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Obesity and depressed mood associations differ by race/ ethnicity in adolescent girls

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Abstract

Objectives—To evaluate bidirectional associations between obesity and depressed mood in adolescent girls, and assess whether these associations differed by racial/ethnic group.

Methods—We analyzed data collected from 918 adolescent girls studied in 6th and 8th grades as part of the Trial of Activity for Adolescent Girls (TAAG). Racial/ethnic group was defined as non-Hispanic white, non-Hispanic black, and Hispanic. Height and weight were measured and obesity was defined as a BMI-for-age at or above the 95th percentile. The Center for Epidemiologic Studies Depression Scale (CES-D) was used to measure depressive symptoms. Generalized estimating equations were used to examine associations between 6th grade obesity and 8th grade depressed mood, as well as 6th grade depressed mood and 8th grade obesity.

Results—Racial/ethnic group was a statistically significant effect modifier in both directions of association ($p < 0.02$). Among white girls, 6th grade obesity was associated with greater likelihood of depressed mood in 8th grade (odds ratio (OR) = 2.47, 95% confidence interval (CI): 1.85, 3.30); for black and Hispanic girls OR= 1.16 and 0.82, respectively. Also for white girls, 6th grade depressed mood was associated with greater likelihood of obesity in 8th grade (OR = 4.47, CI: 1.96, 10.24); whereas for black and Hispanic girls OR= 0.83 and 1.89, respectively.

Conclusions—These analyses suggest that associations between obesity and depressed mood may be most problematic among adolescent girls in the white racial/ethnic group, and our results are consistent both with depressed mood contributing to obesity and obesity contributing to depressed mood.

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Keywords

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INTRODUCTION

Independently, obesity and depression each have a large negative impact on public health (1). Understanding the psychological antecedents and consequences of adolescent obesity is important in the context of the population increases in obesity prevalence that have occurred during the past three decades (2). Evidence indicates that obesity can contribute to depressed mood (3–5) and also that depressed mood can contribute to obesity and excess weight gain (6–11). These bidirectional associations may be more evident in females compared to males (12). In the *Children in the Community Study* (3, 6), and the *Dunedin Multidisciplinary Health and Development Study* (9) males and females were studied, but associations between depressed mood and obesity were only present among females. However, Mustillo *et al.* found that for boys but not girls, chronic obesity between the ages of 9 and 16 years in the *Great Smoky Mountains Study* was associated with depression (13), and other studies have not found consistent associations in either boys or girls (14).

Cultural differences in preference for and/or acceptance of a higher body weight may contribute to lower levels of body dissatisfaction among African-American adolescent girls compared to white girls (15, 16). As a result, a weaker linkage between obesity and depression for African-American adolescent girls compared to white girls has been hypothesized (17). However, the few prospective analyses of United States adolescents or young adults that have examined differences in associations between depression and obesity by racial/ethnic group have not found evidence for such interactions (7, 11).

Using prospective data collected from a sample of adolescent girls studied in 6th and 8th grades, our objective was to investigate whether bidirectional associations between obesity and depressed mood exist in this sample of middle school girls and whether these associations were different among white, black, and Hispanic girls. We sought to understand the nature of the relationship between depressive symptoms and obesity, and particularly to determine whether patterns varied by racial/ethnic group.

METHODS

Study sample

Data were collected as part of the Trial of Activity for Adolescent Girls (TAAG). TAAG was a multi-center group-randomized trial designed to test an intervention to reduce the usual decline in physical activity in middle-school girls (18, 19). TAAG was a collaboration consisting of six field centers (San Diego State University, Tulane University, University of Arizona, University of Maryland, University of Minnesota, and University of South Carolina) the coordinating center (University of North Carolina Chapel Hill), and the project office (National Heart, Lung, and Blood Institute). Public middle schools in which a majority of students lived in the surrounding community were eligible to participate. Six schools were selected at each of the six field centers for a total of 36 schools. TAAG schools represented the demographic and socioeconomic makeup of their school districts, with preference given to schools with greater racial/ethnic and socioeconomic diversity. Details of recruitment and participation are presented elsewhere (20, 21). Parental consent and student assent were obtained prior to each measurement period. The protocol was approved by the institutional review boards of all participating institutions in fall 2002 and annually thereafter.

