Higher Caesarean Section Rates in Women With Higher Body Mass Index: Are We Managing Labour Differently?

Haim A. Abenhaim, MD, MPH,[1] Alice Benjamin, MD[2]

[1]Department of Obstetrics and Gynecology, Jewish General Hospital, McGill University, Montreal QC

[2]Department of Obstetrics and Gynecology, Royal Victoria Hospital, McGill University, Montreal QC

Abstract

Background: Higher body mass index has been associated with an increased risk of Caesarean section. The effect of differences in labour management on this association has not yet been evaluated.

Methods: We conducted a cohort study using data from the McGill Obstetrics and Neonatal Database for deliveries taking place during a 10-year period. Women's BMI at delivery was categorized as normal (20 to 24.9), overweight (25 to 29.9), obese (30 to 39.9), or morbidly obese (≥ 40). We evaluated the effect of the management of labour on the need for Caesarean section using unconditional logistic regression models.

Results: Data were available for 11 922 women, of whom 2289 women had normal weight, 5663 were overweight, 3730 were obese, and 240 were morbidly obese. After adjustment for known confounding variables, increased BMI category was associated with an overall increase in the use of oxytocin and in the use of epidural analgesia, and with a decrease in use of forceps and vacuum extraction among second stage deliveries. Higher BMI was also found to be associated with earlier decisions to perform a Caesarean section in the second stage of labour. When adjusted for these differences in the management of labour, the increasing rate of Caesarean section observed with increasing BMI category was markedly attenuated ($P < 0.001$).

Conclusion: Women with an increased BMI are managed differently in labour than women of normal weight. This difference in management in part explains the increased rate of Caesarean section observed with higher BMI.

Key Words: Obesity, body mass index, Caesarean section, labour management

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Résumé

Contexte : Un indice de masse corporelle accru a été associé à une hausse du risque de césarienne. L'effet des différences en matière de prise en charge du travail sur cette association n'a pas encore été évalué.

Méthodes : Nous avons mené une étude de cohorte au moyen de données issues de la *McGill Obstetrics and Neonatal Database* pour ce qui est des accouchements étant survenus au cours d'une période de 10 ans. L'IMC des femmes à l'accouchement a été catégorisé comme suit : normal (de 20 à 24,9), surcharge pondérale (de 25 à 29,9), obésité (de 30 à 39,9) ou obésité morbide (≥ 40). Nous avons évalué l'effet de la prise en charge du travail sur la nécessité de procéder à une césarienne au moyen de modèles de régression logistique inconditionnels.

Résultats : Des données étaient disponibles au sujet de 11 922 femmes : 2 289 présentant un poids normal, 5 663 présentant une surcharge pondérale, 3 730 étant obèses et 240 étant massivement obèses. À la suite de la neutralisation de l'effet des variables confusionnelles connues, la hausse de la catégorie d'IMC a été associée à une hausse globale du recours à l'oxytocine et du recours à l'analgésie péridurale, ainsi qu'à une baisse du recours aux forceps et à la ventouse obstétricale parmi les accouchements en étant au second stade. Nous avons également constaté que l'IMC accru était associé à la prise plus tôt de la décision de procéder à une césarienne pendant le second stade du travail. À la suite de la neutralisation de l'effet de ces différences en matière de prise en charge du travail, la relation directement proportionnelle constatée entre le taux de césarienne et la catégorie d'IMC s'en est trouvée considérablement atténuée ($P < 0,001$).

Conclusion : Les femmes qui présentent un IMC accru font l'objet d'une prise en charge du travail différente de celle dont font l'objet les femmes de poids normal. Cette différence en matière de prise en charge explique, en partie, le taux accru de césarienne constaté en présence d'un IMC accru.

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INTRODUCTION

Obesity is a well-established risk factor for maternal and neonatal morbidity. The effect of maternal obesity on adverse perinatal outcomes such as preeclampsia, gestational diabetes, preterm birth, and macrosomia is well established.[1–6] Among the different adverse perinatal outcomes observed in obese women, a consistent increase in the incidence of Caesarean section has been associated with increased BMI or degree of obesity.[7–12] This increase in Caesarean section has been observed among all women, and even more so among women with a previous Caesarean section.[13–17] It is unclear why women who are obese are more likely to require a Caesarean section. While this may in part be due to having a condition carrying a higher risk for Caesarean section (gestational diabetes, macrosomia, preeclampsia), these have typically been adjusted for in most studies that have evaluated obesity and Caesarean sections, and therefore cannot solely account for the observed association between obesity and the increased risk of undergoing Caesarean section.

