OBSTETRICS

Interpregnancy body mass index change and success of term vaginal birth after cesarean delivery

Lisa S. Callegari, MD, MPH; Lauren A. Sterling, BS; Sarah T. Zelek, MPH; Stephen E. Hawes, PhD; Susan D. Reed, MD, MPH

OBJECTIVE: We investigated the effect of interpregnancy body mass index (BMI) change on success of term vaginal birth after cesarean (VBAC) among normal, overweight and obese women.

STUDY DESIGN: Using 1992-2009 Washington State birth certificate data linked with hospitalization records, we conducted a population-based retrospective cohort study of nulliparous women (BMI $\geq$18.5 kg/m^2) with a primary cesarean in their first birth and a term trial of labor in their second. Interpregnancy weight change (difference between first and second prepregnancy BMIs) was categorized as maintenance (<1 BMI unit change), loss ($\geq$1 unit), moderate gain ($\geq$1 and <2 units), high gain ($\geq$2 units). We estimated relative risks of VBAC success using generalized linear models with a log-link function, adjusting for maternal age, race/ethnicity, nativity, marital status, education, smoking, primary cesarean indication, interpregnancy interval, birth year for second birth, and prenatal care adequacy.

RESULTS: Among 8302 women who attempted a term trial of labor, 65% had a successful VBAC. Women with normal BMI before their first pregnancy experienced an 8% decrease in VBAC success with moderate gain (relative risk [RR], 0.92; 95% confidence interval [CI], 0.87—0.98) and a 12% decrease in success with high gain (RR, 0.88; 95% CI, 0.83—0.93), compared with normal weight women who maintained weight. Weight loss increased VBAC success in women who were overweight (RR, 1.12; 95% CI, 1.01—1.25) or obese before their first delivery (RR, 1.24; 95% CI, 1.04—1.49), compared with overweight and obese women, respectively, who maintained weight.

CONCLUSION: Women can improve their chance of successful VBAC through interpregnancy weight management.

Key words: body mass index, interpregnancy weight change, obesity, vaginal birth after cesarean, VBAC

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A third of deliveries in the United States occur by cesarean, with the largest single indication being a prior cesarean delivery.[1] Cesarean deliveries increase risks of maternal morbidity and complications in future pregnancies, and are more costly than vaginal deliveries.[2] Vaginal birth after cesarean (VBAC) is a safe option for most women with a prior low transverse cesarean delivery, and has been advocated as a strategy to decrease the national cesarean rate.[3-5] Identifying modifiable patient-level factors associated with VBAC success could improve patient counseling and ultimately reduce unnecessary cesarean deliveries.

From the Department of Epidemiology, University of Washington School of Public Health (all authors); Department of Obstetrics and Gynecology, University of Washington School of Medicine (Drs Callegari and Reed); and Health Services Research and Development, Puget Sound Health Care System, Department of Veterans Affairs (Dr Callegari), Seattle, WA.

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Reprints: Lisa S. Callegari, University of Washington, VA HSR&D Puget Sound, 1100 Olive Way, Suite 1400 Seattle, WA 98101. lcallega@uw.edu.

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Prepregnancy obesity is a known risk factor for both primary cesarean delivery[6] and failed VBAC.[7-11] Several prior studies have identified an association between interpregnancy body mass index (BMI) increase and elevated risk of primary cesarean,[12-13] but little is known about the effect of BMI changes in the interpregnancy period on VBAC success rates. One case series from a single institution found that weight gain between pregnancies decreased VBAC success,[9] but no prior studies have used population-based data to examine associations between interpregnancy BMI change and VBAC success.

This study from Washington State compares VBAC success in term singleton births among normal, overweight, and obese women who lost or gained weight between their first and second pregnancies, relative to women who maintained weight. We hypothesized that interpregnancy weight gain would decrease VBAC success rates, whereas weight loss among overweight

and obese women would increase success rates.

