SciForschen
Open HUB for Scientific Research

(ISSN 2380-5528)

Obesity: Open Access

Review article | Volume: 1.3 | Open Access

Maternal Obesity and Pregnancy Outcomes

Pai-Jong Stacy Tsai[1]* and Nicole E Marshall[2]

[1]*Assistant Professor, Department of Obstetrics and Gynecology, University at Buffalo, 219 Bryant Street, Buffalo, NY 14222, USA*
[2]*Assistant Professor, Department of Obstetrics and Gynecology, Oregon Health Sciences University, 3181 S.W. Sam Jackson Park Rd., Portland, OR 97239, USA*

***Corresponding author:** Pai-Jong Stacy Tsai, MD, MPH, Assistant Professor, Department of Obstetrics and Gynecology, University at Buffalo, 219 Bryant Street, Buffalo, NY 14222, USA, **E-mail:** Tsai36@yahoo.com

Received date: 5 Nov 2015; **Accepted date:** 24 Nov 2015; **Published date:** 27 Nov 2015.

Citation: Tsai PJS, Marshall NE (2015) Maternal Obesity and Pregnancy Outcomes. Obes Open Access 1(3): http://dx.doi.org/10.16966/2380-5528.113

Abstract

Obesity in pregnancy is associated with increased pregnancy complications such as congenital malformations, stillbirths, macrosomia, neonates with low Apgar scores, pre-eclampsia, and gestational diabetes. In addition to these adverse outcomes, obese women face additional challenges due to longer labor progression, increased cesarean deliveries and postoperative complications, difficulties in administering anesthesia, and increased risk of thromboembolic disease. The purpose of this review is to provide an evidence-based guide to obstetric providers when caring for obese women in the intrapartum and postpartum period.

Keywords: Obesity; Labor; Cesarean delivery; Postpartum; Anesthesia; Thromboembolism

Introduction

Obesity affects more than 30% of reproductive age women and continues to be a major public health problem in the United States [1]. The rate of morbid obesity in reproductive age women exceeds 7%, which is 50% higher compared to men in the same age group [1]. Prevalence studies of women who have recently given birth found that approximately 1 in 5 was obese. The prevalence rate varies based on state and race/ethnicity [2]. The highest prevalence of pre-pregnancy obesity was found in Mississippi (24.2%) and West Virginia (25.1%) and the lowest prevalence was noted in Colorado (13.9%) and Utah (14.0%) [2]. The prevalence of pre-pregnancy obesity overall was 70% higher in non-Hispanic blacks compared to non-Hispanic whites and Hispanics [2].

Obesity in pregnancy has been associated with increased pregnancy complications. Recent studies have shown that when compared to normal weight women, obese women are at increased risk of having stillbirths [3], cesarean section, infections, preeclampsia, and gestational diabetes [4,5]. Their neonates are at increased risk of having congenital malformations [6-8], being large for gestational age, and having low Apgar scores at birth [4,5]. In addition, the mother's obesity has been linked to childhood obesity and metabolic syndrome [9,10].

During the intrapartum and postpartum period, obese women face additional challenges due to longer labor progression, increased cesarean section and postpartum complications rates, difficulties in administering anesthesia, and increased risk of thromboembolic disease. The purpose of this review is to provide an evidence-based guide to practitioners when caring for obese women in the intrapartum and postpartum period. For the purpose of this review, overweight is defined as body mass index (BMI) of 25 to 29.9 kg/m^2 and obesity is defined as BMI greater than or equal to 30 kg/m^2.

Labor Induction and Progression

Studies have shown an increased risk of labor induction in obese women compared to normal weight women. In a 15-year, population-based cohort study, Robinson et al. [11] noted an increased risk of labor induction in moderately obese women compared to normal weight women with an odds ratio (OR) of 1.94 and confidence interval (CI) 1.86-2.04. This risk is even higher in severely obese women compared to normal weight women (OR 2.77, CI 2.39-3.21). Bhattacharya et al. [12] also noted higher induced labor in morbidly obese women (OR 1.8, CI 1.3-2.5) compared to normal weight women. One explanation for the increased induction rates may be related to the possible association of prolonged and postterm gestation with obesity [13,14]. In addition to the increased induction rates, obesity is also associated with increased induction failure and this associated have been found to be directly related to class of obesity. Wolfe et al. [15] noted a failure rate as high as 80 percent in class III (BMI ≥ 40) obese women without a prior vaginal delivery and macrosomic fetus.

