

TOPICS IN OBSTETRICS & GYNECOLOGY

Practical CE Newsletter for Clinicians

Impact of Abnormal Gestational Weight Gain and Prepregnancy BMI on Maternal and Neonatal Outcomes

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Learning Objectives: After participating in this continuing professional development activity, the provider should be better able to:

1. Plan patient-specific recommendations for gestational weight gain based on prepregnancy body mass index.
2. Predict adverse pregnancy, perinatal, and maternal outcomes based on abnormal gestational weight gain during pregnancy.
3. Counsel patients regarding the effects of abnormal maternal gestational weight on offspring.

Key Words: Gestational weight, Pregnancy, Weight gain

Obesity continues to be a global health pandemic. According to the Centers for Disease Control and Prevention, in 2018 the prevalence of obese adults in the United States exceeded 40%, and since 2000 has increased by over 10%.¹ Nearly half (41%) of women older than 20 years are classified as obese, and 18.4% of children aged 6 to 11 years are considered obese.² It is well known that obesity is associated with negative health outcomes such as diabetes mellitus and cardiovascular disease for both women and children.³

Pregnancy is a known risk factor for obesity in women. Both excessive gestational weight gain and postpartum weight retention may lead to obesity.⁴ Additionally, high prepregnancy body mass index (BMI) and abnormal gestational weight gain are associated with adverse

obstetrical outcomes and increase the risk of childhood obesity in the infant.⁵⁻¹⁰ Combating the obesity pandemic includes preventing excessive gestational weight gain.

In response to the concern for adverse obstetrical outcomes related to baseline BMI, the US Institute of Medicine (IOM) revised gestational weight gain guidelines in 2009 for the first time in nearly 2 decades (Table 1),¹¹ with the biggest change being further restricting gestational weight gain goals for obese women. These guidelines serve to not only focus on achieving a healthy infant birth weight, but also aim to diminish adverse long-term maternal and child health outcomes, including obesity. However, over the 10 years since the 2009 IOM guidelines were implemented, maternal and childhood obesity and their associated adverse pregnancy outcomes still remain a significant problem.

In this article, we summarize the current literature regarding gestational weight gain, prepregnancy BMI, maternal and child obesity, and the implementation of the 2009 IOM guidelines. We also discuss inconsistencies in measuring gestational weight gain and how this has affected application of the 2009 IOM guidelines. Finally, we consider the best practices for optimizing maternal and child health outcomes with regard to weight and pregnancy.

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Table 1. Total Weight Gains and Rates of Weight Gain Recommended for Women With Singleton Pregnancies

Prepregnancy Weight Status (Body Mass Index Category)	Recommended Total Weight Gain Range		Recommended Rates of Weight Gain in the Second and Third Trimester*	
	lb	kg	lb/wk	kg/wk
Underweight (<18.5 kg/m ²)	28–40	12.5–18	1.0 (1.0–1.3)	0.51 (0.44–0.58)
Normal (18.5–24.9 kg/m ²)	25–35	11.5–16	1.0 (0.8–1.0)	0.42 (0.35–0.50)
Overweight (25–29.9 kg/m ²)	15–25	7–11.5	0.6 (0.5–0.7)	0.28 (0.23–0.33)
Obese (≥30 kg/m ²)	11–20	5–9	0.5 (0.4–0.6)	0.22 (0.17–0.27)

*Calculations assume a 0.5- to 2-kg (1.1-4.4 lb) weight gain in the first trimester.

