Mediators involved in the relation between depressive symptoms and weight status in female adolescents and young adults

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Abstract

Depression may be a risk factor for overweight status, but mechanisms involved in this relationship are unclear. This study explored behavioral factors involved in the relationship between adolescent depression symptoms and adult overweight status. A population-based cohort of female participants in Project EAT (*n*=1,035) was followed over 10 years and reported on psychological functioning, weight status, and eating and activity patterns in early/middle adolescence (1999=Time 1; T1), middle adolescence/early young adulthood (2004=Time 2; T2), and early/middle young adulthood (2009=Time 3; T3). Structural equation models were fit which included T1 depression scores predicting overweight status at T3, with T2 fruit and vegetable consumption, moderate-to-vigorous physical activity, and binge eating examined as mediators. There were small but significant effects of T1 depression scores predicting an increased likelihood of T3 overweight status (standardized estimate=0.038; *p*=.007), and of T2 binge eating mediating the relation between T1 depression and T3 overweight status (standardized indirect effect estimate=.036; *p*=.009). Binge eating may be one pathway to overweight among depressed females, suggesting that recognition and treatment of eating pathology in individuals with depression may help prevent overweight. Examination of other behavioral (and non-behavioral) factors explaining the relationship between depression and overweight is warranted.

Keywords

Overweight; obesity; depression; mediation; longitudinal; eating behaviors; physical activity

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Overweight and depression have significant personal and economic impacts.[1,2] These conditions frequently co-occur, and their relationship is likely bi-directional,[3] but explanatory mechanisms are unclear. Understanding these mechanisms could inform shared intervention efforts. Problematic eating and activity patterns are common in both conditions,[4,5] and may contribute to overweight in individuals with depression.

While depression often involves diminished appetite and weight loss, increased appetite and concomitant weight gain may occur,[2] which can promote the onset and/or exacerbation of overweight. Binge eating, involving overeating accompanied by feelings of loss of control, is strongly associated with overweight and depressive symptoms.[6] One conceptualization involves viewing binge eating as a maladaptive method of managing negative mood.[7] Poor dietary quality is cross-sectionally associated with depression symptoms,[8] and some prospective data indicate that persistent depression symptoms predict worsening dietary habits over time.[9] Depression is also characterized by psychomotor retardation, fatigue, and low energy, which may foster decreased physical activity.[10] Despite evidence suggesting that poor dietary and activity patterns are common features of both overweight and depression, it is unclear whether these factors mediate the relation between the conditions.

Our previous research found that increases in depression symptoms among early/middle adolescent females (but not males) predicted increased incidence of overweight in early/middle young adulthood.[11] Utilizing the same population-based cohort of females followed from adolescence to young adulthood, the *current* study expands upon these prior findings by examining eating behaviors and physical activity as potential mediators of the relation between depression symptoms and overweight. To our knowledge, no prior research has prospectively examined this mediation relationship; however, such data could inform obesity prevention efforts by identifying mechanisms contributing to excess weight gain among individuals with depression, which could then be addressed in targeted intervention programs. We hypothesized that binge eating, poor dietary quality, and infrequent exercise in middle adolescence/early young adulthood would independently mediate the relation between depression symptoms in early/middle adolescence and overweight in early/middle young adulthood.

MATERIALS AND METHODS

Participants

Data were drawn from Project EAT (Eating and Activity in Teens and Young Adults), a 10-year longitudinal study of eating-related, anthropometric, and psychosocial factors among young people. Participants were female middle and high school students in and around Minneapolis/St. Paul, Minnesota assessed in early/middle adolescence [EATI; Time 1 (T1); age 11-18y] from 1998-1999.[12] Follow-up data were collected 5- and 10-years later [EAT-II: Time 2 (T2)=middle adolescence/early young adulthood; age 16-23y; EAT-III: Time 3 (T3)=early/middle young adulthood; age 21-29y] to investigate changes in weight-related outcomes and their correlates. All study protocols were approved by the University of Minnesota's Institutional Review Board.

Measures

The EAT survey assesses cognitions, behaviors, and attitudes related to eating and psychological functioning. Test-retest data for the EAT-I survey were collected on 161 adolescents completing identical versions of the survey approximately two weeks apart.

Self-reported height and weight were used to determine body mass index (BMI; kg/m^2). Overweight referred to a BMI 85th percentile[13] at T1 and T2, and a BMI 25 at T3. Self-report of height and weight was validated in 125 EAT-III participants, representing a range of demographic and anthropometric features, who were consecutively invited to have height and weight measured at the University of Minnesota by trained research staff. Self-reported and measured BMI were highly correlated in females (r=.98). Age, sex, and race/ethnicity were self-reported. Five levels of socioeconomic status (SES) were based on participant report of the highest educational attainment by either parent at T1. Eligibility for public assistance, eligibility for free/reduced-price school meals, and parental employment status were used to approximate missing SES information.[12]

Kandel and Davies' scale for adolescents[14] assessed the frequency of depression symptoms during the past year. This measure has good concurrent validity and internal consistency[14] (present study α=.84).

