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Interpregnancy Body Mass Index Changes: Distribution and Impact on Adverse Pregnancy Outcomes in the Subsequent Pregnancy

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Abstract

Objective—To examine the change in body mass index (BMI) categories between pregnancies and its effect on adverse pregnancy outcomes.

Study Design—We performed a retrospective cohort study of women with two consecutive deliveries from 2005 to 2010. Analysis was limited to women with BMI recorded at <24 weeks for both pregnancies. Standard BMI categories were used. Adverse pregnancy outcomes included preterm birth at <37 weeks, intrauterine growth restriction (IUGR), pregnancy-related hypertension, and gestational diabetes mellitus (GDM). Women with increased BMI category between pregnancies were compared with those who remained in the same BMI category.

Results—In total, 537 women were included, of whom 125 (23%) increased BMI category. There was no association between increase in BMI category and risk of preterm birth, IUGR, or pregnancy-related hypertension. Women who increased BMI category had an increased odds of GDM compared with women who remained in the same BMI category (6.4 vs. 2.2%; $p = 0.018$). The increased risk remained after controlling for age, history of GDM, and starting BMI (adjusted odds ratio: 8.2; 95% confidence interval: 2.1–32.7; $p = 0.003$).

Conclusion—Almost one-quarter of women increased BMI categories between pregnancies. This modifiable risk factor has a significant impact on the risk of GDM.

Keywords

body mass index; interpregnancy weight gain; gestational diabetes

The prevalence of obesity, defined as a body mass index (BMI) of greater than 30 kg/m², has increased dramatically in the last several decades.^{1,2} Approximately one-third of reproductive age women in the United States are obese, and more than half of pregnant

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Note

A poster with this data was presented at the Society for Maternal–Fetal Medicine Pregnancy Meeting on February 4, 2013.

Conflict of Interest

None.

women are overweight or obese.³ As a result of this trend, the care of pregnant obese woman has become an important yet challenging area for improvement in obstetrics.

During pregnancy, obese women are at an increased risk of a variety of adverse outcomes including pregnancy-related hypertension, gestational diabetes mellitus (GDM), growth restriction, and cesarean delivery.^{4–11} When compared with their normal weight counterparts, obese women are also more likely to be delivered through cesarean section and experience more postoperative morbidity.^{12–14}

Multiple studies have demonstrated that pregnancy-related risks are compounded by excess weight gain in pregnancy.^{15,16} In an effort to encourage healthy weight gain, the Institute of Medicine (IOM) released revised guidelines in 2009 for weight gain in pregnancy across all BMI classes.¹⁷ Truong et al demonstrated that those women who gained an excess of 20 pounds beyond the recommended upper limit suffered worse maternal and neonatal outcomes during their pregnancy.¹⁸

Kabiru and Raynor evaluated change in BMI category during a single pregnancy in 5,100 women and found an increased risk of GDM, cesarean section, and preeclampsia.¹⁹ Data are limited on change in BMI categories between pregnancies and their impact, if any, on subsequent pregnancy outcomes.

Therefore, the objectives of this study were to (1) examine the distribution of change in BMI category between two pregnancies and (2) characterize the effect of an increase in BMI category on adverse pregnancy outcomes in a subsequent pregnancy with the hypothesis that an increase in BMI category would be associated with an increase in adverse pregnancy outcomes.

Methods

This was a planned secondary analysis of a large retrospective cohort study of women with two consecutive deliveries at the Hospital of the University of Pennsylvania during 2005 to 2010.²⁰ This study uses this cohort to evaluate changes in BMI category between pregnancies and their impact on adverse pregnancy outcomes and mode of delivery in a subsequent pregnancy. Approval from the Institutional Review Board was obtained prior to the initiation of the study.