In addition to increased risk of labor induction, obese women have slower labor progression and increased labor augmentation. In a retrospective cohort analysis of term singleton pregnancies, Beyer et al. [16] noted a significantly longer duration of labor in the obese group. The average length of labor was 7.9 hours in the control group compared to 9.5 hours in the BMI>40 group. They did not specifically distinguish between first and second stage of labor. Both Hilliard et al. [17] and Norman et al. [18] showed longer duration of first stage labor among obese women compared to normal weight women. Norman et al. [18] specifically noted progression of the early part of the first stage is slower in obese women. Vahratian et al. [19] also examined the first stage of labor and noted longer duration of labor from 4 to 10 cm in both overweight and obese women compared to normal-weight women (7.5, 7.9, and 6.2 hours, respectively). Jensen et al. [20] noted a significant increase in labor augmentation with oxytocin or early amniotomy in obese women. In a cohort of nulliparous women undergoing labor induction, maternal weight was inversely proportional to the cervical dilation rate and associated with longer labor [21]. In contrast, a study conducted by the Maternal-Fetal Medicine Units Network specifically examined the second stage of labor and did not find a significant association between maternal BMI and longer second stage of labor or increased risk of cesarean delivery [22].

The reason for slower labor progression is unclear. One explanation may be that obese women have weaker contractions that lead to prolonged labor. Buhimschiet et al. [23] attempted to address this issue by examining intrauterine pressure of obese women in the second stage of labor and

found that there was no difference compared to normal weight women. Chin et al. [24] studied contraction strength in obese women in first stage of labor and showed that obese women were equally able to achieve Montevideo units ≥ 200.

Elective inductions with no clear medical indication should be avoided when caring for obese women due to the increased risk of induction failure. The diagnosis of arrest labor disorders should be made with caution given the classic Friedman's labor curve may not apply to obese women.

Vaginal Birth after Cesarean Section (VBAC)

Several studies have addressed the issue of mode of delivery for obese women with a prior cesarean delivery. The documented success rate of VBAC in obese women ranges from 13 to 68%. In 2001, Chauhan et al. [25] noted the success rate for a vaginal delivery after cesarean in obese women (defined weight greater than 300 pounds) was 13 percent and that those undergoing a trial of labor had higher rates of endometritis and wound breakdown compared to repeat elective cesarean delivery group of the same weight (OR 1.78, CI 1.05-3.02). The study was conducted during a time where overall VBAC rates were at its lowest. In 2003, Edwards et al. [26] examined VBAC versus cesarean section in 122 mother-infant pairs with mother's BMI greater than 40 and noted a VBAC success rate of 57%. They also noted an increase in rates of chorioamnionitis, endometritis, and composite puerperal infection in the VBAC group. The study also conducted a cost analysis and noted similar mean cost of care between the two groups. Similarly, in 2004, Durnwald et al. [27] noted decreased success rate of VBAC (54.6%) in the obese cohort compared to normal weight women and no difference in the success rate in overweight women (65.6%). Juhasz et al. [28] noted obese women were almost 50% less likely to have a successful VBAC compared to normal weight women (OR 0.53, CI 0.29-0.98) and those who gained more than 40 pounds were almost 40% less likely to have a successful VBAC compared to those who gained less. The highest VBAC success rate of 68% was seen in the Maternal-Fetal Medicine Units Network (MFMU) Cesarean Registry [29]. A secondary analysis of this registry conducted in 2006 showed a VBAC failure rate of 39% in morbidly obese women compared to 15% in normal weight women. Similar to previous studies, they also noted a higher rate of endometritis in obese women undergoing trial of labor compared to normal weight women undergoing trial of labor and obese women undergoing repeat cesarean section. This is the only study to note a higher rupture rate, increasing from 0.9% in normal weight women to 2.1% in morbidly obese women [30]. Lower 5 minute Apgar scores and term admissions to the NICU increased with increasing BMI, but there were no difference in birth injury, sepsis, stillbirth, or neonatal death and there were no cases of hypoxic-ischemic encephalopathy [30].

