Labour Progression in Women with Increased BMI: Evaluation of Caesarean Section Trends in Obstetric Practice

Dr. Emma de Vries[1]*
[1]University Medical Center Utrecht, Department of Obstetrics and Perinatal Medicine, Utrecht, Netherlands

Abstract

OBJECTIVE: To determine if obese pregnant women undergo Caesarean sections without an adequate trial of labour, as this may impact future birth and pregnancy outcomes.

METHODS: A retrospective analysis was done on 526 parturients at Victoria Hospital in London, Ontario. Women were categorized according to parity and pre-pregnancy body mass index (BMI; normal weight, BMI 18.5–24.9 kg/m^2; obese class II, BMI 35.0–39.9 kg/m^2; obese class III, BMI ≥40 kg/m^2). Patient charts and partograms were reviewed for labour progression (time at cervical dilation), demographics and infant outcomes (Canadian Task Force Classification II-2).

RESULTS: Obese class II and III primiparous women required an additional 1.62 and 2.67 hours (p=0.012), respectively, to reach a dilation of 10cm compared to their normal weight counterparts; obese class II and III multiparous women required an additional 1.25 and 2.05 hours (p=0.003), respectively. A higher BMI was associated with increased oxytocin use and infant birth weight in primiparas. Obese women had less gestational weight gain and required more cervical exams. Caesarean section rates were low for obese parturients (primiparas: 19%, multiparas: 0.8%) and not significantly different between BMI categories.

CONCLUSION: This study confirmed published results that labour progresses more slowly as maternal BMI increases. The study was performed in a centre with a specialized BMI pregnancy clinic; thus weight gain adherence, awareness of labour differences and patient counseling may have contributed to low Caesarean section rates. Obstetric care providers should consider

differences in maternal BMI labour progression before undertaking a potentially premature Caesarean birth, especially in primiparas.

Key Words: Labour progression, Obesity, Caesarean section, Pregnancy outcomes, BMI, Labour management

Introduction

Canadian women include an increasingly diverse population with respect to factors such as age, ethnicity, socioeconomic status, parity and maternal body habitus. The prevalence of overweight and obese women of childbearing age has increased over generations [1, 2] and as body mass index (BMI) increases, the odds ratio (OR) for Caesarean section increases from 2.31 for BMI 30-34.9 kg/m^2 to an OR of 3.60 for BMI ≥40 kg/m^2 [3]. Additionally, there is a linear relationship between BMI and Cesarean section rate for full term pregnancies, increasing from 7.3% in normal weight women to 15.5%, 20.4%, and 27.3% for obese class I, II, and III, respectively [4]. While there are many indications for a primary Cesarean section, the most common reason for intrapartum Cesarean delivery is "failure to progress" in either the first or second stage of labour [5].

The basis for decision-making on when to proceed with a Cesarean section for labour dystocia or arrest is the Friedman curve [6], which has been used to define normal and abnormal labour progression since its creation in 1955 [7]. Based on this curve, Caesarean section for failure to progress is recommended along the curve at a predicted rate, despite individual differences. In recent years, the appropriateness of the use of the Friedman curve for current parturients has been debated, as it was created based on a small, homogenous population of younger women with a lower average BMI and infant birth weight than the modern obstetrical population [7-10]. Several studies, including the assessment of 118,978 singleton pregnancies in the United States, have demonstrated that the first stage of labour progresses significantly more slowly as BMI increases in both nulliparous and multiparous women [11-13]. However, these studies do not indicate whether the Cesarean section rates in pregnant women with obesity are modifiable.

With the knowledge that obese women progress through labour more slowly than their leaner counterparts, interventions that specifically target antepartum, labour and delivery management in the obese population may have the greatest impact on Cesarean section rates. The objectives of this study were to estimate the effect of obesity on the duration and progression of the first stage of labour in Canadian parturients and to determine whether their Caesarean section was performed prematurely for failure to achieve adequate labour progression using a labour curve unadjusted for their BMI. This information will help clinicians support an extended length of labour to prevent the first and repeat Caesarean sections.