Our analysis was restricted to women with a term singleton gestation in the index pregnancy and subsequent delivery at 16 weeks' gestation. The first pregnancy in the study period was called the index pregnancy and may not equate to the woman's first pregnancy. The second consecutive pregnancy with delivery at 16 weeks was considered to be the subsequent pregnancy. Women were excluded from this study if they had no BMI recorded at <24 weeks for either the index or subsequent pregnancy. BMI was calculated based on weight measured at the first prenatal visit and patient-reported height defined according to the IOM BMI categories: normal weight, 18.5–24.9 kg/m²; overweight, 25–29.9 kg/m²; obese, 30–40 kg/m²; and morbidly obese, >40 kg/m². The proportion of underweight women in our population was 3%; these women were excluded from further analyses due to low prevalence.

Our primary objectives were to (1) evaluate the distribution of change in BMI categories between two pregnancies and (2) determine the effect of an increase in BMI category on adverse pregnancy outcomes in a subsequent pregnancy. Adverse pregnancy outcomes that were evaluated in the subsequent pregnancy included preterm birth (medically indicated or spontaneous preterm birth at <37 weeks' gestation), pregnancy-related hypertension, which included gestational hypertension and preeclampsia (defined by the Task Force on Hypertension in Pregnancy),²¹ fetal growth restriction (defined by birth weight < 10 percentile), and GDM (diagnosed based on the Carpenter–Coustan criteria for the 3-hour glucose tolerance test). Women with pre-GDM were excluded from the outcome analysis for GDM. We also evaluated the mode of delivery in the second pregnancy and the rate of macrosomia (defined as birth weight > 4,000 g).

Women who increased BMI categories between pregnancies were compared with those who remained in the same BMI category, regardless of their BMI in the index pregnancy. Associations between categorical variables were calculated using chi-square tests. Histograms were used to assess normality of the data. Student's *t*-tests and Mann–Whitney *U*-tests were used to compare continuous data, where appropriate. Multivariable logistic regression was used to calculate odds ratios (ORs) and control for confounders. Confounders were determined by association with exposure and outcome at a level of significance of $p < 0.1$. Backward stepwise elimination was used to create a comprehensive multivariable model. Data analysis was performed with STATA software (Version 12.0 for Windows, StataCorp, College Station, TX). Statistical significance was set at a $p < 0.05$. The sample size was fixed based on the parent study.

Results

There were 887 patients in the parent cohort. Of them, 350 women did not have a recorded BMI at <24 weeks in both pregnancies; therefore, 537 women met the inclusion criteria for this study. Overall, 23.3% of women in the study increased BMI category between pregnancies.

The demographic characteristics are displayed in ►Table 1 for the overall cohort and for women with and without an increase in the BMI category. Two-thirds of our study population was African-American, and the average BMI was 28 kg/m².

►Fig. 1 shows the distribution of change in BMI category between the two pregnancies. The majority of normal weight women stayed within their BMI category. Of the 161 women who were overweight in the index pregnancy, 40% became obese, whereas only 6% became normal weight. Of the 116 obese women in the index pregnancy, 16% were morbidly obese in the subsequent pregnancy. Almost all (91%) of morbidly obese patients remained morbidly obese in their second pregnancy.

As seen in ►Table 1, women whose BMI was unchanged were significantly older than women whose BMI increased in their second pregnancy (29 vs. 26 years; $p = 0.0002$). There were no differences in race, parity, medical comorbidities, or interpregnancy interval between the groups ($p = 0.21$).

►Table 2 demonstrates the association between increased BMI and adverse pregnancy outcomes. There was no increased risk of preterm birth, IUGR, or pregnancy-related hypertension in women whose BMI category increased between pregnancies compared with those women whose BMI was unchanged, nor was there a difference in the rate of macrosomia. There was, however, an increased risk of GDM among women who increased BMI category (2.18 vs. 6.40%; $p = 0.02$). This held true when adjusting for maternal age, GDM in a prior pregnancy, and starting BMI category (adjusted OR [aOR]: 8.2; 95% confidence interval [CI]: 2.1–32.7; $p = 0.003$).

When evaluating the mode of delivery in the subsequent pregnancy, there was no statistical difference in the rate of cesarean section between women who did and those did not increase BMI category when controlling for cesarean in the index pregnancy (aOR: 0.58; 95% CI: 0.3–1.1; $p = 0.09$).