Girls were selected within schools by random sampling of all eligible girls. Reasons for ineligibility were unable to read and understand English, told by a doctor to avoid exercise, or other medical contraindication. In spring 2003, a sample of 45 to 60 sixth-grade girls per school was selected; parental consent and student assent were obtained for 1721 of the 2160 eligible girls for an average recruitment rate of 80%. Two years later, in spring 2005, a new cross-sectional sample of 90 to 120 eighth-grade girls was selected from the same schools and to maximize the number of girls available for longitudinal studies, all previously-measured 8th grade girls who remained in their original school were recruited, even if they were not in the new cross-sectional sample. 1214 girls were assessed both in 6th and 8th grade.

Our analyses include those girls assessed in 6th and 8th grades, who provided complete data on age, depressive symptoms, and weight status. Seven girls were excluded because they did not have information on depressive symptoms at 8th grade, two girls were excluded because they were over age 16 at 6th grade, and 27 girls were excluded because they were missing information on 1 or more covariates (we conducted analyses to determine the extent to which inclusion of these girls impacted our findings). The objective of our analyses was to understand differences among racial/ethnic groups in associations between depressive symptoms and obesity; thus we limited our analyses to the three most prevalent racial/ethnic groups (Hispanic, non-Hispanic black, non-Hispanic white). We excluded 121 girls whose racial/ethnic group was Asian, Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, or other, leaving 918 girls for our analyses. Girls were not excluded from our analyses based on their 6th grade BMI or level of depressive symptoms.

Measurements

Measurements were taken during spring 2003 and 2005 by trained and certified staff. Periodic recertification ensured that performance standards were met continuously.

Obesity—Height (without shoes) was measured to the nearest 0.1 cm using a portable stadiometer (Shorr Productions). Weight (light clothing without shoes) was measured to the nearest 0.1 kg using a digital scale (Seca 880). BMI was calculated as weight (kg)/height² (m). The Centers for Disease Control and Prevention (CDC) 2000 sex-specific BMI-for-age growth charts were used to determine BMI z-scores (22). Following recommendations for defining obesity in children and adolescents in the US (23), we defined obesity as a BMI-for-age at or above the 95th percentile of the CDC growth reference.

Depressive symptoms—The Center for Epidemiologic Studies Depression Scale (CES-D) was used to measure depressive symptoms. This 20-item self-administered instrument is widely used to assess depression in community studies and has been validated with adolescents (24). Consistent with previous analyses of TAAG data (25), we defined depressed mood as a CES-D score at or above 24. This cut point was determined to maximize sensitivity and specificity to detect Major Depressive Disorder in adolescent girls (26).

Racial/Ethnic Group—Each girl responded to two questions about her racial/ethnic group. The first asked whether the girl thought of herself as Hispanic, Mexican American, or of Spanish origin. The second asked whether the girl thought of herself as white, black or African-American, Asian, Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, or other. We categorized racial/ethnic group based on these questions as non-Hispanic white, non-Hispanic black, and Hispanic; we will refer to these groups as white, black, and Hispanic. Too few girls identified with other racial/ethnic groups to allow for

meaningful analyses, and thus we restricted our analysis to these three major race/ethnicity groups.

Covariates

Exact age was calculated from reported birth date and the date of assessments. As an indicator of low family income we relied on whether a girl qualified for free/reduced school lunch at 6th grade. Participation in the free/reduced lunch program was assessed via self-report; girls were asked, “Do you get free or low-cost lunches at school?” We also included as a covariate a measure of the amount of time typically spent home alone after school on weekdays because this variable was related to depressive symptoms in previous analyses of TAAG (25). Girls reported the number of hours they typically spent at home alone after school in 6th grade, and we categorized this as none, less than 1 hour per day, or 1 or more hours per day. Self-esteem and physical activity are related to obesity and to depressed mood, but we did not consider these variables to be potential confounders of associations between obesity and depressed mood; both of these variables may be intermediates between obesity and depressed mood, and it is also likely that associations of self-esteem and physical activity with depressed mood and obesity differ by racial/ethnic group. Future research could delineate these relationships, which were not the focus of our current analyses.

Statistical analyses

Differences by racial/ethnic group in characteristics of girls were compared by chi-square, with Bonferroni adjustment for multiple comparisons, and by analysis of variance, with Tukey-Kramer adjustment for multiple comparisons. Pearson correlations between CES-D score and BMI z-score were determined overall and by racial/ethnic group.