Methods

Data were retrospectively obtained from 526 singleton term (gestational age 37 weeks 0 days to 41 weeks 2 days) parturients at Victoria Hospital in London, Ontario from January 2013 to December 2014. This study was performed in a centre that has a specialized BMI clinic in which women received additional counselling from both obstetricians and dieticians regarding recommendations for weight gain, nutrition, and physical activity in pregnancy. Baseline demographic, intrapartum, and pregnancy outcome data were obtained from the London Health Sciences Centre's Perinatal Database: a prospectively collected database on all births in the tertiary care facility for southwestern Ontario, serving a population of approximately 1.5 million people. Data on labour progression (i.e., time at cervical dilation), parity, height, and weight were obtained from patient medical records, entered at intake into obstetrical care and on the partogram during labour. The study was approved by the Western University Research Ethics Board (REB 104766).

Data were collected on primiparous and multiparous women who presented in active labour, whose fetuses were in vertex presentation and included both vaginal and Caesarean births performed for the primary indication of failure to progress. BMI (weight (kg)/[height (m)]^2) was calculated from data in the first antenatal record corresponding to the patient's pre-pregnancy height and weight. The last recorded weight in pregnancy was collected and used to calculate gestational weight gain (GWG) by subtracting the pre-pregnancy weight from the weight at the last recorded antenatal visit. Three comparison groups were defined by pre-pregnancy BMI according to the World Health Organization definitions: normal weight, 18.5 – 24.9 kg/m^2; obese class II, 35.0 – 39.9 kg/m^2; and obese class III, ≥40 kg/m^2. Normal BMI parturients were matched to obese parturients for induction, need for cervical preparation, parity, and age (within 5 years) as these are all factors known to affect labour progression [10, 14]. Exclusion criteria included unknown pre-pregnancy BMI, age < 18 years or > 40 years, any major congenital anomalies, prior Caesarean section, no trial of labour (defined as < 2 cervical examinations recorded on the partogram), stillbirth, pre-eclampsia/eclampsia, placental complications (e.g., abruption, previa), uterine complications (e.g., rupture, dehiscence), and cord complications (e.g., prolapse).

Baseline characteristics were compared between the three BMI groups and stratified by parity. Pearson chi-square tests or analyses of variance with Bonferroni post-hoc correction were used to compare associations between BMI groups and categorical or continuous variables, respectively. For continuous variables, comparisons were made between the normal weight group and two obese groups combined. Repeated-measures analysis with polynomial modelling was used to construct mean labour curves by parity for each BMI group (SAS v.9.4; SAS Institute Inc., Cary, NC, USA). As the aim was to examine progression in the first stage of labour, the curves included all parturients who reached 10 cm, including women who underwent second stage Caesarean section. A Cox regression survival analysis was used to compare BMI groups in terms of cervical dilation at time of Caesarean delivery for failure to progress (SPSS v.24; IBM Corporation, Armonk, NY, USA). For all analyses, p-values < 0.05 were considered statistically significant.

Results

The demographic characteristics of the primiparous and multiparous populations according to pre-pregnancy BMI category are presented in Tables 1 and 2, respectively. Of the 282 primiparas who met inclusion criteria, 43 (15.2%) delivered by Caesarean section. While the rate of Caesarean section in primiparas increased across BMI categories to a rate of 23.4% in the highest BMI group, this was not statistically significant. As BMI increased (between BMI <25 kg/m^2 and ≥40 kg/m^2) in primiparas, there was a significant increase in the number of cervical exams, the use of oxytocin, and infant birth weight; as well as significantly lower maternal height and less GWG.

