The Effect of Gestational Weight Gain on Persistent Increase in Body Mass Index in Adolescents: A Longitudinal Study

Valery A. Danilack, MPH, PhD,¹⁻³ E. Christine Brousseau, MD,^{1,3} and Maureen G. Phipps, MD, MPH¹⁻³

Abstract

Background: Weight retention after pregnancy is a concern for adolescents who may be entering adulthood at unhealthy weights.

Methods: We studied associations between each of three measures: prepregnancy body mass index (BMI), gestational weight gain (GWG), and postpregnancy BMI in a longitudinal follow-up of an adolescent pregnancy study cohort. BMI and GWG were compared using *t*-tests and linear regression.

Results: Among 91 adolescents, mean prepregnancy BMI was 24.6 [standard deviation (SD) 5.7] and mean GWG was 15.5 kg [SD 6.3]. Overall, prepregnancy BMI was not significantly related to GWG ($p=0.145$). Among 42 teens with postpregnancy weight data, within 4 years of their first delivery, mean postpregnancy BMI was 26.3 [SD 5.0] with an average BMI increase of 2.0 points [SD 5.1] ($p=0.013$) from prepregnancy. Within 4 years of their first delivery, 45% of teens moved to a higher BMI category. For every 4.5 kg (10 lb) increase in GWG, BMI within 4 years increased on average by 1.6 points ($p=0.006$). The association persisted (1.0 points, $p=0.049$) after controlling for prepregnancy BMI.

Conclusions: Teens experienced an increase in BMI from prepregnancy to within 4 years after their first delivery, and this increase was related to GWG. Adolescent mothers are at risk for developing and maintaining unhealthy BMI after pregnancy, which may be amplified by GWG.

Keywords: pregnancy in adolescence, body mass index, weight gain

Introduction

A HIGH PREPREGNANCY body mass index (BMI) and excessive gestational weight gain (GWG) can lead to adverse pregnancy outcomes and influence weight after pregnancy.¹ Excess weight gain in pregnancy and retention of that weight after delivery are known risk factors for long-term obesity in adults.² Weight retention and continued weight gain after pregnancy are particular concerns for adolescents who may gain more weight in pregnancy than adults and who may be more likely to have additional pregnancies with further increases in weight.^{3,4} Both high prepregnancy BMI and excessive GWG could contribute to adolescent mothers entering adulthood at an unhealthy weight. To better understand and highlight the influence of pregnancy on weight gain in adolescence, we studied the associations between prepregnancy BMI and GWG, prepregnancy BMI and postpregnancy BMI, and GWG and postpregnancy BMI in a cohort of adolescent pregnancies. A few prior studies investigated long-term weight gain among cohorts

of predominantly African American teen mothers, and we wanted to expand on their findings within a cohort where the majority of teens were Hispanic.^{5,6}

Materials and Methods

The study cohort was originated from a randomized controlled trial aimed to reduce postpartum depression after adolescents' first delivery with a behavioral intervention.⁷ Participants were recruited between February 2007 and August 2008 through an urban prenatal clinic and were eligible if they were 17 years old or younger at the time of conception and had a gestational age less than 25 weeks when they first presented for prenatal care. Potential participants were excluded if they were receiving mental health services from a healthcare provider or if they met criteria for a current affective disorder, substance use disorder, anxiety disorder, or psychosis.⁷ In the original study, prepregnancy weight and height, weight at the first prenatal visit, and weight at delivery

¹Division of Research, Women & Infants Hospital, Providence, Rhode Island.

²Department of Epidemiology, Brown University School of Public Health, Providence, Rhode Island.

³Department of Obstetrics and Gynecology, Warren Alpert Medical School of Brown University, Providence, Rhode Island.

TABLE 1. DESCRIPTIVE STATISTICS OF PARTICIPANT CHARACTERISTICS ($n=91$)

Participant characteristics	Mean [standard deviation] or n (%)			p-Value for t-test or chi-square
	Overall	Postpartum follow-up ($n=42$)	No follow-up ($n=49$)	
Prepregnancy body mass index	24.6 [5.7]	24.5 [5.6]	24.7 [5.9]	0.822
Underweight (<18.5)	3 (3.3)	1 (2.4)	2 (4.1)	0.713
Normal weight (18.5–24.9)	55 (60.4)	28 (66.7)	27 (55.1)	
Overweight (25.0–29.9)	22 (24.4)	9 (21.4)	13 (26.5)	
Obese (≥ 30)	11 (12.1)	4 (9.5)	7 (14.3)	
Gestational weight gain in kg	15.5 [6.3]	14.9 [6.1]	15.9 [6.4]	0.473
Maternal age at delivery in years	16.5 [1.2]	16.5 [1.9]	16.5 [1.3]	0.979
Maternal race/ethnicity				0.938
Hispanic	50 (55.0)	22 (52.4)	28 (57.1)	
African American	17 (18.7)	8 (19.1)	9 (18.4)	
White	13 (14.3)	6 (14.3)	7 (14.3)	
Other	11 (12.1)	6 (14.3)	5 (10.2)	
Completed weeks' gestation at delivery	39.2 [2.1]	39.2 [1.8]	39.3 [2.3]	0.795
Number of prenatal care visits	12.1 [3.5]	11.5 [3.1]	12.7 [3.7]	0.123
Assigned group from randomized trial				0.605
Intervention	46 (50.6)	20 (47.6)	26 (53.1)	
Control	45 (49.4)	22 (52.4)	23 (46.9)	