The management of labour is also a well-established determinant of the need for Caesarean section. Factors such as use of oxytocin, use of epidural analgesia, instrumentation, and duration of labour are all associated with the Caesarean section rate.[18–20] Maternal BMI has also been associated with Caesarean section rates,[4,8,11] although the reasons for this association are not well established. Furthermore, the effect these possible differences in the management of labour may have on the association between obesity and Caesarean section rate has yet to be determined. The purpose of our study was two-fold: first, to determine whether increased maternal BMI is associated with differences in the management of labour, and second, to determine whether any difference in the management of labour may in part explain the increased Caesarean section rate observed in obese women.

MATERIALS AND METHODS

We performed a hospital-based cohort study using the McGill Obstetrical and Neonatal Database. The database contains detailed obstetrical and neonatal information on all infants weighing 500 g or more (whether born alive or stillborn) delivered at the Royal Victoria Hospital, a tertiary care teaching hospital of McGill University in Montreal. The data were coded by a medical record room archivist, verified by a database manager who works full time on this database, and reviewed by a neonatologist, an obstetrician, or both in cases needing special scrutiny.

The population used in this study consisted of all live births occurring in the 10-year period between April 1, 1991, and March 31, 2001, for which maternal BMI at the time of delivery was available. We excluded elective Caesarean sections, stillbirths, breech presentations, and women with a BMI < 20. BMI was calculated using the last measured weight (within 2 weeks of delivery) during the index pregnancy and the measured height at the first pregnancy visit. BMI was categorized as normal (20.0 to 24.9), overweight (25.0 to 29.9), obese (30.0 to 39.9), or morbidly obese (≥ 40.0), as previously described.[4]

Baseline clinical characteristics included maternal age at time of delivery, gestational age as assigned by the treating physician (using menstrual dates vs. early ultrasound), parity (nulliparous vs. parous), previous Caesarean section, pre-existing diabetes mellitus, having developed gestational diabetes in current pregnancy, having developed preeclampsia in current pregnancy, status of cervix upon admission (the first measured cervical dilatation during the admission leading to delivery), induction of labour, and birth weight. The management of labour variables were use of oxytocin at any point during labour, use of epidural analgesia, intervention time for Caesarean section performed in the first stage of labour (the time from onset of labour to Caesarean section), intervention time for Caesarean section performed in the second stage of labour (the duration of second stage of labour before Caesarean section), and instrumental delivery (forceps or vacuum). The Caesarean section intervention time was a comparison of the mean Caesarean section intervention time in the different BMI groups with the mean Caesarean section intervention time in the reference group (with normal BMI). The objective of this variable was to determine whether obstetricians performed Caesarean section sooner in women with an elevated BMI than in women with a normal BMI.

The analysis was conducted in three steps. The first step was an unadjusted descriptive analysis of baseline characteristics in the different BMI categories. The second step was an analysis measuring the effect of BMI category on the different management of labour variables. Adjustment for maternal age, gestational age, parity, previous Caesarean section, pre-existing diabetes mellitus, gestational diabetes mellitus, preeclampsia, induction of labour, cervix dilatation on admission, and birth weight was carried out using a logistic regression model for categorical outcomes and a linear regression model for continuous outcomes (Caesarean section intervention time). The third step was an adjusted analysis of the association between BMI category and Caesarean section while adjusting for the causal intermediates (labour

Table 1. Baseline characteristics of 11 922 deliveries among different BMI categories at delivery

