

Maternal Morbid Obesity and the Risk of Adverse Pregnancy Outcome

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OBJECTIVE: To evaluate whether morbidly obese women have an increased risk of pregnancy complications and adverse perinatal outcomes.

METHODS: In a prospective population-based cohort study, 3,480 women with morbid obesity, defined as a body mass index (BMI) more than 40, and 12,698 women with a BMI between 35.1 and 40 were compared with normal-weight women (BMI 19.8–26). The perinatal outcome of singletons born to women without insulin-dependent diabetes mellitus was evaluated after suitable adjustments.

RESULTS: In the group of morbidly obese mothers (BMI greater than 40) as compared with the normal-weight mothers, there was an increased risk of the following outcomes (adjusted odds ratio; 95% confidence interval): preeclampsia (4.82; 4.04, 5.74), antepartum stillbirth (2.79; 1.94, 4.02), cesarean delivery (2.69; 2.49, 2.90), instrumental delivery (1.34; 1.16, 1.56), shoulder dystocia (3.14; 1.86, 5.31), meconium aspiration (2.85; 1.60, 5.07), fetal distress (2.52; 2.12, 2.99), early neonatal death (3.41; 2.07, 5.63), and large-for-gestational age (3.82; 3.50, 4.16). The associations were similar for women with BMIs between 35.1 and 40 but to a lesser degree.

CONCLUSION: Maternal morbid obesity in early pregnancy is strongly associated with a number of pregnancy complications and perinatal conditions. (*Obstet Gynecol* 2004; 103:219–24. © 2004 by The American College of Obstetricians and Gynecologists.)

LEVEL OF EVIDENCE: II-2

Today, obesity is a worldwide individual and public health issue because it contributes to the development of several chronic diseases. The rate of obesity in the general population is increasing dramatically. Obesity among fertile women is reaching epidemic proportions.¹ In Sweden, the prevalence of overweight women in their fertile years

doubled during 1980–1997.² The number of women suffering from morbid obesity has also markedly increased in this country during the last decade.

It is already commonly known that maternal overweight and obesity are associated with adverse pregnancy outcome, such as maternal hypertension, preeclampsia, gestational diabetes, more frequent cesarean delivery, delivery of large-for-gestational-age (LGA) infants, and stillbirths.^{3–8} There are obvious signs in a few studies that pregnancies in morbidly obese women show even more complications and adverse outcomes,^{9–11} although low patient numbers limit their statistical power.

The objective of this study was to thoroughly assess, in a large prospective data set from the Swedish medical health register, whether morbid obesity, defined by a body mass index (BMI) 35.1–40 or BMI greater than 40, was associated with an increased risk of adverse perinatal outcome and if so to quantify this risk after adjustment for conceivable confounders.

MATERIALS AND METHODS

The local ethics committee approved this study. The study population consisted of 972,806 pregnancies delivered in Sweden January 1, 1992, through December 31, 2001. In 805,275 (82.8%) cases, information on maternal height and weight in early pregnancy was available. The women were identified by using the Swedish Medical Birth Registry. Medical data on almost all (98–99%) deliveries in Sweden are listed in the register, which also includes stillbirths after 28 weeks of gestation. The register contains a large number of items concerning pregnancy, delivery, and pediatric neonatal examination. It is based on a copy of the standardized medical record forms completed at the maternity health care centers, at the start of prenatal care, usually in gestational weeks 10–12, records from the delivery units, and the pediatric examination of the newborn. The system is identical throughout the country. A description and validation of the register content is available.^{12,13} The midwife records maternal weight and height on a standardized form at the

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first visit at the maternity health care center. Ninety percent of the women present themselves to this antenatal clinic during the first trimester of their pregnancy.

Body mass index (kg/m^2) was calculated from maternal weight and height data. Obese women were defined by a BMI greater than 29. Within this group, two subgroups of morbidly obese women were studied: BMI 35.1–40 and BMI greater than 40. The definition of morbid obesity may vary; therefore, we decided to evaluate the 2 groups separately. Obese women were compared with normal-weight women (BMI 19.8–26).

