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Depression severity, diet quality, and physical activity in women with obesity and depression

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Abstract

Major depressive disorder (MDD) is prevalent in clinical weight loss settings and predicts poor weight loss outcomes. It is unknown whether the severity of depressive symptoms among those with MDD is associated with diet quality or physical activity levels. This knowledge is important for improving weight loss treatment for these patients. It was hypothesized that more severe depression is associated with poorer diet quality and lower physical activity levels among individuals with obesity and MDD. Participants were 161 women with current MDD and obesity enrolled in the baseline phase of a weight loss trial between 2007 and 2010. Depression severity was measured with the Beck Depression Inventory II. The Alternate Healthy Eating Index (AHEI) was applied to data from three 24-hour diet recalls to capture overall diet quality. Daily metabolic equivalents expended per day (MET-hrs/d) were calculated from three 24-hour physical activity

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recalls. Greater depression severity was associated with poorer overall diet quality (estimate=-.26, SE=.11, p=.02), but not with physical activity (estimate=.07, SE=.05, p=.18), in linear regression models controlling for income, education, depression-related appetite change, binge eating disorder, and other potential confounds. Associations with diet quality were primarily driven by greater intake of sugar ($r=.20$, $p<.01$), saturated fat ($r=.21$, $p<.01$), and sodium ($r=.22$, $p<.01$). More severe depression was associated with poorer overall diet quality, but not physical activity, among treatment-seeking women with MDD and obesity. Future studies should identify mechanisms linking depression to diet quality, and determine whether diet quality improves with depression treatment.

Keywords

Diet quality; Depression; Obesity; AHEI; Physical activity

Major depressive disorder (MDD) has been consistently associated with higher adiposity (1,2) and weight gain (3), with the strongest effects in women (1,4). MDD is also associated with worse weight loss treatment outcomes (5). The severity of depressive symptoms can vary substantially across individuals, and may influence the eating and physical activity patterns linked to obesity among those with MDD. High rates of depression are seen in clinical weight loss settings (5), and a better understanding of the relations between depression severity and lifestyle behaviors is needed to improve weight loss treatment for these patients.

Low diet quality, characterized by reduced intake of fruits, vegetables, fiber, and protein derived from nuts and legumes, and excessive intake of saturated and *trans* fats, sodium, and alcohol, is associated with higher adiposity and increased risk for weight gain (6,7). Higher scores on measures of depressive symptoms have been associated with lower diet quality in several population-based studies (8–10), but this association has not been examined among those with diagnosed MDD.

Any observed association between depression severity and diet quality might be accounted for by socioeconomic status given that depression is more prevalent at lower income levels (11), higher quality diets are more costly (12), and low-income neighborhoods often have limited access to healthy foods (13). In non-clinical samples, the association between depression and diet quality is often attenuated (8,10) or absent (14) once socioeconomic factors are accounted for in statistical models. The association between depression severity and diet quality may also be driven by changes in appetite, which is a key symptom of depression itself (15). Appetite changes in depression can be characterized by increased or diminished intake, and change in either direction could potentially impact diet quality. A third factor that might drive the association between diet quality and depression is binge eating disorder (BED), which is highly prevalent in women with depression (5,16). Foods consumed during binge episodes are higher in fat and more likely to include desserts and snacks (17), which would have a detrimental influence on diet quality. The present study explored the contribution of each of these variables to the association between depression severity and diet quality.

Individuals with depression engage in less leisure time physical activity than those without depression (18,19). Modeling National Health and Nutrition Examination Survey data from 1999–2004, Beydoun and Wang (14) found that the link between depression and higher body weight among women was largely accounted for by decreased physical activity. Whether depression severity predicts lower physical activity levels among individuals with obesity and MDD is unknown. It is plausible that more severe depression would correlate

with reduced physical activity due to greater fatigue and loss of energy, which are core symptoms of depression. It is also possible that an observed association between depression severity and physical activity would be explained by their common links to low socioeconomic status (11,20).