Adverse Pregnancy, Perinatal, and Maternal Outcomes Associated With Insufficient or Excessive Gestational Weight Gain

The 2009 IOM guidelines provide both the lower and upper limits of recommended weight gain based on BMI. A recent systematic review that included over 1 million pregnant women calculated that 23% and 47% of pregnancies had weight gain below and above guidelines, respectively.⁵

Excessive Weight Gain

Weight gain above IOM guidelines is associated with macrosomia and cesarean delivery.^{5,12} All women who gain weight above IOM guidelines irrespective of prepregnancy BMI are at increased risk for hypertensive disorders of pregnancy,¹³ maternal eclampsia, and cardiopulmonary morbidities.^{7,8} Excessive postpartum weight retention is an important risk factor for women to be classified as obese, further predisposing them to cardiovascular disease and diabetes later in life.^{3,14} Postpartum obesity is associated with decreased rates of breastfeeding, postpartum anemia, and depression.¹⁴

Insufficient Weight Gain

Gestational weight gain below guidelines is associated with pregnancy complications including preterm birth and small-for-gestational-age neonates.^{5,12,13} Insufficient gestational weight gain has been associated with maternal obesity, cardiovascular disease, and diabetes later in life.¹⁵ Suboptimal weight gain in a woman's first pregnancy may impact the outcomes of her second pregnancy, by increasing her risk of preterm delivery and small-for-gestational-age neonates, even if she gains the appropriate amount of weight in the subsequent pregnancy.¹⁶

Although IOM guidelines may be difficult to achieve, women who meet them have fewer maternal and perinatal complications.¹⁶ Table 2 provides a summary of the adverse outcomes associated with abnormal gestational weight gain.

Adverse Outcomes for Offspring Associated With Insufficient or Excessive Gestational Weight Gain

Maternal weight gain outside the IOM guidelines has detrimental effects in the short and long term for not only the mother

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but also the child. Outcomes for offspring based on maternal gestational weight gain are summarized in Table 2.

Excessive Weight Gain

Weight gain above IOM guidelines is associated with neonatal death⁷ and large-for-gestational-age neonates.¹³ Higher gestational weight gain and prepregnancy BMI are associated with higher risks of childhood obesity.⁹ Excessive

maternal weight gain even with a healthy prepregnancy BMI increases the offspring's risk of obesity in childhood and adulthood.¹⁰ Mothers who exceeded guidelines for gestational weight gain were more likely to have daughters who were overweight or obese in their 40s.⁶ This is irrespective of the daughter's weight at birth, childhood, or adolescence. In addition to elevated risk for obesity, children of obese pregnant women are at increased risk for

Table 2. Summary of Outcomes Associated With Insufficient or Excessive Gestational Weight Gain