We present cross-tabulations, by racial/ethnic group, of cross-sectional associations between 6th grade obesity and depressed mood, as well as cross-tabulations of each direction (6th grade obesity predicting 8th grade depressed mood; and 6th grade depressed mood predicting 8th grade obesity) of the prospective associations. We present crude odds ratios and 95% confidence intervals for each direction of the prospective association overall, as well as stratified by 6th grade level of the 8th grade outcome. We tested for homogeneity of the odds ratios across these strata using the Breslow-Day test, and calculated the Mantel-Haenszel summary odds ratio and 95% confidence-interval. All analyses were conducted using SAS Version 9.1.3.

We used generalized estimating equations (GEE), implemented via SAS PROC GENMOD, to adjust for covariates and to determine whether prospective associations differed by racial/ethnic group. These models account for the clustering of girls within schools. Analyses included the main effect for the predictor of interest, a three-level indicator for racial/ethnic group, and the interactions between racial/ethnic group and the predictor. Our focus is on obesity and depressed mood as dichotomous variables, so we employed a logit link and binomial error distribution; we also evaluated associations in each direction of association using CES-D score and BMI z-score as continuous variables using an identity link and normal error distribution. Preliminary analyses were conducted to determine whether quadratic or cubic terms should be included with linear terms as continuous predictors; nested models were compared with log-likelihood tests and linear models were found to be adequate. We adjusted for 6th grade age, free or reduced lunch, and time home alone after school; we assessed the need to adjust for whether the school was a TAAG intervention or control school, and this did not affect the associations.

To assess the potential for confounding by 6th grade levels of the 8th grade outcome we evaluated models that were adjusted for 6th grade obesity or depressed mood as appropriate; we also evaluated the extent to which results differed with adjustment for 6th grade CES-D or BMI z-score as continuous variables. We present models both with and without adjustment for 6th grade obesity or depressed mood. To assess effect modification we present models stratified by obesity or depressed mood at 6th grade.

RESULTS

In 6th grade, girls were on average 12 years old; 15.6% were obese, and 14.3% had depressed mood. Two years later, 15.1% of girls were obese and 17.9% had depressed mood (Table 1). Differences in characteristics were apparent by racial/ethnic group. At 6th and 8th grades, black and Hispanic girls had higher BMI z-scores and were more likely to be obese than white girls. At 6th grade, white girls had lower average CES-D scores than black or Hispanic girls, and white and Hispanic girls were less likely than black girls to have depressed mood. At 8th grade, the percentage of white and Hispanic girls with depressed mood had increased and the percentage of black girls with depressed mood had decreased; thus differences by race/ethnicity in depressive symptoms at 8th grade diminished.

The correlation between BMI z-score at 6th and 8th grades ($r = 0.91$) was greater than the correlation between CES-D score at 6th and 8th grades ($r=0.39$), and this pattern was consistent across racial/ethnic groups (results not shown). Most girls (79%) who were obese at 6th grade remained obese at 8th grade, and the number of girls not obese at 6th grade who became so by 8th grade was small ($n=26$). Compared to obesity, there was less persistence in depressed mood between 6th and 8th grades; fewer than half of girls (37%) who had depressed mood at 6th grade remained depressed at 8th grade, and 115 girls who did not have depressed mood at 6th grade had depressed mood at 8th grade.

At 6th grade, 30 girls (12 white, 9 black, 9 Hispanic) were both obese and had depressed mood; the odds of having depressed mood in 6th grade for white girls who were obese in 6th grade were 3.2 times (95% confidence interval (CI): 1.6, 6.5) that of white girls who were not obese (Table 2a); whereas for black and Hispanic girls this cross-sectional odds ratio was not statistically significant and was of smaller magnitude (black girls, OR=0.6 (95% CI: 0.3, 1.4); Hispanic girls, OR=1.6 (95% CI: 0.7, 3.8)). In the bottom of Table 2a, we present cross-tabulations by racial/ethnic group of prospective associations between 6th grade obesity and 8th grade depressed mood; in Table 2b we present these cross-tabulations stratified by 6th grade depressed mood. Among white girls, overall, and for those who did not have depressed mood in 6th grade, obesity in 6th grade was associated with higher odds for depressed mood in 8th grade. The Mantel-Haenszel summary odds ratio (95% CI) across strata of 6th grade depressed mood was 2.0 (1.0, 3.9) for white girls, 1.3 (0.5, 3.1) for black girls, and 0.8 (0.4, 1.9) for Hispanic girls (Table 2b). In Table 3, we present cross-tabulations by racial/ethnic group of prospective associations between 6th grade depressed mood and 8th grade obesity overall and with stratification by 6th grade obesity. The Mantel-Haenszel summary odds ratio (95% CI) across strata of 6th grade obesity was 3.9 (1.1, 13.8) for white girls, 1.6 (0.4, 5.5) for black girls, and 1.5 (0.4, 6.2) for Hispanic girls (Table 3b).