Materials and Methods

Data collection

We conducted a retrospective cohort study using the Washington State Longitudinal Births Database, which contains birth certificate data linked to maternal birth hospital records. Birth certificate data is recorded shortly after delivery, usually submitted electronically to the Washington State Department of Health. The process of collecting birth certificate information may vary by location or mother. The information may be obtained directly from the mother, the medical record, health care providers, or a combination. Linked hospital data are obtained from the coded hospital discharge records and are derived from billing systems.[14]

Study subjects were selected from nulliparous women who had two births on record between 1992 and 2009, with the first birth a primary cesarean delivery and the second a term singleton live birth. We excluded women who in their second pregnancy had an elective repeat cesarean delivery with no evidence of a trial of labor (TOL) or were missing mode of delivery. For second cesarean deliveries coded as a "primary cesarean," we assumed a TOL from evidence of attempted vacuum or forceps delivery or other labor indicators, such as labor induction or prolonged labor. Women were subsequently excluded if at their TOL they were less than 16 years of age, delivered a neonate less than 37 weeks' gestation, or age or gestational age were missing. We then excluded women in whom BMI data at either their first or second delivery was missing. Lastly, we excluded women with an underweight prepregnancy BMI given the different health implications of interpregnancy weight change in this population compared with normal, overweight, and obese women.[15] Institutional review board exemption was obtained from the University of Washington.

Measures

Using the prepregnancy BMI from their first pregnancy, women were divided into 3 weight strata based on the World Health Organization classification system, with normal weight defined as BMI of 18.5-24.9 kg/m^2, overweight as BMI of 25.0-29.9 kg/m^2, and obese as BMI of greater than or equal to 30.0 kg/m^2.[16] Interpregnancy weight change was measured as the difference between prepregnancy BMI in the first and second pregnancies, consistent with previously published literature.[12,13] The prepregnancy weight on the birth certificate is usually the weight recorded at the first prenatal visit; rarely prepregnancy weights are self-reported. BMI was calculated as weight in kilograms divided by height in meters squared using weight obtained from the birth certificate and height either from the birth certificate or from the mother's driver's license. Subjects were categorized into 4 interpregnancy weight change groups: maintenance (<1 BMI unit change), weight loss (≥ 1 unit decrease), moderate gain (≥ 1 and <2 units increase), and high gain (≥ 2 units increase). In addition, we separated high gain into ≥ 2 and <3 units and ≥ 3 units to assess the potential differential effect of higher weight gain. For a woman of an average height of 5 feet 4 inches,[17] a 1 unit BMI change corresponds to approximately 6 lbs. and a 2 unit change to 12 lbs. VBAC success was defined as a vaginal delivery documented for the second pregnancy, and failure was indicated by a cesarean delivery reported on the birth certificate with indication that a TOL was attempted.

Maternal demographic characteristics were obtained from the birth certificate, including maternal age, years of education, tobacco use, marital status, race/ethnicity, and whether the mother was born outside of the United States. We coded race/ethnicity as nonHispanic White, Hispanic, nonHispanic black, Asian, or other. Adequacy of prenatal care was determined by the Kotelchuck Index, a measure derived from both time of initiation of prenatal care and number of prenatal visits.[18] We categorized women as having inadequate prenatal care if they had a Kotelchuck Index score of $<80\%$.[18] Because indication for cesarean birth is not captured on the birth certificate, we created a variable to capture indication for the primary cesarean delivery combining data from birth certificates with the *International Classification of Diseases*-9 codes from linked hospital record data. We used a stepwise approach to assign a single indication to each cesarean delivery in the following priority order: (1) indicated, including malpresentation, placenta previa or abruption, prolapsed cord or vasa previa, multiple gestation or active herpes genitalis; (2) fetal distress; (3) dystocia, including diagnoses of cephalopelvic disproportion, prolonged or dysfunctional labor; (4) failed induction, including cesarean deliveries following induction without any of the above codes; and (5) other indications including all remaining cesarean births not included in (1)-(4).

Data analysis

Because of the high prevalence of the successful VBAC outcome, generalized linear models with a log-link function were used to directly calculate the relative risks (RRs) and 95% confidence intervals (CIs) for the association between interpregnancy weight change and VBAC.[19] Variables for inclusion in the model were selected a priori based on biologic plausibility and literature review, including review of published prediction models for VBAC success.[20] These variables included age, maternal race/ethnicity, marital status, maternal education, prenatal smoking, indication for primary cesarean, interpregnancy time interval, and prenatal care adequacy. In addition, we included whether the mother was born outside of the US as a potential confounder given the association of nativity both with obesity rates[21] and cesarean delivery rates.[22] We also included the year of birth as an adjustment variable to account for temporal fluctuations in practice patterns relating to VBAC seen in Washington State and nationally.[2]

To examine the potential impact of missing BMI and other covariate data on our results, we performed multiple imputation as a sensitivity analysis. We imputed values for women missing any height measurement or missing