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INTERIM UPDATE

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Committee on Practice Bulletins—Obstetrics. This Practice Bulletin was developed by the Committee on Practice Bulletins–Obstetrics with the assistance of Patrick M. Catalano, MD and Gayle Olson Koutrouvelis, MD.

INTERIM UPDATE: The content in this Practice Bulletin has been updated as highlighted (or removed as necessary) to reflect limited, focused changes to align with ACOG Committee Opinion No. 828, *Indications for Outpatient Antenatal Fetal Surveillance*, to provide additional information on cell-free DNA screening in this population, and to provide additional recommendations for pregnant patients with a body mass index of 50 or greater.

Obesity in Pregnancy

Obstetrician–gynecologists are the leading experts in the health care of women, and obesity is the most common medical condition in women of reproductive age. Obesity in women is such a common condition that the implications relative to pregnancy often are unrecognized, overlooked, or ignored because of the lack of specific evidence-based treatment options. The management of obesity requires long-term approaches ranging from population-based public health and economic initiatives to individual nutritional, behavioral, or surgical interventions. Therefore, an understanding of the management of obesity during pregnancy is essential, and management should begin before pregnancy and continue through the postpartum period. Although the care of the obese woman during pregnancy requires the involvement of the obstetrician or other obstetric care professional, additional health care professionals, such as nutritionists, can offer specific expertise related to management depending on the comfort level of the obstetric care professional. The purpose of this Practice Bulletin is to offer an integrated approach to the management of obesity in women of reproductive age who are planning a pregnancy.

Background

Epidemiology

Incidence and Trends

Obesity is commonly classified based on body mass index (BMI), defined as weight in kilograms divided by height in meters squared (kg/m^2). The World Health Organization organizes BMI ranges into six categories to define underweight, normal weight, overweight, and obesity (classes I, II, and III, Table 1) (1). Based on the 2017-2018 National Health and Nutrition Examination Survey, the prevalence of obesity in women of reproductive age (20–39 years) in the United States is 39.7% (2).

From 1999 to 2010, the prevalence of obesity increased from 28.4% to 34.0% in women aged 20–39 years, with a higher prevalence in non-Hispanic black and Mexican American women (3). From 1999-2000

Table 1. World Health Organization Body Mass Index Categories

Category	BMI*
Underweight	Less than 18.5
Normal weight	18.5–24.9
Overweight	25.0–29.9
Obesity class I	30.0–34.9
Obesity class II	35.0–39.9
Obesity class III	40 or greater

BMI, body mass index.

*Weight in kilograms divided by height in meters squared (kg/m^2)

Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 2000;894:i-xii, 1–253.

through 2017-2018, the overall prevalence of obesity and severe obesity (defined as a BMI greater than or equal to 40) increased in the United States, but the observed increase in the prevalence of obesity and severe obesity between 2015-2016 and 2017-2018 was not significant (2). The prevalence of obesity was lowest among non-Hispanic Asian women (17.2%) compared with non-Hispanic White (39.8%), Hispanic (43.7%), and non-Hispanic black (56.9%) women (2).

Effects on Pregnancy

Pregnancy Loss

There is an increased risk of spontaneous abortion (odds ratio [OR], 1.2; 95% confidence interval [CI], 1.01–1.46) and recurrent miscarriage (OR, 3.5; 95% CI, 1.03–12.01) in obese women compared with age-matched controls (4). Obese women are at increased risk of pregnancies affected by neural tube defects; hydrocephaly; and cardiovascular, orofacial, and limb reduction anomalies (5). In a systematic review and meta-analysis, an increase in certain congenital anomalies was noted in the offspring of obese women compared with nonobese women (Table 2). The risk of gastroschisis in the neonates among obese gravidas, however, was significantly reduced (OR, 0.17; 95% CI, 0.10–0.30) (5).

Antepartum Complications

Compared with normal-weight women, obese women are at increased risk of cardiac dysfunction, proteinuria, sleep apnea, nonalcoholic fatty liver disease (6), gestational diabetes mellitus (7), and preeclampsia (8). Obese gravidas are at an increased risk for stillbirth (9). Pregnant women who have undergone bariatric surgery should be evaluated for nutritional deficiencies and the need for vitamin supplementation when indicated.

Table 2. Increases in Congenital Anomalies in Obese Versus Nonobese Gravidas

Congenital Anomaly	Increased Risk
Neural tube defects	OR, 1.87; 95% CI, 1.62–2.15
Spina bifida	OR, 2.24; 95% CI, 1.86–2.69
Cardiovascular anomalies	OR, 1.30; 95% CI, 1.12–1.51
Septal anomalies	OR, 1.20; 95% CI, 1.09–1.31
Cleft palate	OR, 1.23; 95% CI, 1.03–1.47
Cleft lip and palate	OR, 1.20; 95% CI, 1.03–1.40
Anorectal atresia	OR, 1.48; 95% CI, 1.12–1.97
Hydrocephaly	OR, 1.68; 95% CI, 1.19–2.36
Limb reduction anomalies	OR, 1.34; 95% CI, 1.03–1.73

Abbreviations: CI, confidence interval; OR, odds ratio.

Data from 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;301:636–50.