Binge-eating was ascertained as follows: "In the past year, have you ever eaten so much food in a short period of time that you would be embarrassed if others saw you?"; "During the times when you ate this way, did you feel you couldn't stop eating or control what or how much you were eating?"[15] These items have good concurrent validity and test-retest reliability[16] (present study test-retest agreement=92% for overeating, 84% for loss of control). An affirmative response to both questions was classified as binge eating.

Fruit and vegetable intake (F/V), assessed by the youth form of the Willett semi-quantitative Food Frequency Questionnaire,[17] served as a proxy for dietary quality. Fruit intake (excluding juice) was estimated by summing the reported consumption of 9 varieties, including berries, melons, citrus, and stone fruits. Vegetable intake (excluding French fries) was estimated by summing the reported consumption of 19 varieties, including legumes and root, starchy, and cruciferous vegetables.

A modified Leisure Time Exercise Questionnaire[18] assessed moderate-to-vigorous physical activity (MVPA). This measure correlates significantly with other adolescent physical activity measures.[19] Participants report how many hours per week they engage in vigorous ("your heart beats rapidly"), moderate ("not exhausting"), and mild (require "little effort") activities (range=<0.5 hours/week to 6+ hours/week). Summing moderate and vigorous hours produced weekly MVPA.

Statistical Analysis

Using MPlus 7.1, structural equation models were fit including T1 depression scores predicting T3 overweight status, with T2 binge eating, F/V, and MVPA as mediators. T1 overweight status, age, race/ethnicity, and SES were covariates in submodels for the mediators and for overweight status at T3. Mediators were included in the model

simultaneously and their residual errors allowed to correlate. Overweight status and binge eating are dichotomous and were modeled using a probit regression with weighted least-squares. Estimates of the indirect effect of T1 depression on T3 overweight through the T2 mediators represent the expected change on the probit scale of T3 overweight status due to changes in the T2 mediator resulting from one standard deviation differences in T1 depression symptoms. Significance tests for indirect effects were obtained with bootstrapping.

Of the original 2,373 female EAT-I participants, 1,083 (45.6%) had data available at all three time-points. Forty-eight participants were missing data on one or more predictor variables, leaving 1,035 participants for the current analyses. Seventy-five females were pregnant or breast-feeding at T3, so their T3 weight status is treated as missing; however, their remaining data are included in analyses using full information maximum likelihood. Because attrition from the T1 sample was not random, data were weighted with the inverse of the estimated probability that an individual responded at all three time-points. This weighting, along with subpopulation analysis, generates estimates that represent the demographic composition of the original Project EAT sample corresponding to the analytic subgroups.

RESULTS

Table 1 describes sample characteristics. Higher T1 (early/middle adolescence) depression predicted an increased likelihood of T3 (early/middle young adulthood) overweight (standardized estimate=0.038; p=.007). While both T2 (middle adolescence/early young adulthood) binge eating and F/V were predictors of T3 overweight, only binge eating significantly mediated the relation between T1 depression and T3 overweight (standardized indirect effect=.036; p=.009) due to its strong relationship with T1 depression (see Figure 1). While T1 depression predicted lower T2 MVPA, MVPA was not a mediator as it did not relate to T3 overweight (p>.05).

DISCUSSION

This study expands upon the previously-identified longitudinal relationship between depression and overweight by identifying behavioral mediators explaining this relationship. Among females, higher early/middle adolescent depression symptoms predicted binge eating frequency during middle adolescence/early young adulthood, which in turn predicted overweight in early/middle young adulthood. The mediation effect for binge eating frequency was small, and F/V and MVPA were not significant mediators. Thus, the relationship between adolescent depression and adult overweight may also operate through other behavioral (or non-behavioral) variables.

Binge eating affects 10-30% of obese individuals,[15] and our results indicate that it may represent one pathway to overweight among females with depression symptoms in adolescence. Binge eating may develop as a method of alleviating depression symptoms,[7] ultimately contributing to weight gain and overweight status. Females presenting with depression symptoms should be screened and treated for eating pathology to prevent the

later onset of overweight; this is especially important given that binge eating prevalence increased over time in our sample (although this may reflect improved understanding of the term "binge eating"). Interventions should aim to resolve current depression symptoms, and help individuals develop healthier affect regulation strategies.

Study strengths include the longitudinal design and the community-based sample. Limitations include the use of brief, self-report measures to assess anthropometric, behavioral, and psychosocial variables. Assessments occurred at 5-year intervals, which may have precluded the detection of more nuanced changes in depression symptoms, eating and activity behaviors, and weight status occurring between assessments. Finally, treatment-seeking (for either overweight or depression) was not assessed, which may have impacted our findings, especially since antidepressant usage can impact weight control.[20]