The unit of analysis was delivery. The possible impact of the fact that a woman may have more than one delivery during the study period was checked by only including the first delivery of each woman during the study period.

Primary outcomes were, antenatally, the occurrence of preeclampsia, abruptio placenta, placenta previa, and stillbirths after 28 weeks of gestation among singleton pregnancies. Around-term variables evaluated were the rate of cesarean delivery, labor inductions, pre- and postterm delivery, instrumental delivery, anal sphincter injury, shoulder dystocia, postpartum hemorrhage, and epidural anesthesia. Small-for-gestational age infants were defined as those with birth weights more than 2 standard deviations below the mean birth weight for gestational age according to a Swedish reference curve,¹⁴ and LGA infants were those with birth weight above 2 standard deviations. Estimated gestational age was in most cases based on second-trimester ultrasound screening.

Neonatal outcomes studied were as follows: meconium aspiration, fetal distress, low Apgar score (less than 7 at 5 minutes), and early neonatal death (less than 7 days after birth). The outcome variables are registered in the Swedish Medical Birth Registry by using the International Classification of Diseases. Women with insulin-dependent diabetes mellitus were excluded.

Maternal age, parity, smoking, and year of birth were thought to be potential confounding factors and were included as covariates in the adjusted analyses. Maternal education, as a marker of socioeconomic status, was also added (information only available for the years 1992–1995). Preexisting hypertension and gestational diabetes were not included as confounders in this analysis for 2 reasons. First, a true confounder affects both the exposure and the outcome. Exposure in this study was prepregnancy massive obesity. Second, our purpose was to address the outcome, not necessarily the path.

Adjusted odds ratios (ORs) were determined by using Mantel-Haenszel technique.¹⁵ The morbidly obese groups, BMI 35–40 and BMI greater than 40, were each compared with normal-weight women (BMI 19.8–26). Estimates of 95% confidence intervals (95% CI) were

made with a test-based method, based on the Mantel-Haenszel χ^2 (Miettinen OS. Simple interval estimation of risk ratio [letter]. *Am J Epidemiol* 1974;100:515–6).

RESULTS

The majority of the women in the study population were of European Caucasian origin, 1% were born in South America, 1.4% were Asian, and 1% came from Sub-Saharan Africa. Maternal BMI could be calculated for 82.8% of all births registered during the study period. In this group, 1.6% (12,698 of 805,275) had a BMI between 35.1 and 40 and 0.4% (3,480 of 805,275) had a BMI greater than 40. Morbidly obese women, defined as having a BMI greater than 35, represented 2% of all pregnant women with a known BMI in this work.

The morbidly obese women were compared with normal-weight women with respect to maternal age, parity, maternal smoking in early pregnancy, and the number of multiple pregnancies (Table 1). The women who were obese were slightly older, more often multiparous, and smokers. Multiple pregnancies occurred equally often across BMI strata.

The following comparisons were restricted to singleton deliveries. Antenatal complications are presented in Table 2. The risk of preeclampsia among the morbidly obese women was increased almost 5-fold. The corresponding OR for women with BMIs between 35.1 and 40 was 3.90. Being morbidly obese carried an almost 3-fold increase in risk of antepartum stillbirths relative to normal-weight women, adjusted OR 2.79 (95% CI 1.94, 4.02). Abruptio placenta occurred equally often among normal-weight women and morbidly obese women. There was a decreased risk of placenta previa in the morbidly obese group, even more pronounced among the heaviest mothers.

Cesarean delivery was more common in morbidly obese women (Table 3). The frequency was almost 3 times as high for morbidly obese women as it was for women of normal BMI. The risk of instrumental delivery was increased 18% in women with a BMI between 35.1 and 40 and increased 34% in women with a BMI greater than 40. When the analyses were restricted to only the first delivery of each woman during the study period, no significant change in OR was obtained. Shoulder dystocia occurred 3 times more often among the morbidly obese women.