This study tested the hypothesis that greater depression severity is associated with poorer diet quality and lower physical activity among treatment-seeking women with obesity and MDD. Income and education, specific symptoms of depression, and BED (in the case of diet quality) were examined as potential drivers of the associations between depression severity and these lifestyle factors.

METHODS

Participants

Participants were 161 women with current MDD and obesity who were enrolled in the baseline phase of a behavioral trial for treating comorbid depression and obesity between 2007 and 2010 (21). Eligible women were aged 21 to 65 years, had a body mass index (BMI) between 30–40 kg/m², had current MDD based on Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) criteria (15), and scored between 12 and 24 on the Hamilton Rating Scale for Depression [HRSD; (22)]. Current tobacco use, serious mental illness (i.e., a psychotic disorder, bipolar disorder, post-traumatic stress disorder, or bulimia), recent initiation or dose adjustment of antidepressant or thyroid medications, weight loss medication or treatment, bariatric surgery, diabetes, and other criteria (21) were exclusionary. Participants were recruited through electronic and print advertisements.

Procedures

Participants completed an initial telephone screening, followed by an in-person medical and depression assessment. The Structured Clinical Interview for DSM-IV (23) and the HRSD were administered to determine the presence of MDD and psychiatric exclusionary criteria. Eligible participants progressed to the baseline assessment, which included self-report measures of depressive symptoms [i.e., Beck Depression Inventory II (BDI-II)]. Three 24-hour diet and physical activity recalls were conducted by telephone during the baseline phase. Participants were compensated a total of \$50 for completing the baseline assessment phase of this study. The University of Massachusetts Medical School Institutional Review Board approved study procedures, and all subjects provided written informed consent.

Measures

Anthropometrics—Body mass index (BMI, kg/m²) was calculated from weight measured with a digital scale (model 5002, Scale-Tronix, White Plains, NY) and height measured with a stadiometer (model 214, Seca, Hamburg, Germany).

Demographics—Education level and household income were collected via self-report. Education was categorized as: 0=less than bachelors degree (n=88), 1=bachelors degree (n=49), and 2=postgraduate degree (n=24). Income was categorized as: 0=\$0–\$39,999 (n=36), 1=\$40,000–\$74,999 (n=67), and 2=\$75,000 or more (n=58).

Antidepressant medication use—Participants completed the Brief Medication Questionnaire (24), which assesses the name, dose, and frequency of all medications taken during the past week.

Depression—The BDI-II (25) is a widely-used, 21-item measure of the number and severity of depressive symptoms experienced within the past two weeks. Participants

endorse statements corresponding to increasingly severe manifestations of a given depressive symptom on a scale from 0 (absent) to 3 (severe). The sum of item responses, which ranges from 0 to 63, reflects the overall severity of depressive symptoms. The test developers recommend cutoffs for classifying minimal (0–13), mild (14–19), moderate (20–28) and severe (≥ 29) depressive symptoms. In addition to the total BDI-II score, the BDI-II item capturing depression-related appetite change was recoded from the most significant decrease in appetite (–3) to no change in appetite (0), to the most significant increase in appetite (+3). The HRSD (22) is a 21-item interviewer-administered rating scale that assesses intensity and frequency of depressive symptoms. The HRSD was administered for the purposes of assessing eligibility only.

The Structured Clinical Interview for the Diagnostic and Statistical Manual-IV (23) was used during the screening appointment to assess current and previous mood, anxiety, psychotic, alcohol and substance-related, and eating disorders. Presence of BED was categorized as: 0=no history or past history of BED (n=131), or 1=current BED (n=30).

Diet recalls—Three unscheduled 24-hour diet recalls were conducted by telephone on randomly selected days over a 3-week window spanning one week before to two weeks after the baseline assessment. A trained registered dietitian used a computer-guided multiple-pass technique to assess dietary intake on two weekdays and one weekend day. A reference booklet depicting various food portions was provided to participants to facilitate portion size estimation. Dietary intake data were analyzed using Nutrition Data System for Research (NDSR) software (version 2010, Nutrition Coordinating Center, University of Minnesota, MN). The senior study dietitian (B.C.O.) reviewed the audiotaped recalls to assure quality of dietary data collection.

