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Research paper

Does major depression affect risk for adolescent obesity?

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ABSTRACT

Objective: The purpose of this paper is to reexamine the association between major depression and obesity in adolescents, testing the hypothesis that body image mediates this association. This is the first paper to examine this question using DSM-IV diagnosis of depression and data from a two-wave cohort of adolescents.

Methods: Participants were 4175 youths 11–17 years of age sampled from the community who were followed up a year later ($n=3134$). Major depression was assessed using DSM-IV diagnostic criteria. Body image was measured with perceived weight. Obesity was defined as BMI \geq 95th percentile using measured height and weight.

Results: When we examined a model which included obesity, perceived weight, major depression and covariates, there was no association between major depression at baseline and obesity at follow-up. We found no independent association between major depression and body weight.

Limitations: The study was limited in that it is not a national sample, BMI was the only measure of adiposity, perceived weight was the only measure of body image, and there were no data on lifetime trajectories of depression, obesity, or body image.

Conclusions: If there is an etiologic link between major depression and body weight among adolescents, it most likely operates through processes involving components of body image, since controlling for body image eliminated the association between depression and obesity. Clinically, addressing body image in depressed patients who are obese may improve outcomes.

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1. Introduction

Does major depression increase the risk of obesity in adolescence? A small number of studies suggest the answer is yes.

In their meta-analytic study, Luppino et al. (2010) identified only 6 papers that met their criteria for prospective studies of the relation between obesity and depression involving adolescents, that is, subjects were under the age of 18 at baseline. They found that the pooled data from the studies of adolescents which examined obesity as a risk factor for subsequent depression found little increased risk. The pooled data for the studies examining the reverse association showed that depression increased risk for subsequent obesity.

We recently published a paper which provides more precise elaboration of the association between major depression and body weight. Using prospective data from Teen Health 2000 (TH2K), we found that obese youths were not at increased risk of major

depression, but that depressed youths at baseline were at increased risk of being obese a year later (Roberts and Duong, 2013a).

Historically, obesity has been a stigmatized condition with reports documenting social exclusion, occupational and educational discrimination, and prejudice attributed to negative attitudes. This is true for adults (Puhl and Heuer, 2009) as well as children and adolescents (Puhl and Latner, 2007). The putative multiple adverse social and interpersonal consequences of obesity have resulted in the widespread assumption that the obese suffer psychologically both as a direct consequence of social adversities and indirectly through negative “reflected appraisal” (Wardle et al., 2006).

While there are epidemiologic data linking clinical depression to obesity among adolescents, there is evidence from the literature suggesting that the primary effect of obesity is indirect rather than direct. That is, the association between obesity and depression may be mediated by other factors. One of these factors is body image, in particular perceived weight and body satisfaction (Roberts and Duong, 2013b). Longitudinal studies indicate that poor body image is associated with greater psychological distress, more

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disordered eating, binge eating and fewer health-promoting behaviors such as physical activity and consumption of fruits and vegetables (Daniels et al., 2005; Neumark-Sztainer et al., 2007; ter Bogt et al., 2006).

In our earlier paper, we did not examine the role of body image in relation to major depression and obesity (Roberts and Duong, 2013a). Thus, we could not examine the temporal relation between body image, major depression and obesity. That is the focus of this paper. We use data from the same two-wave cohort study, TH2K, to examine the prospective association between these three constructs.

Our hypothesis is that there is an association between major depression and obesity but this relationship is mediated by body image, i.e., perceived weight better accounts for risk of obesity than depression.

2. Methods

2.1. Study sample

The sample was selected from households in the Houston metropolitan area enrolled in two local health maintenance organizations. One youth, aged 11–17 years, was sampled from each eligible household, oversampling for ethnic minority households. Initial recruitment was by telephone contact with parents. A brief screener was administered on ethnic status of the sample youths and to confirm data on age and sex of youths. Every household with a child 11–17 years of age was eligible. Because there were proportionately fewer minority subscriber households, sample weights were developed and adjusted by post-stratification to reflect the age, ethnic, and sex distribution of the 5-county Houston metropolitan area in 2000. The precision of estimates are thereby improved and sample selection bias reduced to the extent that it is related to demographic composition (Andrews et al., 1967). Thus, the weighted estimates generalize to the population 11–17 years of age in a metropolitan area of 4.7 million people.