Multivariate models: obesity in 6th grade as predictor of depressed mood two years later

The association between 6th grade obesity and 8th grade depressed mood depended upon racial/ethnic group (p value for interaction <0.001) (Table 4, top). For white girls, but not black or Hispanic girls, obesity in 6th grade was associated with higher odds for depressed mood in 8th grade and this association was not substantively changed with adjustment for 6th grade depressed mood (Table 4), 6th grade CES-D score (results not shown), or in the strata of girls who did not have depressed mood at 6th grade (Table 4). Odds ratios for white girls

were statistically significantly different from Hispanic girls; white girls were significantly different from black girls in the unadjusted model, but with adjustment for covariates and 6th grade depressed mood the precision of estimates for black girls was reduced (Table 4).

Multivariate models: depressed mood in 6th grade as a predictor of obesity two years later

There was some evidence that the prospective association between 6th grade depressed mood and obesity in 8th grade differed by racial/ethnic group (Table 4, bottom). The interaction between 6th grade depressed mood and racial/ethnic group was statistically significant ($p < .05$) in the unadjusted model as well as with adjustment for covariates. Among white girls with depressed mood in 6th grade, the odds of obesity in 8th grade were 4.47 times (95% CI: 1.96, 10.24) the odds for white girls without depressed mood; this was statistically significantly different from the association among black girls (OR=0.83). Although with adjustment for 6th grade obesity, the interaction with racial/ethnic group was no longer statistically significant ($p=0.22$), the odds ratio for white girls remained statistically significant (OR=3.68, 95% CI: 1.72, 7.87). For black and Hispanic girls, odds ratios were smaller and confidence intervals were wide (Table 4). Very few girls were obese in 8th grade that had not been obese in 6th grade, and stratification by 6th grade obesity status resulted in odds ratios with extremely wide confidence intervals.

Results of models in which BMI z-score and CES-D score were tested as continuous variables were consistent with results using dichotomous variables (results not shown). Results were also not substantively different with inclusion of girls who were excluded because they were missing information on one or more covariates (results not shown).

DISCUSSION

In this prospective study of white, black, and Hispanic middle-school girls in the United States, bidirectional associations between obesity and depressed mood differed by racial/ethnic group. The strongest associations between depressed mood and obesity were seen for white girls. Among white girls studied over a two-year follow-up period, obesity predicted higher odds for depressed mood, and depressed mood predicted higher odds for obesity. These prospective associations for white girls were consistent with cross-sectional associations at 6th grade, and remained with adjustment for covariates, and with adjustment for the 6th grade level of the outcome. Among black and Hispanic girls, obesity was not strongly associated with depressed mood in either direction of association. However, confidence intervals for black and Hispanic girls were wide.

It is difficult to compare our results to those of other studies of adolescents because of differences in how obesity and depression are assessed and whether results were stratified by gender. In a large nationally representative sample of US adolescents, BeLue *et al.*(27) observed that obese white and Hispanic youth were more likely than their non-obese peers to be reported to have mental health problems, whereas this was not found for black youth. However in two large multi-ethnic cross-sectional samples of adolescents in the United Kingdom, obesity and depressive symptoms were not strongly related and no differences were observed by gender or ethnicity (14). Our results differ somewhat from those found in the NHLBI Growth and Health Study (NGHS), in which no interaction with race was observed in models predicting young adult obesity from adolescent depression (11). In the NGHS, Hispanic girls were not studied, results are not presented stratified by racial/ethnic group, and their participants were older than the girls in TAAG (11). In addition, girls in TAAG were assessed approximately 5 to 10 years after NGHS, and it is possible that cohort differences in prevalence and perception of obesity could be responsible for the different findings. Bidirectional associations between depressive symptoms and obesity were examined in the National Longitudinal Study of Adolescent Health (7). In that study, for all

racial/ethnic groups, depressed mood predicted obesity one year later. The study differed from ours in that it included boys, data were collected in 1995 and 1996, and obesity was based on self-reported height and weight. Associations between obesity and depressive symptoms may be stronger in females than males (3, 6, 9, 12), and misclassification of obesity based on self-reported height and weight may be related to depression (28).