In summary, VBAC success rate in obese women appears to be lower compared to normal weight women and maybe associated with higher infectious morbidity and rupture/dehiscence rates. Trial of labor after cesarean delivery in obese women should include extensive patient counseling and provider awareness.

Cesarean Section

Studies have noted an increased risk of cesarean delivery in obese women. A meta-analysis of 33 studies noted cesarean delivery rates among overweight and obese women to be two to three times higher compared to normal weight women [31,32]. The odds ratio of a cesarean delivery were 1.46 (CI 1.34-1.60) among overweight, 2.05 (CI 1.86-2.27) among obese, and 2.89 (CI 2.28-3.79) in morbidly obese women compared to normal weight women [31]. Analysis from The First and Second Trimester Evaluation of Risk (FASTER) trial also noted a significant increased in rates of cesarean delivery among nulliparous women; the rate was 20.7% for normal weight women, 33.8% for obese women, and 47.4% for morbidly obese women [4]. A meta-analysis from the United Kingdom found the odds ratio for cesarean section in overweight women was 1.53 (CI 1.48-1.58), obese women was 2.26 (CI 2.04-2.51), and morbidly obese women was 3.38 (CI 2.49-4.57) compared to normal weight women [33]. Subgroup analysis of this study noted similar findings in elective cesarean delivery with odds ratio 1.32 (CI 1.21-1.45) in overweight women and 1.87 (CI 1.64-2.12) in obese women. In emergency cesarean delivery, the odds ratio was 1.64 (CI 1.55-1.73) in overweight women and 2.23 (CI 2.07-2.42) in obese women. In a retrospective cohort analysis of term, singleton pregnancies, Beyer et al. [16] found a higher rate of cesarean section in the BMI>40 group compared to the control group, 12.7% in the control verse 27.3% in the BMI>40 group.

In a population-based cross sectional study of nulliparous women at term, an increased risk of cesarean delivery was noted with increasing BMI. BMI seems to have a dose-response effect on the risk of cesarean delivery [34]. The study noted a six-fold increase in cesarean delivery in extreme morbidly obese group (BMI>50), which is nearly three times that of class I obese women (BMI 30-34.9) [34]. In a cohort of nulliparous women undergoing induction of labor, the risk of cesarean delivery was increased by 17 percent with each 10 kilogram increase in maternal weight [21]. One study examined specifically women undergoing labor induction for pre-eclampsia and noted an increased risk of cesarean delivery with increasing BMI [35]. Obesity and pre-gestational diabetes were noted to be independent risk factors for cesarean delivery [36]. Obese women with comorbiditiesare also noted to have higher cesarean deliveries rates compared to obese women without comorbidities [37].

Obesity has been identified as an independent risk factor for both elective and emergent cesarean delivery. BMI seems to have a dose-response effect on this risk and this risk is exacerbated by comorbid conditions, such as pregestational diabetes and pre-eclampisa.

Postpartum Concerns

Several studies have noted an association between obesity and postpartum hemorrhage [38]. Bhattachyra et al. [12] noted a 50 percent increase in postpartum hemorrhage in obese women when compared to normal weight women (OR1.5, CI 1.3-1.7). Robinson et al. [11] noted that postpartum hemorrhage was noted to be slightly increased in moderately obese women compared to nonobese women (OR 1.12, CI 1.02-1.22), although there were no differences in the rates of blood transfusion.

Obese women undergoing cesarean deliveries are also at increased risk of wound infection, ranging from 12% to 30% [39-42]. Robinson et al. [11] found that compared to nonobese women, moderately obese women had a 1.7 times (OR 1.67, CI 1.38-2.00) higher risk of wound infection and severely obese women had a 4.8 times (OR 4.79, CI 3.30-6.95) higher risk of wound infection. Women who experienced wound complications were more likely to be older and had higher rates of smoking and diabetes [41]. Even with the use of prophylactic antibiotics, obesity was found to be an independent risk factor for wound infection and endometritis [42]. When examining the type of skin incision, vertical skin incision was found to be associated higher rates of wound complications [40] and increased operative time, blood loss, and vertical hysterotomy in women [41]. One study examined differences in postoperative morbidity between supraumbilical versus Pfannenstiel skin incision and noted no significant differences [43]. In a prospective controlled clinical trail, the use of closed subcutaneous drainage systems were not found to be beneficial in reducing wound breakdown [44]. On the contrary, one study noted an increased in wound complications associated with the use of subcutaneous drains at cesarean delivery [41]. Meta-analysis of 6 studies noted 34% reduction in postoperative wound disruptions with closure of the subcutaneous tissue with cesarean delivery in women with at least 2 cm of subcutaneous adipose tissue [45].