Although the absolute risk of stillbirth is low, an increase of roughly 1 and 1.9 per 1,000 is seen in overweight and obese women, respectively (9). The risk of stillbirth rises with increasing obesity; after controlling for characteristics including maternal age, nulliparity, and comorbid conditions, the hazard ratio for stillbirth is 1.71 for prepregnancy BMI 30.0–34.9, 2.00 for BMI 35.0–39.9, 2.48 for BMI greater than 40, and 3.16 for women with BMI 50, compared with women with BMI less than 30 (10). Black pregnant patients with obesity experienced even more stillbirths than White pregnant patients with obesity (adjusted hazard ratio, 1.9; 95% CI, 1.7–2.1 compared with adjusted hazard ratio, 1.4; 95% CI, 1.3–1.5) (9). Although race is not a biologic risk factor for stillbirth, it is likely a proxy for the negative influence of racism on health (11). Race is a social rather than a biological construct and the effects of racism (structural, institutionalized, and interpersonal) and biases (implicit and explicit) are implicated in many health inequities; these are more likely than race to be related to elevated risk (12, 13). In a retrospective cohort study that included more than 2.8 million women, the association of BMI during pregnancy with stillbirth was investigated. Between 30 weeks and 42 weeks of gestation, increasing obesity significantly contributed to stillbirth at each increasing gestational age interval studied. Particularly in the obesity class III group and the group of women who had a BMI of at least 50, the adjusted hazard ratio for stillbirth was 1.40 and 1.69 at 30–33 weeks of gestation, increasing to 3.20 and 2.95 at 37–39 weeks of gestation and 3.30 to 8.95 at 40–42 weeks of gestation, respectively. In addition, an analysis of increasing gestation by week stratified by BMI class showed that when compared with normal-weight pregnant women, women with a BMI of at least 50 had a 5.7-fold and 13.6-fold greater risk of stillbirth at 39 weeks and 41 weeks of gestation, respectively (10).

In a systematic review and meta-analysis, the relative risk for each 5-unit increase in maternal BMI in overweight and obese pregnant women, compared with normal-weight pregnant women, was 1.21 for fetal death (95% CI, 1.09–1.35), 1.24 for stillbirth (95% CI, 1.18–1.30), 1.16 for perinatal death (95% CI, 1.00–1.35), 1.15 for neonatal death (95% CI, 1.07–1.23), and 1.18 for infant death (95% CI, 1.09–1.28). Absolute risks are shown in Table 3 (14).

Intrapartum Complications

Although obesity is associated with indicated preterm birth, the data conflict as to whether a similar association

Table 3. Absolute Risks Per 10,000 Pregnancies for Body Mass Index Categories 20, 25, and 30

	Maternal BMI		
	20	25	30
Fetal death	76	82 (95% CI, 76–88)	102 (95% CI, 93–112)
Stillbirth	40	48 (95% CI, 46–51)	59 (95% CI, 55–63)
Perinatal death	66	73 (95% CI, 67–81)	86 (95% CI, 76–98)
Neonatal death	20	21 (95% CI, 19–23)	24 (95% CI, 22–27)
Infant death	33	37 (95% CI, 34–39)	43 (95% CI, 40–47)

Abbreviations: BMI, body mass index; CI, confidence interval.

Data from 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;311:1536–46.

exists for spontaneous preterm birth (15–17). Obese pregnant women are at increased risk of cesarean delivery, failed trial of labor, endometritis, wound rupture or dehiscence, and venous thrombosis (18, 19). Obese gravidas undergoing a trial of labor after a previous cesarean delivery have an almost twofold increase in composite maternal morbidity and a fivefold increased risk of neonatal injury (18).

Postpartum Complications and Long-Term Outcomes

Obesity-related complications during pregnancy are associated with future metabolic dysfunction in these women. Forty-six percent of obese pregnant women have gestational weight gain in excess of the Institute of Medicine (IOM) pregnancy weight gain guidelines (20). Excess gestational weight gain is a significant risk factor for postpartum weight retention. This further increases the risk of metabolic dysfunction and pregravid obesity in future pregnancies. Pregravid obesity is associated with early termination of breastfeeding, postpartum anemia, and depression (21–23).

Fetal Complications and Childhood Morbidities

Fetuses of obese gravidas are at increased risk of macrosomia and impaired growth (24, 25). Likewise, infants of obese women tend to have more body fat than infants of normal-weight women. Long-term risks for the offspring of obese women include an increased risk of metabolic syndrome (26) and childhood obesity (27). The risk of childhood obesity in the offspring of obese women persists even after adjustment for complications, such as gestational diabetes mellitus (28). In a large Scandinavian study, higher maternal BMI was associated with an increased risk of childhood asthma (29). Maternal obesity also has been linked to altered behavior in the offspring, including an increased risk of autism spectrum disorders, childhood developmental delay, and attention-deficit/hyperactivity disorder (30). As compelling as these data may seem, it is impossible to separate different prenatal and postnatal influences on outcomes in the offspring of obese women. Family socioeconomic issues, behavior, activity, and diet often are considered as confounding factors in the analysis of metabolic outcomes in the offspring of obese women and limit the interpretation and generalizability of these results (31).