Data were collected on one sample youth and one adult caregiver in each household using computer-assisted personal interviews and self-administered questionnaires. The computerized interview contained the structured psychiatric interview (see below) and demographic data on the youths and the household. Height and weight measures were conducted after the completion of the interviews. The interviews and measurements were conducted by trained, lay interviewers. The interviews took on average 1–2 h, depending on the number of psychiatric problems present. Interviews, questionnaires, and measurements were completed with 4175 youths at baseline, representing 66% of the eligible households. There were no significant differences in gender, age or among ethnic groups in completion rates. All youths and parents gave written informed consent prior to participation. All study forms and procedures were approved by the University of Texas Health Science Center Committee for Protection of Human Subjects.

The sample, in addition to being representative, was also diverse in terms of age, ethnic status, and family income (reported by parent). In terms of ethnicity, 35.4% were European Americans, 35.4% were African American, 24.4% were Latino American, and 4.6% were Other. In terms of family income, 24.0% had an annual income of less than \$35,000, 40.7% between \$35,000 and \$64,999, and 35.3% more than \$65,000 (data not shown.)

Data on psychiatric disorders were collected using the youth version of the Diagnostic Interview Schedule for Children, Version 4 (DISC-IV), a highly structured instrument with demonstrated reliability and validity (Angold et al., 2012; Shaffer et al., 2000).

Interviews were conducted by college-educated, lay

interviewers who had been extensively trained using protocols provided by Columbia University. Interviews with the DISC-IV were administered using laptop computers.

2.2. Measures

We examine the association between obesity and major depression using DSM-IV diagnostic criteria (American Psychiatric Association, 2000). Thus, we define major depression as at least one major depressive episode in the previous 12 months (prevalence was 1.7%). Younger youths and females were more likely to be depressed. There were no ethnic nor income differences in prevalence of depression (data not shown).

Height and weight were measured using standard field procedures such as a Tanita digital scale (Armstrong and Welsman, 1997; Lohman et al., 1991; National Institutes of Health, 1998). BMI is defined as weight in kg/squared height in meters (kg/m^2). Weight status is categorized as healthy weight (BMI < 85th percentile), overweight ($85\text{th} \leq \text{BMI} < 95\text{th}$ percentile), and obese (BMI $\geq 95\text{th}$ percentile) (Centers for Disease Control and Prevention, 2014; Ogden et al., 2008). For the overall sample at baseline, 18.2% were overweight ($85\text{th} \leq \text{BMI} < 95\text{th}$) and 20.8% were obese (BMI $\geq 95\text{th}$). Thus, 39% were overweight or obese. Younger youths were heavier, as were males, minority youths, and those from lower income families (data not shown). For purposes of analyses, due to low prevalence of major depression, weight is dichotomized: healthy weight vs. obese.

Body image is measured with an item that assessed perceived weight and inquires whether youths perceive themselves as: (a) skinny; (b) somewhat skinny; (c) average weight; (d) somewhat overweight, or (e) overweight. Youths who rate themselves as somewhat or overweight are scored as having poor body image, in this case perceived overweight. We have used this measure, scored the same way, before (Roberts and Duong, 2013b). Females and Latinos were more likely to perceive themselves as overweight. Unlike body weight, there was no association between family income and perceived weight (data not shown).

Faith et al. (2002) have noted many studies of obesity and depression fail to control for relevant covariates that might mediate or moderate the observed association. Another problem is that there is little consistency across studies. Luppino et al. (2010) found only age and gender were consistent across studies. As a result, the direction and magnitude of the effects of covariates remain unclear. We include as covariates known correlates of both depression and obesity: age, gender, family income, physical activity, and dieting behavior. Age is categorized as 12 or younger, 13–15, and 16 or older. Family income is categorized as less than \$35,000, \$35,000–\$64,999, and \$65,000 or more. Physical activity is measured with an item that asks on how many days in the past week youths walked or bicycled at least 30 min at a time. Responses are 0, 1, 2, 3, 4, 5, 6 or 7 days. Scores were dichotomized as “0 day” and 1 day or more in the past week. Dieting behavior is considered to be important in the context of weight and psychological functioning (Needham and Crosnoe, 2005; Ross, 1994). Our items include (1) refused to eat foods you thought would make you fat; (2) made yourself throw up; (3) took pills to lose weight; (4) took laxatives; (5) fasted for at least 24 h. The time referent is past month. The items are summed, yielding a score of 0–5, and dichotomized as 0 and 1 or more days.

2.3. Statistical analyses

The relationship between weight status (healthy weight vs. obese) and depression (yes, no) is examined, using odds ratios controlling for covariates. Healthy weight group (BMI < 85th percentile) is the referent. In our analyses, depression is

considered the exposure and obesity is considered the outcome; that is, greater depression is hypothesized to increase risk for obesity, all other things equal.