Alternate Healthy Eating Index (AHEI)—Diet quality was measured by the AHEI, a scoring system designed to evaluate overall diet quality as it pertains to chronic disease risk. The AHEI was developed to replace the U.S. Department of Agriculture's Healthy Eating Index (HEI). The AHEI has been shown to predict incident cardiovascular disease and diabetes more accurately than the original HEI and current (2005) version of the HEI (26–28). The AHEI total score was derived by summing scores for the following eight dietary components: fruit (servings/day), vegetables (servings/day), nuts and legumes (servings/day), ratio of white to red meat, cereal fiber (g/d), *trans* fat (% of calories), ratio of polyunsaturated fat to saturated fat, and alcohol (servings/d). Intake of each dietary component was scored on a continuous scale from 0–10, with 10 representing compliance with accepted dietary guidelines. Long-term duration of multivitamin use was not included in the total score due to the focus on current dietary patterns associated with depression severity. Possible scores ranged from 0–80, with higher scores reflecting better overall diet quality.

Physical activity recalls—Engagement in physical activity was assessed during three telephone 24-hour physical activity recalls (29). Recalls captured time spent in light (1.5 metabolic equivalents; METs), moderate (4.0 METs), vigorous (6.0 METs), and very vigorous (8.0 METs) intensity physical activity in purposeful exercise, occupational activities, and household activities. Total metabolic equivalents expended per day (MET-hrs/d) were calculated.

Data Analysis

Descriptive statistics characterized the sample. The distributions of the physical activity variable and several individual dietary components were logarithmically transformed to correct for skew. However, as transformation did not impact the statistical significance of

any test conducted, results derived from the non-transformed variables are reported. BDI-II and AHEI scores were normally distributed and did not require transformation. Unpaired *t*-tests compared those with and without current BED on depression severity, BMI, and AHEI. Associations between depression severity and diet quality were tested in linear regression models controlling for age, BMI, antidepressant medication use, education, household income, depression-related appetite change, and DSM-IV BED. Pearson correlations tested relations of depression severity with the eight AHEI components and seven other dietary measures relevant to cardiometabolic risk [% of calories from total fat, saturated fat, carbohydrate, and protein; sodium (mg/day); dietary fiber (g/day); and total sugars (g/day)]. To control for type I error with multiple testing, total family-wise alpha level was set at $\alpha=.15$ and correlations were considered significant at $p<.01$. The association between depression severity and physical activity level was tested in a linear regression model controlling for age, BMI, and antidepressant medication use. Analyses were performed in STATA 11.1 (College Station, TX, USA).

RESULTS AND DISCUSSION

Sample characteristics (N=161) are shown in Table 1. BDI-II scores ranged from 12 to 38 out of a possible 63, with a mean score of 21.1 (SD=5.8), which corresponds to moderate severity depressive symptoms according to recommended cutoffs (25). Minimal, mild, moderate, and severe depressive symptoms were reported by 6.2%, 38.5%, 40.4%, and 14.9% of participants, respectively. The prevalence of antidepressant use in this sample (28%) was similar to that among individuals with moderate and severe depressive symptoms in the U.S. population (32%) (30).

Those with current BED (n=30) did not differ from those without current BED (n=131) in depression severity ($t_{(159)}=-0.67$, $p=.50$), BMI ($t_{(159)}=-0.10$, $p=.92$), or AHEI scores ($t_{(159)}=1.31$, $p=.19$). BMI was negatively correlated with AHEI scores ($r_{(159)}=-.21$, $p=.01$), but was unrelated to daily MET-hours of physical activity ($r_{(159)}=-.13$, $p=.11$) and depression-related appetite change ($r_{(159)}=-.05$, $p=.54$). Nearly two-thirds of the sample (n=106, 65.8%) engaged in less than 60 mins/week of moderate or vigorous physical activity, and only 17 participants (10.6%) exceeded 150 mins/week.