Facilities and Equipment Considerations

Accommodation of the physical needs of obese pregnant women is necessary in inpatient and outpatient settings. For labor and delivery, birthing beds capable of supporting an obese gravida for a vaginal delivery with appropriate monitoring equipment should be available. Other common requirements include large chairs, blood pressure cuffs, and wheelchairs (32). Increase in equipment size necessitates increased storage space and number of staff to safely assist patients. Because of the increased need for emergency cesarean delivery in obese pregnant women, doorways and hallways must be spacious enough to accommodate large beds and the additional staff needed to move patients safely. Operating rooms equipped with motorized lifts will make it easier to assist the obese patient onto the operating table (33). These rooms should have sufficient space to allow staff to move safely and efficiently (34). The operating table should accommodate the size and weight of the patient, or two tables joined together may be required. Operating tables typically accommodate 205 kg (450 lb), although some tables can accommodate 455 kg (1,000 lb). The setup should allow the surgeon adequate maneuverability during the surgical procedure, provide protection on patient pressure areas to avoid neural injuries and pressure sores, and ensure availability of secure belts and gel pads to prevent movement of the patient on the table (35). Although there is no consensus on the optimal positioning of the obese gravida at the time of cesarean delivery (36), the operating tables should be able to accommodate various positions to the satisfaction of anesthesia and obstetric staff, as well as patient safety. Long instruments may be necessary to facilitate the surgeon's access to proper tissue planes.

Clinical Considerations and Recommendations

▶ *Are there interventions for the management of obesity before and during pregnancy?*

Optimal control of obesity begins before pregnancy. Weight loss before pregnancy, achieved by surgical or nonsurgical methods, has been shown to be the most effective intervention to improve medical comorbidities (37, 38). Because even small weight reductions before pregnancy in women with obesity may be associated with improved pregnancy outcomes, weight loss before pregnancy should be encouraged. Motivational interviewing has been used successfully within the clinical setting to promote weight loss, dietary modification, and exercise (39, 40). Motivational interviewing techniques involve an individualized, patient-centered approach toward exploring and resolving ambivalence. The goal of motivational interviewing is to help patients move through the stages of dealing with unhealthy behavior. In a review of randomized trials using motivational interviewing for obese nonpregnant patients, a significant decrease in weight and a nonsignificant decrease in BMI was achieved (41). Although achieving a normal BMI is the ideal, a weight loss of 5–7% over time can significantly improve metabolic health (40). The U.S. Preventive Services Task Force recommends that all adults aged 18 years and older with a BMI of 30 or greater be offered or referred to intensive multicomponent behavior interventions for weight loss and weight loss maintenance 42).

Medications for weight management are not recommended during the prepregnancy time or during pregnancy because of safety concerns and adverse effects (43, 44). These types of drugs include typical anorectics, which alter the release and reuptake of neurotransmitters that suppress appetite, and other drugs that decrease intestinal fat absorption by inhibiting pancreatic lipase. Metformin, which is used to treat type 2 diabetes, decreases hepatic glucose production and has been associated with decreased gestational weight gain in some studies when used to treat mild gestational diabetes (45). In pregnant patients who are overweight or obese but do not have diabetes, metformin in addition to diet and lifestyle advice starting at 10–20 weeks did not improve pregnancy or birth outcomes (46).

The primary weight management strategies during pregnancy are dietary control, exercise, and behavior modification. These strategies have been used either alone (47–49) or in combination (50, 51) to avoid excessive gestational weight gain. In at least one study, general dietary strategies appeared to be more useful than exercise in avoiding excessive gestational weight gain in pregnancy (52). Some studies on diet have examined the role of foods with a low glycemic index (47), whereas others have employed probiotic interventions (53). A recent meta-analysis that included 49 randomized trials and 11,444 women analyzed interventions to prevent excessive gestational weight gain. The interventions in this review included diet only, low-glycemic or low-caloric diets, diet plus exercise, and exercise only. The exercise varied and was supervised in some cases and unsupervised in others. Interventions reduced the risk of excessive gestational weight gain by 20% compared with control groups (54). There was no clear difference between intervention versus no intervention for cesarean delivery overall (relative risk, 0.95; 95% CI, 0.88–1.03), although the effect estimate showed a 5% difference in favor of the interventions. There was no difference between the groups for preterm delivery or macrosomia, however, in a subgroup analysis of overweight and obese women, the interventions decreased the risk of macrosomia by 15% (54, 55).

▶ *What are the recommendations for weight gain in pregnancy for overweight and obese women?*

Gestational weight gain recommendations aim to optimize outcomes for the pregnant woman and her infant. At the initial prenatal visit, prepregnancy weight and height should be recorded for all women to allow calculation of BMI. If the prepregnancy weight is unknown, the initial prenatal visit weight is recorded. Body mass index calculated at the first prenatal visit should be used to provide diet and exercise counseling guided by IOM recommendations for gestational weight gain during pregnancy.

The IOM guidelines recommend a total weight gain of 6.8–11.3 kg (15–25 lb) for overweight pregnant women (BMI of 25–29.9) (20, 56). Given the limited data on pregnancy weight gain by obesity class, the IOM recommendation for weight gain is 5.0–9.1 kg (11–20 lb) for all obese women (Table 4).