Based on the data reviewed, obesity is associated with an increased risk of postpartum hemorrhage and wound complications after cesarean delivery. The use of vertical incision compared to Pfannenstiel incision may be associated with higher complications rates. The use of subcutaneous drainage systems is not recommended for cesarean deliveries in obese patients; however, closure of the subcutaneous tissue may improve wound complication rates.

Anesthesia Challenges

Obesity has been associated with increased risk of anesthesia-related complications [46,47]. Difficult endotracheal intubation in an obstetric population has been noted to be 10 times higher than the general population and it is even higher in the morbidly obese cohort [48]. Administering general anesthesia to obese pregnant patients have been associated with increased aspiration and failed intubations, resulting in maternal mortality [49].

Due to the increased risk of failed intubation, regional anesthesia is the preferred method for obese patients in labor and for cesarean delivery. However, increasing maternal BMI has been associated with increased failure rates in regional anesthesia [50]. One study noted higher initial epidural failure rates (42% versus 6%), requiring replacement of catheter, in obese women compared to normal weight women [51]. Not only do obese women have higher initial placement failure rate, there is also higher incidence of failed epidural during labor due to epidural migration in subcutaneous adipose tissue [52]. Due to these complications, it is imperative to involve anesthesia services early in the care of obese obstetric patients.

Thromboembolic Concerns

Thromboembolic disease, the leading cause of maternal death in the United States, is noted to be 4 to 5 times higher in the pregnant-state, and obesity further increases this risk. Heit et al. [53] noted the relative risk for venous thromboembolism (VTE) among pregnant or postpartum women was 4.29 (CI 2.49-5.22) and the overall incidence was 199.7 per 100,000 woman-years, with the highest incidence in the postpartum period [53]. James et al. [54] noted a rate of 1.72 per 1000 deliveries with 1.1 deaths per 100,000. Obesity increased the risk of VTE by 4.4 times (OR 4.4, CI 3.4-5.7) [54]. Another study from the United Kingdom noted the incidence of antenatal pulmonary embolism (PE) to be 1.3 per 10,000 women and the main risk factors were multipartiy and BMI>30 kg/m^2 [55]. Incidence of VTE was noted to be increased with increasing BMI in a population-based study of 142,000 singleton deliveries in Canada [11]. When compared to nonobese women, moderately obese women had double the risk of antepartum VTE (OR 2.17, CI 1.30-3.63) and severely obese women had four times the risk of antepartum VTE (OR 4.13, CI 1.26-13.54) [11]. A Danish study noted obesity to be associated with increased risk of VTE during pregnancy and puerperium (OR 5.3, CI 2.1-13.5). Specifically, obesity was associated with a higher risk of PE (OR 14.9, CI 3.0-74.8) compared to deep venous thrombosis (OR 4.4, CI 1.6-11.9) [56]. In a study from Norway, BMI>25 kg/m^2 in combination with immobilization increased the risk of antepartum VTE by 62 folds (OR 62.3, CI 12.5-338.0) [57].

Based on the current recommendations from the American College of Chest Physicians, initiation of pharmacologic thromboprophylaxis during pregnancy and postpartum is stratified based on history of previous VTE or the presence thrombophilia [58]. For patients undergoing cesarean delivery with increased risk of VTE due to the presence of one major risk factor or at least two minor risk factors, pharmacologic thromboprophylaxis or mechanical prophylaxis is recommended. If the patients have multiple additional risk factors for VTE and undergoing cesarean delivery, pharmacologic prophylaxis should be combined with the use of mechanical prophylaxis [58]. The recommendation of bed rest in pregnancy should be made with caution as it significantly increases the risk of VTE in obese patients.