Massive obesity was associated with both early and late deliveries. Compared with normal-weight women, morbidly obese women were more likely to be induced, even after deduction of preeclampsia patients: the adjusted OR 2.38 (95% CI 2.17, 2.60).



Table 1. Maternal Characteristics Among Morbidly Obese, Obese, and Normal-Weight Women

	BMI 19.8–26, N = 535,900		BMI 29.1–35, N = 69,143		BMI 35.1–40, N = 12,698		BMI > 40, N = 3,480	
	N	%	N	%	N	%	N	%
Maternal age (y)								
15–19	10,544	2.0	1,026	1.5	157	1.2	42	1.2
20–24	88,083	16.4	12,043	17.4	2,245	17.7	583	16.7
25–29	198,820	37.1	24,451	35.4	4,712	37.1	1,234	35.4
30–34	163,980	30.6	20,501	29.6	3,729	29.4	1,050	30.2
35–39	63,490	11.8	9,182	13.3	1,524	12.0	475	13.6
40–44	10,611	2.0	1,845	2.7	320	2.5	93	2.7
45–49	372	0.07	95	0.1	11	0.09	3	0.09
Parity								
1	229,558	42.8	23,337	33.8	4,220	33.2	1,057	30.4
2	196,483	36.7	25,053	36.2	4,560	35.9	1,222	35.1
3	79,130	14.8	12,458	18.0	2,240	17.6	670	19.2
4	30,729	5.7	8,255	11.9	1,669	13.1	531	15.3
Maternal smoking								
Unknown	12,669	2.4	1,767	2.6	358	2.8	121	3.5
No smoking	444,336	82.9	54,209	78.4	9,636	75.9	2,635	75.7
Smoking < 10 cigarettes/day	52,058	9.7	8,032	11.6	1,567	12.3	412	11.8
Smoking ≥ 10 cigarettes/day	26,837	5.0	5,135	7.4	1,137	9.0	312	9.0
Pregnancy, multiple	7,955	1.5	1,092	1.6	209	1.6	62	1.8

BMI = body mass index.

The prevalence of LGA infants was almost 4 times as high among morbidly obese women than among women with normal BMI (Table 4). The risk was also increased for having a small-for-gestational-age infant among the morbidly obese (greater than 40), although after removing women with preeclampsia, this increased risk was no longer statistically significant: adjusted OR 1.23 (95% CI 0.94, 1.60).

Neonatal outcome data are presented in Table 5. There was a more than 2-fold risk increase for fetal distress and low Apgar scores among infants of the morbidly obese women. Meconium aspiration occurred more often in infants of morbidly obese women than in women with normal BMI values: adjusted OR 2.85 (95% CI 1.60, 5.07). This variable was studied only when a vaginal delivery had been performed. The risk seems to be the same among women with a BMI between 35.1 and 40. For the years 1992–1995, information on maternal

education was available. Adjustment for this factor reduced the estimated ORs only marginally.

A comparison also was made between women with a known BMI and those with an unknown BMI (17.3%) in our sample concerning the above-described variables. There were no differences in ORs. Those with unknown BMI seem to be a random sample of all pregnancies and therefore do not give a selection bias.

DISCUSSION

In this large population-based cohort study, a strong association exists between maternal morbid obesity in early pregnancy and a number of threatening complications during pregnancy, delivery, and in the neonatal period. This association has been pointed out in earlier studies, although low numbers of cases limited their statistical power.