Citing a lack of sufficient data regarding short-term and long-term maternal and newborn outcomes, the IOM report did not recommend lower targets for pregnant women with more severe degrees of obesity (20, 56). Gestational weight gain below the IOM recommendations among overweight pregnant women has been noted

Table 4. **Recommendations for Total and Rate of Weight Gain during Pregnancy by Pregnancy Body Mass Index**

Prepregnancy Weight Category	Body Mass Index*	Recommended Range of Total Weight Gain (lb)	Recommended Rates of Weight Gain† in the Second and Third Trimesters (lb) (Mean Range [lb/wk])
Underweight	Less than 18.5	28–40	1 (1–1.3)
Normal weight	18.5–24.9	25–35	1 (0.8–1)
Overweight	25–29.9	15–25	0.6 (0.5–0.7)
Obese (includes all classes)	30 and greater	11–20	0.5 (0.4–0.6)

*Body mass index is calculated as weight in kilograms divided by height in meters squared or as weight in pounds multiplied by 703 divided by height in inches

†Calculations assumed a 1.1-4.4 lb weight gain in the first trimester

Modified from Institute of Medicine (US). Weight gain during pregnancy: reexamining the guidelines. Washington DC. National Academies Press; 2009. Copyright 2009 National Academy of Sciences.

to have varying effects on fetal growth and neonatal outcomes (57). Among extremely obese women with weight loss or restricted weight gain during pregnancy, the risk of a small-for-gestational-age (SGA) infant contrasts with perceived benefits, such as a decrease in the rate of cesarean delivery, decreased risk of a large-for-gestational-age infant, and postpartum weight retention. One study using data from the Centers for Disease Control and Prevention Pregnancy Nutrition Surveillance System assessed the association of gestational weight gain and prevalence of SGA at birth with class of obesity. Prepregnancy BMI was used for selection of obesity class as follows: class I, BMI 30.0–34.9; class II, BMI 35.0–39.9; and class III, BMI of at least 40.0. For women with class I obesity, no weight gain or weight loss up to 4.9 kg (11 lb) was associated with an increased risk of SGA (adjusted OR, 1.2; 95% CI, 1.24–2.12) (58). A later study of inadequate weight gain (no more than 5 kg [11 lb] versus more than 5 kg [11 lb]) in overweight and obese women showed similar findings. The neonates of women who gained no more than 5 kg (11 lb), compared with women who gained more than 5 kg (11 lb), were more likely to be SGA (9.6% versus 4.9% [adjusted OR, 2.6; 95% CI, 1.4–4.7; $P=.003$]), have lower birth weight, smaller length, lower lean and fat mass, and smaller head circumference (59). Finally, a systematic review focused on outcomes in obese women with gestational weight loss identified increased risk of SGA below the 10th percentile (adjusted OR, 1.76; 95% CI, 1.45–2.14) and 3rd percentile (adjusted OR, 1.62; 95% CI, 1.19–2.20) (60). Collectively, these reports indicate that inadequate weight gain and gestational weight loss should not be encouraged for obese pregnant women.

▶ ***How should antepartum care be altered for the obese patient?***

Antenatal Diagnosis of Congenital Anomalies

Obese women have an increased risk of fetal structural congenital anomalies (5). Detection of congenital anomalies by ultrasonography is significantly reduced with increasing maternal BMI ($P<.001$, test for trend) (Table 5). Obese women should be counseled about the limitations of ultrasound in identifying structural anomalies.

One retrospective cohort study examined ultrasound images for pregnant women at 18–24 weeks of gestation who underwent either standard or targeted ultrasonography (61). Detection of anomalous fetuses decreased with increasing maternal BMI by at least 20% in obese women compared with normal-weight women. Potential means to optimize ultrasonographic image quality in obese pregnant women include a vaginal approach (62) in the first trimester or using the maternal umbilicus as an acoustic window, as well as tissue harmonic imaging (63, 64). Fetal magnetic resonance imaging obviates many of these technical problems, but because its use is limited by cost and availability, magnetic resonance imaging is not recommended for routine screening (65).

A secondary analysis of the First- and Second-Trimester Evaluation of Risk for aneuploidy trial evaluated the effect of BMI on the ultrasonographic detection of fetal structural anomalies and soft markers for aneuploidy (66). Only the detection of increased nuchal fold, echogenic bowel, and echogenic cardiac focus as markers for aneuploidy were not altered by BMI. When two or more markers were evaluated, a lower sensitivity with an elevated false-negative rate and missed-diagnosis rate were observed in obese women compared with

Table 5. Detection of Fetal Anomalies

Body Mass Index	Standard Ultrasonography	Targeted Ultrasonography
Normal (less than 25)	66%	97%
Overweight (25-29.9)	49%	91%
Class I obesity (30-34.9)	48%	75%
Class II obesity (35-39.9)	45%	88%
Class III obesity (40 or more)	22%	75%

Data from Dashe JS, McIntire DD, Twickler DM. Effect of maternal obesity on the ultrasound detection of anomalous fetuses. Obstet Gynecol 2009;113:1001–7.

normal-weight women (22% sensitivity and 78% false-negative rate versus 32% sensitivity and 68% false-negative rate, respectively). The detection rate for cardiac anomalies among women with a BMI less than 25 was higher (21.6%), with a significantly lower false-positive rate (78.4% [95% CI, 77.3–79.5%]) in comparison with obese women (8.3%) with a higher false-positive rate (91.7% [95% CI, 90.1–92.2%]). In an additional analysis using a logistic regression model, maternal obesity significantly decreased the likelihood of ultrasonographic detection of common anomalies (adjusted OR, 0.7; 95% CI, 0.6–0.9; $P=.001$) (66). Maternal obesity also affects measures of serum analytes because of the increased plasma volume in obese pregnant women. Although weight adjustment for analytes improves detection of neural tube defects and trisomy 18, this adjustment does not improve detection of Down syndrome (65).