Prepregnancy BMI	Total Gestational Weight Gain	Adverse Outcome	
		Maternal	Offspring
Underweight ($<18.5 \text{ kg/m}^2$)	<28 lb (inadequate)	<i>Current pregnancy risks:</i> PTB, SGA <i>Future health risks:</i> maternal obesity, CVD, T2DM, PTB, SGA	<i>Early complications:</i> childhood obesity <i>Late complications:</i> T2DM, HTN
	Between 28 and 30 lb (adequate)	No increased risk for adverse outcome	No increased risk for adverse outcome
	>40 lb (excessive)	<i>Current pregnancy risks:</i> HDP, cardiopulmonary morbidities, eclampsia, LGA, CD <i>Future health risks:</i> postpartum weight retention, CVD, T2DM	<i>Early complications:</i> neonatal death, macrosomia, childhood obesity <i>Late complications:</i> obesity
Normal (18.5–24.9 kg/m^2)	<25 lb (inadequate)	<i>Current pregnancy risks:</i> PTB, SGA <i>Future health risks:</i> maternal obesity, CVD, T2DM, PTB, SGA	<i>Early complications:</i> childhood obesity <i>Late complications:</i> T2DM, HTN
	Between 25 and 35 lb (adequate)	No increased risk for adverse outcome	No increased risk for adverse outcome
	>35 lb (excessive)	<i>Current pregnancy risks:</i> GDM, HDP, cardiopulmonary morbidities, preeclampsia, eclampsia, LGA, failed IOL, CD <i>Future health risks:</i> postpartum weight retention, CVD, T2DM	<i>Early complications:</i> neonatal death, macrosomia/SD, childhood obesity <i>Late complications:</i> obesity
Overweight (25–29.9 kg/m^2)	<15 lb (inadequate)	<i>Current pregnancy risks:</i> GDM, HTN, preeclampsia, SGA, PTB <i>Future health risks:</i> maternal obesity, CVD, T2DM, PTB, SGA,	<i>Early complications:</i> stillbirth, macrosomia/SD, NICU admission, childhood obesity <i>Late complications:</i> T2DM, HTN
	Between 15 and 25 lb (adequate)	<i>Current pregnancy risks:</i> GDM, HTN, preeclampsia <i>Future health risks:</i> no increased risk	<i>Early complications:</i> stillbirth, macrosomia/SD, NICU admission <i>Late complications:</i> none
	>25 lb (excessive)	<i>Current pregnancy risks:</i> GDM, HDP, cardiopulmonary morbidities, preeclampsia, eclampsia, LGA, CD <i>Future health risks:</i> CVD, T2DM, HTN, postpartum weight retention	<i>Early complications:</i> stillbirth, macrosomia/SD, NICU admission, neonatal death, childhood obesity <i>Late complications:</i> obesity
Obese ($\geq 30 \text{ kg/m}^2$)	<11 lb (inadequate)	<i>Current pregnancy risks:</i> GDM, preeclampsia, PTB, SGA, CD <i>Future health risks:</i> CVD, T2DM, HTN, PTB, SGA, maternal obesity	<i>Early complications:</i> stillbirth, macrosomia/SD, congenital anomalies, NICU admission, childhood obesity <i>Late complications:</i> T2DM, HTN
	Between 11 and 20 lb (adequate)	<i>Current pregnancy risks:</i> SAB, GDM, cardiac dysfunction, preeclampsia LGA, CD <i>Future health risks:</i> HTN	<i>Early complications:</i> stillbirth, macrosomia/SD, congenital anomalies, NICU admission, childhood obesity <i>Late complications:</i> none
	>20 lb (excessive)	<i>Current pregnancy risks:</i> GDM, HDP, cardiopulmonary morbidities, preeclampsia, eclampsia, LGA, CD <i>Future health risks:</i> post-partum weight retention, CVD, T2DM, HTN	<i>Early complications:</i> stillbirth, macrosomia/SD, congenital anomalies, neonatal death, NICU admission, childhood obesity <i>Late complications:</i> obesity, MS

BMI, body mass index; CD, cesarean delivery; CVD, cardiovascular disease; GDM, gestational diabetes mellitus; HDP, hypertensive disorders of pregnancy; HTN, hypertension; IOL, induction of labor; LGA, large for gestational age; MS, metabolic syndromes (hypertension, dyslipidemia, glucose intolerance); NICU, neonatal intensive care unit; PTB, preterm birth; SAB, spontaneous abortion; SD, shoulder dystocia; SGA, small for gestational age; T2DM, type 2 diabetes mellitus.

development of hypertension, dyslipidemia, and glucose intolerance.¹⁷

Insufficient Weight Gain

Gestational weight gain below guidelines is associated with small-for-gestational-age neonates.^{5,12,13} Maternal undernutrition and related insufficient gestational weight gain may create a “survival phenotype” for neonates with short- and long-term sequelae. Once birth occurs, these neonates compensate with excessive calories leading to rapid weight gain and early-onset childhood obesity. Offspring from pregnancies with insufficient maternal weight gain also have long-term adverse outcomes including impaired glucose and lipid metabolism in adolescence and an increased risk of adult-onset diabetes and hypertension.¹⁸

Role of Prepregnancy BMI

Abnormal prepregnancy BMI is itself a risk factor for adverse perinatal outcomes. A meta-analysis including almost 200,000 patients demonstrated that the risk of developing an adverse perinatal outcome (defined as ≥ 1 of the following: preeclampsia, gestational hypertension, gestational diabetes, cesarean delivery, preterm birth, small-for-gestational-age neonates, or large-for-gestational-age neonates) was strongly associated with prepregnancy BMI and weakly associated with gestational weight gain.¹⁹