Table 2. Antenatal Complications Among Singleton Pregnancies

	Controls, N = 526,038 [N (%)]	BMI 29.1–35, N = 69,143 [N (%)]	Adjusted OR* (95% CI)	BMI 35.1–40, N = 12,402 [N (%)]	Adjusted OR* (95% CI)	BMI > 40, N = 3,386 [N (%)]	Adjusted OR* (95% CI)
Preeclampsia	7,111 (1.4)	1,917 (2.8)	2.62 (2.49, 2.76)	421 (3.4)	3.90 (3.54, 4.30)	119 (3.5)	4.82 (4.04, 5.74)
Abruptio placenta	938 (0.2)	325 (0.5)	1.00 (0.89, 1.12)	29 (0.2)	1.01 (0.70, 1.47)	8 (0.2)	0.96 (0.80, 1.14)
Placenta previa	1,305 (0.2)	156 (0.2)	0.87 (0.73, 1.02)	19 (0.2)	0.57 (0.37, 0.89)	3 (0.09)	0.32 (0.11, 0.94)
Stillbirths after 28 weeks of gestation	1,470 (0.3)	353 (0.5)	1.79 (1.59, 2.01)	72 (0.6)	1.99 (1.57, 2.51)	28 (0.8)	2.79 (1.94, 4.02)

BMI = body mass index; OR = odds ratio; CI = confidence interval.

Controls were normal-weight women, BMI 19.8–26.

* Adjustments were made for maternal age, parity, smoking in early pregnancy, and year of birth.



Table 3. Labor and Delivery Complications Among Singleton Pregnancies

	Controls, N = 526,038 [N (%)]	BMI 29.1–35, N = 69,143 [N (%)]	Adjusted OR* (95% CI)	BMI 35.1–40, N = 12,402 [N (%)]
Cesarean delivery	57,407 (10.9)	11,587 (16.7)	1.76 (1.72, 1.80)	2,661 (21.5)
Instrumental delivery	36,418 (6.9)	4,097 (5.9)	1.16 (1.12, 1.21)	706 (5.7)
Anal sphincter laceration [†]	13,664 (2.6)	1,372 (2.0)	1.01 (0.95, 1.07)	237 (1.9)
Shoulder dystocia [†]	753 (0.1)	199 (0.3)	2.14 (1.83, 2.49)	44 (0.4)
Major postpartum hemorrhage [†]	29,813 (5.7)	4,158 (6.0)	1.19 (1.15, 1.23)	643 (5.2)
Epidural anesthesia [†]	106,038 (20.2)	13,164 (19.0)	1.20 (1.18, 1.23)	2,370 (19.1)
Induction of labor	40,455 (7.7)	9,035 (13.1)	1.77 (1.73, 1.81)	2,029 (16.4)
Delivery at term (n)	464,314	58,214	Reference	10,408
Delivery at 42 weeks of gestation	37,640 (7.2)	6,072 (8.8)	1.37 (1.33, 1.41)	1,197 (9.6)
Delivery before 37 weeks of gestation	23,905 (4.5)	3,716 (5.4)	1.22 (1.14, 1.31)	788 (6.4)
Delivery before 32 weeks of gestation	3,062 (0.6)	546 (0.8)	1.45 (1.32, 1.59)	136 (1.1)

BMI = body mass index; OR = odds ratio; CI = confidence interval.

Controls were normal-weight women, BMI 19.8–26. Delivery at term (gestational week 37–41) was the reference concerning gestational weeks at delivery.

* Adjustments were made for maternal age, parity, smoking in early pregnancy, and year of birth.

[†] Only vaginal delivery.

Perlow et al¹⁰ determined in the late 1980s the impact of massive obesity (weight more than 300 pounds = more than 136 kg) on perinatal outcome. The study included 111 women who fulfilled this definition. They found an increased risk for overall cesarean delivery (OR 2.9), Apgar score at 5 minutes less than 7 (OR 3.0), birth weight more than 4,500 g (OR 8.1), and intrauterine growth restriction (OR 9.3). More recently, in a study from the United Arab Emirates concerning 188 morbidly obese women, BMIs greater than 40 were presented.⁹ An increased risk for cesarean delivery (OR 2.3) and birth weight above 4,000 g (OR 3.9) was described.

