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# Postpartum Depressive Symptoms: Gestational Weight Gain as a Risk Factor for Adolescents Who Are Overweight or Obese

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## Abstract

**Introduction—**Obesity is a risk factor for adverse physical health outcomes during pregnancy. Much less is known about the association between obesity and maternal mental health. Evidence suggests that prenatal depression is associated with excessive weight gain during pregnancy, and that this relationship may vary according to pregravid body mass index (BMI). Young women may be particularly vulnerable to postpartum depression. The objective of this study is to examine the association between pre-pregnancy BMI, gestational weight gain, and postpartum depressive symptoms among adolescents.

**Methods—**Participants were 505 pregnant adolescents, ages 14–21 followed during pregnancy and six-months postpartum. Data were collected via interviews and medical record abstraction. Multilevel linear mixed models were used to test the association between excessive gestational weight gain as defined by National Academy of Medicine Guidelines and postpartum depressive symptoms measured via the validated Center for Epidemiologic Studies Depression (CES-D) scale. Analyses controlled for sociodemographic factors (maternal age, race, ethnicity, relationship status), health behaviors (nutrition, physical activity), prenatal depressive symptoms, and postpartum weight retention.

**Results—**Pre-pregnancy body mass index was classified as follows: 11% underweight, 53% healthy weight, 19% overweight and 18% obese. One-half (50%) of participants exceeded recommended guidelines for gestational weight gain. Adolescents with excessive gestational weight gain who entered pregnancy overweight or obese had significantly higher postpartum depressive symptoms, (β, 2.41; SE,1.06 and β, 2.58; SE, 1.08, respectively; both $P < 0.05$), compared to those with healthy pre-pregnancy BMI and appropriate gestational weight gain Adolescents who gained gestational weight within clinically recommended guidelines were not at risk for increased depressive symptoms.

**Discussion—**Adolescents who enter pregnancy overweight or obese and experience excessive weight gain may be at increased risk for postpartum depressive symptoms. Healthcare providers should offer preventive interventions during pregnancy and the inter-conceptional period to support healthy weight gain and safeguard women's mental health.

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**Keywords**

Postpartum depressive symptoms; gestational weight gain; obesity; pregnancy; adolescent

## INTRODUCTION

One-half of women in the United States enter pregnancy overweight or obese; this rate continues to rise with global changes in diet and lifestyle.[1,2] Pregnant women with high pregravid body mass index (BMI) are at increased risk for adverse health outcomes, such as preterm birth and infant mortality, maternal and child obesity, hypertension and asthma.[3–5] Gaining optimal weight during pregnancy may reduce the risk of adverse birth outcomes associated with obesity.[6] Moreover, excessive gestational weight gain is an independent risk factor for cesarean birth and postpartum weight retention as well as obesity and consequent chronic diseases among children.[7–9] For these reasons, the National Academy of Medicine developed recommendations for appropriate gestational weight gain based on pre-pregnancy body mass index.[10] Pregnancy is often viewed as a period in which women are highly motivated to improve their health behaviors,[11] but studies indicate that 41% to 64% of pregnant women gain weight exceeding these clinical recommendations. [12]

Although the physical health risks associated with obesity and excessive weight gain during pregnancy are well established, much less is known about the influence of these factors on maternal mental health. Postpartum depression is a debilitating disorder that can impact maternal function and the ability to develop secure maternal-infant attachment.[13–15] It is the most prevalent maternal health condition associated with pregnancy, affecting one in nine new mothers.[16] Prevalence of postpartum depression among adolescent mothers is particularly high ranging from 8 to 47%.[17] This may be due to a tendency for adolescent mothers to experience greater social isolation and decreased parental confidence, compared to adult mothers.[18] Studies have also shown the burden of postpartum depressive symptoms to be especially high among low-income adolescent mothers[17] and black and Latina women.[19]

There is an association between pre-pregnancy BMI and symptoms of prenatal depression.[20] A recent study of more than 13,000 pregnant women found those who entered pregnancy obese were at significantly greater risk for prenatal depression than those with healthy pregravid weight, controlling for sociodemographic risk factors and health behaviors.[21] Similarly, evidence suggests that prenatal major depression is associated with excessive gestational weight gain, but only among women with a high BMI at the start of pregnancy.[22]

The objective of this study is to examine the association between pre-pregnancy BMI, gestational weight gain, and postpartum depressive symptoms among a clinic-based sample of predominantly low-income, minority adolescents. We hypothesize that excessive gestational weight gain is associated with an increased risk of postpartum depressive symptoms, with varying strength of association based on pre-pregnancy BMI.