Prepregnancy BMI: Obese

When compared with nonobese pregnant women, increasing gravida BMI corresponds to increasing risks of adverse outcomes irrespective of gestational weight gain. According to the meta-analysis, when the adverse outcomes were stratified by prepregnancy BMI, 61.1% of women with class 3 obesity (BMI ≥ 40) suffered adverse outcomes. Furthermore, women with the highest prepregnancy BMI (≥ 40) and with gestational weight gain ranging from 20 to 21.9 kg had the overall highest rate (94.4%) of adverse events.¹⁹ Obese women are also more likely to have maternal complications including cardiac dysfunction, gestational diabetes mellitus, hypertension, and preeclampsia.^{13,14,20} They are at increased risk to have fetal complications, including congenital anomalies, miscarriages, demise at any time from viability to infancy, macrosomia or impaired growth, neonatal intensive care unit (NICU) stay 48 hours or more, and in-hospital newborn mortality.^{14,21} Of note, maternal obesity is associated with a reduction in the risk of gastroschisis in offspring.¹⁴ Obese maternal BMI and maternal hyperinsulinemia may lead to increased nutrient transfer to the fetus, fetal hyperinsulinemia, and increased fetal growth.^{22,23} Intrapartum, women with obese prepregnancy BMI are at increased risk for cesarean delivery, infection, wound complications, and venous thrombosis. They are less likely to have a successful trial of labor after cesarean delivery and may experience up to 5 times the risk of neonatal injury.¹⁴

Prepregnancy BMI: Overweight

Women classified as overweight before pregnancy with high gestational weight gain had an increased risk (56.4%) of any adverse outcome as listed earlier.¹⁹ Overweight women who had excessive weight gain had increased risk of cesarean delivery, preeclampsia, eclampsia, cardiopulmonary morbidities, postpartum weight retention, and future cardiovascular disease.^{5,12,13} Women classified as overweight before pregnancy who had insufficient weight gain had increased risk of small-for-gestational-age neonates and an increased risk of preterm birth.⁵ Irrespective of gestational weight gain, overweight women have higher rates of hypertension, gestational diabetes, macrosomia, shoulder dystocia, and preeclampsia.^{20,21} Additionally, adverse neonatal outcomes such as stillbirth, NICU stay 48 hours or more, and in-hospital newborn mortality are associated with overweight maternal prepregnancy BMI.²¹

Prepregnancy BMI: Underweight

Irrespective of gestational weight gain, 34.7% of women with underweight prepregnancy BMI had an adverse outcome as listed earlier.¹⁹ Women classified as underweight before pregnancy with insufficient gestational weight gain had an increased risk (50.2%) of overall adverse perinatal outcomes.¹⁹ These women specifically had an increased risk of small-for-gestational-age neonates and an increased risk of preterm birth.⁵ Women with an underweight BMI before pregnancy with excessive weight gain had increased risk of cesarean delivery, eclampsia, cardiopulmonary morbidities, postpartum weight retention, and future cardiovascular disease.¹² Women classified as underweight before pregnancy who had adequate gestational weight gain were not found to be at increased risk of adverse outcomes.²⁴

Prepregnancy BMI: Normal Weight

Across all levels of gestational weight gain, 34.1% of women with normal prepregnancy BMI had an adverse outcome.¹⁹ Women classified as having a normal BMI before pregnancy who had insufficient weight gain had an increased risk of small-for-gestational-age neonates and an increased risk of preterm birth.^{5,24} Women with a normal BMI before pregnancy who had excessive weight gain had increased risk of cesarean delivery, preeclampsia, eclampsia, gestational diabetes, cardiopulmonary morbidities, postpartum weight retention, failed induction, large-for-gestational-age neonates, and future cardiovascular disease.^{12,13,24} Women classified in the normal BMI range who achieved recommended levels of gestational weight gain were not at increased risk of adverse outcomes.²⁴