Baseline characteristic	BMI 20 to 24.9 (n = 2289) %	BMI 25 to 29.9 (n = 5663) %	BMI 30 to 39.9 (n = 3730) %	BMI ≥ 40 (n = 240) %
Age, years				
< 25	13.1	9.6	8.5	6.7
25 to 29.9	30.7	28.8	29.8	31.3
30 to 34.9	34.7	39.7	39.6	34.6
≥ 35	21.5	21.9	22.1	27.5
Gestational age, weeks				
< 37	9.1	5.8	6.0	7.1
37 to 38+6	28.0	24.7	25.4	31.3
39 to 40+6	50.3	52.8	50.4	44.2
≥ 41	12.6	16.7	18.2	17.5
Multiparous	49.5	49.5	52.3	55.8
Previous Caesarean section	5.4	5.5	8.6	7.9
Multifetal gestations	0.9	1.3	3.3	2.1
Pre-existing diabetes mellitus	0.2	0.3	0.9	2.5
Gestational diabetes mellitus	4.8	6.4	9.0	12.9
Preeclampsia	1.5	1.8	4.9	11.7
Induction of labour	23.7	29.3	37.2	50.0
Cervical dilatation on admission, cm				
Closed	6.0	7.9	9.0	14.2
1 to 2	31.9	34.6	39.8	41.5
3 to 4	40.9	39.9	36.6	31.7
≥ 5	21.2	17.6	14.6	12.6
Birth weight, g				
< 2500	7.2	3.4	3.6	4.2
2500 to 3499	62.7	52.7	44.2	37.1
3500 to 3999	24.5	33.4	34.7	33.8
≥ 4000	5.6	10.6	17.5	25.0

management variables). A likelihood ratio test was used to evaluate the effect of the causal intermediates in the exposure–outcome relation. The second and third steps were carried out with an unconditional logistic regression using the odds ratio as an unbiased measure of the relative risk. Tests for trend were performed using the Wald test in the regression models. All analyses were two-tailed, and $P < 0.05$ was considered statistically significant. We used Statview Statistics software version 5.0 (SAS Institute Inc., Cary NC).

In keeping with provincial legislation, the use of this database for research purposes was approved by the Director of Professional Services and the Institutional Review Board of the McGill University Health Centre.

RESULTS

Baseline characteristics are listed in Table 1. From a total cohort of 36 756 deliveries, we excluded breech deliveries (1982), elective Caesarean sections (1792), stillbirths (142), and deliveries in women with a recorded BMI < 20 (17 081; we concluded that these were miscalculated.) Of the remaining 15 882, delivery BMI data were available for 11 922 deliveries; 2289 women had a normal BMI, 5663 women were overweight, 3730 women were obese, and 240 women were morbidly obese. Higher BMI category appeared to be associated with higher maternal age, parity, previous Caesarean section, twin pregnancy, pre-existing and gestational diabetes mellitus, the need for induction of labour, and a non-favourable cervix at the admission

Table 2. Differences in the management of labour among the different BMI categories

	Normal	Overweight	Obese	Morbidly obese	*P*
Interventions, OR (95% CI)*					
Oxytocin	1.0	1.31 (1.15 to 1.49)	1.51 (1.31 to 1.75)	3.05 (1.89 to 4.94)	< 0.001
Epidural	1.0	1.12 (0.99 to 1.28)	1.11 (0.96 to 1.28)	1.83 (1.14 to 2.95)	< 0.001
Forceps	1.0	1.00 (0.81 to 1.24)	0.78 (0.61 to 0.99)	0.23 (0.07 to 0.73)	< 0.001
Vacuum	1.0	0.89 (0.70 to 1.13)	0.71 (0.53 to 0.93)	0.29 (0.09 to 0.93)	< 0.001
Caesarean section intervention time, mean (SD)†					
1st stage, hrs	0.0	1.6 (8.3)	1.2 (8.4)	0.7 (7.0)	NS
2nd stage, min‡	0.0	−23.8 (83.8)	−23.1 (86.9)	−64.7 (77.2)	0.04

NS: not significant.

* Adjusted for age, parity, gestational age, previous Caesarean section, pre-existing and gestational diabetes, preeclampsia, cervix on admission, induction of labour, and birthweight.

† Mean difference.

‡ The minus sign reflects a shorter time than the normal weight subjects.

leading to delivery. There was also a trend for higher birth weights to be associated with higher BMI categories. There was no specific pattern of gestational age at delivery among the BMI categories.

The effect of BMI category on labour interventions is shown in Table 2. There was a significantly higher rate of oxytocin use and epidural analgesia in women with above normal BMI, and this use appeared to increase with increasing BMI category. Inverse associations were observed between increasing BMI category and both rate of instrumental delivery (forceps and vacuum) and intervention time for Caesarean section delivery during the second stage of labour.

