do not broadly support the countercausation hypothesis that obesity may be caused or aggravated by psychological defense mechanisms associated with depression, in which case weight loss may predictably increase psychological distress and possibly

depression. We found that subjects losing more weight predictably had greater falls in their BDI scores. Greater falls were also seen in subjects who we found to be at increased risk for obesity-related depression symptoms, ie, those who were younger or women, and those with poor preoperative AE scores. These findings also support the hypothesis that severe obesity causes or aggravates depression.

There are clear limitations to the study. Our subjects were seeking a surgical solution to their obesity problem. They may therefore have greater physical, mental, or psychosocial distress than those who did not present. In addition, patients were asked to complete the questionnaires in the context of seeking treatment for obesity. Thus, problems associated with obesity may be overrepresented in their responses. This problem may be partly addressed by including a comparison of an interviewer-rated scale such as the Hamilton Depression Scale with the BDI in future studies.

Obese subjects in our community may understandably experience many of the symptoms of depression. The stigmatization and discrimination experienced by obese subjects within our society cause major psychosocial distress. Combined with poor body image and repeated, usually failed attempts to lose weight, these stresses may lead to feelings of low self-esteem, guilt, and failure. Obesity is commonly accompanied by symptoms of sleep disturbance, daytime tiredness, and concerns regarding physical health.

When using the DSM-IV criteria to diagnose a major depressive disorder, one is obliged to exclude symptoms that are a direct physiological effect of a general medical condition. Could the physiological rather than psychological effects of obesity cause some symptoms, for example, those of sleep disturbance and daytime tiredness? This is an area that has not really been explored. This study provides some insight into the relationship between daytime sleepiness as measured by the ESS and obesity. Several studies have now found excessive daytime sleepiness in the absence of sleep apnea in obese subjects.^{57,58} In the present study, we demonstrate a positive relationship between the ESS and BDI scores, with a greater fall in ESS score associated with a greater fall in BDI score with weight loss. Clearly, the relationship between excessive daytime sleepiness and depression in obese subjects needs further careful exploration.

This study found no relationship between preoperative BDI score and weight loss after Lap-Band surgery. We have previously shown that a history of depression is not associated with the extent of weight loss.⁵⁴

The results of this study support the hypothesis that depression is a comorbidity of obesity. Characteristic attitudes and symptoms of depression in obese subjects are associated with major impairment of physical and mental quality-of-life measures. Younger women with poor body image are at greatest risk. Weight loss after Lap-Band surgery is associated with a major and sustained reduction in BDI scores, with greatest improvement in those with greater weight loss and those at greatest risk.

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The Department of Surgery, Monash University, Alfred Hospital, Melbourne, Victoria, is conducting "The clinical

evaluation of the Lap-Band: an adjustable gastric banding system used in morbidly obese patients." These studies are part of an international multicenter retrospective and prospective evaluation of the Bioenterics Lap-Band. Inamed Health Corporation, Santa Barbara, Calif, the manufacturer of the Lap-Band, provides funding for these post-marketing studies in Australia. Inamed Health Corporation has also provided a research fellowship to Dr Dixon.

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