Our results are consistent with other studies that have shown cultural differences in body shape preferences (15, 29). Whereas African-American and Hispanic cultures may have more tolerance for, or even prefer, a larger female figure, in the US the white culture has adopted a preference for a slimmer female body type (29). These cultural differences, whether internalized by girls themselves or contributing to stigmatization, could be hypothesized as one potential explanation for the differences by racial/ethnic group we observed in associations between obesity and depressed mood.

Glymour reported that when an exposure is related to baseline levels of a dependent variable in an observational study, bias can be introduced by including the baseline value of the dependent variable as a covariate or by restricting the analysis to those who did not have the dependent variable (e.g., obesity) at baseline (30). To address this potential for bias, as well as evaluate confounding and effect modification, we present our results with and without adjustment for the 6th grade level of the 8th grade outcome, as well as stratified by the 6th grade level of the 8th grade outcome.

Tracking of weight status in adolescents and adults is high (31). Consistent with this, we observed a correlation of 0.9 between 6th and 8th grade BMI z-scores that was not related to racial/ethnic group; of the 918 girls we studied, only 26 girls were obese in 8th grade who were not also obese in 6th grade, and only 30 girls were not obese in 8th grade who had been obese in 6th grade. Thus we have limited power to determine the extent to which depressed mood in 6th grade predicts 8th grade obesity in analyses stratified by 6th grade obesity. Persistence of depressed mood between 6th and 8th grades was less striking, but still substantial. Given the tracking of weight status and depressive symptoms, it is difficult to determine temporal relationships. Nevertheless, in our analyses these relationships appear to be different by racial/ethnic group.

Our research has some limitations. We were not able to account for maturational timing in our analyses. Differences in pubertal timing among racial/ethnic groups have been established (32), obesity is associated with earlier maturation in females (33, 34), and earlier maturation may increase risk for depression (35, 36). Other potential confounding variables that we were unable to adjust for are cigarette smoking and use of anti-depressant medication. Although we do not think that a large proportion of girls in 6th grade were smokers, cigarette smoking has been shown in other studies to be related to depression (37) and reduced body weight (38). Although the overall level of depressed mood observed in this cohort of adolescent girls is consistent with estimates from community studies of US adolescents (39, 40), the decline in the prevalence of depressed mood among black girls between 6th and 8th grades (25.1% to 18.4%) was unexpected.

In summary, in prospective analyses of US middle-school girls, we found that bidirectional associations between obesity and depressed mood differed by racial/ethnic groups and were strongest among white girls. Further studies are needed to understand why these associations differ by racial/ethnic group and to identify possible protective factors among black and Hispanic youth that could be conveyed to all adolescents. Although the association between obesity and depressed mood was strongest among white girls, the prevalence of obesity and of depressed mood among black and Hispanic girls was higher than for white girls. Thus,

these conditions are likely to often co-occur in adolescent girls irrespective of racial/ethnic group.

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Table 1

Selected characteristics of girls by racial/ethnic group at 6th and 8th grades

	White (n=538)	Black (n=179)	Hispanic (n=201)	P value ^a	Total (n=918)
6th grade					
Age (years)	11.9 (0.4) ^b	12.0 (0.5)	11.9 (0.4)	.008 ^{ce}	11.9 (0.4)
Free/reduced lunch (%)	16.5	62.0	48.3	<.0001 ^{cde}	32.4
Time alone after school (%)				<.0001 ^{cd}	
None	39.6	36.3	41.8		39.4
<1 hour per day	39.2	24.0	27.4		33.7
1 hour per day	21.2	39.7	30.9		26.9
BMI (kg/m ²)	19.6 (3.9)	22.3 (5.4)	21.5 (4.8)	<.0001 ^{cd}	20.5 (4.5)
BMI z-score ^f	0.2 (1.0)	0.8 (1.1)	0.7 (1.0)	<.0001 ^{cd}	0.5 (1.1)
Obesity (%) ^g	9.3	26.8	22.4	<.0001 ^{cd}	15.6
CES-D	12.6 (8.5)	16.5 (10.4)	14.4 (8.2)	<.0001 ^{cd}	13.7 (8.9)
Depressed mood (%) ^h	10.4	25.1	14.9	<.0001 ^{ce}	14.3
8th grade					
Age (years)	13.9 (0.4)	14.0 (0.5)	13.9 (0.5)	.19	13.9 (0.4)
BMI (kg/m ²)	21.4 (4.3)	24.3 (6.0)	23.3 (5.1)	<.0001 ^{cd}	22.4 (5.0)
BMI z-score	0.4 (1.0)	0.9 (1.0)	0.8 (1.0)	<.0001 ^{cd}	0.6 (1.0)
Obesity (%)	8.6	27.4	21.9	<.0001 ^{cd}	15.1
CES-D	14.0 (9.5)	15.2 (8.9)	16.0 (10.0)	.029 ^d	14.7 (9.5)
Depressed mood (%)	16.2	18.4	21.9	.19	17.9