The mean AHEI score in the current sample (M=29.6, SD=8.4) was lower than observed in other cohorts. Median AHEI scores (excluding duration of multivitamin use) ranged between 35 and 42 in the Women's Health Initiative Observational Study (31), the Health Professional's Follow-up Study (27), and the Nurse's Health Study (12) cohorts. Though higher diet quality would be expected in the latter two cohorts of health professionals, women with obesity and depression in the current sample appear to have poorer diet quality than the general population.

Greater depression severity was associated with poorer diet quality independent of depression-related appetite change, BED, income and education, and other covariates (model $R^2=.17$; Table 2). With respect to individual components of diet, more severe depression was correlated (at $p<.01$) with lower white to red meat ratio ($r_{(159)}=-.25$, $p=.001$), higher percentage of calories from saturated fat ($r_{(159)}=.21$, $p<.01$), and greater intake of sodium ($r_{(159)}=.22$, $p<.01$) and total sugar ($r_{(159)}=.20$, $p<.01$). Depression severity was unrelated to polyunsaturated to saturated fat ratio ($r_{(159)}=-.18$, $p=.02$) and to percentage of calories from *trans* fat ($r_{(159)}=.18$, $p=.02$). Depression severity was unrelated to healthful components of diet such as intake of fruit ($r_{(159)}=-.01$, $p=.89$), vegetables ($r_{(159)}=.06$, $p=.49$), nuts and legumes ($r_{(159)}=.01$, $p=.89$), cereal fiber ($r_{(159)}=-.08$, $p=.29$), and total dietary fiber ($r_{(159)}=.09$, $p=.25$). Correlations of depression with alcohol intake ($r_{(159)}=.00$, $p=.96$)

and percentages of calories from total fat ($r_{(159)}=.11$, $p=.15$), carbohydrate ($r_{(159)}=-.07$, $p=.39$), and protein ($r_{(159)}=-.09$, $p=.26$) were not significant.

As poor diet quality has been linked to weight gain and cardiometabolic risk in population-based studies (6,7,26–28), further research is needed to determine the extent to which depression may contribute to these outcomes by influencing diet quality. As depression-related appetite change, BED, and income and education did not account for the association between depression severity and diet quality, other potential mechanisms underlying the association between depression severity and diet quality should be investigated. For example, individuals with depression appear to have a stronger preference for sweet foods (32) and consume fast food more frequently than individuals without depression (33), both of which would be expected to influence the specific components of diet that were related to depression severity in this study (i.e., sodium, sugar, saturated fat, ratio of white to red meat).

Depression severity was unrelated to daily MET-hours of activity (estimate=.07, SE=.05, $p=.18$) in a model controlling for age, BMI, and antidepressant medication use. Excluding BMI or including the depressive symptoms of fatigue and loss of energy in subsequent models did not impact the association. This finding contrasts with prior studies (14,18,19), and may stem from the fact that a large portion of the sample was physically inactive. Interventions to increase physical activity in women with obesity and depression are clearly needed, and are being evaluated in the behavioral trial in which the current sample is enrolled (21).

Study strengths included the use of structured clinical interviews to diagnose MDD, and multiple 24-hour recalls to assess dietary intake and physical activity. The study sample was composed of women with comorbid depression and obesity who were willing to participate in an intensive, 6-month behavioral intervention. Therefore, our results cannot be generalized to other groups, including men, smokers, or those with a BMI below 30 or above 40. Other study limitations include a lack of objectively measured physical activity (e.g., accelerometry) and a restricted range of depression severity in our sample due to the exclusion of individuals with severe depression (i.e., current suicidality, HRSD scores>26).

Conclusions

Among treatment-seeking women with obesity and MDD, more severe depressive symptoms were associated with lower overall diet quality. This effect was driven by greater intake of saturated fat, sodium, and sugar, which suggests that future weight loss interventions for individuals with moderate or severe MDD should focus on modifying these unhealthy components of diet. The observed association was not explained by income or education, depression-related appetite change, or concurrent BED. Depression severity was not associated with physical activity in this study. Future studies should seek to elucidate the potential causal mechanisms underlying these associations, and determine whether improvement in depression improves diet quality and vice versa.