When it comes to relatively rare complications, such as shoulder dystocia and stillbirth, sufficient patient numbers concerning the morbidly obese women have not previously been available. In a recent report from Sweden, the risk of stillbirth was doubled among obese women (BMI greater than 30).⁷ Our findings indicate an almost 3-fold increased risk of antepartum stillbirth in the group of morbidly obese women. Whatever mechanism is behind the association between maternal obesity and stillbirth, it seems to be influenced by the degree of obesity.

Massive obesity seems to be protective from placenta previa. The information on this condition comes to the register from the delivery units and therefore it is unlikely that the decreased risk is due to undetected cases by ultrasound among the massively obese.

In a large study from London, no increased risk of instrumental delivery was seen among women with a BMI greater than 30.³ That is in contrast with our findings because we found a slightly increased risk specifically for the massively obese women. Anal sphincter lacerations were surprisingly not over-represented in the group of morbidly obese women despite the increased prevalence of LGA infants, instrumental deliveries, and the use of epidural anesthesia. All of these are factors well documented to be associated with an increased risk of perineal lacerations.^{16,17} A possible explanation is that midline episiotomy is not practiced at all in Sweden. There were increased numbers of labor inductions. From a clinical point of view, this is relevant and warrants further evaluation, such as the reasons for induction of labor, which is beyond the scope of this study.

The advantage of register studies is that the large number of individuals available for evaluation gives

Table 4. Risk of Delivering a SGA or LGA Infant in Singleton Pregnancies Among Obese and Morbidly Obese Women

Maternal body mass index	AGA	SGA < 2 SD	Adjusted OR* (95% CI)	LGA > 2 SD	Adjusted OR* (95% CI)
19.8–26	486,783	10,981	Reference	26,339	Reference
29.1–35	58,738	1,257	0.98 (0.93, 1.04)	7,744	2.20 (2.14, 2.26)
35.1–40	10,260	234	1.02 (0.90, 1.17)	1,848	3.11 (2.96, 3.27)
>40	2,675	79	1.37 (1.09, 1.71)	610	3.82 (3.50, 4.16)

SGA = small for gestational age; LGA = large for gestational age; AGA = appropriate for gestational age; SD = standard deviation; OR = odds ratio; CI = confidence interval.

* Adjustments were made for maternal age, parity, smoking in early pregnancy, and year of birth.



Adjusted OR* (95% CI)	BMI > 40, N = 3,386 [N (%)]	Adjusted OR* (95% CI)
2.32 (2.22, 2.42)	821 (24.2)	2.69 (2.49, 2.90)
1.18 (1.09, 1.28)	195 (5.8)	1.34 (1.16, 1.56)
1.02 (0.90, 1.17)	60 (1.8)	1.04 (0.80, 1.35)
2.82 (2.10, 3.71)	13 (0.4)	3.14 (1.86, 5.31)
1.36 (1.25, 1.48)	187 (5.5)	1.70 (1.45, 1.98)
1.17 (1.12, 1.24)	571 (16.9)	1.17 (1.06, 1.30)
2.27 (2.16, 2.38)	618 (18.3)	2.53 (2.32, 2.75)
Reference	2,746	Reference
1.49 (1.40, 1.58)	379 (11.2)	1.80 (1.62, 2.01)
1.48 (1.37, 1.59)	260 (7.7)	1.85 (1.63, 2.10)
1.95 (1.65, 2.31)	44 (1.3)	2.32 (1.73, 3.12)

higher statistical power and makes it possible to demonstrate associations with low-prevalence pregnancy outcome variables. The drawback is the sometimes-low validity of information.

Exposure information (weight and height) was recorded in early pregnancy and therefore prospective regarding the pregnancy outcome variables. Recall bias was thus avoided. Exposure information could be retrieved for 82.8% of all births registered during the study period. We evaluated the group of women with missing data on weight and height and no ORs concerning the outcome variables studied were increased compared with women with known BMI. The possibility of selection bias of extremely obese women in the group of women with missing data is thus less probable.