Cell-free DNA test failures are seen more frequently in patients with obesity (67). Accurate cell-free DNA screening requires a minimum fetal fraction, most commonly estimated at about 2–4%. The median fetal fraction obtained between 10 and 14 weeks of gestation is around 10%; however, increasing BMI is associated with decreased fetal fraction. In patients who weigh more than 250 pounds (113 kg), 10% may have a fetal fraction of less than 4% (68–70). Patients whose cell-free DNA screening test results are not reported by the laboratory or are uninterpretable (a no call test result) should be informed that test failure is associated with an increased risk of genetic conditions, should receive further genetic counseling, and be offered comprehensive ultrasound evaluation and diagnostic testing. Although repeat screening may be considered in the setting of a sample drawn at an early gestational age or a specific concern regarding sample characteristics, because repeat sampling delays a diagnostic test, it is not advised if screening results are consistent with sonographic anomalies, or if a patient is at a gestational age at which the delay may compromise their reproductive options. The success of repeat sampling after a test failure in a general screening population is 75–80%; it is substantially lower in patients with obesity (71–73).

Metabolic Disorders of Pregnancy

Women with obesity are at increased risk of metabolic syndrome. Increased insulin resistance during pregnancy may cause preexisting but subclinical cardiometabolic dysfunction to emerge as preeclampsia, gestational diabetes, and obstructive sleep apnea (OSA) (74). These complications are associated with adverse pregnancy outcomes (75–77). Obese pregnant women should be screened for glucose intolerance and OSA at the first antenatal visit with history, physical examination, and laboratory and clinical studies, as needed.

Women with suspected OSA (snoring, excessive daytime sleepiness, witnessed apneas, or unexplained hypoxia) should be referred to a sleep medicine specialist for evaluation and possible treatment (78). If OSA is confirmed, or for pregnant women with known OSA, evaluation by a sleep medicine expert is recommended for management based on the severity of symptoms and level of impairment.

Compared with women without OSA, women with OSA are more likely to experience preeclampsia (adjusted OR, 2.5; 95% CI, 2.2–2.9), eclampsia (adjusted OR, 5.4; 95% CI, 3.3–8.9), cardiomyopathy (adjusted OR, 9.0; 95% CI, 7.5–10.9), pulmonary embolism (adjusted OR, 4.5; 95% CI, 2.3–8.9), and in-hospital mortality (adjusted OR, 5.28; 95% CI, 2.45–11.53) (79). Studies evaluating the effects of OSA on fetal growth, early delivery, or stillbirth are inconclusive because of small sample size, observation designs, and incomplete ascertainment of maternal comorbid conditions (78–80).

All pregnant patients should be screened for gestational diabetes mellitus based upon medical history, clinical risk factors, or laboratory screening test results to determine blood glucose levels. Routine screening generally is performed at 24–28 weeks of gestation. Early pregnancy screening for glucose intolerance (gestational diabetes or overt diabetes) should be based on risk factors (81). If the initial early diabetes screening result is negative, a repeat diabetes screening generally is performed at 24–28 weeks of gestation (81).

Stillbirth and Antenatal Fetal Surveillance

Obesity in pregnancy is associated with an increased risk of early fetal loss and stillbirth (6). For patients with prepregnancy BMI of 35.0–39.9, weekly antenatal fetal surveillance may be considered beginning by 37 0/7 weeks of gestation. For patients with prepregnancy BMI 40 or greater, weekly antenatal fetal surveillance may be considered beginning at 34 0/7 weeks of gestation (11).

▶ *How might intrapartum care be altered for the obese patient?*

Numerous studies report an increased risk of cesarean delivery among overweight and obese women compared with normal-weight women. One meta-analysis showed that the unadjusted odds ratios for cesarean delivery are 1.46 (95% CI, 1.34–1.60), 2.05 (95% CI, 1.86–2.27), and 2.89 (95% CI, 2.28–3.79) among overweight, obese, and severely obese women, respectively, compared with normal-weight women (19). Maternal obesity alone is not an indication for induction of labor (82); however, obese women are at increased risk of a prolonged pregnancy and have an increased rate of labor induction (83).

Increasing maternal BMI, particularly for the nulliparous woman, has been associated with longer labor (84). In a study that adjusted for maternal height, labor induction, membrane rupture, oxytocin use, epidural anesthesia use, net maternal weight gain, and fetal size, the median duration of labor from 4 cm to 10 cm of cervical dilation was significantly longer in overweight and obese women (85). Another study found that increasing maternal BMI was not associated with longer second stage of labor (86). Allowing a longer first stage of labor before performing cesarean delivery for labor arrest should be considered in obese women. Although some data indicate an inverse relationship between prepregnancy BMI and success rates for vaginal birth after cesarean delivery, this has not been demonstrated in all studies (87). One study demonstrated no association between obesity and vaginal birth after cesarean success rates (88). Another study noted that pregnant women with class III obesity undergoing a trial of labor after previous cesarean delivery had greater rates of composite morbidity (prolonged hospital stay, endometritis, rupture or dehiscence) and neonatal injury (fractures, brachial plexus injuries, and lacerations) compared with women with class III obesity who had elective repeat cesarean delivery, but the absolute frequency of morbidities was low (18). Pregnant patients with a higher BMI have higher rates of complications with an elective repeat cesarean delivery as well as with a trial of labor after cesarean. Obesity is not a contraindication to labor after cesarean: the decision to undergo after cesarean depends on the patient's preferences, and such a decision should rely on tenets of shared medical decision making (89).