To test for mediation, we test (1) whether depression predicts obesity, (2) whether depression predicts body image, (3) whether body image predicts obesity, and (4) whether controlling for body image attenuates the association between depression and obesity (Baron and Kenny, 1986).

We also examine the association between depression and weight separately for males and females, given that some studies have reported that gender modifies this association (Merikangas et al., 2012; Mustillo et al., 2003; Roberts and Duong, 2013a).

The estimated odds ratios and their 95% confidence limits were calculated using survey logistic regression (PROC SURVEYLOGISTIC) procedures in SAS V9.1 (SAS Institute, 2004) and Taylor series approximation to compute the standard error of the odds ratio. Lepkowski and Bowles (1996) have indicated that the difference in computing standard error between this method and other repeated replication methods such as the jackknife is very small. Analyses for this paper were done in the latter months of 2014.

3. Results

Table 1 shows the association between major depression at baseline and risk of subsequent obesity. The crude odds show a twofold increased risk for the overall sample and a fourfold increased risk for males, but no increased risk for females. Adjusting for covariates, there is still a prospective association between depression and weight, but only for the overall sample. We should note that the odds for males, 3.54, is not trivial. However, due to the low prevalence of depression in males, there was not sufficient power in multivariate analyses (as indicated by the very large confidence interval).

Data from Table 2 indicate that, net of covariates, there is no association between major depression and perceived weight. Crude odds show a threefold risk for the overall sample and nearly eightfold for males. Again, there is no effect for females.

Table 3 presents data for the association between perceived weight at baseline and subsequent obesity. Multivariate analyses indicate there is no association for males. However, perceived overweight increases risk for obesity almost threefold for females and twofold for the total sample. However, the crude odds indicate a strong association between body image and obesity. Perceived overweight at baseline increases the odds of obesity at follow-up 30-fold for the overall sample and for males and almost 40-fold for females.

As can be seen in Table 4, major depression increased the odds of future obesity two-fold in the overall sample and four-fold

Table 1
Odds ratios for the prospective association between major depression and obesity.

Major depression at wave 1	Weight status at wave 2			
	Crude OR, 95% C.I.		Adjusted OR, 95% C.I.	
	Healthy weight	Obese	Healthy weight	Obese
Total ^a	1	2.21 (1.10–4.42)	1	2.87 (1.34–6.18)
Male ^b	1	4.14 (1.39–12.33)	1	3.54 (0.23–54.56)
Female ^b	1	1.59 (0.57–4.42)	1	0.61 (0.23–1.63)

Boldface indicates statistically significant odds ratios ($p < 0.05$).

^a Adjusting for age, gender, family income, diet, physical activity, and weight status at wave 1.

^b Adjusting for age, family income, diet, physical activity, and weight status at wave 1.

Table 2
Odds ratios for the prospective association between depression and body image (perceived weight).

Major depression at wave 1	Body image at wave 2			
	Crude OR, 95% C.I.		Adjusted OR, 95% C.I.	
	Good body image	Poor body image	Good body image	Poor body image
Total ^a	1	3.17 (1.75–5.74)	1	0.50 (0.23–1.09)
Male ^b	1	7.85 (2.72–22.64)	1	0.27 (0.05–1.48)
Female ^b	1	1.88 (0.89–3.97)	1	0.61 (0.25–1.49)

Boldface indicates statistically significant odds ratios ($p < 0.05$).

^a Adjusting for age, gender, family income, diet, physical activity and perceived weight at wave 1.

^b Adjusting for age, family income, diet, physical activity and perceived weight at wave 1.

Table 3
Odds ratios for the association between perceived weight and obesity (two-wave analyses).

Perceived body weight at wave 1	Obesity at wave 2			
	Crude OR, 95% C.I.		Adjusted OR, 95% C.I.	
	Healthy weight	Obese	Healthy weight	Obese
Total ^a	1	29.98 (22.87–39.31)	1	2.36 (1.33–4.19)
Male ^b	1	32.13 (21.73–47.51)	1	1.83 (0.85–3.96)
Female ^b	1	39.03 (25.80–59.06)	1	2.72 (1.14–6.50)

Boldface indicates statistically significant odds ratios ($p < 0.05$).

^a Adjusting for age, gender, family income, diet, physical activity and perceived weight at wave 1.

^b Adjusting for age, family income, diet, physical activity and perceived weight at wave 1.

Table 4
Odds ratios for the association between major depression and obesity, controlling for perceived weight.