BMI = body mass index; CES-D = Centers for Epidemiologic Studies Depression Scale

^aTest for differences by racial/ethnic group: Chi-square for percentages, analysis of variance for means (Tukey-Kramer adjustment for multiple comparisons)

^bMean (standard deviation) tabulated unless % indicated

^cWhite different from black

^dWhite different from Hispanic

^eBlack different from Hispanic

^fBMI z-score from CDC 2000 BMI-for-age growth reference

^gObesity = BMI z-score \geq 95th percentile

^hDepressed mood = CES-D \geq 24

Table 2a
Cross-tabulations of obesity at 6th grade and depressed mood at 6th grade and at 8th grade by racial/ethnic group

Racial/ethnic group	White/		Black		Hispanic	
	6 th grade mood ^a	6 th grade mood	6 th grade mood	6 th grade mood	6 th grade mood	6 th grade mood
Cross-sectional						
6 th grade weight status	CES-D 24	CES-D < 24	CES-D 24	CES-D < 24	CES-D 24	CES-D < 24
BMI 95 th percentile ^b	12 (24.0%) ^c	38 (76.0%)	9 (18.8%)	39 (81.3%)	9 (20.0%)	36 (80.0%)
BMI < 95 th percentile	44 (9.0%)	444 (91.0%)	36 (27.5%)	95 (72.5%)	21 (13.5%)	135 (86.5%)
OR (95%CI)		3.2 (1.6, 6.5)		0.6 (0.3, 1.4)		1.6 (0.7, 3.8)
Prospective						
6 th grade weight status	8 th grade mood	8 th grade mood	8 th grade mood	8 th grade mood	8 th grade mood	8 th grade mood
BMI 95 th percentile	CES-D 24	CES-D < 24	CES-D 24	CES-D < 24	CES-D 24	CES-D < 24
BMI < 95 th percentile	15 (30.0%)	35 (70.0%)	9 (18.8%)	39 (81.2%)	9 (20.0%)	36 (80.0%)
OR (95%CI)	72 (14.8%)	416 (85.2%)	24 (18.3%)	107 (81.7%)	35 (22.4%)	121 (76.6%)
		2.5 (1.3, 4.8)		1.0 (0.4, 2.4)		0.9 (0.4, 2.0)

OR = odds ratio, CI = confidence interval, BMI = body mass index, CES-D = Centers for Epidemiologic Studies Depression Scale

^aDepressed mood = CES-D 24

^bBMI z-score from CDC 2000 BMI-for-age growth reference; Obesity = BMI z-score 95th percentile

^cn (row percent) tabulated

^dBreslow-Day test for homogeneity of the odds ratios; *P* value < 0.05 would suggest that the odds ratios across strata are not homogeneous.

Table 2b

Stratified by 6th grade depressed mood – cross-tabulation of 6th grade Obesity and 8th grade depressed mood

Prospective, stratified by 6 th grade depressed mood										
Girls with depressed mood at 6 th grade										
White n=56			Black n=45			Hispanic n=30				
8 th grade mood			8 th grade mood			8 th grade mood				
6 th grade weight status	CES-D	24	CES-D < 24	CES-D	24	CES-D < 24	CES-D	24	CES-D < 24	
BMI 95 th percentile	5	(41.7%)	7	(58.3%)	5	(55.6%)	4	(44.4%)	3	(33.3%)
BMI < 95 th percentile	16	(36.7%)	28	(63.6%)	13	(36.1%)	23	(63.9%)	7	(33.3%)
OR (95%CI)	1.3 (0.3, 4.6)		2.2 (0.5, 9.7)		1.0 (0.2, 5.2)					
Girls without depressed mood at 6 th grade										
White n=482			Black n=134			Hispanic n=171				
8 th grade mood			8 th grade mood			8 th grade mood				
6 th grade weight status	CES-D	24	CES-D < 24	CES-D	24	CES-D < 24	CES-D	24	CES-D < 24	
BMI 95 th percentile	10	(26.3%)	28	(73.7%)	4	(10.3%)	35	(89.7%)	6	(16.7%)
BMI < 95 th percentile	56	(12.6%)	388	(87.4%)	11	(11.6%)	84	(88.4%)	28	(20.7%)
OR (95% CI)	2.5 (1.1, 5.4)		0.9 (0.3, 2.9)		0.8 (0.3, 2.0)					
Breslow-Day <i>P</i> value ^d	.37		.34		.78					
Mantel-Haenszel OR (95% CI)	2.0 (1.0, 3.9)		1.3 (0.5, 3.1)		0.8 (0.4, 1.9)					