A clearer understanding of mechanisms explaining the relation between depression and overweight is needed. Binge eating may represent one pathway among females; however, modest effects and absence of other mediation effects may indicate that environmental variables and/or their interaction with behavioral factors contribute more heavily to overweight risk than behavioral factors alone. Future studies should further explore the relationship between depression and overweight to prevent adverse health outcomes throughout development.
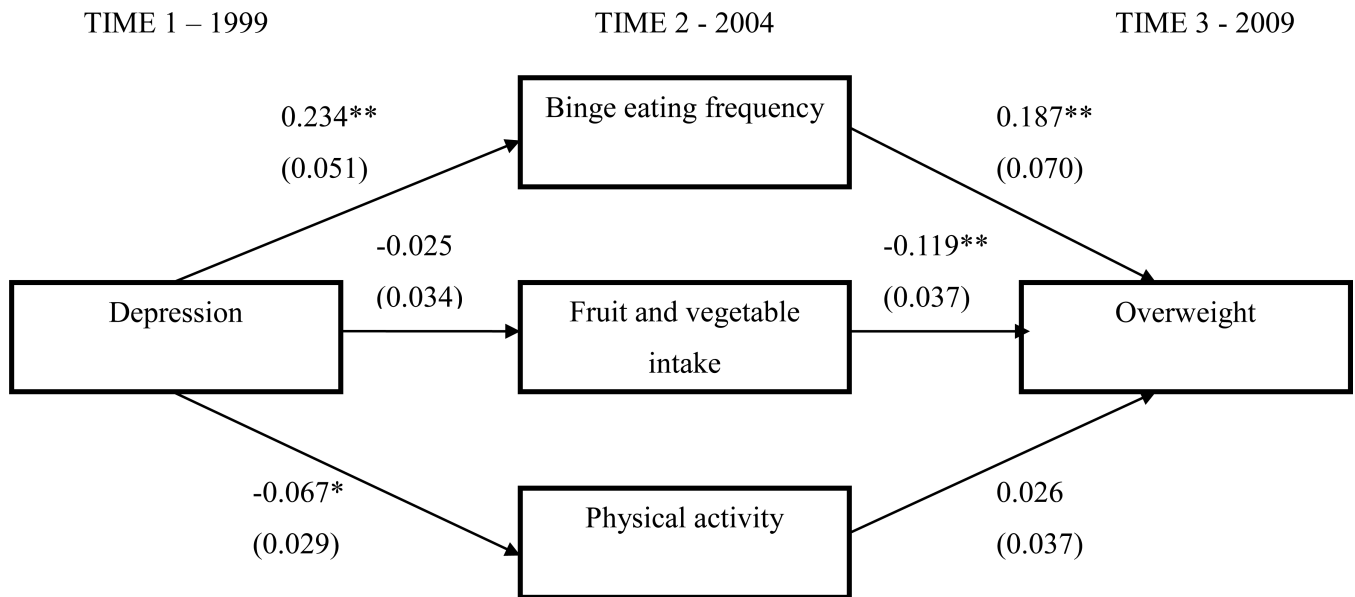
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TIME 1 – 1999   TIME 2 - 2004   TIME 3 - 2009

0.234**   Binge eating frequency   0.187**

(0.051)   (0.070)

-0.025   -0.119**

(0.034)   Fruit and vegetable   (0.037)

Depression   intake   Overweight

-0.067*   0.026

(0.029)   Physical activity   (0.037)

Figure 1.
Mediation paths. *Note*: Estimates are standardized regression coefficients; numbers in parentheses are bootstrapped standard errors. Time 1=early/middle adolescence; Time 2=middle adolescence/early young adulthood; Time 3=early/middle young adulthood. All analyses controlled for Time 1 weight status. *p<.05; **p<.01.

Table 1

Sample characteristics, M±SD unless otherwise indicated (*N*=1,035)

	Time 1	Time 2	Time 3
Demographic and Anthropometric Variables			
Age	14.9±1.6	19.5±1.6	25.3±1.6
Caucasian	48.5 (502)	See Time 1	See Time 1
Asian	19.0 (197)	See Time 1	See Time 1
Race/ethnicity, % (*n*) Black	18.8 (195)	See Time 1	See Time 1
Hispanic	4.9 (51)	See Time 1	See Time 1
Other	8.7 (90)	See Time 1	See Time 1
Socioeconomic status	3.0±1.3	See Time 1	See Time 1
Body mass index (kg/m^2)	22.16±4.56	23.90±4.96	25.99±6.22
Overweight, % (*n*)	24.6 (255)	26.8 (277)	44.5 (461)
Psychosocial and Behavioral Variables			
Depression symptoms	11.1±2.6	11.7±2.8	11.5±2.90
Binge eating, % (*n*)	10.8 (112)	10.5 (109)	15.0 (155)
Fruit/vegetable intake, daily servings	4.1±2.8	3.6±2.5	5.1±3.6
Moderate-to-vigorous physical activity, hours/week	5.7±4.5	4.1±3.5	3.4±3.4

Note: Time 1=early/middle adolescence (age 11-18y); Time 2=middle adolescence/early young adulthood (age 16-23y); Time 3=early/middle young adulthood (age 21-29y). Socioeconomic status range=1 (low) to 5 (high). Depression symptoms range=6 to 18; moderate-to-vigorous physical activity range=less than ½ hour per week to 6+ hours a week