

# Obesity as a Prospective Predictor of Depression in Adolescent Females

Kerri N. Boutelle

University of Minnesota and University of California,  
San Diego

Peter Hannan, Jayne A. Fulkerson, and

Scott J. Crow  
University of Minnesota

Eric Stice  
Oregon Research Institute

**Objective:** Both obesity and depression are prominent during adolescence, and it is possible that obesity is a trigger for adolescent depression. The purpose of this paper is to evaluate whether overweight or obese status contributes to the development of depression in adolescent girls. **Design:** Participants were 496 adolescent girls who completed interview based measures of depression and had their height and weight measured at four yearly assessments. Repeated measures logistic regressions with generalized estimating equations were used to evaluate whether overweight or obese status were associated with major depression or an increase in depressive symptoms the following year. **Main Outcome Measures:** Major depression and depressive symptoms were evaluated using a modified version of the K-SADS interview. Overweight and obese status was determined by using standardized protocols to measure height and weight. **Results:** Results showed that obese status, not overweight status, was associated with future depressive symptoms, but not major depression. This study demonstrated that obesity is a risk factor for depressive symptoms, but not for clinical depression. **Conclusions:** As depressive symptoms are considered along the spectrum of depression with clinical depression at the high end, these results suggest that weight status could be considered a factor along the pathway of development of depression in some adolescent females.

**Keywords:** Adolescence, obesity, depression, longitudinal

Adolescence is an important period of development for both depression and obesity. The prevalence of major depression among all children and teens ages 9 to 17 years has been estimated at 5% (Shaffer et al., 1996), and the prevalence of obesity and overweight in teens is over 30% (Ogden et al., 2006). The overall risk of developing psychiatric disorders typically rises during the adolescent years (Brooks, Harris, Thrall, & Woods, 2002; Sorenson, Rutter, & Aneshensel, 1991) and is associated with future depression (Lewinsohn, Rohde, Klein, & Seeley, 1999; Weissman et al., 1999). Given that adolescence is a vulnerable period for the development of both depression and obesity, and the fact that obesity rates among youth are increasing, more research is needed to understand whether obesity contributes to the development of depression among youth.

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Kerri N. Boutelle, University of Minnesota and University of California, San Diego; Peter Hannan, Department of Epidemiology, University of Minnesota; Jayne A. Fulkerson, Department of Nursing, University of Minnesota; Scott J. Crow, Department of Psychiatry, University of Minnesota; and Eric Stice, Oregon Research Institute.

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Correspondence concerning this article should be addressed to Kerri N. Boutelle, Associate Professor of Pediatrics and Psychiatry, University of California, San Diego, 9500 Gilman Drive, MC 0985, La Jolla, CA 92093-0985. E-mail: kboutelle@ucsd.edu

Obesity is associated with several developmental factors that could contribute to the development of depression (Cicchetti & Toth, 1995; Rolf, Masten, Cicchetti, Nuechterlein, & Weintraub, 1990), including greater rates of teasing, social isolation, and low self-esteem (Jackson, Grilo, & Masheb, 2000; Strauss, 2000; Strauss & Pollack, 2003). Examination of the relationship between obesity and depression during adolescence, and the identification of possible etiological factors that contribute to the development of depression, are critical to the development of appropriate interventions.

Only a few longitudinal studies have assessed the temporal relationship between depression and obesity in adolescence. These studies evaluated depression as a risk factor for obesity later in life and found that depression in youth is positively associated with increased body mass index (BMI) during adulthood (Goodman & Huang, 2002; Pine, Cohen, Brook, & Coplan, 1997; Pine, Goldstein, Wolk, & Weissman, 2001; Richardson et al., 2003). In addition, based on the same data used in the present study, results showed that for each depressive symptom endorsed, obesity onset risk increased fourfold (Stice, Presnell, Shaw, & Rohde, 2005). The literature has been consistent in the conclusion that depression increases the risk of obesity in the future.