Compared with normal-weight pregnant women, pregnant women with class III obesity have a significantly increased risk of postpartum atonic hemorrhage (bleeding greater than 1,000 mL) after a vaginal delivery (5.2%) but not after cesarean delivery (90).

▶ *What are the operative and perioperative considerations in labor and delivery for the obese patient?*

Maternal obesity presents challenges associated with management of anesthesia as well as increased risk of complicated and emergent cesarean deliveries. For these reasons, an anesthesia consultation for the obese gravida should be obtained before labor or in early labor to allow adequate time to develop an anesthetic plan that addresses the availability of proper equipment for blood pressure monitoring, venous access, and the influence of comorbid conditions such as sleep apnea (34, 91). Consultation with anesthesia service should be considered for obese pregnant women with OSA because they are at an increased risk of hypoxemia, hypercapnia, and sudden death. Development of a preoperative and postoperative protocol for management of these patients may be of benefit (78). Factors to consider in this planning include use of epidural or spinal anesthesia, antibiotics, and choice of incision.

Epidural or Spinal Anesthesia

The use of epidural or spinal anesthesia for intrapartum pain relief is recommended but may be technically difficult because of body habitus and loss of landmarks. The risk of epidural analgesic failure is greater in obese women compared with normal-weight and overweight women (92); therefore, early labor epidural catheter placement should be considered after discussing risks and benefits with the patient. Epidural catheters placed for labor may reduce the decision-to-incision interval for an emergency cesarean delivery. At term, pregnant women with class III obesity have significantly greater hypotension and prolonged fetal heart rate decelerations, after controlling for epidural bolus dose and hypertensive disorders, compared with normal-weight pregnant women (93). The combination of spinal anesthesia and obesity significantly impairs respiratory function for up to 2 hours after the procedure (94). General anesthesia also poses a risk for obese pregnant women because of potential difficulties with endotracheal intubation due to excessive tissue and edema (95). General anesthesia is not contraindicated in obese pregnant women, but consideration should be given to preoxygenation, proper patient positioning, and having fiberoptic equipment available for intubation (96).

Antibiotics

Broad-spectrum antimicrobial prophylaxis is recommended for all cesarean deliveries unless the patient is already receiving antibiotics for conditions such as chorioamnionitis. For obese women undergoing cesarean delivery, consideration may be given to using a higher preoperative antibiotic dose for surgical prophylaxis. Some recommendations based on general surgical procedures would suggest a 2-g prophylactic cefazolin dose for women who weigh more than 80 kg (175 lb), with an increase to 3 g for those who weigh more than 120 kg (265 lb) (35, 97). Few studies have specifically addressed the question of weight-based dosage for antibiotic prophylaxis at the time of cesarean delivery. In a study of normal-weight, overweight, and obese women who received 2 g of cefazolin 30–60 minutes before skin incision, drug concentrations in adipose tissue were inversely proportional to BMI. In obese and extremely obese patients, adipose tissue concentrations of cefazolin were obtained. At the time of skin incision, concentrations were less than 4 micrograms/g of tissue, the minimally inhibitory concentration for gram-negative rods, in 20% and 33% of obese and severely obese patients, respectively; at skin closure, concentrations reached these levels in 20% and 44% of patients, respectively (98). A double-blind randomized controlled trial of women with BMI of 30 or greater randomized antibiotic dosage to 2 g or 3 g cefazolin; adipose tissue concentrations did not significantly differ between the two dosage strategies, and thus, this trial did not support the use of the 3-g dose (99). Conclusive recommendations for weight-based dosage are difficult to establish because of a lack of evidence demonstrating different adipose tissue concentrations or decreased surgical site infections with higher dosage strategies in an obese cohort. See ACOG Practice Bulletin No. 199, *Use of Prophylactic Antibiotics in Labor and Delivery*, for additional information.

Incision

The optimal skin incision for primary cesarean delivery in class II and III obese patients has not been determined. One study, using data from a perinatal database, reported that a vertical skin incision was associated with a higher rate of wound complications compared with a transverse incision (100). The relationship between skin incision and the development of wound complications in women with class III obesity was evaluated in a secondary analysis of the Maternal–Fetal Medicine Units Network cesarean registry. A univariate analysis using a composite of wound complications (infection, seroma, hematoma, wound evisceration, and facial dehiscence) showed that patients with a vertical skin incision had a significantly higher rate of wound complications; after adjustment for confounding factors, vertical incision was associated with a significantly lower risk of wound complications (101). The discrepancy was most likely because of selection bias and the observational nature of the study. Other reports on obese women with a large panniculus have reported favorable outcomes with a supraumbilical incision (102). Closure of the subcutaneous tissue with a depth greater than 2 cm can significantly decrease the incidence of wound disruption (103). However, the use of a subcutaneous drain with bulb suction in obese women with at least 4 cm of subcutaneous fat was not effective in preventing wound complications and may have potentiated postcesarean wound complications (104). Subcutaneous drains increase the risk of postpartum cesarean wound complications and should not be used routinely. Preoperative skin cleansing before cesarean delivery with an alcohol-based solution should be performed unless contraindicated (105). A reasonable choice is a chlorhexidine–alcohol skin preparation. Vaginal cleansing before cesarean delivery in laboring patients and those with ruptured membranes using either povidone–iodine or chlorhexidine gluconate may be considered (106). Skin closure techniques and supplemental oxygen have not proved useful in decreasing the rate of postcesarean infectious morbidity (107, 108).