Table 1: Demographics of Primiparas

Characteristic	BMI Categories (kg/m2) at initial visit (pre-pregnancy BMI)			p-value
	Normal Weight < 25.0	Obese Class II 35.0 – 39.9	Obese Class III > 40	
Total	140	95	47	
Maternal age, y, mean (SD)	30.76 (4.78)	29.99 (4.77)	29.40 (4.48)	0.181
Maternal height, m, mean (SD)	1.67 (0.07)	1.66 (0.07)	1.62 (0.10)	0.006**
Maternal pre-pregnancy weight, kg, mean (SD)	61.45 (6.91)	103.49 (10.52)	117.01 (17.57)	<0.001**
Weight gain during pregnancy, kg, mean (SD)	15.54 (5.70)	9.48 (6.67)	9.71 (8.37)	<0.001**
Gestational age at delivery, wk, mean (SD)	40.23 (1.09)	39.86 (1.19)	39.98 (1.30)	0.052
Diabetes, n (%)	7 (5.0)	9 (9.7)	6 (12.8)	0.167
Dilation at admission, cm, mean (SD)	3.26 (1.81)	3.06 (1.49)	2.79 (1.52)	0.219
Number of cervical examinations, mean (SD)	6.06 (2.65)	6.40 (2.46)	7.51 (3.16)	0.006**
Labour Induction, n (%)	127 (48.3)	67 (40.1)	53 (55.8)	0.050
Oxytocin use, n (%)	89 (63.6)	65 (68.4)	40 (85.1)	0.022*
Epidural analgesia, n (%)	119 (85.0)	81 (85.3)	40 (85.1)	0.998
Caesarean delivery, n (%)	16 (11.4)	16 (16.8)	11 (23.4)	0.123
Infant birth weight, kg, mean (SD)	3.49 (0.47)	3.60 (0.48)	3.62 (0.51)	0.023*

Note: p-values represent comparisons between the normal weight group and the other two groups combined (i.e., obese class II and II)

Table 2: Demographics of Multiparas

Characteristic	BMI Categories (kg/m2) at initial visit (pre-pregnancy BMI)			p-value
	Normal Weight < 25.0	Obese Class II 35.0 – 39.9	Obese Class III > 40	
Total	123	73	48	
Maternal age, y, mean (SD)	31.76 (4.70)	30.26 (5.66)	29.33 (4.97)	0.010**
Maternal height, m, mean (SD)	1.65 (0.06)	1.65 (0.06)	1.67 (0.07)	0.384
Maternal pre-pregnancy weight, kg, mean (SD)	59.76 (6.42)	102.26 (9.46)	117.53 (14.72)	<0.001**
Weight gain during pregnancy, kg, mean (SD)	14.37 (8.52)	9.63 (11.02)	5.11 (6.89)	<0.001**
Gestational age at delivery, wk, mean (SD)	39.76 (1.01)	39.79 (1.09)	39.51 (1.17)	0.315
Diabetes, n (%)	7 (5.7)	8 (11.3)	8 (16.7)	0.077
Dilation at admission, cm, mean (SD)	3.78 (1.68)	3.95 (1.91)	3.35 (1.51)	0.175
Number of cervical examinations, mean (SD)	4.18 (1.56)	4.52 (1.73)	5.23 (2.22)	0.002**
Labour Induction, n (%)	49 (39.8)	23 (31.5)	22 (45.8)	0.289
Oxytocin use, n (%)	39 (31.7)	29 (40.3)	24 (50.0)	0.076
Epidural analgesia, n (%)	87 (70.7)	54 (75.0)	42 (87.5)	0.073
Caesarean delivery, n (%)	0 (0.0)	1 (1.4)	0 (0.0)	0.496
Infant birth weight, kg, mean (SD)	3.48 (0.47)	3.62 (0.50)	3.64 (0.53)	0.058

Note: p-values represent comparisons between the normal weight group and the other two groups combined (i.e., obese class II and II)

Of the multiparas, 244 women met inclusion criteria; however, only one was delivered by Caesarean section. As BMI increased in multiparas, there was a significant increase in the number of cervical exams ($p=0.002$) and significantly less GWG ($p<0.001$).

The mean labour curves show that labour progressed more slowly as BMI increased for both primiparas (Figure 1) and multiparas (Figure 2). When comparing normal BMI primiparous women to obese class II and class III women, the time difference to reach a dilation of 10 cm was 1.62 and 2.67 hours, respectively ($p=0.012$; Figure 1). When comparing normal BMI multiparous women to obese class II and class III women, the time difference to reach 10 cm was 1.25 and 2.05 hours, respectively ($p=0.003$; Figure 2). Neither set of curves presented a clear inflection point to distinguish between the latent and active phases of labour. Furthermore, in all groups the rate of cervical change increased as labour progressed (Figures 1 and 2).