OR = odds ratio, CI = confidence interval, BMI = body mass index, CES-D = Centers for Epidemiologic Studies Depression Scale

^a Depressed mood = CES-D 24

^b BMI z-score from CDC 2000 BMI-for-age growth reference; Obesity = BMI z-score 95th percentile

^c n (row percent) tabulated

^d Breslow-Day test for homogeneity of the odds ratios; *P* value < 0.05 would suggest that the odds ratios across strata are not homogeneous.

Table 3a
 Cross-tabulations of depressed mood at 6th grade and obesity at 6th grade and at 8th grade by racial/ethnic group

Racial/ethnic group	White			Black			Hispanic		
	6 th grade weight status	BMI	95 th %tile ^b	6 th grade weight status	BMI	95 th %tile	6 th grade weight status	BMI	95 th %tile
Cross-sectional									
6 th grade mood ^d									
CES-D ≥ 24	12 (21.4%) ^c	44 (78.6%)	9 (20.0%)	36 (80.0%)	9 (30.0%)	21 (70.0%)			
CES-D < 24	38 (7.9%)	444 (92.1%)	39 (29.1%)	95 (70.9%)	36 (21.1%)	135 (78.9%)			
OR (95% CI)		3.2 (1.6, 6.5)		0.6 (0.3, 1.4)		1.6 (0.7, 3.8)			
Prospective									
6 th grade mood									
CES-D ≥ 24	13 (23.2%)	43 (76.8%)	11 (24.4%)	34 (75.6%)	9 (30.0%)	21 (70.0%)			
CES-D < 24	33 (6.8%)	449 (93.2%)	38 (28.4%)	96 (71.6%)	35 (20.5%)	136 (79.5%)			
OR (95% CI)		4.1 (2.0, 8.4)		0.8 (0.4, 1.8)		1.7 (0.7, 4.0)			

OR = odds ratio, CI = confidence interval, CES-D = Centers for Epidemiologic Studies Depression Scale, BMI=body mass index

^aDepressed mood = CES-D ≥ 2

^bBMI z-score from CDC 2000 BMI-for-age growth reference; Obesity = BMI z-score ≥ 95th percentile

^cn (row percent) tabulated

^dBreslow-Day test for homogeneity of the odds ratios; P-value <0.05 would suggest that the odds ratios across strata are not homogeneous.

Table 3b

Stratified by 6th grade obesity - cross-tabulations of 6th grade depressed mood and 8th grade obesity

Prospective, stratified by obesity at 6 th grade		White n=50		Black n=48		Hispanic n=45	
		8 th grade weight status		8 th grade weight status		8 th grade weight status	
6 th grade mood	BMI	95 th %tile	BMI < 95 th %tile	BMI	95 th %tile	BMI	95 th %tile
CES-D < 24	11 (91.7%)	1 (8.3%)	8 (88.9%)	1 (11.1%)	8 (88.9%)	1 (11.1%)	8 (22.2%)
CES-D < 24	25 (65.8%)	13 (34.2%)	33 (84.6%)	6 (15.4%)	28 (77.8%)	8 (22.2%)	8 (22.2%)
OR (95% CI)		5.7 (0.7, 49.3)		1.5 (0.2, 13.8)		2.3 (0.2, 21.1)	
Girls not obese at 6th grade							
		White n=488		Black n=131		Hispanic n=156	
		8 th grade obesity		8 th grade obesity		8 th grade obesity	
6 th grade mood	BMI	95 th %tile	BMI < 95 th %tile	BMI	95 th %tile	BMI	95 th %tile
CES-D < 24	2 (4.6%)	42 (95.5%)	3 (8.3%)	33 (91.7%)	1 (4.8%)	20 (95.2%)	20 (95.2%)
CES-D < 24	8 (1.8%)	436 (98.2%)	5 (5.3%)	90 (94.7%)	7 (5.2%)	128 (94.8%)	128 (94.8%)
OR (95% CI)		2.6 (0.5, 12.6)		1.6 (0.4, 7.2)		0.9 (0.1, 7.8)	
Breslow-Day P value ^d		.54		.93		.56	
Mantel-Haenszel OR (95% CI)		3.9 (1.1, 13.8)		1.6 (0.4, 5.5)		1.5 (0.4, 6.2)	