# METHODS

## Procedure

This study is a secondary analysis of data from a randomized controlled trial of *CenteringPregnancy Plus*, a group prenatal care intervention aimed at improving reproductive health outcomes, conducted between 2008 and 2012.[23] Standard individual prenatal care typically consists of an initial long (1–2 hour) intake visit and subsequent brief (10–15 minute) visits that occur monthly before 28 weeks gestation, bi-weekly from 28–36 weeks gestation, and weekly beyond 36 weeks with a licensed clinician (physician, midwife, or nurse practitioner).[24] Each visit includes a physical exam and education to address pregnancy-related issues (eg, nutrition, weight gain, safety). *CenteringPregnancy Plus* group prenatal care bundles the *CenteringPregnancy* model with reproductive health promotion and sexual risk reduction. Group prenatal care likewise begins with a standard clinical intake conducted individually. With the exception of health concerns requiring privacy and cervical assessments late in pregnancy, all care thereafter occurs in a group setting with 8 to 12 other women of similar gestational age. Two health providers, a physician or midwife and an assistant, facilitate 10 structured sessions (120 minutes each) during which participants receive a physical exam, engage in self-care activities of weight and blood pressure assessment, and participate in group discussions to address issues related to prenatal care, childbirth preparation, postpartum care, HIV prevention including sexual risk reduction, and mental health and psychosocial functioning (eg, depression, stress reduction). Additional laboratory work and ultrasounds for both individual and group prenatal care occur throughout pregnancy as indicated or per clinical guidelines.

Fourteen community hospitals and health centers predominantly serving low-income and minority women in New York City were randomized to deliver the group prenatal care intervention or standard individual care. Women between the ages of 14–21 years old seeking prenatal care at participating clinical sites were referred to the study by either healthcare providers or research staff. Additional eligibility criteria included the following: less than 24 weeks gestation, no medical indication of a high-risk pregnancy, ability to speak English or Spanish, and willingness to participate in the study procedures.

Participants completed a baseline survey during their second trimester of pregnancy (14–24 weeks gestation) and follow-up surveys during their third trimester (32–42 weeks gestation), and approximately six and twelve months (5–8 months and 11–14 months, respectively) postpartum. Surveys were conducted in English and Spanish using audio-handheld assisted personal interview technology whereby participants listened to questions with headphones while viewing them on a computer screen. Information on participants' sociodemographic characteristics was collected during the baseline interview; data on a variety of psychosocial factors and health behaviors were collected at all time points. Trained research staff conducted systematic medical record reviews to abstract data on maternal health and birth outcomes, including participants' weight at each prenatal care and postpartum visit.

All procedures were approved by the Institutional Review Boards at Yale University, Clinical Directors Network, and each clinical site. Participants gave their informed consent prior to being included in the study and were compensated $20 for each interview.

## Sample

The cohort for this study is limited to women with complete data for the second trimester, third trimester, and six-month postpartum interviews, and whose medical records contained recorded weight at each prenatal care visit, resulting in a sample size of 505. Compared to women included in this analytic sample, those excluded were more likely to be Hispanic, less likely to be non-Hispanic black, less likely to be single and had higher levels of postpartum depressive symptoms ($P<.05$ for all).

## Measures

**Primary outcome: Postpartum Depressive Symptoms—**Depressive symptoms were measured at each timepoint using a 15-item version of the Center for Epidemiologic Studies-Depression Scale (CES-D). Consistent with previous research among pregnant women, the five somatic items were removed as they may be related to pregnancy (eg, poor appetite, restless sleep).[25,26] Participants indicated how often during the previous week they felt or behaved in the specified way using a Likert scale ranging from 0 (less than 1 day) to 3 (5–7 days). Items were summed to form a scale score ranging from 0 to 45, where higher scores indicated greater depressive symptoms.

**Primary predictor: Excessive weight gain—**Excessive weight gain was determined using National Academy of Medicine's guidelines. For women with healthy pre-pregnancy weight (BMI 18.5–24.9 kg/m2), the recommended range of total weight gain is 25–35 pounds, whereas for women who are underweight (BMI <18.5 kg/m2), overweight (BMI 25–29.9 kg/m2), and obese (BMI ≥30 kg/m2), ranges are 28–40, 15–25, and 11–20 pounds, respectively.[10] Pre-pregnancy BMI was calculated based on self-reported pre-pregnancy height and weight. Weight was recorded at each prenatal visit, and abstracted systematically from the medical records. Weight gain was calculated by subtracting pre-pregnancy weight from the final third trimester weight prior to birth Following previous research, [27,28] weight gain was categorized as excessive if it exceeded the maximum recommended weight gain based on clinical guidelines, accounting for pre-pregnancy BMI category and gestational age at final weight assessment. Gestational age was determined by ultrasound, also abstracted from the medical records.