Discussion

Our study demonstrates that almost 25% of women increased their BMI category between pregnancies, and 40% of overweight women become obese. This increase in BMI category is associated with an increased risk of GDM without an identifiable increased risk of pregnancy-related hypertension, preterm birth, intrauterine growth restriction, or macrosomia.

Pregnancy is a time of relatively rapid weight gain in a woman's life. Excess weight gain in pregnancy has been associated with multiple adverse outcomes. To date, however, there has been only one study examining weight gain in the context of changes in BMI category.¹⁹ This was a retrospective study evaluating change in BMI category during pregnancy rather than the change in BMI categories between pregnancies, which is what we evaluated.

We found an association between GDM and women who increased their BMI category between pregnancies, which is similar to prior studies evaluating inter-pregnancy BMI and weight changes as a continuous variable.^{22–28} Contrary to these studies, however, we did not find an increased risk of pregnancy-related hypertension, preterm birth, or growth restriction. We also did not find an increase in BMI to be protective against small for gestational age in contrast to a large cohort study by Cheng et al.²⁹ This may be secondary to the small sample size or our examination of BMI change as a categorical rather than continuous change. However, there may also be other explanations for why we did not see a difference in the other adverse pregnancy outcomes. As over half of our population started their index pregnancy overweight or obese, it is possible that further increase in weight did not significantly increase their baseline elevated risk. It is also plausible that the interpregnancy interval between these pregnancies was not long enough for maternal physiology to change significantly enough to impact the health of the pregnancy in the same way as it does in a woman whose BMI has been high throughout her adult life. Lastly, the women who did not change BMI category in this study were significantly older than those women who did change BMI category; it is possible that age-related risks outweighed any weight-related changes.

This study has several strengths and limitations. While a large number of women had missing data, the majority of women from the original cohort (60%) did have a recorded BMI at <24 weeks in both pregnancies. The exact impact that this missing data has on our results is unclear; however, restricting the BMI to <24 weeks is important as it limits the impact that weight gain in pregnancy itself has on adverse pregnancy outcomes. While the high percentage of African-American women makes it less generalizable to other populations, this is an important group of women to study due to their high risk of pregnancy complications. Lastly, due to the fixed sample size, we may not have been powered to detect differences in individual adverse outcomes; it is, therefore, possible that some of our negative results are due to Type II error.

This study confirms that a significant proportion of women increase BMI category between pregnancies, and this increase in BMI category is associated with a higher risk of GDM. Given the high prevalence of GDM and its association with maternal and neonatal morbidity, attention should be paid to interpregnancy changes in BMI category, a modifiable risk factor. Efforts to curb excess pregnancy weight gain as recommended by the IOM may decrease postpartum weight retention, thereby decreasing the rates of GDM and improving long-term health outcomes for women in the future.

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References

1. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. *JAMA* 2010;303(03): 235–241 [PubMed: 20071471]
2. National Center for Health Statistics. Prevalence of obesity among adults and youth: United States, 2011–2014 2015 Available at <https://www.cdc.gov/nchs/data/databriefs/db219.pdf>. Accessed June 9, 2017
3. Catalano PM. Management of obesity in pregnancy. *Obstet Gynecol* 2007;109(2 Pt 1):419–433 [PubMed: 17267845]
4. Stothard KJ, Tennant PW, Bell R, Rankin J. Maternal overweight and obesity and the risk of congenital anomalies: a systematic review and meta-analysis. *JAMA* 2009;301(06):636–650 [PubMed: 19211471]
5. Anderson NH, McCowan LM, Fyfe EM, et al.; SCOPE Consortium. The impact of maternal body mass index on the phenotype of pre-eclampsia: a prospective cohort study. *BJOG* 2012;119(05): 589–595 [PubMed: 22304412]
6. Salihu HM, Dunlop AL, Hedayatzadeh M, Alio AP, Kirby RS, Alexander GR. Extreme obesity and risk of stillbirth among black and white gravidas. *Obstet Gynecol* 2007;110(03):552–557 [PubMed: 17766599]
7. Yao R, Ananth CV, Park BY, Pereira L, Plante LA; Perinatal Research Consortium. Obesity and the risk of stillbirth: a population-based cohort study. *Am J Obstet Gynecol* 2014;210:457e1–457.e9 [PubMed: 24674712]
8. Aune D, Saugstad OD, Henriksen T, Tonstad S. Maternal body mass index and the risk of fetal death, stillbirth, and infant death: a systematic review and meta-analysis. *JAMA* 2014;311(15): 1536–1546 [PubMed: 24737366]