A number of potential confounding factors associated with maternal obesity were adjusted for in this study, such as maternal age, parity, and smoking in early pregnancy. A putative confounding factor, not stratified for in this study, is socioeconomic level that could have affected the results, but smoking during pregnancy is strongly correlated with socioeconomic level in Sweden.¹⁸ For part of the material, maternal education was

added as a confounder. This reduced the estimated ORs marginally.

We did not exclude women with gestational diabetes diagnosed in late pregnancy. It is possible that our sample includes women with undetected or unreported non-insulin-dependent diabetes, which could explain the results, but these conditions can be regarded as intermediaries. The same is true for the inclusion of women with chronic hypertension. The purpose of this study was to evaluate the pregnancy outcome in the group of morbidly obese women and not to identify the mechanisms behind the associations. Earlier studies also found that stratifying for a number of potential factors that could influence the outcome did not substantially change the risk estimates.³

It is possible that a multiple-testing problem exists. Most effects found are strong and highly statistically significant, but some are moderate and show marginal statistical significance and may be the result of multiple testing, for example, the increased risk for postpartum bleeding.

Another problem concerning studies in this field is the definition of obesity and even more difficult the definition of morbid obesity. Different values for defining obesity were used in different studies, which make it difficult to compare risk estimates. To facilitate such comparisons, we present risk estimates for both women with BMIs between 35.1 and 40 and women with BMIs greater than 40. There seems to be overall slightly higher risk estimates in the group with BMIs greater than 40 as compared with the group with BMIs between 35.1 and 40, although ratios are not statistically significantly different.

This large study points out a strong association between maternal morbid obesity in early pregnancy and a number of threatening complications during pregnancy, delivery, and in the neonatal period. The importance of these findings could be examined from different views. It

Table 5. Neonatal Outcomes Among Singleton Pregnancies

	Controls, N = 526,038 [N (%)]	BMI 29.1–35, N = 69,143 [N (%)]	Adjusted OR* (95% CI)	BMI 35.1–40, N = 12,402 [N (%)]	Adjusted OR* (95% CI)	BMI > 40, N = 3,386 [N (%)]	Adjusted OR* (95% CI)
Meconium aspiration [†]	731 (0.1)	85 (0.1)	1.64 (1.30, 2.06)	42 (0.3)	2.87 (2.13, 3.85)	11 (0.3)	2.85 (1.60, 5.07)
Fetal distress	10,470 (2.0)	1,865 (2.7)	1.61 (1.53, 1.69)	429 (3.5)	2.13 (1.93, 2.35)	131 (3.9)	2.52 (2.12, 2.99)
Low Apgar score (< 7 at 5 minutes)	4,956 (0.9)	966 (1.4)	1.58 (1.47, 1.69)	205 (1.7)	1.81 (1.57, 2.08)	86 (2.5)	2.91 (2.36, 3.58)
Birthweight > 4500g	17,277 (3.3)	5,080 (7.3)	2.15 (2.08, 2.23)	1,188 (9.6)	3.03 (2.85, 3.21)	384 (11.3)	3.55 (3.20, 3.93)
Early neonatal death [‡]	750 (0.1)	84 (0.1)	1.59 (1.25, 2.01)	35 (0.3)	2.09 (1.50, 2.91)	14 (0.4)	3.41 (2.07, 5.63)

BMI = body mass index; OR = odds ratio; CI = confidence interval.

Controls were normal-weight women, BMI 19.8–26.

* Adjustments were made for maternal age, parity, smoking in early pregnancy, and year of birth.

[†] Only vaginal deliveries.

[‡] Based on livebirths.



implicates the need of prepregnancy advice and counseling to young women and could be a convincing argument for weight reduction in this group. Pregnancies among morbidly obese women must be classified as high-risk pregnancies, and appropriate antenatal care should be provided. In addition, massive obesity among women of child-bearing age is associated with a number of health risks later in life.

Pregnancy is a life event in which women are inclined to behavioral changes. Is it possible that with appropriate management before and during pregnancy, the gestational weight gain could be reduced and maybe even contribute to persistent behavioral changes concerning nutrition and physical exercise postpartum?

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