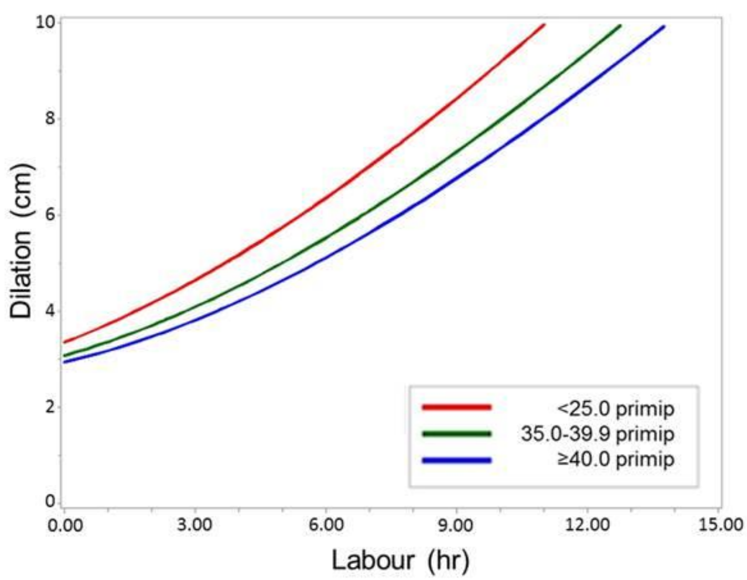

Figure 1: Labour curves for primiparas according to BMI category. Data represent the mean dilation of normal weight (BMI <25), obese class II (BMI 35-39.9), and obese class III (BMI ≥40) primiparas who reached 10 cm.

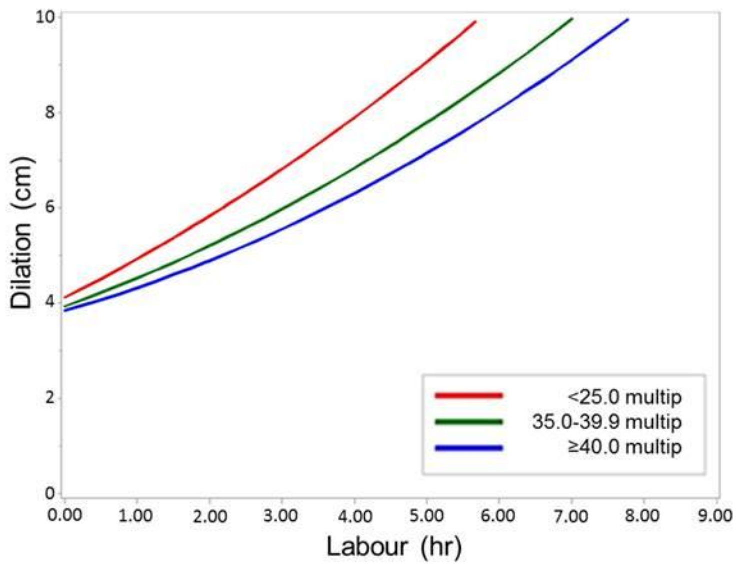

Figure 2: Labour curves for multiparas according to BMI category. Data represent the mean dilation of normal weight (BMI <25), obese class II (BMI 35-39.9), and obese class III (BMI ≥40) primiparas who reached 10 cm.

The primary question for this study was whether Caesarean sections are being performed prematurely on the labour curve for obese women. The data on multiparous parturients were excluded from further analysis since there was only one Caesarean section in this group. Across all three BMI categories, the women who underwent Caesarean section showed prolonged labour progression that did not approach their mean BMI-adjusted labour curves (Figure 3). Despite the increased trend of Caesarean sections in obese primiparas, there was no significant difference between BMI groups in terms of dilation at time of Caesarean section (Figure 4).

