

OBSTETRICS

Inadequate weight gain in overweight and obese pregnant women: what is the effect on fetal growth?

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OBJECTIVE: We sought to evaluate inadequate gestational weight gain and fetal growth among overweight and obese women.

STUDY DESIGN: We conducted an analysis of prospective singleton term pregnancies in which 1053 overweight and obese women gained >5 kg (14.4 ± 6.2 kg) or 188 who either lost or gained ≤ 5 kg (1.1 ± 4.4 kg). Birthweight, fat mass, and lean mass were assessed using anthropometry. Small for gestational age (SGA) was defined as ≤ 10 th percentile of a standard US population. Univariable and multivariable analysis evaluated the association between weight change and neonatal morphometry.

RESULTS: There was no significant difference in age, race, smoking, parity, or gestational age between groups. Weight loss or gain ≤ 5 kg was associated with SGA, 18/188 (9.6%) vs 51/1053 (4.9%); (adjusted odds ratio, 2.6; 95% confidence interval, 1.4–4.7; $P = .003$). Neonates of women who lost or gained ≤ 5 kg had lower

birthweight (3258 ± 443 vs 3467 ± 492 g, $P < .0001$), fat mass (403 ± 175 vs 471 ± 193 g, $P < .0001$), and lean mass (2855 ± 321 vs 2995 ± 347 g, $P < .0001$), and smaller length, percent fat mass, and head circumference. Adjusting for diabetic status, pre-pregnancy body mass index, smoking, parity, study site, gestational age, and sex, neonates of women who gained ≤ 5 kg had significantly lower birthweight, lean body mass, fat mass, percent fat mass, head circumference, and length. There were no significant differences in neonatal outcomes between those who lost weight and those who gained ≤ 5 kg.

CONCLUSION: In overweight and obese women weight loss or gain ≤ 5 kg is associated with increased risk of SGA and decreased neonatal fat mass, lean mass, and head circumference.

Key words: fetal anthropometry, gestational diabetes, gestational weight loss

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The problem of obesity during pregnancy is now recognized as a major public health concern.¹ In the United States 55.8% of the female population 20-39 years of age is overweight (body mass index [BMI] 25.0-29.9) or obese (BMI ≥ 30), based on World Health Organization (WHO) BMI criteria (kg/m^2).² Because of the increase in obesity there has been an increase in term mean birthweight in developed countries^{3,4} including the United States.⁵ Although there are reports that the increase neonatal weight has reached a plateau or decreased⁶ this may relate more to changes in population demographics such as ethnicity and earlier gestational age at delivery.⁷ Being overweight or obese are significant problems for women and their offspring during pregnancy. In early gestation there is a significant increased risk of early spontaneous abortion and congenital malformations.^{8,9} In later gestation there is a significant increased risk for the metabolic dysfunction associated with insulin resistance presenting as gestational diabetes mellitus (GDM) and preeclampsia.¹⁰ At delivery there is an increased risk for cesarean delivery, postpartum wound infection, and deep vein thrombosis.¹¹ For the neonate there is an increased risk of fetal macrosomia and more specifically fetal adiposity.¹² Increased adiposity at birth is associated with increased risks of problems such as shoulder dystocia but may also be the harbinger of childhood obesity and metabolic dysfunction.¹³

The Institute of Medicine (IOM) in 2009 revised the gestational weight gain guidelines, recommending that obese women should have a gestational weight gain of at least 5 kg during pregnancy (5-9 kg), to at least meet the obligatory physiologic changes of pregnancy.¹⁴ However some authors have recommended very limited weight gain, no weight gain, or even weight loss during pregnancy to optimize pregnancy outcomes.¹⁵⁻¹⁷ Hence the purpose of this research was to examine the effect of limited gestational weight gain or weight loss during pregnancy on fetal weight, anthropometry, and estimates

of neonatal body composition in overweight and obese women.

MATERIALS AND METHODS

This was a retrospective analysis of prospective multicenter data from 1241 singleton term pregnancies in overweight and obese women examining the effect of limited gestational weight gain or weight loss during pregnancy on fetal growth. The data included 890 patients who were enrolled in the previously reported *Eunice Kennedy Shriver* National Institutes of Child Health and Human Development Maternal-Fetal Medicine Units (MFMU) Network multicenter randomized trial of treatment of mild GDM.¹⁸ In all, 351 patients, who were enrolled in another ongoing study of GDM at MetroHealth Medical Center evaluating neonatal growth at delivery, were also included in this analysis. Limited gestational weight gain or loss during pregnancy was estimated as the documented weight at the last prenatal visit minus self-recalled prepregnancy weight, and at MetroHealth, when possible, confirmed by a first-trimester weight at the first prenatal visit. Height was either measured at the first prenatal visit using a stadiometer or obtained from the prenatal chart. Subjects in this analysis included 395 women with a 50-g glucose challenge test (GCT) <135 mg/dL; 418 women with a GCT ≥ 135 mg/dL but normal oral glucose tolerance test (OGTT) defined as fasting <95 mg/dL, 1-hour <180 mg/dL, 2-hour <155 mg/dL, and 3-hour <140 mg/dL; and 255 with treated and 173 with untreated GDM (≥ 2 abnormal values on the aforementioned OGTT). All subjects who required treatment in addition to diet were treated with insulin. There were 36 in the MFMU cohort and 29 in the MetroHealth cohort, total 65 or 5.2% of the 1241 subjects in the entire cohort.

All the subjects participating in the 2 studies provided written informed consent. The study was approved by the human subjects committee at each of the participating MFMU sites as well as the Institutional Review Board at MetroHealth Medical Center and the Scientific Review Committee of the

Clinical Research Unit of the Clinical and Translational Science Collaborative at Case Western Reserve University. Subjects enrolled in this analysis met the criteria for eligibility as reported elsewhere in the primary report.¹⁸ Subjects were excluded if they met any of the following conditions: an abnormal result on a GCT at <24 weeks' gestation or previous GDM; stillbirth in a prior pregnancy, multifetal gestation, asthma, or chronic hypertension, received corticosteroid therapy; or were carrying a fetus thought to be anomalous. Similar inclusion and exclusion criteria were used for eligibility for the MetroHealth subjects.

The primary outcome for this study was neonatal morphometry and body composition. Small for gestational age (SGA) was defined as $<10\%$ for gestational age based on birthweight percentiles from 1994 through 1996.¹⁹ Birthweight was measured on a calibrated scale and length on a measuring board. Trained research staff performed the anthropometric measures used to estimate neonatal body composition.²⁰ The flank skinfold was measured in the mid-axillary line just above the crest of the ilium. Skinfold measurement was made by lifting the skin with the thumb and index finger with care not to include any underlying tissue. Each skinfold was measured several times until a consistent and stable reading was obtained. The circumference of the head was determined using a tape measure. The coefficient of variation in the anthropometric measures is about 3% and 7% for the skinfolds. Estimates of neonatal body composition were made using the previous validated equation: fat mass = 0.39055 (birthweight kg) + 0.0453 (flank skinfold mm) - 0.03237 (length cm) + 0.54657 . Lean body mass was calculated as birthweight minus fat mass, and percent body fat as fat mass/birthweight $\times 100$. The correlation of this anthropometric model with air displacement plethysmography (Pea Pod; COSMED, Rome, Italy) estimates of neonatal fat and lean body mass ($n = 216$) is: fat mass ($r = 0.83$, $P < .001$) and lean body mass ($r = 0.94$, $P < .0001$) (unpublished data).

We compared baseline characteristics and neonatal outcomes by maternal

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