The association between BMI category and the risk of undergoing a Caesarean section is shown in the Figure. A strong association is seen between increasing BMI category and the odds of undergoing a Caesarean section. When adjusted for known confounding variables, an increasing rate of Caesarean section is observed with increasing BMI category, although this is partly attenuated. Adjusting for differences in labour management as well as the known confounding variables resulted in a complete attenuation of the association between increasing BMI category and increasing Caesarean section rate, the likelihood ratio declining from 1.34 (95% CI 1.22 to 1.47) to 1.07 (95% CI 0.80 to 1.43) ($P < 0.001$).

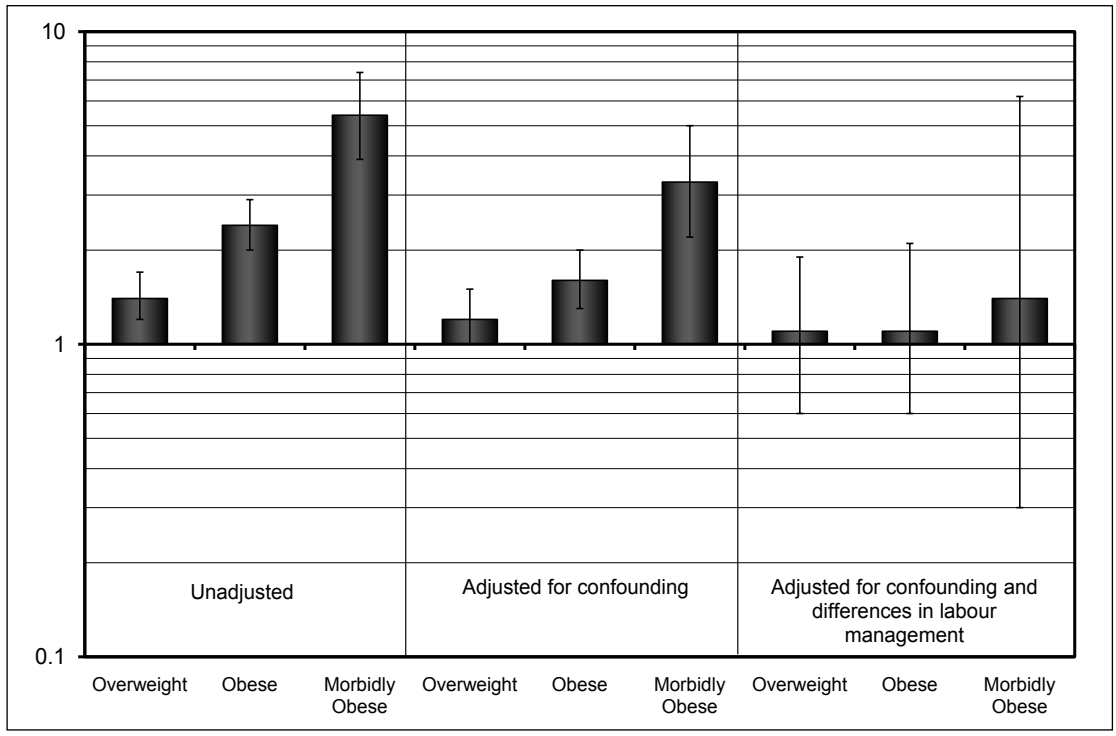
DISCUSSION

Obesity is a well-established risk factor for requiring a Caesarean section.[1–6] Many associated factors such as maternal age, gestational diabetes, preeclampsia, and macrosomia play important roles in this association as true confounding variables. When adjusted for these variables, however, the association between obesity and an increased risk of Caesarean section still remains. In our study, we sought to evaluate the relation between differences in the management of labour and the association between obesity and Caesarean section rate. Our results suggest that this association may in part be due to differences in the way obese women are managed in labour.

In the design of our study, one of the first elements considered was defining our exposure. Most studies that have evaluated BMI and pregnancy outcomes have used pre-pregnancy BMI as the exposure. We chose instead to use the delivery BMI as the exposure because this would enable us to better evaluate the role of labour management in the association between BMI and Caesarean section rate independent of the effect of pregnancy outcomes (such as preeclampsia, gestational diabetes, and macrosomia). By using delivery BMI, these outcome variables become confounders and can easily be adjusted for. If we had used pre-pregnancy BMI, these variables would have become elements in the causal pathway and controlling for them could have biased the effect of labour management on the association between BMI and Caesarean section rate.