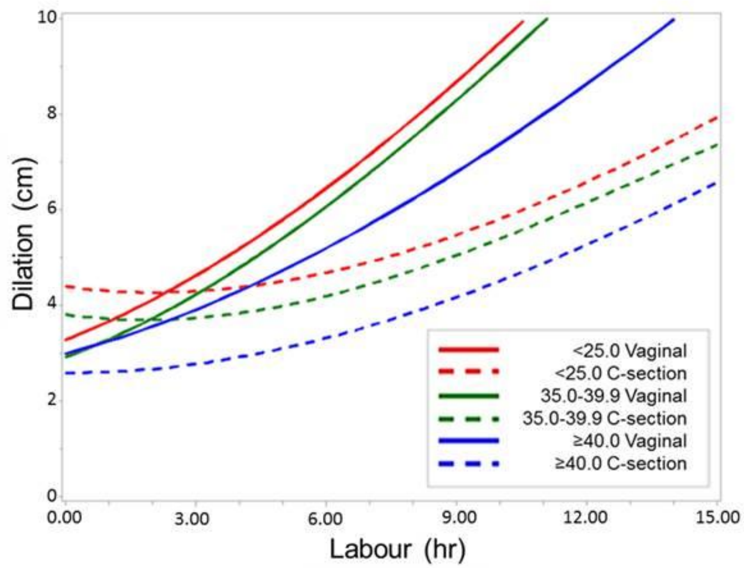

Figure 3: Labour curves of vaginal deliveries and Caesarean sections in primiparas according to BMI. Data represent the mean dilation of primiparas who completed the first stage of labour (solid lines) and those who underwent first stage Caesarean section (dashed lines) for failure to progress.

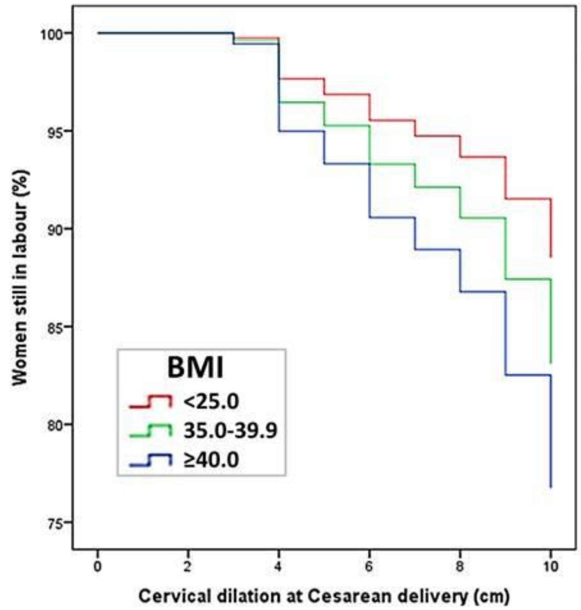

Figure 4: Timing of Caesarean section according to cervical dilation at delivery in primiparas for each of the BMI categories. Data represent the mean values for normal weight (BMI <25), obese class II (BMI 35-39.9), and obese class III (BMI ≥40) primiparas.

Discussion

We confirmed that the first stage of labour progresses more slowly across increasing BMI categories in our Canadian cohort. BMI was an independent predictor of labour progression, supporting the concept that allowing for slower progression in labour for obese women may decrease their rate of Caesarean sections. These results are most relevant for primiparous patients, in whom an initial Caesarean section is more likely to affect future birth options. We also determined an increased number of cervical exams with longer labours; although statistically significant, the clinical significance is unclear and was not specifically evaluated.

Women with an elevated BMI had larger infants than their normal weight peers, which may contribute to the longer labour [16]. They were also more likely to receive oxytocin for labour augmentation. Although one may hypothesize this is secondary to the larger fetus, this could also reflect fewer adequate contraction patterns. Evidence from in vitro studies demonstrates this is secondary to uterine muscle dysfunction and decreased force and frequency of myometrial contractions [15].