Measuring Gestational Weight Gain

One of the biggest challenges in assessing adequate gestational weight gain are the evidence-practice gaps that exist in how to measure it. Different hospitals, and even different clinics within the same hospital system, have differing ways to measure gestational weight gain. Some hospitals measure total gestational weight gain, whereas others measure

incremental gestational weight gain. Without a standardized practice, it is difficult to assess the literature and apply findings to clinical practice.²⁵ Total gestational weight gain, as defined by the 2009 IOM guidelines,¹¹ is the amount of weight a pregnant woman gains between the time of conception and the onset of labor. However, obtaining an objectively measured weight at both conception and at the onset of labor can be difficult.²⁵

The American College of Obstetricians and Gynecologists (ACOG) recommends that a BMI should be calculated at the initial prenatal visit, using prepregnancy weight if known.^{14,26} If prepregnancy weight is not available, the initial prenatal visit weight may be used. From here, providers should use IOM guidelines to recommend appropriate weight gain.¹⁴

Role of Diet, Exercise, and Breastfeeding

During Pregnancy

Methods for optimizing gestational weight gain are under investigation. The most targeted modifiable maternal risk factors are unhealthy diet and sedentary behavior.²⁷ Previous research has shown that diet and physical activity-based interventions reduce excessive gestational weight gain and lower the odds of cesarean delivery.²⁸ Moderate aerobic exercise alone has been shown to also better control gestational weight gain and reduce the risk of gestational diabetes.²⁹ Aerobic training in pregnancy, particularly for overweight and sedentary women, improves women's cardiorespiratory capacity, which may be negatively impacted by pregnancy.³⁰ In addition to moderate exercise, frequent nutrition counseling sessions on a balanced diet focusing on healthier food choices and eating patterns also reduces gestational weight gain and postpartum weight retention.²⁹ When used in combination, lifestyle modifications such as dietary guidance, membership in fitness centers, physical training, and personal coaching result in higher adherence to the IOM guidelines.³¹ Until proven techniques are known, prioritizing conversations about recommended weight gain and improving weight measurement practices are essential in helping mothers achieve the IOM recommendations.

Before Pregnancy

Although healthy diet and exercise during pregnancy are certainly important, optimizing weight loss before pregnancy may help to prevent the outcomes associated with high prepregnancy BMI. ACOG endorses motivational interviewing as a successful method to promote weight loss, healthy dieting, and exercise before conception.¹⁴ Motivational interviewing involves an individualized and patient-centered approach to changing habits and when used in obese non-pregnant patients, has been shown to reduce weight.¹⁴ ACOG encourages preconception assessment of BMI status and subsequent counseling including information concerning maternal and fetal risks associated with increased BMI.³² The data presented in this article highlight the importance of routine counseling on healthy

BMI to achieve optimal pregnancy and long-term outcomes. If more women start pregnancy with BMIs within the normal range, adverse outcomes could be reduced.

Postpartum

Prenatal counseling about postpartum weight loss to achieve a healthy BMI helps set expectations and goals before delivery. This not only serves to mitigate later health outcomes associated with increased BMI, but also serves to ensure women are at a healthy BMI in the event of a future pregnancy. There have been conflicting data regarding the positive role of breastfeeding in postpartum weight loss.^{33,34} However, breastfeeding women do lose weight postpartum as part of the natural process of the energy cost of lactation.^{35,36}

Conclusion

Adverse pregnancy outcomes from insufficient and excessive maternal weight gain (summarized in Table 2) have remained prevalent over the 10+ years since the implementation of the 2009 IOM gestational weight gain guidelines. Data suggest that when adhered to, women who gain weight within the guidelines have the most optimal pregnancy outcomes. Counseling patients on achieving weight gain goals is made more difficult by the fact that the measurement of prepregnancy BMI is not standardized when a recent prepregnancy weight is not available. This review underscores the importance of achieving a normal prepregnancy BMI and then adhering to the recommended gestational weight gain to optimize pregnancy outcomes. Encouraging healthy habits before conception and bringing attention to IOM guidelines throughout prenatal care may reduce the risk of adverse maternal and neonatal outcomes related to abnormal gestational weight gain.