**Control variables—**All analyses controlled for sociodemographic factors and health behaviors linked to postpartum depressive symptoms or depression or pregnancy weight gain in previous research.[17,18,21,28,29–31] Covariates included maternal age, race or ethnicity (Latina, non-Latina black, and other), relationship status (married or living with partner versus other), and postpartum weight retention (pounds greater than pre-pregnancy weight). Dietary habits were assessed using a modified version of REAP (Rapid Eating Assessment for Patients), a 10-item measure that asks about a range of nutrition-related behaviors (eg, skipping breakfast, eating meals out).[32] Physical activity was determined using WAVE (Weight, Activity, Variety, Excess), a four-item scale that assesses frequency of moderate activity, playing an organized sport, building exercise into daily activities, and sedentary behavior such as two hours or more per day of watching television or playing video games. [32] Both REAP and WAVE use a 5-point response scale ranging from 0 (never) to 4

(everyday). Items were summed, with higher scores for REAP denoting poorer nutrition (range 0–44) and for WAVE indicating more exercise (range 0–16).

Women who experience depressive symptoms during pregnancy are more likely to report depressive symptoms postpartum.[33] Previous research has also shown, compared to women who receive standard individual care, those who receive group prenatal care may have healthier weight trajectories[28] and experience greater reductions in perinatal depressive symptoms.[34] Thus, analyses also adjusted for third trimester CES-D scale scores and study condition (ie, assignment to group versus individual care).

### Data Analyses

All analyses were conducted using StataSE 13.0 (StataCorp LLC, College Station TX). Means and frequencies were calculated to characterize the sample on all covariates. T-tests and chi-square tests were conducted to compare women who had appropriate versus excessive weight gain. Multilevel linear mixed models were used to test the association between pre-pregnancy BMI, excessive gestational weight gain, and postpartum depressive symptoms, with site modeled as a random effect and all other predictors as fixed effects.[35]

## RESULTS

### Participant characteristics

Table 1 shows participant characteristics for the full sample and stratified by appropriate versus excessive weight gain. At study entry, participants had a mean (SD) age of 18.62 (1.70) years. Fifty-three percent self-identified as Latina, 39% as non-Latina black, and 9% as other race. Forty-five percent were married or living with partner. Eleven percent of participants entered pregnancy underweight, 53% were healthy weight, 19% were overweight and 18% were obese. One-half (50%) of participants had gestational weight that exceeded the recommended guidelines. Compared to women with appropriate gestational weight gain, those with excessive gestational weight gain were significantly more likely to enter pregnancy overweight (13% versus 25%) or obese (13% versus 22%) ($P<.001$). Furthermore, they retained more weight at 6-months postpartum (4 versus 17 pounds), a difference that is both clinically meaningful and statistically significant ($P<.001$). There was no difference in age, race or ethnicity, relationship status, dietary habits, physical activity, or prenatal depressive symptoms between adolescents with appropriate versus excessive gestational weight gain.

### Association between gestational weight gain and postpartum depressive symptoms

Table 2 shows the associations between pre-pregnancy BMI, gestational weight gain, and postpartum depressive symptoms. Controlling for sociodemographic and behavioral factors, adolescents who entered pregnancy overweight and who gained excessive gestational weight had significantly greater postpartum depressive symptoms (on average 2.4 and 2.6 points higher, respectively) compared to those who with a healthy pregravid weight and appropriate weight gain (β, 2.41; SE, 1.06 and β, 2.58; SE, 1.08, respectively; both $P<.05$). Considering that the mean score for postpartum depressive symptoms was 9.6, this represents a greater than 20% increase in depressive symptoms. Women who entered pregnancy underweight or

at a healthy weight and gained excessive weight were not at increased risk for postpartum depressive symptoms. Moreover, regardless of pre-pregnancy BMI, women who gained gestational weight within clinically-recommended guidelines were not at risk for increased postpartum depressive symptoms.

Among the control variables, having higher levels of prenatal depressive symptoms (β, 0.58; SE, 0.04, $P<.001$) and poorer dietary habits (β, 0.12,; SE, 0.05; $P=.02$) was significantly associated with greater postpartum depressive symptoms. Higher levels of physical activity were significantly associated with fewer postpartum depressive symptoms (β, −0.24; SE, 0.11; $P=.03$). None of the other study variables were independently associated with level of postpartum depressive symptoms.