9. Salihu HM, Luke S, Alio AP, Deutsch A, Marty PJ. The impact of obesity on spontaneous and medically indicated preterm birth among adolescent mothers. *Arch Gynecol Obstet* 2010;282(02):127–134 [PubMed: 19707780]
10. Lynch AM, Hart JE, Agwu OC, Fisher BM, West NA, Gibbs RS. Association of extremes of prepregnancy BMI with the clinical presentations of preterm birth. *Am J Obstet Gynecol* 2014;210(05):428e1–428.e9 [PubMed: 24321446]
11. Hendler I, Goldenberg RL, Mercer BM, et al. The Preterm Prediction Study: association between maternal body mass index and spontaneous and indicated preterm birth. *Am J Obstet Gynecol* 2005;192(03):882–886 [PubMed: 15746686]
12. Weiss JL, Malone FD, Emig D, et al.; FASTER Research Consortium. Obesity, obstetric complications and cesarean delivery rate—a population-based screening study. *Am J Obstet Gynecol* 2004; 190(04):1091–1097 [PubMed: 15118648]
13. Hibbard JU, Gilbert S, Landon MB, et al.; National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. Trial of labor or repeat cesarean delivery in women with morbid obesity and previous cesarean delivery. *Obstet Gynecol* 2006;108(01):125–133 [PubMed: 16816066]
14. Chu SY, Kim SY, Schmid CH, et al. Maternal obesity and risk of cesarean delivery: a meta-analysis. *Obes Rev* 2007;8(05):385–394 [PubMed: 17716296]
15. Baugh N, Harris DE, Aboueissa A-M, Sarton C, Lichter E. The impact of maternal obesity and excessive gestational weight gain on maternal and infant outcomes in Maine: analysis of pregnancy risk assessment monitoring system results from 2000 to 2010. *J Pregnancy* 2016;2016:5871313 [PubMed: 27747104]
16. Hannaford KE, Tuuli MG, Odibo L, Macones GA, Odibo AO. Gestational Weight Gain: Association with Adverse Pregnancy Outcomes. *Am J Perinatol* 2017;34(02):147–154 [PubMed: 27355980]
17. Institute of Medicine and National Research Council Committee to Reexamine IOM Pregnancy Weight Guidelines. *Weight Gain during Pregnancy: Reexamining the Guidelines* Washington, DC: National Academies Press; 2009
18. Truong YN, Yee LM, Caughey AB, Cheng YW. Weight gain in pregnancy: does the Institute of Medicine have it right? *Am J Obstet Gynecol* 2015;212(03):362e1–362.e8 [PubMed: 25725659]
19. Kabiru W, Raynor BD. Obstetric outcomes associated with increase in BMI category during pregnancy. *Am J Obstet Gynecol* 2004;191(03):928–932 [PubMed: 15467566]
20. Levine LD, Bogner HR, Hirshberg A, Elovitz MA, Sammel MD, Srinivas SK. Term induction of labor and subsequent preterm birth. *Am J Obstet Gynecol* 2014;210(04):354e1–354.e8 [PubMed: 24184339]
21. American College of Obstetricians and Gynecologists; Task Force on Hypertension in Pregnancy. *Report on Hypertension in Pregnancy* Washington, DC: SCOG; 2013
22. McBain RD, Dekker GA, Clifton VL, Mol BW, Grzeskowiak LE. Impact of inter-pregnancy BMI change on perinatal outcomes: a retrospective cohort study. *Eur J Obstet Gynecol Reprod Biol* 2016;205:98–104 [PubMed: 27567535]
23. Knight-Agarwal CR, Williams LT, Davis D, et al. Association of BMI and interpregnancy BMI change with birth outcomes in an Australian obstetric population: a retrospective cohort study. *BMJ Open* 2016;6(05):e010667
24. Wallace JM, Bhattacharya S, Campbell DM, Horgan GW. Inter-pregnancy weight change and the risk of recurrent pregnancy complications. *PLoS One* 2016;11(05):e0154812 [PubMed: 27145132]
25. Haugen M, Brantsæter AL, Winkvist A, et al. Associations of pre-pregnancy body mass index and gestational weight gain with pregnancy outcome and postpartum weight retention: a prospective observational cohort study. *BMC Pregnancy Childbirth* 2014;14:201 [PubMed: 24917037]
26. Getahun D, Ananth CV, Peltier MR, Salihu HM, Scorza WE. Changes in prepregnancy body mass index between first and second pregnancies and risk for large-for-gestational-age birth. *Am J Obstet Gynecol* 2007;196:e1–e8
27. Bogaerts A, Van den Bergh BR, Ameye L, et al. Interpregnancy weight change and risk for adverse perinatal outcome. *Obstet Gynecol* 2013;122(05):999–1009 [PubMed: 24104777]