Conclusion

Obese women in the intrapartum and postpartum period face unique challenges that include slower labor progression, decreased VBAC success rates, and increased risk of cesarean delivery, postpartum hemorrhage, infection, anesthesia failure, VTE risk. In summary, when caring for obese women:

- Elective inductions with no clear medical indication should be avoided in obese women due to the increased risk of induction failure and increased risk of cesarean complications.
- The diagnosis of arrest labor disorders should also be made with caution given the classic Friedman's labor curve may not apply to obese women.
- Trial of labor after cesarean delivery in obese women should include extensive patient counseling given decreased VBAC success rate and may be associated with higher infectious morbidity and rupture/dehiscence rates.
- The use of vertical incision is not beneficial over other incision types.
- The use of subcutaneous drainage systems is not recommended for cesarean deliveries in obese women.
- Closure of the subcutaneous tissue may improve wound complication rates.

References

1. Flegal KM, Carroll MD, Kit BK, Ogden CL (2012) Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA 307: 491-497.
2. Chu SY, Kim SY, Bish CL (2009) Prepregnancy obesity prevalence in the United States, 2004-2005. Matern Child Health J 13: 614-620.
3. Kristensen J, Vestergaard M, Wisborg K, Kesmodel U, Secher NJ (2005) Pre-pregnancy weight and the risk of stillbirth and neonatal death. BJOG 112: 403-408.
4. Weiss JL, Malone FD, Emig D, Ball RH, Nyberg DA, et al. (2004) Obesity, obstetric complications and cesarean delivery rate--a population-based screening study. Am J Obstet Gynecol 190: 1091-1097.
5. Ovesen P, Rasmussen S, Kesmodel U (2011) Effect of prepregnancy maternal overweight and obesity on pregnancy outcome. Obstet Gynecol 118: 305-312.
6. Watkins ML, Rasmussen SA, Honein MA, Botto LD, Moore CA (2003) Maternal obesity and risk for birth defects. Pediatrics 111: 1152-1158.
7. Honein MA, Moore CA, Watkins ML (2003) Subfertility and prepregnancy overweight/obesity: possible interaction between these risk factors in the etiology of congenital renal anomalies. Birth Defects Res A Clin Mol Teratol 67: 572-577.
8. Stothard KJ, Tennant PW, Bell R, Rankin J (2009) Maternal overweight and obesity and the risk of congenital anomalies: a systematic review and meta-analysis. JAMA 301: 636-650.
9. Whitaker RC (2004) Predicting preschooler obesity at birth: the role of maternal obesity in early pregnancy. Pediatrics 114: e29-e36.
10. Boney CM, Verma A, Tucker R, Vohr BR (2005) Metabolic syndrome in childhood: association with birth weight, maternal obesity, and gestational diabetes mellitus. Pediatrics 115: e290-e296.
11. Robinson HE, O'Connell CM, Joseph KS, McLeod NL (2005) Maternal outcomes in pregnancies complicated by obesity. Obstet Gynecol 106: 1357-1364.

12. Bhattacharya S, Campbell DM, Liston WA (2007) Effect of Body Mass Index on pregnancy outcomes in nulliparous women delivering singleton babies. BMC Public Health 7: 168.

13. Caughey AB, Stotland NE, Washington AE, Escobar GJ (2009) Who is at risk for prolonged and postterm pregnancy? Am J Obstet Gynecol 200: 683.e1-5.

14. Stotland NE, Washington AE, Caughey AB (2007) Prepregnancy body mass index and the length of gestation at term. Am J Obstet Gynecol 197: 378.e1-5.

15. Wolfe KB, Rossi RA, Warshak CR (2011) The effect of maternal obesity on the rate of failed induction of labor. Am J Obstet Gynecol 205: 128.e1-7.

16. Beyer DA, Amari F, Ludders DW, Diedrich K, Weichert J (2011) Obesity decreases the chance to deliver spontaneously. Arch Gynecol Obstet 283: 981-988.

17. Hilliard AM, Chauhan SP, Zhao Y, Rankins NC (2012) Effect of obesity on length of labor in nulliparous women. Am J Perinatol 29: 127-132.