However, very little research has evaluated the opposite relationship, where obesity is a predictor for depression, and the published research shows a mixed picture. In one study (Mustillo et al., 2003) obesity was evaluated as a predictor of seven psychopathology diagnoses over an 8-year period in White children. Results showed that chronically obese boys had significantly

higher rates of depression compared to nonobese boys, while findings for girls were nonsignificant. In another study (Anderson, Cohen, Naumova, Jacques, & Must, 2007), adolescents were assessed at three subsequent timepoints over 20 years. This study showed that adolescent obesity predicted an increased risk for major depression disorder in females but not for males. On the other hand, two previous epidemiological studies found that initial BMI was not related to risk for future onset of depression (Stice & Bearman, 2001; Stice, Hayward, Cameron, Killen, & Taylor, 2000).

In particular, it is important to evaluate the relationship between obesity and future depression in female adolescents, because they are more likely than males to develop depression. Studies have shown that, similar to depression among adults, the incidence of depression among adolescents is greater for females than males (Brooks et al., 2002; Lewinsohn et al., 1999; Lewinsohn, Rohde, & Seeley, 1998). These gender differences have been reported to emerge between the ages of 13 and 15 years (Born, Shea, & Steiner, 2002; Hankin & Abramson, 1999, 2001; Sweeting & West, 2003). The reasons for this gender difference have not been well established (Lyubomirsky & Nolen-Hoeksema, 1995; Morrow & Nolen-Hoeksema, 1990). Feminist theories of adults suggest that females experience more depression because of the experience of chronic strain and psychological factors, such as rumination (Nolen-Hoeksema, Larson, & Grayson, 1999). Since popularity in adolescence is attributed to appearance in girls, and athletics in boys (Chase & Dummer, 1992), girls may be especially at risk for developing depression when they are overweight. For these reasons, it is especially important to evaluate whether obesity is a risk factor for depression in females.

The purpose of this study was to evaluate whether overweight and obesity increase risk for the future development of depression in females during the high-risk adolescent years. In order to comprehensively evaluate the relationship between obesity status and depression, this study evaluated a number of alternative definitions of both overweight and depression, including 1) obese and overweight status, 2) chronic overweight as a risk factor, and 3) the prevalence of major depression and a depressive symptom score. This study also evaluated this relationship over a 1-year period, which should allow for greater sensitivity in establishing temporal precedence.

## Methods

### Participants

Participants were 496 adolescent girls from four public and four private middle schools in the Austin, Texas metropolitan area (see Table 1 for demographic characteristics).

### Procedures

The study was described to parents and participants as an investigation of adolescent physical and mental health. A letter describing the study and consent/assent forms were sent to parents of eligible girls with a stamped self-addressed return envelope. A second mailing was sent to nonresponders. Active parental consent and adolescent assent was secured before data collection. This method resulted in a 56% participation rate. Further methodolog-

Table 1  
*Description of the Sample (n = 496) at Time 1 (T1)*

Variable	N (%)
Age	13.0 years ( <i>SD</i> = 0.7); range = 11–15
Ethnicity	
White	336 (68.1)
Black	36 (7.3)
Latina	90 (18.3)
Asian	8 (1.6)
Native American	4 (0.8)
Other/mixed	19 (3.9)
Parental education	
High school or less	22 (4.4)
High school	81 (16.3)
Some college	99 (20.0)
College graduate	196 (39.5)
Graduate degree	98 (19.8)
Early puberty	96 (19.4)
School type	
Public	409 (82.5)
Private	87 (17.5)

ical details are described in other published manuscripts (Stice, Burton, & Shaw, 2004; Stice, Presnell, & Bearman, 2001; Stice et al., 2005).

Girls participated in a structured interview, completed a questionnaire, and had their weight and height measured at baseline (T1) and at three annual follow-ups (T2–T4). Assessors were bachelors-, masters-, and doctoral-prepared students with degrees in psychology. Assessors attended 24 hours of training, wherein they were taught structured interview skills, reviewed diagnostic criteria for relevant *Diagnostic and Statistical Manual of Mental Disorders* (1994; *DSM-IV*), observed simulated interviews, and role-played interviews. Assessors were required to demonstrate high ( $\kappa > .80$ ) interrater diagnostic agreement with experts before data collection. Five percent of all interviews that were conducted for each assessment were selected randomly for retest and an additional 5% were selected randomly for interrater reliability assessments. The data from the interviews were directly entered into the computer and used syntax to determine agreement. Interviews were recorded periodically during the study to ensure that assessors continued to show high interrater agreement with experts. All assessments took place during regular school hours or immediately after school on the school campus or at the participants' homes. Girls received a \$15 gift certificate to a local book and music store as an incentive for study participation. This study was approved by the University of Texas Institutional Review Board.