28. Ehrlich SF, Hedderson MM, Feng J, Davenport ER, Gunderson EP, Ferrara A. Change in body mass index between pregnancies and the risk of gestational diabetes in a second pregnancy. *Obstet Gynecol* 2011;117(06):1323–1330 [PubMed: 21606742]
29. Cheng CJ, Bommarito K, Noguchi A, Holcomb W, Leet T. Body mass index change between pregnancies and small for gestational age births. *Obstet Gynecol* 2004;104(02):286–292 [PubMed: 15292001]

Fig. 1.
Distribution of body mass index (BMI) category changes between pregnancies.

Table 1

Demographic information for the study cohort in the index pregnancy

	Overall population, <i>N</i> = 537	BMI unchanged, <i>N</i> = 412	BMI increased, <i>N</i> = 125	<i>p</i> -Value
Maternal age ^a	28 (23–33)	29 (24–33)	26 (22–31)	0.0002
BMI ^b	28.3 (6.9)	28.4 (7.5)	28 (4.4)	0.5
Race ^c				
African-American	353 (68.8)	248 (63.4)	105 (86.1)	<0.001
White	114 (22.2)	105 (26.9)	9 (7.4)	
Other	46 (9)	38 (9.7)	8 (6.6)	
Parity in the first pregnancy				0.2
Primiparas	350 (65.2)	274 (66.5)	76 (60.8)	
Multiparas	187 (34.8)	138 (33.5)	49 (39.2)	
Medical comorbidities				
Chronic hypertension	21 (3.9)	18 (4.4)	3 (2.4)	0.3
Pregestational diabetes mellitus	6 (1.1)	5 (1.2)	1 (0.8)	0.7
Interpregnancy interval ^a	1.52 (0.92–2.35)	1.51 (0.94–2.26)	1.82 (0.82–2.65)	0.2

Abbreviation: BMI, body mass index.

Note: data are presented as *n* (%) unless otherwise indicated.^aReported in years as median (interquartile range).^bBody mass index reported as mean (standard deviation).^cDoes not add to total population numbers due to 24 women with missing race information.

Table 2

Adverse pregnancy outcomes in subsequent pregnancy

	BMI category unchanged, <i>N</i> = 412	BMI category increased, <i>N</i> = 125	<i>p</i>-Value^a
Preterm birth	37 (9%)	8 (6.4%)	0.4
Pregnancy-related hypertension	43 (10.4%)	11 (8.8%)	0.6
IUGR < 10%	30 (7.3%)	6 (4.8%)	0.3
Gestational diabetes	9 (2.2%)	8 (6.4%)	0.02
Macrosomia	31 (7.5%)	11 (8.8%)	0.6

Abbreviations: BMI, body mass index; IUGR, intrauterine growth restriction.

Note: Data are presented as *n* (%) unless otherwise indicated.^aValues calculated from chi-square analysis.