were abstracted from paper medical records. For this analysis, we additionally abstracted prenatal, delivery, and postpregnancy weights from the electronic medical record.

We replaced missing weight values in the original study data with newly abstracted weights when possible. GWG was calculated as the difference between prepregnancy weight and delivery weight of the index pregnancy, which was every participant's first delivery. BMI was calculated for prepregnancy weight and for the most recent postpregnancy weight available up to 4 years after the index delivery using standard adult BMI formulas.⁸ We categorized patients as follows, based on BMI before or after pregnancy: Underweight ($< 18.5 \text{ kg/m}^2$), normal weight (18.5 kg/m^2 to $< 25 \text{ kg/m}^2$), overweight (25 kg/m^2 to $< 30 \text{ kg/m}^2$), and obese ($\geq 30 \text{ kg/m}^2$).⁸

Baseline characteristics were described using mean and standard deviation (SD) for continuous variables and number and percent for categorical variables. Teens with postpartum follow-up data were compared with those without postpartum follow-up data using *t*-tests for continuous variables and chi-square tests for categorical variables. Prepregnancy BMI and GWG were compared using generalized linear models, with prepregnancy BMI modeled both as continuous and in four categories in two separate models. GWG and change in BMI from prepregnancy to postpartum follow-up were analyzed using a generalized linear model. In the GWG and change in BMI model, we additionally adjusted for prepregnancy BMI. The size of the sample limited the amount of confounding control that was possible, particularly for the analyses using postpartum data. Analyses were conducted using SAS 9.3 (SAS Institute, Inc., Cary, NC). This study was approved by the Women & Infants Hospital of Rhode Island Institutional Review Board.

Results

Among 91 participants with prepregnancy BMI available, mean age at delivery was 16.5 years [SD 1.2] (Table 1). The majority were Hispanic (55%), whereas 19% were African American and 13% were White. On average, participants delivered at 39.2 weeks gestation [SD 2.1]. Mean pre-

pregnancy BMI was 24.6 [SD 5.7] ($n=91$) and mean GWG was 15.5 kg [SD 6.3] ($n=90$). Three adolescents were underweight, 55 were normal weight, 22 were overweight, and 11 were obese before their first pregnancy (Table 1). One person did not have data available for weight at delivery. Overall, prepregnancy BMI was not significantly related to GWG (*p*-value for linear regression with BMI continuous=0.145). However, GWG increased with increasing prepregnancy BMI for underweight (mean 13 kg gain), normal weight (15 kg), and overweight (17 kg) teens, whereas obese teens had the lowest GWG (12 kg) (*p*-value for linear regression with BMI in four categories=0.171).

Forty-two teens had postpregnancy weight data within 4 years of their first delivery. Teens that had postpartum follow-up did not differ from those without postpartum follow-up by any baseline characteristics (Table 1). Time between the first delivery and the most recent weight measure available ranged

FIG. 1. Scatterplot and linear regression of relationship between gestational weight gain and change in body mass index (BMI) points prepregnancy to postdelivery (within 4 years of first delivery).

from 20 months to 48 months, with 22 of 42 postpregnancy weight measurements recorded between 36 and 48 months after the first delivery. Twenty-six out of 42 teens had at least one additional delivery within 4 years of the index pregnancy, but only weight measurements outside of pregnancy were considered. Mean postpregnancy BMI was 26.3 [SD 5.0] with an average BMI increase of 2.0 points [SD 5.1] ($p=0.013$) from pre-pregnancy. Among these 42 teens, 19 teens (45%) moved to a higher BMI category, 18 (43%) remained in the same BMI category, and 5 (12%) moved to a lower BMI category. For every 4.5 kg (10 lb) increase in GWG, BMI within 4 years after delivery increased on average by 1.6 points ($p=0.006$) (Fig. 1). The association persisted (1.0 points, $p=0.049$) after controlling for prepregnancy BMI.