As in previous studies, our results demonstrate that increasing BMI category is strongly associated with Caesarean section rate.[7–12] Several possible explanations for this association must be explored. The first is the possibility of confounding variables. We dealt with confounding by exclusion of subjects or by adjustment in the analysis. Subjects with characteristics that were exclusively associated with either a Caesarean section or a vaginal delivery were excluded at the outset. These included elective Caesarean section, stillbirth, and breech presentation. Variables that were likely to be associated (but not exclusively) with both the exposure and the outcome were adjusted for in the

Association between BMI category and odds of undergoing a Caesarean section



analysis. We included all measured confounding variables that were likely to be important confounders on a priori knowledge. These included maternal age, parity, previous Caesarean section, gestational and pre-existing diabetes, preeclampsia, multifetal pregnancies, induction of labour, initial cervical dilatation, and neonatal birth weight.

After adjusting for confounding, we evaluated the effect of labour management on the association between BMI and Caesarean section rate. In our results, increasing BMI category was strongly associated with differences in use of epidural analgesia, oxytocin, forceps, and vacuum delivery. As well, increasing BMI category was strongly associated with a decrease in the second stage Caesarean section intervention time, suggesting that physicians were quicker to perform a Caesarean section in an obese woman than in a woman of normal BMI. To evaluate the effect of these differences in management, we adjusted for them in a logistic regression model. Prior to adjusting for these variables, we had to account for the fact that Caesarean section intervention time is a measure that is uniquely associated with Caesarean section. Therefore, adjusting for it directly in a logistic regression model would have resulted in the Jacobian matrix becoming singular. An alternative method to account for this variation in labour management was thus devised. We created a variable which identified precipitous Caesarean sections that were performed sooner than expected in our population. We defined these as Caesarean sections performed in a Caesarean section intervention time interval that was shorter than the mean Caesarean section intervention time interval in our population. In our cohort, this mean was 8.7 hours in the first stage of labour or 204 minutes in the second stage of labour. By introducing this variable into our regression model, we were able to adjust for the shorter Caesarean section intervention time that was characteristic of increasing BMI category. When we then adjusted for differences in the management of labour in the analysis, we found that the association between BMI category and Caesarean section rate was substantially attenuated, suggesting that the underlying association between obesity and Caesarean section may in large part be due to differences in the management of labour.

It is unclear why Caesarean section intervention time should differ by BMI category. One possibility is that increasing BMI category is associated with a higher Caesarean section rate for fetal distress and not necessarily with a higher rate for dystocia. When we stratified the analysis by indications and examined only Caesarean sections performed for dystocia, the same association (a significant reduction in the association between BMI category and Caesarean section rate) was observed. A second possibility is that obstetricians may fear encountering shoulder dystocia or having to perform a difficult emergency Caesarean section in an obese patient.[21–23] While this cannot be evaluated in the setting of this or any clinical study, it is conceivable that the obstetrician's perception of risk during labour and delivery may be influenced by the woman's BMI.

One of the limitations of our study was that information on the exposure of interest, delivery BMI, was unavailable for 3960 subjects (24.9%) within the initial cohort. Since not all subjects had information about their weight within the two weeks before delivery, it may be questioned whether or not our study population was representative of the entire cohort. To address this, we compared baseline characteristics and Caesarean section rates between subjects who had a BMI calculated at delivery with subjects missing a delivery BMI. Subjects with no BMI calculated at delivery had a mean maternal age similar to those with a calculated BMI (30.8 years and 30.5 years, respectively), had a similar percentage of multiparity (50.5% vs. 52.1%), and similar rates of previous Caesarean section (6.5% vs. 6.6%) and Caesarean section (13.4% vs. 13.1%), suggesting that the study population is likely to reflect the entire cohort accurately.

Another limitation of our study was that we used established BMI categories to classify women on the basis of their delivery BMI; this does not take into consideration the normal weight gain that may be expected in pregnancy. Although this may wrongfully classify women in higher BMI categories, it is unlikely that this would change the interpretation of our results, which focused primarily on the differences in management seen with increasing BMI categories and not with absolute BMI categories.

CONCLUSION

We have demonstrated that BMI category is strongly associated with differences in the management of labour and delivery. Importantly, these differences may in part explain the well-established association between obesity and an increased risk of Caesarean section. Because of the potential morbidities associated with Caesarean section, we must modify our management approaches to allow equal opportunity for a vaginal birth for all women.

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