We were interested to know the stage of labour at which the C-sections were being performed for women with higher BMIs, if, in fact, they were simply following a BMI-adjusted labour curve. Our survival analysis demonstrated no significant difference between BMI groups in terms of dilation at time of Caesarean section. There had been education for our obstetrical care providers on these issues during the trial; awareness of this may have contributed to the low Caesarean section rates at this centre, which are in contrast to higher rates for this population in the literature [1, 11, 19].

Interestingly, our cohort demonstrated decreasing GWG with increasing obesity class. This may be a result of the counseling and care patterns within a specialized BMI in pregnancy clinic. Given that high GWG has been associated with increased rates of operative birth [20, 21], this factor itself may have contributed to lower Caesarean section rates.

Limitations of this study include the choice to select groups based on pre-pregnancy weight, rather than maternal weight at the time of labour. Although recognized to have a greater impact on labour and birth outcomes [16], weight was not reliably measured at labour admission in our study and the last recorded weights were available from variable gestational ages. Therefore, pre-pregnancy weight was used to allocate patients to BMI categories. A second limitation is the fact that cervical dilatation remains a subjective measurement performed by multiple nurses and physicians over time.

Our cohort had a relatively high rate of labour inductions, which is explained by our regional function as the birthing site for women with BMI ≥40 kg/m^2 (transport and family considerations), as well as induction to avoid the development of pregnancy-associated complications of larger babies, hypertensive disorders and stillbirth [22-24]. This practice increases the labour induction rate for women with BMI ≥40 kg/m^2, and for our protocol, we matched women for this. The low Caesarean birth rate in our study is in line with evidence that induction of labour may only have a weak association, if any, with increased risk of Caesarean birth [25, 26]. In the population of women with a BMI ≥40 kg/m^2, having a first vaginal birth very likely helps to avoid future Caesarean sections.

Despite attempts to match for factors known to affect labour progression, there is the possibility that important confounders were not controlled and, therefore, cannot be evaluated. As with other studies on labour progression in obese women [11-13], we excluded first stage Caesarean sections from the mean labour curves, potentially shortening the labour duration through information censoring. Given that Caesarean section rates for failure to progress increased across BMI categories, removing women who underwent Cesarean section prior to reaching 4 cm of cervical dilation would have only minimized the differences between the labour curves.

Conclusion

We confirmed prior evidence that labour progresses more slowly as maternal BMI increases [11-13], supporting that the findings of large, multicenter studies are applicable to our

Canadian population. Interestingly, despite a trend towards increased rates of Caesarean section as BMI increased, the rates of Caesarean section remained low in the present study (19% in primiparous women with BMI >35) compared to other studies [1, 11, 19]. Furthermore, it was found that obese women were not undergoing higher rates of Caesarean birth in our cohort, potentially as a result of a multidisciplinary BMI pregnancy clinic and physician awareness of the slower progression in women with elevated BMI. This is encouraging, as it highlights that consideration of differences in maternal BMI during labour management can influence birth outcomes such as Caesarean delivery, thereby impacting future reproductive outcomes for this higher risk group of women.

Acknowledgements

We acknowledge Suhair Al Shanteer, MD, MScHIS and Darlene Palmer, CHIM from LHSC-Decision Support Department with their assistance in retrieval of the study population and matched controls. We also acknowledge Samantha Bedell with her assistance with manuscript editing and preparation.