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Table 1

Sample characteristics (N=161)

| | M (SD) | n (%) |
|---|---------------|--------------|
| Age (y) | 45.9 (10.8) | |
| Height (cm) | 163.1 (6.4) | |
| Weight (kg) | 94.1 (11.1) | |
| Body mass index (kg/m ²) | 35.4 (3.3) | |
| Hispanic ethnicity | | 16 (9.9) |
| Race | | |
| Caucasian / White | | 137 (85.1) |
| American Indian / Alaska Native | | 10 (6.2) |
| Black / African-American | | 7 (4.3) |
| Multi-ethnic | | 5 (3.1) |
| Asian | | 2 (1.2) |
| Education level [n (%)] | | |
| Less than bachelors degree | | 88 (54.7) |
| Bachelors degree | | 49 (30.4) |
| Postgraduate degree | | 24 (14.9) |
| Annual household income (USD) | | |
| \$0-\$39,999 | | 36 (22.4) |
| \$40,000-\$74,999 | | 67 (41.6) |
| \$75,000 or more | | 58 (36.0) |
| Beck Depression Inventory II (0–63) | 21.1 (5.8) | |
| Duration of current depressive episode (months) * | 17.0 (23.1) | |
| Current DSM-IV Binge Eating Disorder | | 30 (18.6) |
| Taking antidepressant medication | | 45 (28.0) |
| Alternate Healthy Eating Index (0.0–80.0) | 29.6 (8.4) | |
| Vegetables (servings/day) § | 2.3 (1.4) | |
| Fruit (servings/day) § | 1.1 (1.1) | |
| Nuts and legumes (servings/day) § | 0.8 (1.1) | |
| White to red meat ratio § | 2.0 (1.2) | |
| Cereal fiber (g/day) § | 2.8 (3.7) | |
| % calories from <i>trans</i> fat § | 1.7 (0.8) | |
| Polyunsaturated to saturated fat ratio § | 0.7 (0.3) | |
| Alcohol (servings/day) § | 0.4 (0.8) | |
| % calories from saturated fat | 11.8 (2.9) | |
| % calories from total fat | 33.8 (6.6) | |
| % calories from carbohydrate | 48.2 (7.4) | |
| % calories from protein | 16.3 (3.5) | |
| Sodium (mg/day) | 3492 (1361) | |
| Total dietary fiber (g/day) | 19.4 (8.5) | |

| | M (SD) | n (%) |
|---|---------------|--------------|
| Total sugars (g/day) | 110.8 (55.7) | |
| Physical activity (recalled, MET-hrs/d) | 27.9 (4.0) | |
| Moderate and vigorous physical activity (recalled, mins/week) | 63.2 (81.6) | |

* Excludes one outlying case with reported depression duration of 480 months.

§ Contributes to Alternate Healthy Eating Index score.

Table 2

Linear regression models (N=161) predicting diet quality (AHEI) from depression severity (BDI-II).

| | Estimate | SE | P |
|---------------------------------------|-----------------|-----------|----------|
| Beck Depression Inventory II (BDI-II) | -.26 | .11 | .02 |
| Age (years) | .06 | .06 | .33 |
| BMI (kg/m ²) | -.42 | .19 | .03 |
| Antidepressant medication use | .74 | 1.44 | .61 |
| Education | | | |
| < Bachelors degree (n=88) | Reference | | |
| Bachelors degree (n=49) | 1.86 | 1.44 | .20 |
| Postgraduate degree (n=24) | 5.90 | 1.87 | <.01 |
| Household income | | | |
| < \$40,000 (n=36) | Reference | | |
| \$40,001-\$75,000 (n=67) | -2.47 | 1.67 | .14 |
| >\$75,000 (n=58) | -2.49 | 1.73 | .10 |
| Depression-related appetite change | .26 | .55 | .63 |
| DSM-IV Binge eating disorder (BED) | -1.86 | 1.61 | .25 |