Discussion

Adolescent mothers are at risk for developing and maintaining unhealthy BMI, which may be amplified by high GWG. Our finding of high GWG in adolescents is supported by previous studies, which have also addressed maternal characteristics and perinatal outcomes associated with GWG in adolescent pregnancies.^{4,9–11} The association between GWG and long-term obesity has been described in adults,^{1,2} and our data are in agreement with a growing number of other studies which have confirmed a similar association among adolescents.^{5,6} Our results are similar to those by Joseph et al. who found that higher prepregnancy BMI and excessive GWG were important predictors of weight 1 year postpartum.⁶ While 84% of the sample in the Joseph et al. study were African American, we found similar relationships between prepregnancy BMI, GWG, and postpartum BMI in a sample of which 55% of participants were Hispanic and only 19% were African American.

There are several limitations that warrant discussion. We only were able to access postdelivery data on participants who returned for care within our hospital's healthcare system. Over 70% of study participants had healthcare encounters documented in the electronic medical record 4–6 years after enrollment in the study, suggesting the majority of participants did not move out of the area after their first delivery and that the medical record was a reasonable source to ascertain data. However, only 42 of 91 participants had postpregnancy weight data within 4 years of delivery. Due to the limited sample size, we were not able to control for potential covariates of interest, such as maternal age and race/ethnicity. We deemed prepregnancy BMI to be the most important potential confounder in the analysis. It is impossible to completely differentiate anthropometric changes over time attributable to normal adolescent growth versus pregnancy-related weight retention, and so absolute measures of weight and weight gain may be difficult to interpret. However, we would not expect relative measures of association to be biased since the entire study sample experienced an adolescent pregnancy and delivery. We were unable to address adequately the impact of additional pregnancies on BMI due to the small sample size and limitations in available data; however, this could be an important focus of future research. The results are generalizable to other teen populations, but may not be generalizable to teens receiving mental health services from a healthcare provider or meeting criteria for a current affective disorder, substance use disorder, anxiety disorder, or psychosis, as they were not eligible for the original study.

Despite data limitations, the preliminary findings of this study can be an impetus for future research and changes in clinical practice. To prevent postpartum obesity in late adolescence and ensuing health issues, it is important to strive for healthy prepregnancy BMI and GWG levels in adolescents.

Funding

Supported by a grant from the National Institute of Mental Health (R34MH77588)

Author Disclosure Statement

No competing financial interests exist.

References

1. Bogaerts A, Devlieger R, Van den Bergh BR, et al. Obesity and pregnancy, an epidemiological and intervention study from a psychosocial perspective. *Facts Views Vis Obgyn* 2014;6:81–95.
2. Rooney BL, Schaubberger CW. Excess pregnancy weight gain and long-term obesity: One decade later. *Obstet Gynecol* 2002;100:245–252.
3. Harper LM, Chang JJ, Macones G. Adolescent pregnancy and gestational weight gain: Do the Institute of Medicine recommendations apply? *Am J Obstet Gynecol* 2011;205:140.e1–140.e8.
4. Howie LD, Parker JD, Schoendorf KC. Excessive maternal weight gain patterns in adolescents. *J Am Diet Assoc* 2003;103:1653–1657.
5. Groth SW. The long-term impact of adolescent gestational weight gain. *Res Nurs Health* 2008;31:108–118.
6. Joseph NP, Hunkali KB, Wilson B, et al. Pre-pregnancy body mass index among pregnant adolescents: Gestational weight gain and long-term post partum weight retention. *J Pediatr Adolesc Gynecol* 2008;21:195–200.
7. Phipps MG, Raker CA, Jocelyn CF, et al. Randomized controlled trial to prevent postpartum depression in adolescent mothers. *Am J Obstet Gynecol* 2013;208:192.
8. Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion. About Adult BMI. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), 2017. Available at: https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html#InterpretedAdults Accessed September 11, 2017.
9. Elchert J, Beaudrot M, DeFranco E. Gestational weight gain in adolescent compared with adult pregnancies: An age-specific body mass index approach. *J Pediatr* 2015;167:579–585.
10. Houde M, Dahdouh EM, Mongrain V, et al. The effect of adequate gestational weight gain among adolescents relative to adults of equivalent body mass index and the risk of preterm birth, cesarean delivery, and low birth weight. *J Pediatr Adolesc Gynecol* 2015;28:502–507.
11. MacSween K, Whelan E, Woolcott CG. Gestational weight gain and perinatal outcomes in adolescent mothers: A retrospective cohort study. *J Obstet Gynaecol Can* 2016;38:338–345.

Address correspondence to:
Valery A. Danilack, MPH, PhD
Division of Research
Women & Infants Hospital
101 Dudley Street
Providence, RI 02905

E-mail: valery_danilack@brown.edu