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Current Issue Highlights

Continuing Professional Development Quiz: Volume 41, Number 10

To earn CME credit, you must read the article and complete the quiz and evaluation on the enclosed answer form, answering at least seven of the 10 quiz questions correctly. **Select the best answer and use a blue or black pen to completely fill in the corresponding box on the enclosed answer form.** Please indicate any name and address changes directly on the answer form. If your name and address do not appear on the answer form, please print that information in the blank space at the top left of the page. Make a photocopy of the completed answer form for your own files and mail the original answer form in the enclosed postage-paid business reply envelope. Your answer form must be received by Lippincott CME Institute by **July 14, 2023**. Only two entries will be considered for credit. For more information, call (800) 638-3030.

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1. Which one of the following negative outcomes is associated with gestational weight gain that is below IOM guidelines in women with normal prepregnancy BMI?
 - A. Small-for-gestational-age neonates
 - B. Large-for-gestational-age neonates
 - C. Macrosomia
 - D. Cesarean delivery
2. Which one of the following negative outcomes is associated with gestational weight gain that exceeds IOM guidelines in patients with normal prepregnancy BMI?
 - A. Gastroschisis
 - B. Postpartum weight retention
 - C. Preterm birth
 - D. Small-for-gestational-age neonates
3. Which of the following statements regarding weight gain in pregnancy is *true*?
 - A. Weight gain in a woman's first pregnancy will not affect the outcomes of her second pregnancy.
 - B. Postpartum weight retention should not be discussed during prenatal care.
 - C. Excessive gestational weight gain is associated with increased risk of childhood obesity regardless of prepregnancy BMI.
 - D. With adequate gestational weight gain, an obese prepregnancy BMI is not associated with increased risk of childhood obesity.
4. All of the following negative outcomes are associated with gestational weight gain that exceeds IOM guidelines in patients with an overweight prepregnancy BMI, *except*
 - A. gestational diabetes mellitus
 - B. postpartum weight retention
 - C. spontaneous preterm birth
 - D. hypertensive disorders of pregnancy
5. Which one of the following negative outcomes is associated with inadequate gestational weight gain in patients with an obese prepregnancy BMI?
 - A. Small-for-gestational-age neonates
 - B. Large-for-gestational-age neonates
 - C. Shoulder dystocia
 - D. Eclampsia
6. Infants of mothers classified as obese before pregnancy have an increased risk of all of the following, *except*
 - A. childhood obesity
 - B. preterm birth
 - C. congenital anomalies
 - D. gastroschisis

Educational objective: 3
7. Which one of the following describes the recommended measurement of gestational weight gain according to the ACOG?
 - A. Calculate BMI at the first prenatal visit using the prepregnancy weight.
 - B. Calculate BMI at in the second trimester using the current pregnancy weight.
 - C. Calculate BMI at the first prenatal visit using the first prenatal visit weight.
 - D. It is not necessary to measure gestational weight gain.

Educational objective: 1
8. Physical activity-based interventions during pregnancy may reduce which one of the following?
 - A. Risk of hypertensive disorders of pregnancy
 - B. Gestational weight gain
 - C. Risk of preterm labor
 - D. Risk of NICU admission

Educational objective: 1
9. Motivational interviewing before pregnancy may promote all of the following, *except*
 - A. exercise
 - B. weight gain
 - C. weight loss
 - D. healthy dieting
10. Which one of the following statements regarding the 2009 IOM guidelines is *true*?
 - A. When adhered to, the 2009 IOM guidelines are associated with positive pregnancy outcomes.
 - B. The 2009 IOM guidelines restrict weight gain the most for overweight women.
 - C. Weight gain above IOM guidelines is not associated with negative neonatal and maternal outcomes.
 - D. There has been great success in ensuring women adhere to the 2009 IOM guidelines.