18. Norman SM, Tuuli MG, Odibo AO, Caughey AB, Roehl KA, et al. (2012) The effects of obesity on the first stage of labor. Obstet Gynecol 120: 130-135.

19. Vahratian A, Zhang J, Troendle JF, Savitz DA, Siega-Riz AM (2004) Maternal prepregnancy overweight and obesity and the pattern of labor progression in term nulliparous women. Obstet Gynecol 104: 943-951.

20. Jensen H, Agger AO, Rasmussen KL (1999) The influence of prepregnancy body mass index on labor complications. Acta Obstet Gynecol Scand 78: 799-802.

21. Nuthalapaty FS, Rouse DJ, Owen J (2004) The association of maternal weight with cesarean risk, labor duration, and cervical dilation rate during labor induction. Obstet Gynecol 103: 452-456.

22. Robinson BK, Mapp DC, Bloom SL, Rouse DJ, Spong CY, et al. (2011) Increasing maternal body mass index and characteristics of the second stage of labor. Obstet Gynecol 118: 1309-1313.

23. Buhimschi CS, Buhimschi IA, Malinow AM, Weiner CP (2004) Intrauterine pressure during the second stage of labor in obese women. Obstet Gynecol 103: 225-230.

24. Chin JR, Henry E, Holmgren CM, Varner MW, Branch DW (2012) Maternal obesity and contraction strength in the first stage of labor. Am J Obstet Gynecol 207: 129.e1-e6.

25. Chauhan SP, Magann EF, Carroll CS, Barrilleaux PS, Scardo JA, et al. (2001) Mode of delivery for the morbidly obese with prior cesarean delivery: vaginal versus repeat cesarean section. Am J Obstet Gynecol 185: 349-354.

26. Edwards RK, Harnsberger DS, Johnson IM, Treloar RW, Cruz AC (2003) Deciding on route of delivery for obese women with a prior cesarean delivery. Am J Obstet Gynecol 189: 385-389.

27. Durnwald CP, Ehrenberg HM, Mercer BM (2004) The impact of maternal obesity and weight gain on vaginal birth after cesarean section success. Am J Obstet Gynecol 191: 954-957.

28. Juhasz G, Gyamfi C, Gyamfi P, Tocce K, Stone JL (2005) Effect of body mass index and excessive weight gain on success of vaginal birth after cesarean delivery. Obstet Gynecol 106: 741-746.

29. Landon MB, Leindecker S, Spong CY, Hauth JC, Bloom S, et al. (2005) The MFMU Cesarean Registry: factors affecting the success of trial of labor after previous cesarean delivery. Am J Obstet Gynecol 193: 1016-1023.

30. Hibbard JU, Gilbert S, Landon MB, Hauth JC, Leveno KJ, et al. (2006) Trial of labor or repeat cesarean delivery in women with morbid obesity and previous cesarean delivery. Obstet Gynecol 108: 125-133.

31. Chu SY, Kim SY, Schmid CH, Dietz PM, Callaghan WM, et al. (2007) Maternal obesity and risk of cesarean delivery: a meta-analysis. Obes Rev 8: 385-394.

32. Flegal KM, Carroll MD, Ogden CL, Curtin LR (2010) Prevalence and trends in obesity among US adults, 1999-2008. JAMA 303: 235-241.

33. Poobalan AS, Aucott LS, Gurung T, Smith WC, Bhattacharya S (2009) Obesity as an independent risk factor for elective and emergency caesarean delivery in nulliparous women--systematic review and meta-analysis of cohort studies. Obes Rev 10: 28-35.

34. Garabedian MJ, Williams CM, Pearce CF, Lain KY, Hansen WF (2011) Extreme morbid obesity and labor outcome in nulliparous women at term. Am J Perinatol 28: 729-734.

35. Robinson CJ, Hill EG, Alanis MC, Chang EY, Johnson DD, et al. (2010) Examining the effect of maternal obesity on outcome of labor induction in patients with preeclampsia. Hypertens Pregnancy 29: 446-456.

36. Ehrenberg HM, Durnwald CP, Catalano P, Mercer BM (2004) The influence of obesity and diabetes on the risk of cesarean delivery. Am J Obstet Gynecol 191: 969-974.