Major depression at wave 1	Obesity at wave 2			
	Crude OR, 95% C.I.		Adjusted OR, 95% C.I.	
	Healthy weight	Obese	Healthy weight	Obese
Total ^a	1	2.21 (1.10–4.42)	1	1.21 (0.22–6.57)
Male ^b	1	4.14 (1.39–12.33)	1	2.31 (0.15–36.46)
Female ^b	1	1.59 (0.57–4.42)	1	0.88 (0.32–2.40)

Boldface indicates statistically significant odds ratios ($p < 0.05$).

^a Adjusting for age, gender, family income, diet, physical activity and perceived weight at wave 1.

^b Adjusting for age, family income, diet, physical activity and perceived weight at wave 1.

among males. There was no effect for females, as we reported in our cross-sectional analyses as well (Roberts and Duong, 2013b). When we controlled for covariates, including perceived weight, there was no association between major depression at baseline overall or by gender indicating that perceived weight fully accounts for the observed association between major depression found in earlier research (Blaine, 2008; Luppino et al., 2010; Roberts and Duong, 2013a). The odds for males decreased from 4.1 to 2.3, but still was not significant at the 0.05 level.

4. Discussion

To our knowledge, this is the first study to examine the prospective association between obesity, body image and major depression among adolescents. We found that, as hypothesized, body image (perceived weight) mediated the association initially observed between major depression and obesity.

Frisco et al. (2010) examined weight pessimists (perceived weight worse than actual weight), weight realists (accurate weight perceptions) and weight optimists (perceived weight better than actual weight) and found weight pessimists to be at greater risk for depressive symptoms. We could not confirm their findings in our earlier paper (Roberts and Hao, 2013). The same is true here, using data from a prospective study and a mediation strategy. Major depression at baseline increased risk of obesity.

Major depression increased risk of greater perceived weight, but not after controlling for covariates. Perceived weight increased the risk for obesity dramatically, 30- to 40-fold. Controlling for covariates, there was still increased risk for females and for the overall sample. In the full model, there was no prospective association between major depression and obesity when perceived weight was introduced as a control along with the other covariates. These results support our hypothesis that body image is the exposure increasing risk for obesity, fully mediating the association initially observed between major depression and obesity.

In a previous paper (Duong and Roberts, 2014), 22% perceived themselves as overweight, 74% of these were overweight. By contrast, 48% perceived themselves as average weight and 51% were normal weight. About 28% perceived themselves as skinny, and 42% were healthy weight. The tendency was for obese youths not to perceive themselves as overweight and for skinny youths to be heavier than they perceived. At followup, 15% of those who perceived themselves as skinny, 44% of those who perceived themselves as average weight, and 81% of those who perceived themselves as overweight were overweight or obese at followup 6 years later.

As reported by others, we found evidence that gender modified the associations between major depression, obesity and body image (Blaine, 2008; Frisco et al., 2009; Merikangas et al., 2012; Mustillo et al., 2003). However, the full model results did not indicate that gender modification was operant. We should note that the odds for males was over 2, which is not trivial. However, due to the low prevalence of major depression, we had reduced power.

Merikangas et al. (2012) note that evidence thus far on obesity and depression among adolescents has been confounded by diverse sample characteristics and methodologic differences in measuring both depression and weight. Many studies have relied on self-reports of weight, which appears to contribute to confirmation bias. Most studies also have focused on symptoms of depressed mood, rather than diagnosed depression, thus ignoring more severe manifestations and more rigorously measured depression status.

Our study was prospective, following youths a year later with the same measures. We estimated BMI values using measured height and weight. Major depression was assessed using DSM-IV diagnostic criteria.

5. Limitations

Our study had limitations. Our sample was not, strictly speaking, a community-based sample. We were able to complete assessments with only 66% of those sampled at baseline, raising the possibility of nonresponse bias. We have carefully examined potential biases from these design characteristics in previous publications (Roberts and Roberts, 2007; Roberts et al., 2009) and

demonstrated that bias was minimal. We should note that the response rate for adolescents in the National Comorbidity Survey Replication Adolescent Survey was 75% (Kessler et al., 2009).

Our estimate of the association between weight and depression may be attenuated because we could not examine lifetime trajectories of either major depression or weight. Data on these factors from early childhood through adolescence are needed, but such studies have not been done.

Another potential issue is that we did not include data from parent reports of outcomes or predictors (with the exception of family income). While there is argument that data from multiple informants is desirable, many studies attest to considerable discordance in parent–child reports of psychopathology and functioning (Roberts et al., 2005). In a previous paper, we have demonstrated substantial differences in parent–child concordance across ethnic groups, such that minority parents reported fewer problems in their children, but there were no differences using youth reports across ethnic groups (Roberts et al., 2005). This suggests that reliance on youth reports may be less problematic than use of parent reports, particularly for major depression.