## DISCUSSION

One-half of young women in our study gained more weight during pregnancy than recommended clinical guidelines, consistent with prior research among adolescents.[29,36] Among young women who entered pregnancy overweight or obese, we found excessive gestational weight gain independently predicted greater postpartum depressive symptoms, adding to a growing body of literature about the detrimental effects of excessive weight gain during pregnancy.

Results correspond to findings of a study by Bodnar and colleagues that concluded that gestational weight gain significantly modified the association between pre-pregnancy body mass index and likelihood of major depressive disorder among women who entered pregnancy overweight.[22] At least one study of non-pregnant women and men also found the association between depression and weight gain varies according to BMI: those who were obese were at greater risk of gaining weight during a period of depression than those who were non-obese.[37]

A combination of biological, psychological and social mechanisms may underlie the association between pre-pregnancy BMI, gestational weight gain, and postpartum depressive symptoms. There is a well-established evidence base for the link between obesity and depression, both in the general population and new mothers.[20,38,39] For women, pregravid BMI and pregnancy-related weight changes may be a function of inflammation and metabolic changes, poor self-esteem, and stigma.[39,40] Co-occurrence of depression and parental stress is high among adolescent mothers, who are more likely to experience parental stress than their adult counterparts.[41] The increased risk for adverse maternal and child health outcomes among women with high pre-pregnancy BMI and excessive gestational weight gain may exacerbate stress during and after the pregnancy.

This study has several limitations. Our findings are based on a sample of young, predominantly low-income, minority women who received prenatal care in urban clinic settings; thus, may not be generalizable to other populations. Additionally, the measures for the predictors and outcomes, such as pre-pregnancy weight and height used to calculate BMI and the CES-D scale used to assess various symptoms of depression occurring in the past week, are subject to self-report bias. No other measures of depressive symptoms were

collected. Data also were not available regarding prior history of depression or other psychosocial and sociocultural factors that may influence risk of experiencing postpartum depressive symptoms. The average CES-D score among the study cohort was below that considered to be of clinical concern. However, the findings are still clinically relevant in that they suggest a potential interaction between excessive gestational weight gain and high pregravid BMI on postpartum depressive symptoms that should be explored further. Women excluded from this study due to missing data had significantly higher levels of postpartum depressive symptoms; thus our results are likely to be conservative estimates. Additionally, regardless of whether adolescents' symptoms of depression meet the full criteria for this condition, they may be at risk for later depression and other negative psychosocial outcomes.[42]

Important strengths of the study are its prospective design and its conduct in a number of urban community-based settings serving large numbers of low income and minority adolescent women. Temporal issues regarding when variables were collected precluded our ability to assess potential causal sequence among key variables. Among non-pregnant adults, obesity and depression are commonly comorbid conditions.[38] However, findings are inconsistent regarding whether obesity causes depression or vice versa.[38] Existing research on the causal relationship between gestational weight gain and prenatal depression likewise presents contradictory findings.[21,22,43,44] The association between postpartum depression and weight loss also is likely to be bidirectional.[45] Future research is needed to replicate and extend these findings, disaggregating potential bidirectional relationships between depression and weight gain and loss trajectories across the perinatal period. Results from these and other studies can inform future clinical guidelines and preventive practice for midwives and others who care for women across the perinatal period.

Understanding the effect of obesity and maternal weight gain on postpartum depressive symptoms will broaden the clinical conversation about the benefits of preconception or interconception weight loss and appropriate gestational weight gain. Healthcare providers should be aware of the potentially increased risk of postpartum depressive symptoms among women who enter pregnancy overweight or obese and experience excessive gestational weight gain. Qualitative research suggests that physicians and midwives would benefit from training in communication skills regarding how to address excessive gestational weight gain and obesity in pregnancy.[46,47] Preventive interventions during pregnancy and the interconceptional period could further support women's mental and physical health during and following pregnancy.

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**QUICK POINTS**

- One-half of adolescents' weight gain during pregnancy exceeded recommended guidelines.
- The influence of excessive gestational weight gain on adolescents' risk of postpartum depressive symptoms varied based on pre-pregnancy BMI.
- Among adolescents who entered pregnancy overweight or obese, excessive gestational weight gain independently predicted greater postpartum depressive symptoms.

