OBSTETRICS

Prepregnancy body mass index in a first uncomplicated pregnancy and outcomes of a second pregnancy

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OBJECTIVE: This study examined the effect of body mass index (BMI) before a first uncomplicated pregnancy on maternal and fetal outcomes in a subsequent pregnancy, including preterm births, preeclampsia, cesarean delivery, small for gestational age, large for gestational age, and neonatal deaths.

STUDY DESIGN: We conducted a population-based cohort study (n = 121,092) using the Missouri maternally linked birth registry (1989 through 2005). Multivariable binary logistic regression models were fit to estimate odds ratios and 95% confidence intervals for the parameters of interest after controlling for sociodemographic and pregnancy-related confounders in the second pregnancy.

RESULTS: Compared to women with a normal BMI in their first pregnancy, those who were underweight prepregnancy had increased odds for preterm birth by 20% and small for gestational age by 40% in their second pregnancy, while those with prepregnancy obesity had increased odds for large for gestational age, preeclampsia, cesarean delivery, and neonatal deaths in their second pregnancy by 54%, 156%, 85%, and 37%, respectively.

CONCLUSION: Women starting a first pregnancy with suboptimal BMI may be at risk of adverse maternal and fetal outcomes in a subsequent pregnancy, even if their first pregnancy was uncomplicated or if they reached a normal weight by their second pregnancy. The long-term consequences of suboptimal BMI carry considerable public health implications.

Key words: fetal outcomes, maternal outcomes, prepregnancy body mass index, subsequent pregnancy, uncomplicated pregnancy

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The majority of women in the United States enter pregnancy with a suboptimal body mass index (BMI), most of them being overweight or obese before pregnancy.[1] With the pervasive obesity epidemic, maternal obesity has reached alarming levels among pregnant women, with persisting racial disparities. Prepregnancy obesity affects about 1 in 5 white women and about 1 in 3 African American women in the United States today.[1]

The substantial number of women starting pregnancy with a suboptimal BMI has serious public health implications as prepregnancy BMI is a significant predictor of maternal and fetal outcomes.[2] Prepregnancy underweight is associated with an increased risk for small for gestational age (SGA) and preterm birth (PTB).[2,3] Prepregnancy overweight and obesity are associated with various pregnancy complications including gestational diabetes, gestational hypertension, preeclampsia, cesarean delivery, medically indicated PTB, and stillbirth.[2,4,5] Women who become pregnant while obese are at a higher risk of neonatal and infant death, and of delivering babies who are large for gestational age (LGA) or who have congenital anomalies, including neural tube defects.[2,4,5] Maternal obesity may also have long-term consequences for the offspring, including neurodevelopmental delay, attention deficit hyperactivity disorder, autism spectrum disorder, asthma, obesity, and other metabolic complications.[2,5,6]

While the effects of prepregnancy BMI on pregnancy outcomes have been thoroughly examined,[2-6] little is known about the effect of prepregnancy BMI on the maternal and fetal outcomes in a subsequent pregnancy. In a population-based retrospective cohort analysis, women who were overweight or obese before their first pregnancy had increased adjusted odds for LGA, preeclampsia, and cesarean delivery in their second pregnancy as compared to women who had a normal weight before both pregnancies, even if they had reached a normal weight by their second pregnancy.[7-9] While these findings suggest that prepregnancy BMI might

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have adverse effects on pregnancy outcomes in subsequent pregnancies, it is unclear if the increased risk is driven by recurrence of adverse outcomes in the first pregnancy.

The objective of this study is to examine the effect of prepregnancy BMI in a first uncomplicated pregnancy on maternal and fetal outcomes in a second pregnancy, including PTB, preeclampsia, cesarean delivery, SGA, LGA, and neonatal deaths. To our knowledge, this is the first study to assess the effect of prepregnancy BMI in a first pregnancy on the outcomes of a subsequent pregnancy, independent of complications in the first pregnancy.