### Measures

**Weight status.** Height was measured to the nearest millimeter with a portable direct-reading stadiometer. Weight was assessed to the nearest 0.1 kg using digital scales, with participants wearing light clothing without shoes or coats. At each assessment, two measures of height and weight were obtained and averaged. Height and weight were converted to BMI (=  $[\text{kg}/\text{m}^2]$ ). Since adolescents are growing, BMI was transformed into BMI<sub>z</sub> and BMI-for-age percentile score using the US Centers for Disease Control and Prevention growth curves (Ogden et al., 2002). The standardized

BMI (BMI<sub>z</sub>) define the overweight and obese categories by the cutpoints BMI<sub>z</sub> >1.04 and BMI<sub>z</sub> > 1.64, respectively and are used in the study analyses.

### Depression Measurements

The Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS; Puig-Antich & Chambers, 1983) a structured psychiatric interview, assessed the diagnostic symptoms of *DSM-IV* major depression. This study used an adapted version of the K-SADS, which combined features of the epidemiological and the present episode versions. Responses were used to determine whether each participant met criteria for major depression based on the *DSM-IV* at each assessment point. In order to receive a diagnosis of major depression, girls had to report the presence of at least five symptoms and at a severity rating qualifying them for major depression. Additionally, the past year severity ratings for each symptom were averaged to form a continuous depressive symptom composite at each assessment point. These items ask participants to report on the severity of each symptom during any time that they experienced this symptom during the previous 12 months. Response options ranged from 1 (not at all) to 4 (severe) symptoms. The test-retest reliability ( $\kappa = .73-1.00$ ), internal consistency ( $\alpha = .68-.85$ ), and discriminant validity of this measure have been documented in past studies (Ambrosini, 2000; Lewinsohn et al., 1994; Puig-Antich & Chambers, 1983). A randomly selected subset of participants (5%) were interviewed within a 3-day period by a second clinical assessor who was blind to the first diagnosis, which demonstrated a high interrater agreement ( $\kappa = 1.00$ ). Another randomly selected subset of participants (5%) completed a second diagnostic interview with the same clinical assessor 1 week later, resulting in excellent test-retest reliability ( $\kappa = 1.00$ ). Depressive symptoms and major depression diagnoses derived from this interview in the current data set have been found to have predictive validity for future onset of bulimia nervosa, substance abuse, and obesity (Stice et al., 2004; Stice et al., 2005).

### Demographic Variables

Participants self-reported their age and ethnicity at Time 1 (T1). In addition interviewers directly inquired about the age of menarche using questions adapted from the McKnight Risk Factor Survey (Shisslak et al., 1999). As described in other publications using this sample (Stice et al., 2001), participants were classified as early or nonearly puberty using the relative distribution of age at menarche within the sample.

### Analyses

For modeling the depression categories, repeated measures logistic regressions were used, with generalized estimating equations (GEE) methodology to account for possible correlations in outcomes over time within individual. In brief, models ignoring correlations are estimated for outcomes at Times 2, 3, and 4 and the regression coefficients are pooled. Standard errors are then "corrected" by the use of an empirical estimate of the correlations among the residuals. Note that T1 depression data are omitted because previous obesity status is not available as the independent

variable. The models included in this study use obesity status the previous year and model depression status in the subsequent year, establishing temporal precedence.

A priori adjustments were made for age and early puberty and previous depression status. To strengthen inferences, a temporal sequence was established by using both the overweight and obesity status cutoffs at the previous time as predictors of depressive status. Thus, the logistic regressions were run in a series of analyses that compared those who were nonoverweight (BMI <85th percentile) against those who were obese (BMI  $\geq$ 95th percentile) or those who were overweight (95th percentile >BMI  $\geq$  85th percentile). The depressive symptoms scale showed a continuous and approximately symmetric distribution so the Gaussian assumption for the error distribution was made in the GEE analyses of depressive symptoms.