▶ *How should postpartum care be altered for the obese patient?*

Obesity is a risk factor for venous thromboembolism in the general medical population (109). In a nested case–control study in Denmark of more than 71,000 women, obesity in early pregnancy was associated with an increased risk of venous thromboembolism (adjusted OR, 5.3; 95% CI, 2.1–13.5). The odds ratio was adjusted for age, parity, clomiphene citrate stimulation, and diabetes (110). Because of the increased risk of venous thromboembolism in obese women, it is recommended that pneumatic compression devices be placed before a cesarean delivery and continued postpartum for all women not already receiving thromboprophylaxis (111). However, cesarean delivery in the emergency setting should not be delayed by the time it takes to implement thromboprophylaxis (111). Mechanical thromboprophylaxis is recommended before cesarean delivery, if possible, as well as after cesarean delivery. In addition to the use of pneumatic compression devices, the American College of Chest Physicians recommends early mobilization after cesarean delivery for women without additional risks (112).

For prevention of venous thromboembolism in very-high-risk groups, pharmacologic thromboprophylaxis should be considered in addition to pneumatic compression devices (109, 112). Increasing obesity, immobility, preeclampsia, fetal growth restriction, infection, and emergency cesarean delivery are among the conditions noted to increase the risk of venous thromboembolism (112). The American College of Chest Physicians currently recommends low-molecular-weight (LMW) heparin for the prevention and treatment of venous thromboembolism instead of unfractionated heparin

(112). The optimal prophylactic dose of LMW heparin has not been determined, but enoxaparin 40 mg daily is commonly used (112). A prospective sequential cohort study compared venous thromboembolism prophylaxis using weight-based with BMI-stratified dosage regimens. Venous thromboembolism prophylaxis was started 12 hours after cesarean delivery using weight-based (0.5 mg/kg enoxaparin every 12 hours) dosage or BMI-stratified (BMI of 40–59.9 received enoxaparin 40 mg every 12 hours and BMI of 60 or greater received enoxaparin 60 mg every 12 hours) dosage. The primary outcome was anti-Xa concentrations in the adequate thromboprophylaxis range (0.2–0.6 international units/mL). Anti-Xa concentrations were significantly higher in the weight-based group. Given this, weight-based dosage for venous thromboembolism thromboprophylaxis may be considered rather than BMI-stratified dosage strategies in class III obese women after cesarean delivery (111, 113).

In a retrospective study of 2,492 cesarean deliveries, the risk of surgical site infection after cesarean delivery was 18.4%. The risk of surgical site infection after cesarean delivery was highest among obese women, with an odds ratio of 1.43 (95% CI, 1.09–1.88) after adjustment for diabetes and emergent or elective cesarean delivery (114). Compared with normal-weight women, there is an increased risk of surgical site infections after a cesarean delivery in women who are overweight (OR, 1.6; 95% CI, 1.2–2.2), obesity class I (OR, 2.4; 95% CI, 1.7–3.4), and obesity class II and III (OR, 3.7; 95% CI, 2.6–5.2) (115). Management of surgical site infection after cesarean delivery may include antibiotics, exploration, and debridement (116). If the surgical site infection appears superficial and without purulent drainage, conservative therapy with antibiotics alone may be considered; however, deep surgical site infection may require wound exploration and debridement (116). The resulting open wound can be managed by secondary closure, secondary intention with dressings, and secondary intention using negative pressure wound therapy. Strategies in nonpregnant patients with surgical site infection after laparotomy, including secondary closure or the addition of negative pressure wound therapy to the wound, were associated with improved healing times compared with allowing closure by secondary intention alone (116, 117).

▶ *What are effective postpartum care and interpregnancy strategies for weight loss before the next pregnancy?*

Weight loss between pregnancies in obese women has been shown to decrease the risk of a large-for-gestational-age infant (adjusted OR, 0.61; 95% CI, 0.52–0.73), whereas interpregnancy weight gain has been associated with an increased risk of having a large-for-gestational-age infant (adjusted OR, 1.37; 95% CI, 1.21–1.54) (118).There was no increased risk of a small-for-gestational-age infant unless there was maternal weight loss of more than 8 BMI units (118). The interpregnancy interval in women who lost weight in this study was longer than for those who gained weight between pregnancies. Contraceptive counseling is important with this patient population (119).

The U.S. Preventive Services Task Force recommends weight loss interventions for all adults with obesity (42), and interpregnancy weight loss in obese women may decrease the risk of a large-for-gestational-age neonate in a subsequent pregnancy. Therefore, all women with obesity should be provided with or referred for behavioral counseling interventions focused on improving diet and exercise, in order to achieve a healthier weight before another pregnancy.

Excessive gestational weight gain is associated with short-term and long-term postpartum weight retention (120). In a meta-analysis of the influence of gestational weight gain on postpartum weight retention in studies that included more than 65,000 women, those with a gestational weight gain above the IOM recommendations retained 3.06 kg (6.75 lb) (95% CI; 1.50, 4.63 kg) after 3 years and 4.72 kg (10.41 lb) (95% CI; 2.94, 6.50 kg) after 15 years or more compared with those who gained weight within the recommendations (120). Gestational weight gain below the guidelines was associated with 3 kg (6.6 lb) less weight retention within 6 months postpartum. In another study, in pregnant women who gained in excess of 20 kg (45 lb), the risk of postpartum weight retention was sixfold greater than in women who gained 10–15 kg (22–33 lb) (121).