Materials and Methods

We conducted a population-based retrospective cohort study involving 121,049 women in Missouri who delivered their first 2 singleton pregnancies from 1989 through 2005. Data were obtained from the maternally linked Missouri birth registry, which links birth certificate data of siblings using maternal identifiers. The Missouri birth registry has been deemed very reliable and is used as a gold standard for the validation of other vital statistics data sets in the United States.[10] The registry contains a wide variety of data pertaining to each birth in Missouri, including maternal sociodemographic characteristics, medical and obstetrical information, pregnancy outcomes, and neonatal status at birth. The methods used to link birth records of subsequent pregnancies and their validation have been described in detail elsewhere.[10] In summary, weighted scores were calculated for each pair of records, reflecting the likelihood that the 2 records belong to the same woman.[10] The pairs of pregnancies with the highest overall weighted scores were selected based on the level of agreement across a number of common variables and exact matching on important identifiers (ie, birth date, maternal name).[10] The linkage rate for the Missouri birth registry (1989 through 2005) was 93%.

All nulliparous women in Missouri who delivered their first 2 nonanomalous singleton pregnancies between 20-44 weeks of gestation were eligible for the study. Gestational age was based on the birth certificate variable "clinical estimate of gestation," which has been deemed to provide an accurate estimate of gestational age.[11] As the "clinical estimate of gestation" variable was mandatorily recorded since 1989 and data were available for the cohort only until 2005, the sample in this study was limited to resident women delivering from Jan. 1, 1989, through Dec. 31, 2005. Only women delivering live singleton births (n = 235,587) were included in our study to eliminate any confounding effect of multiple gestation with our outcomes of interest. Women were also excluded from the study (n = 104,004) if their first pregnancies were complicated by chronic conditions (eg, hypertension, renal disease, and diabetes), congenital anomalies diagnosed at birth, or by the outcomes of interest. The final sample consisted of 121,049 (92.0%) women with complete data on the exposure and outcomes of interest and other covariates.

The exposure of interest was prepregnancy BMI in the first pregnancy, defined as underweight (BMI <18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25.0-29.9 kg/m^2), and obesity (BMI $\geq$30.0kg/m^2).[12] The outcomes of interest included PTB, preeclampsia, cesarean delivery, SGA, LGA, and neonatal deaths. PTB is defined by the World Health Organization as delivery $<$37 completed weeks of gestation.[13] SGA and LGA are defined as birthweight $<$10th percentile and $>$90th percentile for gestational age and race, respectively, using the US population as the reference for birthweights.[14] Cesarean delivery included both primary elective and emergency cesarean delivery as indicated on the birth certificate for the second pregnancy after a vaginal delivery in the first pregnancy. Neonatal deaths referred to death that occurred during the first 28 days of the infant's life.[13]

Clinically relevant risk factors that may be associated with prepregnancy BMI and the outcomes of interest were evaluated as potential confounders, including maternal sociodemographic characteristics and pregnancy-related variables. Maternal sociodemographic variables at the time of the second pregnancy included maternal age, education level, marital status, race, and Medicaid status. Pregnancy-related factors from the second pregnancy included prenatal smoking, adequacy of prenatal care utilization assessed using the Kotelchuck index, infant sex, gestational weight gain assessed using the Institute of Medicine guidelines,[12] interpregnancy interval calculated as the time in years from the birth of the first baby until conception of the second pregnancy, and gravida.

Statistical analysis

We assessed differences in sample characteristics by prepregnancy BMI in the first pregnancy using the Pearson χ^2 test for categorical variables and 1-way analysis of variance for continuous variables. For ordinal variables (ie, number of cigarettes smoked during pregnancy and gravida), we used the nonparametric test for equality of medians. Bivariate and multivariable binary logistic regression analyses were used to estimate the crude and adjusted odds ratios (ORs), respectively, for our outcomes of interest and their 95% confidence intervals (CIs). ORs have been reported to approximate relative risks when outcomes are of rare ($<$10%) prevalence, as is the case for our outcomes of interest with the exception of LGA.[15] As the prevalence of LGA in our sample is 10.5%, we conducted a sensitivity analysis using Poisson regression with robust error variance to estimate adjusted relative risks for that outcome and verify our findings.

Potential confounders were included in the multivariable model to reduce the bias in the estimation of risk. Prepregnancy BMI for the first and second pregnancies were highly correlated ($r = 0.84$). As a result, we did not control for prepregnancy BMI in the second pregnancy in the multivariable analysis to avoid multicolinearity. Nevertheless, we performed a second sensitivity analysis including a composite measure of prepregnancy BMI as the exposure. The latter variable included 15 categories based on BMI status in the first and