The TH2K study was not designed to assess the roles of family history or genetics in the epidemiology of psychiatric disorders or obesity among youths. As a result, we could not examine the contribution of these factors relative to those factors examined. Reviews by Rutter et al. (1999) as well as Kendler (1998) suggest that considerable variance in risk of psychiatric disorders is explained by family history and/or genetics. Studies have found that there is a genetic influence on obesity (Silventoinen et al., 2010; Stunkard et al., 1986). It is possible, indeed plausible, that a gene \times environment interaction might better account for the association between depression and obesity (Markward et al., 2009).

We also did not examine directly the role of weight-related stigma, such as measures of weight-related prejudice, discrimination, and teasing/victimization (Puhl and Heuer, 2009; Puhl and Latner, 2007).

6. Conclusions

The literature suggests two possibilities for a link between depression and obesity (Luppino et al., 2010). One is that a depressed person, through dysregulated stress systems or through unhealthy life styles, develops more obesity over time. The other is that obesity, through its negative effects on self-image or somatic consequences, results in development of depression over time. However, our results suggest a third hypothesis—that the etiologic link, if there is one, between major depression and body weight operates through a third factor, body image (defined here as perceived weight), which acts as a mediator. There is a substantial literature suggesting that negative body image is related to poor psychological functioning. Indeed, body image appears to be a better predictor of mental health outcomes than weight per se (Herbozo and Thompson, 2010; Roberts and Duong, 2013b). In the case of our data from TH2K, it appears that body image is more important than depression in terms of risk for obesity, and so our earlier results also fit better with the second hypothesis (Roberts and Duong, 2013b).

We are the first to examine the prospective association between major depression, body image, and obesity in adolescence. Our results raise the question of whether there is any direct link between major depression and obesity, at least among adolescents. In our study, major depression increased risk for obesity as did perceived weight. However, depression did not increase risk for perceived overweight. Baron and Kenny (1986) define a mediator as a factor in which an exposure, E (depression in this case), influences the outcome, O (obesity here). Typically, E is associated

with O; X, the mediator, is associated with O; and E is associated with X, such that introducing X into the model reduces or eliminates the association between E and O (Susser et al., 2006). In this case, the data suggest E and X are unrelated, and E is not related to X in multivariate analyses. Hence, we conclude that X (perceived weight) is the generative factor. In other words, from an epidemiologic perspective, depression need not occur for obesity to occur, if negative body image occurs. Thus, explanatory models for adolescent obesity may need to redefine the role of major depression, perhaps such that major depression increases risk in the presence of negative body image, but negative body image appears to be sufficient in the absence of major depression.

From a clinical perspective, major depression and obesity have been linked in youths in treatment settings (Mansur et al., 2015; Marks et al., 2009; Morgan et al., 2002; Pauli-Pott et al., 2013; Platt et al., 2013; Pott et al., 2010). Given this, clinical interventions for youths who are depressed and obese perhaps should consider including strategies which focus on weight control as well as improving body image and symptoms of depression. For example, our previous study (Duong and Roberts, 2014) found that those who perceived themselves as skinny at baseline were 60% less likely to be overweight at followup. In this case, perceiving one's self as thin protected against future risk of overweight.

Both major depression and obesity are chronic health conditions, and their etiology singly or jointly undoubtedly involves a complex etiologic web, much of which remains unknown (Susser et al., 2006). More prospective studies are needed which examine the association between clinical or diagnosed depression, obesity and body image within the adolescent population. These studies should also focus on potential moderators and mediators of this association. Based on our results, one of these factors should be weight perception and possibly processes involving weight-related prejudice and discrimination.

Our results suggest that, in our attempts to understand the etiology of youth obesity, we may need to rethink the role of depression or other psychiatric disorders as risk factors for obesity and overweight, at least as a direct, independent risk factor.

Conflict of interest

The authors have no conflicts of interest.

Contributors

The study sponsors had no role in the design of the study.

Dr. Roberts is a faculty member of the University of Texas Health Science Center at Houston and has no other institutional affiliation.

Robert E. Roberts, Ph.D., was responsible for study design of Teen Health 2000 and its measures, as well as the design of the research strategy for this paper. He also wrote the paper, excluding statistical analyses and results.

Dr. Duong is employed by the Centers for Disease Control in Vietnam and has no other institutional affiliation.

Hao T. Duong, M.D., MPH, Dr.P.H., conducted analyses of the data, wrote the statistical analyses section and the results section.

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