OR = odds ratio, CI = confidence interval, CES-D = Centers for Epidemiologic Studies Depression Scale, BMI=body mass index

^a Depressed mood = CES-D < 24

^b BMI z-score from CDC 2000 BMI-for-age growth reference; Obesity = BMI z-score > 95th percentile

^c n (row percent) tabulated

^d Breslow-Day test for homogeneity of the odds ratios; P value < 0.05 would suggest that the odds ratios across strata are not homogeneous.

Table 4

Bidirectional prospective associations between obesity and depressed mood

	White	Black	Hispanic	Interaction <i>P</i> value ^d
6th grade obesity^b as predictor of 8th grade depressed mood^c				
Unadjusted	2.48 (1.93, 3.19) ^d	1.03 (0.46, 2.31)	0.86 (0.38, 1.94)	<.0001 ^{e,f}
Adjusted for covariates	2.47 (1.85, 3.30)	1.16 (0.50, 2.72)	0.82 (0.35, 1.92)	<.0001 ^f
Adjusted for covariates and 6 th grade depressed mood ^g	2.09 (1.44, 3.02)	1.29 (0.57, 2.88)	0.76 (0.31, 1.85)	<.0001 ^f
<u>Stratified by 6th grade depressed mood</u>				
Among those with depressed mood at 6 th grade	1.26 (0.37, 4.31)	2.11 (0.78, 5.72)	0.96 (0.29, 3.24)	.50
Among those without depressed mood at 6 th grade	2.50 (1.57, 3.98)	0.98 (0.16, 5.97)	0.72 (0.26, 1.95)	.0002 ^f
6th grade depressed mood as predictor of 8th grade obesity				
Unadjusted	4.13 (1.77, 9.64) ^h	0.82 (0.40, 1.67)	1.66 (0.58, 4.73)	.022 ^e
Adjusted for covariates	4.47 (1.96, 10.24)	0.83 (0.40, 1.71)	1.89 (0.66, 5.40)	.014 ^e
Adjusted for covariates and 6 th grade obesity ⁱ	3.68 (1.72, 7.87)	1.58 (0.65, 3.83)	1.64 (0.36, 7.49)	.22
<u>Stratified by 6th grade obesity</u>				
Among those obese at 6 th grade	6.27 (0.49, 80.04)	1.35 (0.23, 7.96)	2.13 (0.17, 26.30)	.59
Among those not obese at 6 th grade	3.11 (0.85, 11.32)	1.56 (0.51, 4.72)	1.34 (0.12, 14.81)	.56

BMI = body mass index; CES-D = Centers for Epidemiologic Studies Depression Scale

^a *P* value (Wald χ^2) for interaction by race/ethnicity

^b Obesity = BMI z-score 95th percentile of the 2000 CDC BMI-for-age growth charts

^c Depressed mood = CES-D 24

^d Odds ratios (95% confidence interval) for 8th grade depressed mood from 6th grade obesity calculated with generalized estimating equations; all models (except unadjusted) are adjusted for 6th grade age, free lunch, and time home alone. Reference category is girls of specified racial/ethnic group who were not obese in 6th grade.

^e = white different from black;

^f = white different from Hispanic.

^g 3-way interaction between 6th grade depressed mood, 6th grade obesity, and race not statistically significant (*p*=0.28)

^hOdds ratios (95% confidence interval) for 8th grade obesity from 6th grade depressed mood calculated with generalized estimating equations; all models (except unadjusted) are adjusted for 6th grade age, free lunch, and time home alone. Reference category is girls of specified racial/ethnic group who did not have depressed mood at 6th grade.

ⁱ3-way interaction between 6th grade obesity, 6th grade depressed mood, and race not statistically significant ($p=0.91$)