References

1. Vahratian, A., et al., *Maternal prepregnancy overweight and obesity and the pattern of labor progression in term nulliparous women.* Obstet Gynecol, 2004. **104**(5 Pt 1): p. 943-51.
2. Gunderson, E.P., *Childbearing and obesity in women: weight before, during, and after pregnancy.* Obstet Gynecol Clin North Am, 2009. **36**(2): p. 317-32, ix.
3. Barau, G., et al., *Linear association between maternal pre-pregnancy body mass index and risk of caesarean section in term deliveries.* BJOG, 2006. **113**(10): p. 1173-7.
4. Kominiarek, M.A., et al., *The maternal body mass index: a strong association with delivery route.* Am J Obstet Gynecol, 2010. **203**(3): p. 264 e1-7.
5. Zhang, J., et al., *Contemporary cesarean delivery practice in the United States.* Am J Obstet Gynecol, 2010. **203**(4): p. 326 e1-326 e10.
6. Cunningham, F., et al., *Williams Obstetrics: 23rd Edition*. 2009: Mcgraw-hill.
7. Friedman, E.A., *Primigravid labor; a graphicostatistical analysis.* Obstet Gynecol, 1955. **6**(6): p. 567-89.
8. Zhang, J., J.F. Troendle, and M.K. Yancey, *Reassessing the labor curve in nulliparous women.* Am J Obstet Gynecol, 2002. **187**(4): p. 824-8.
9. Zhang, J., et al., *Contemporary patterns of spontaneous labor with normal neonatal outcomes.* Obstet Gynecol, 2010. **116**(6): p. 1281-7.
10. Rinehart, B.K., et al., *Lack of utility of standard labor curves in the prediction of progression during labor induction.* Am J Obstet Gynecol, 2000. **182**(6): p. 1520-6.
11. Kominiarek, M.A., et al., *Contemporary labor patterns: the impact of maternal body mass index.* Am J Obstet Gynecol, 2011. **205**(3): p. 244 e1-8.
12. El-Chaar, D., et al., *The impact of increasing obesity class on obstetrical outcomes.* J Obstet Gynaecol Can, 2013. **35**(3): p. 224-233.
13. Ronzoni, S., et al., *Maternal Obesity Class as a Predictor of Induction Failure: A Practical Risk Assessment Tool.* Am J Perinatol, 2015. **32**(14): p. 1298-304.
14. Greenberg, M.B., et al., *Does length of labor vary by maternal age?* Am J Obstet Gynecol, 2007. **197**(4): p. 428 e1-7.
15. Zhang, J., et al., *Poor uterine contractility in obese women.* BJOG, 2007. **114**(3): p. 343-8.
16. Johnson, J.W., J.A. Longmate, and B. Frentzen, *Excessive maternal weight and pregnancy outcome.* Am J Obstet Gynecol, 1992. **167**(2): p. 353-70; discussion 370-2.
17. Davies, G.A.L., C. Maxwell, and L. McLeod, *No. 239-Obesity in Pregnancy.* J Obstet Gynaecol Can, 2018. **40**(8): p. e630-e639.
18. Muktabhant, B., et al., *Diet or exercise, or both, for preventing excessive weight gain in pregnancy.* Cochrane Database Syst Rev, 2015(6): p. CD007145.
19. Norman, S.M., et al., *The effects of obesity on the first stage of labor.* Obstet Gynecol, 2012. **120**(1): p. 130-5.
20. Goldstein, R.F., et al., *Association of Gestational Weight Gain With Maternal and Infant Outcomes: A Systematic Review and Meta-analysis.* JAMA, 2017. **317**(21): p. 2207-2225.
21. Zhao, R.F., W.Y. Zhang, and L. Zhou, *[Relationship between the risk of emergency cesarean section for nullipara with the prepregnancy body mass index or gestational weight gain].* Zhonghua Fu Chan Ke Za Zhi, 2017. **52**(11): p. 757-764.

22. Chandrasekaran, S. and G. Neal-Perry, *Long-term consequences of obesity on female fertility and the health of the offspring.* Curr Opin Obstet Gynecol, 2017. **29**(3): p. 180-187.
23. Spradley, F.T., A.C. Palei, and J.P. Granger, *Increased risk for the development of preeclampsia in obese pregnancies: weighing in on the mechanisms.* Am J Physiol Regul Integr Comp Physiol, 2015. **309**(11): p. R1326-43.
24. Yao, R., et al., *Obesity and the risk of stillbirth: a population-based cohort study.* Am J Obstet Gynecol, 2014. **210**(5): p. 457 e1-9.
25. Walker, K.F., et al., *Randomized Trial of Labor Induction in Women 35 Years of Age or Older.* N Engl J Med, 2016. **374**(9): p. 813-22.
26. Na, E.D., et al., *Pregnancy outcomes of elective induction in low-risk term pregnancies: A propensity-score analysis.* Medicine (Baltimore), 2019. **98**(8): p. e14284.