Chronic overweight was defined as being overweight in at least 2 of the first 3 years, and was then related with the depression outcomes as assessed at Time 4. Analyses of incident overweight or obesity (i.e., progressed from nonoverweight to overweight) started with only girls having BMI <85th percentile, and dropped subsequent observations once a girl transited over the threshold of overweight or obesity.

Analyses were conducted using SAS (version 8.2, 2000) (Statistical Analysis System, 2001). For all repeated measures regression analyses SAS Proc GENMOD was used, invoking GEE with the REPEATED statement. For logistic regression the binomial error and logit link were used; for analysis of depressive symptoms the normal distribution and identity link were specified.

## Results

### Prevalence Rates of Obesity and Depression

Rates of obesity and overweight were approximately 11% and 12% respectively at T1, and rates decreased by T4 (see Table 2). Thus, combined prevalence of obesity and overweight decreased from 23% at T1 to 16% at T4. Very few youth moved into the obese category from the overweight or nonoverweight category (0–.9%) while 1%–2.6% moved into the overweight category from the nonoverweight category. Nine percent of youth were chroni-

Table 2  
*Rates of Overweight and Depression Diagnoses, Means and Standard Deviations at Each Time Point*

Variable	T1	T2	T3	T4
Number of girls	495	482	477	488
Mean age	13.5	14.5	15.5	16.5
Overweight prevalence rates				
Obesity (>95th %)	10.7	8.5	8.0	7.4
Overweight (>85th %)	12.3	12.2	9.9	8.6
Onset of obesity (>95th %)	—	.9	.9	0
Onset of overweight (>85th %)	—	2.6	2.4	1.1
Depression				
Major depression	2.2	4.4	1.7	5.8
Onset of major depression	—	2.5	1.2	3.5
Mean depressive symptoms score	1.3	1.4	1.4	1.4
<i>SD</i>	(.37)	(.38)	(.37)	(.41)

cally obese, while 20.4% met criteria for being chronically overweight (data not shown).

Rates of major depression varied from approximately 2%–6% over the 4-year time period (see Table 2), while the rates of onset of major depression from nondepressed ranged from 1.2%–3.5%. The mean of the depression symptoms scale varied little over the four times.

### Relationship Between Obesity and Depression

Table 3 shows the prospective relationship between obesity and depression, stratified by overweight status controlling for age, early puberty, and previous depression status. We present regression coefficients, standard errors, odds ratios, confidence intervals, and significance levels of these relationships in Table 3. Overweight status (85%–95%) was not associated with subsequent diagnosis of major depression compared to girls who were not overweight. In addition, there were no significant effects of overweight on the depressive symptom scale. Obese status (>95%) was also not associated with subsequent diagnosis of major depression compared to girls who were not obese. However, there was a significant effect of obesity on the depressive symptom scale ( $p < .01$ ).

To address concerns about the overlap between some of the somatic symptoms of depression and obesity, we removed two of the items that contribute to the depression symptom scale, weight gain, and change in eating patterns. The results were unchanged when these two items were removed.

To be comprehensive, overweight status (85%–95%) and obese status (>95%) were evaluated as predictors of incident depression. Paralleling the above results, neither overweight nor obese status was associated with the incidence of major depression compared to girls who were not overweight (data not shown). In addition, chronic obesity was not associated with depression status at Time 4 (data not shown).

### Discussion

The aim of this study was to assess the prospective 1-year relationship between obesity and depression over 4 years in a sample of female adolescents. This study attempted to evaluate a

number of alternative definitions of both overweight and depression. None of the associations we evaluated with overweight and obese adolescents and subsequent major depression were significant. The only relationship found in these analyses was a significant relationship between obese status (>95%) and depressive symptoms as measured by the continuous depressive symptom scale.

It is interesting that overweight or obese status was not associated with the development of major depression. Obese status was associated however, with an increase in depressive symptoms score. It is possible that weight status alone may not be an acute stressor, but may contribute to low self-esteem, body dissatisfaction, lower social support, and other attitudinal factors that were not measured in this study to contribute to the risk of developing depression. It is also possible that the 1-year time period evaluated in these models was not long enough to impact psychiatric diagnoses, but could contribute to the symptoms of depression.