## Table 1

Participant characteristics

| Variable | Total (n=505) | Appropriate weight gain[a] (n=250) | Excessive weight gain[b] (n=255) | *P*-value |
|---|---|---|---|---|
| **Sociodemographic Characteristics** | | | | |
| Age, mean (SD), y | 18.62 (1.70) | 18.59 (1.78) | 18.65 (1.61) | .677 |
| Race or Ethnicity, n (%) | | | | |
| Latina | 266 (52.7) | 131 (52.4) | 135 (52.9) | .860 |
| Black, non-Latina | 196 (38.8) | 96 (38.4) | 100 (39.2) | |
| Other | 43 (8.5) | 23 (9.2) | 20 (7.8) | |
| Married or living with partner, n (%) | 221 (44.8) | 102 (41.8) | 119 (47.8) | .181 |
| **Health Behaviors** | | | | |
| Dietary habits[c], mean (SD) | 16.98 (6.11) | 17.37 (6.34) | 16.60 (5.87) | .156 |
| Physical activity[d], mean (SD) | 5.87 (2.91) | 5.79 (2.96) | 5.95 (2.88) | .523 |
| **Clinical Characteristics** | | | | |
| Pregravid BMI category, n (%) | | | | |
| Underweight (BMI <18.5kg/m2) | 54 (10.7) | 39 (15.6) | 15 (5.9) | <.001 |
| Healthy weight (18.5–24.9 kg/m2) | 265 (52.5) | 146 (58.4) | 119 (46.7) | |
| Overweight (BMI 25–29.9 kg/m2) | 96 (19.0) | 32 (12.8) | 64 (25.1) | |
| Obese (BMI ≥30 kg/m2) | 90 (17.8) | 33 (13.2) | 57 (22.4) | |
| Prenatal depressive symptoms, mean (SD) | 10.90 (8.27) | 11.36 (8.84) | 10.46 (7.66) | .221 |
| Postpartum depressive symptoms[e], mean (SD) | 9.64 (8.51) | 9.24 (8.51) | 10.04 (8.52) | .287 |
| Postpartum weight retention, mean (SD), lb | 10.65 (16.85) | 3.95 (14.28) | 17.27 (16.60) | <.001 |

Abbreviations: BMI, body mass index.

[a] Total gestational weight gain within recommended clinical guidelines: 25–35 pounds for women with healthy pre-pregnancy weight (BMI 18.5–24.9 kg/m2) and 28–40, 15–25, and 11–20 pounds for women who are underweight (BMI <18.5 kg/m2), overweight (BMI 25–29.9 kg/m2), and obese (BMI ≥30 kg/m2), respectively.[10]

[b] Gestational weight gain exceeded maximum recommended weight gain based on clinical guidelines.

[c] Dietary habits were assessed using a modified version of REAP (Rapid Eating Assessment for Patients), a 10-item measure that asks about a range of nutrition-related behaviors.[32] A 5-point response scale ranges from 0 (never) to 4 (everyday). Total scores range from 0–44, with higher scores indicating poorer nutrition.

[d] Physical activity was determined using WAVE (Weight, Activity, Variety, Excess), [32] a four-item scale that assesses frequency of moderate activity and sedentary behavior. A 5-point response scale ranges from 0 (never) to 4 (everyday). Total scores range from 0–16, with higher scores indicating more exercise.

[e] Depressive symptoms were measured using a 15-item version of the Center for Epidemiologic Studies-Depression Scale. A 3-point response scale ranges from 0 (less than 1 day) to 3 (5–7 days). Total scores range from 0–45, with higher scores indicating greater depressive symptoms.

## Table 2

Association between excessive weight gain and postpartum depressive symptoms[a,b]

| Pregravid BMI | n (%) | β (Standard Error)[c] | |
|---|---|---|---|
| | | Appropriate weight gain(n=250) | Excessive weight gain(n=255) |
| Underweight (BMI <18.5kg/m2) | 54 (10.7) | 0.60 (1.28) | −1.16 (1.89) |
| Healthy weight (18.5–24.9 kg/m2) | 265 (52.5) | 1.00 (reference) | 1.32 (0.92) |
| Overweight (BMI 25–29.9 kg/m2) | 96 (19.0) | 0.95 (1.35) | 2.41 (1.06)[d] |
| Obese (BMI ≥30 kg/m2) | 90 (17.8) | −1.26 (1.33) | 2.58 (1.08)[d] |

Abbreviations: BMI, body mass index.

[a]Controlling for age, race or ethnicity, relationship status, dietary habits, physical activity, prenatal depressive symptoms, postpartum weight retention, and study condition.

[b]Depressive symptoms were measured using a 15-item version of the Center for Epidemiologic Studies-Depression Scale. A 3-point response scale ranges from 0 (less than 1 day) to 3 (5–7 days). Total scores range from 0–45, with higher scores indicating greater depressive symptoms.

[c]The beta coefficient indicates how much change in the dependent variable (postpartum depressive symptoms) is predicted by a 1 unit change in the predictor variable (gestational weight gain).

[d]$P<.05$