37. Suidan RS, Apuzzio JJ, Williams SF (2012) Obesity, Comorbidities, and the Cesarean Delivery Rate. Am J Perinatol 29: 623-628.

38. Perlow JH, Morgan MA (1994) Massive maternal obesity and perioperative cesarean morbidity. Am J Obstet Gynecol 170: 560-565.

39. Schneid-Kofman N, Sheiner E, Levy A, Holcberg G (2005) Risk factors for wound infection following cesarean deliveries. Int J Gynaecol Obstet 90: 10-15.

40. Wall PD, Deucy EE, Glantz JC, Pressman EK (2003) Vertical skin incisions and wound complications in the obese parturient. Obstet Gynecol 102: 952-956.

41. Alanis MC, Villers MS, Law TL, Steadman EM, Robinson CJ (2010) Complications of cesarean delivery in the massively obese parturient. Am J Obstet Gynecol 203: 271.e1-7.

42. Myles TD, Gooch J, Santolaya J (2002) Obesity as an independent risk factor for infectious morbidity in patients who undergo cesarean delivery. Obstet Gynecol 100: 959-964.

43. Houston MC, Raynor BD (2000) Postoperative morbidity in the morbidly obese parturient woman: supraumbilical and low transverse abdominal approaches. Am J Obstet Gynecol 182: 1033-1035.

44. Al-Inany H, Youssef G, Abd ElMaguid A, Abdel Hamid M, Naguib A (2002) Value of subcutaneous drainage system in obese females undergoing cesarean section using pfannenstiel incision. Gynecol Obstet Invest 53: 75-78.

45. Chelmow D, Rodriguez EJ, Sabatini MM (2004) Suture closure of subcutaneous fat and wound disruption after cesarean delivery: a meta-analysis. Obstet Gynecol 103: 974-980.

46. Roofthooft E (2009) Anesthesia for the morbidly obese parturient. Curr Opin Anaesthesiol 22: 341-346.

47. Tan T, Sia AT (2011) Anesthesia considerations in the obese gravida. Semin Perinatol 35: 350-355.

48. Saravanakumar K, Rao SG, Cooper GM (2006) The challenges of obesity and obstetric anaesthesia. Curr Opin Obstet Gynecol 18: 631-635.

49. Cooper GM, McClure JH (2008) Anaesthesia chapter from Saving mothers' lives; reviewing maternal deaths to make pregnancy safer. Br J Anaesth 100: 17-22.

50. Bloom SL, Spong CY, Weiner SJ, Landon MB, Rouse DJ, et al. (2005) Complications of anesthesia for cesarean delivery. Obstet Gynecol 106: 281-287.

51. Hood DD, Dewan DM (1993) Anesthetic and obstetric outcome in morbidly obese parturients. Anesthesiology 79: 1210-1218.

52. Vallejo MC (2007) Anesthetic management of the morbidly obese parturient. Curr Opin Anaesthesiol 20: 175-180.

53. Heit JA, Kobbervig CE, James AH, Petterson TM, Bailey KR, et al. (2005) Trends in the incidence of venous thromboembolism during pregnancy or postpartum: a 30-year population-based study. Ann Intern Med 143: 697-706.

54. James AH, Jamison MG, Brancazio LR, Myers ER (2006) Venous thromboembolism during pregnancy and the postpartum period: incidence, risk factors, and mortality. Am J Obstet Gynecol 194: 1311-1315.

55. Knight M (2008) Antenatal pulmonary embolism: risk factors, management and outcomes. BJOG 115: 453-461.

56. Larsen TB, Sorensen HT, Gislum M, Johnsen SP (2007) Maternal smoking, obesity, and risk of venous thromboembolism during pregnancy and the puerperium: a population-based nested case-control study. Thromb Res 120: 505-509.

57. Jacobsen AF, Skjeldestad FE, Sandset PM (2008) Ante- and postnatal risk factors of venous thrombosis: a hospital-based case-control study. J Thromb Haemost 6: 905-912.

58. Bates SM, Greer IA, Middeldorp S, Veenstra DL, Prabulos AM, et al. (2012) VTE, thrombophilia, antithrombotic therapy, and pregnancy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 141: eS691-S736.