The relationship between obese status and depressed mood as defined by the depressive symptoms score was small but consistent in these data. This relationship also held true when the somatic symptoms of depression (changes in weight or eating patterns) were removed from the depressive symptoms score (data not shown). Recent etiological studies indicate that depressive symptoms are predecessors of the development of major depression (Georgiades, Lewinsohn, Monroe, & Seeley, 2006) and that clinical depression is not categorically distinct from other degrees of depressive symptoms (Lewinsohn, Klein, Durbin, Seeley, & Rohde, 2003; Lewinsohn, Solomon, Seeley, & Zeiss, 2000). Our findings highlight the complex relationship between obesity and depression, and underscore the notion that weight status does not contribute to a diagnosable level of depression, but may contribute to the pathway through heightened depressive symptoms.

In these analyses, we also evaluated whether chronic obesity was associated with the development of depression. Due to the nature of these data (4 years of assessments), only a cross-sectional evaluation was possible. Consistent with the findings from the study by Mustillo and colleagues (Mustillo et al., 2003), this study did not find that females who had chronic obesity were at a greater risk for depression in later years. These findings are consistent across studies regardless of several important differences in study design (i.e., years evaluated, definition of chronic obesity and the adjustment for previous depression in the present study).

The rates of obesity and overweight in adolescents varied throughout the study, and were lower than expected based on recent national studies (Ogden et al., 2006). Current national rates of obesity and overweight are 15% and 16%, while in this study the rates of obesity were 7%–11% and overweight were 9%–12%. It is possible that these lower prevalence rates of overweight and obesity are due to a sampling bias. It is also possible that because these girls were growing, during the period measured in this study, girls may have had an increase in height relative to weight, which would reduce the prevalence of girls who met the weight status criteria. In addition, the rates of depression also varied throughout the four years of this study. Clinical depression varied between 2% and 6% at any time point. Without the drop in prevalence of depression at T3, the rates of depression over the four time points appear to be increasing. Perhaps the drop in major depression at T3 is an anomaly in these data, or rates of depression vary widely from year to year during the course of development. A larger

Table 3  
*Prospective Relationship Between Obesity and a Depression Diagnosis or Depressive Symptoms Stratified by Overweight Status, Controlling for Age, Early Puberty, and Previous Depression Status*

Variable	Beta	SE	p	OR	95% CI
Overweight (85%–95%) vs. nonoverweight					
Major depression	-.49	.48	.31	.61	.24–1.57
Depressive symptoms	.0016	.03	.96*		
Obese (>95%) vs. nonoverweight					
Major depression	.48	.38	.20	1.62	.77–3.38
Depressive symptoms	0.17	.05	<.01*		

\* These relationships were consistent when items reflecting weight gain and eating pattern changes were removed from the depressive symptoms score.

period of observation would be needed to evaluate the variation of major depression point prevalence. There are also potentially distinct differences between this sample and the national studies that may have influenced the rates of obesity and depression. The national surveys include male adolescents, while this study was comprised only of females. In addition, this study was conducted in a single city, which may not be nationally representative of adolescent females across the United States.

As in all studies, the strengths and weaknesses need to be considered when interpreting the findings. Strengths of the study include the focus on temporal relations between obesity and depression, the longitudinal nature of the data, the high retention rates, the high-quality structured psychiatric interviews, and careful measurement of height and weight on a yearly basis. Potential weaknesses include the low prevalence rates of depression, a single report of depression symptoms from the adolescent, and the self-report nature of psychiatric interviews. In addition, while the methods chosen to evaluate these relationships in this study establish clear temporal precedence, and account for correlations within subjects, they are also dependent on the number of events, not the number of subjects. Although there were almost 500 adolescents included in this study, the incidence of depression was fairly low. Another limitation of this study is that our conclusions refer only to female adolescents which may not accurately represent the adolescent population. As with all longitudinal research, it is possible that some unmeasured factors may explain the observed prospective relationships.

Despite these limitations, this study contributes a more clear understanding of the lack of a relationship between obesity and clinical depression among adolescent females, and the small but significant relationship between obese status and depressive symptoms. Future research should consider weight status as a contributing factor to the development of depression symptoms, especially in teens on the highest end of the weight spectrum. Clinicians should be aware of weight status as a potential stressor for youth, and evaluate the impact on self-esteem and potential for teasing.

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