In the Fit for Delivery study, although behavioral intervention did not significantly decrease excessive gestational weight gain in overweight and obese women, intervention did increase the percentages of normal-weight, overweight, and obese women who reached their prepregnancy weights or below at 6 months postpartum (30.7% of the intervention group versus 18.7% of the standard-care group) (122). Traditional means to decrease postpartum weight have employed behavioral intervention involving diet and physical activity (123). In a small study, the use of an Internet-based program that computes energy needs to achieve a defined weight loss based on demographic, anthropometric, and lactation status (U.S. Department of Agriculture's MyPyramid Menu Planner for Moms) resulted in significantly more weight loss in overweight and obese lactating women compared with a control group (124). A larger study of breastfeeding women compared a Mediterranean-style diet with the U.S. Department of Agriculture's My-Pyramid Menu Planner for Pregnancy and Breastfeeding. Both groups achieved moderate weight loss over 4 months (−2.3 ± 3.4 kg and −3.1 ± 3.4 kg for the Mediterranean-style and comparison diets, respectively), but there was no significant difference between groups (125). In a randomized clinical trial, family-based behavioral intervention did not result in a significant increase in postpartum weight loss compared with a control group. After adjusting for covariables in a multivariate analysis, only baseline energy intake, work status, and breastfeeding were significant predictors of weight change (126). Nutrition counseling is recommended for all overweight and obese women, and they should be encouraged to follow an exercise regimen. Although evidence from a Cochrane review suggests that diet alone or diet plus exercise but not exercise alone helped women lose weight postpartum, there may be other beneficial effects from including exercise in lifestyle habits (127). Clinicians should encourage behavioral interventions focused on improving both diet and exercise, which have been shown to improve outcomes compared with programs focused on exercise alone. Nutrition and exercise counseling should continue postpartum and before attempting another pregnancy. For women who were breastfeeding, more evidence is required to confirm whether diet, exercise, or both provides the most benefit for postpartum weight reduction (127).

Summary of Recommendations

The following recommendations are based on good or consistent scientific evidence (Level A):

- ▶ Body mass index calculated at the first prenatal visit should be used to provide diet and exercise counseling guided by IOM recommendations for gestational weight gain during pregnancy.
- ▶ Subcutaneous drains increase the risk of postpartum cesarean wound complications and should not be used routinely.
- ▶ Clinicians should encourage behavioral interventions focused on improving both diet and exercise, which have been shown to improve outcomes compared to programs focused on exercise alone.

The following recommendations are based on limited or inconsistent scientific evidence (Level B):

- ▶ Because even small weight reductions before pregnancy in women with obesity may be associated with improved pregnancy outcomes, weight loss before pregnancy should be encouraged.
- ▶ Allowing a longer first stage of labor before performing cesarean delivery for labor arrest should be considered in obese women.
- ▶ Mechanical thromboprophylaxis is recommended before cesarean delivery, if possible, as well as after cesarean delivery.
- ▶ Weight-based dosage for venous thromboembolism thromboprophylaxis may be considered rather than BMI-stratified dosage strategies in class III obese women after cesarean delivery.
- ▶ All women with obesity should be provided and referred to behavioral counseling interventions focused on improving healthy diet and exercise in order to achieve a healthier weight before another pregnancy.

The following recommendations are based primarily on consensus and expert opinion (Level C):

- ▶ Obese women should be counseled about the limitations of ultrasound in identifying structural anomalies.
- ▶ Early pregnancy screening for glucose intolerance (gestational diabetes or overt diabetes) should be based on risk factors, including maternal BMI of 30 or greater, known impaired glucose metabolism, or previous gestational diabetes.
- ▶ For patients with prepregnancy BMI of 35.0–39.9, weekly antenatal fetal surveillance may be considered beginning by 37 0/7 weeks of gestation. For patients with prepregnancy BMI 40 or greater, weekly antenatal fetal surveillance may be considered beginning at 34 0/7 weeks of gestation.
- ▶ Consultation with anesthesia service should be considered for obese pregnant women with OSA because they are at an increased risk of hypoxemia, hypercapnia, and sudden death.

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The MEDLINE database, the Cochrane Library, and the American College of Obstetricians and Gynecologists' own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1990–February 2013. The search was restricted to articles published in the English language. Priority was given to articles reporting results of original research, although review articles and commentaries also were consulted. Abstracts of research presented at symposia and scientific conferences were not considered adequate for inclusion in this document. Guidelines published by organizations or institutions such as the National Institutes of Health and the American College of Obstetricians and Gynecologists were reviewed, and additional studies were located by reviewing bibliographies of identified articles. When reliable research was not available, expert opinions from obstetrician–gynecologists were used.

Studies were reviewed and evaluated for quality according to the method outlined by the U.S. Preventive Services Task Force:

- I Evidence obtained from at least one properly designed randomized controlled trial.
- II-1 Evidence obtained from well-designed controlled trials without randomization.
- II-2 Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group.
- II-3 Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments also could be regarded as this type of evidence.
- III Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

Based on the highest level of evidence found in the data, recommendations are provided and graded according to the following categories:

Level A—Recommendations are based on good and consistent scientific evidence.

Level B—Recommendations are based on limited or inconsistent scientific evidence.

Level C—Recommendations are based primarily on consensus and expert opinion.

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