The effects of booking body mass index on obstetric and neonatal outcomes in an inner city UK tertiary referral centre

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Summary: The aim of the study was to investigate the effects of booking body mass index (BMI) on obstetric and neonatal outcomes in an inner city UK tertiary referral maternity centre. The Guy's and St Thomas' Maternity and Gynaecology (Terranova Healthcare) Database was studied. All women that delivered at St Thomas' during 2005 with normal and high BMI were included in the study. Subjects were divided into three groups: BMI 19–24.9 (normal); 25–29.9 (overweight) and 30 or greater (obese). Groups were compared using Stata Statistical software. The study included 3642 patients: 2169 normal, 945 overweight and 528 obese. Both overweight and obese groups had a statistically significant association with gestational diabetes (odds ratio [OR] 5.7 and 11.6), hypertension in pregnancy (including preeclampsia [ORs 1.5 and 2.4], preterm rupture of membranes (ORs 3.7 and 5.0) and preterm delivery (ORs 1.4 and 1.6). The rate for caesarean delivery was increased in both overweight and obese women (ORs 1.4 and 1.7). Obesity is an independent risk factor for adverse obstetric outcomes and is significantly associated with caesarean section delivery.

Keywords: complications, high-risk pregnancy, maternal mortality, obesity

INTRODUCTION

Recently, obesity has become the focus of public health concern in western society. In the UK there is an increasing rate of obesity in all age groups, but notably in childhood and adolescents, with a correspondingly greater number of obese women of childbearing age. The proportion of women that were categorized as obese increased from 16.4% in 1993 to 24.2% in 2006.¹ Although, the public is now becoming more aware of the consequences of obesity in the general population, few realize the unique dangers it poses to the health of the mother and fetus.

Importantly, in the last *Confidential Enquiry into Maternal Death*, 27% of all women who died were obese. The report highlighted obesity as a very important risk factor for thromboembolism, hypertension, diabetes, infection, postpartum haemorrhage and cardiac problems, which are all causes of maternal death. It further stressed the need for urgent guidelines in the management of obesity in pregnancy.²

Obesity is usually classified according to the body mass index (BMI). This relies on both the body weight (kilograms) and height (metres). The BMI is calculated from the formula:

$$\text{BMI} = \frac{\text{weight}}{\text{height}^2}$$

It is expressed as a number; so the greater the BMI, the more obese the individual. In terms of BMI, subjects can then be

classified as underweight, normal weight, overweight and obese (Table 1). A generally accepted definition of obesity is the BMI > 30 kg/m².

In the context of obstetric practice, these would obviously have to be related to prepregnancy weight. However, if that is unknown, it should be calculated at a patient's booking visit with the midwife or obstetrician in the first trimester of pregnancy as little weight is gained during this time.³

The obstetric unit at St Thomas' Hospital is a tertiary referral centre for South East England, and it also serves the boroughs of Southwark and Lambeth. These are two of the most deprived inner city communities in London. The population is ethnically diverse, and has great and varied health-care needs, including obstetric care. This study aims to investigate the effects of prepregnancy BMI on obstetric outcomes in the UK in an inner city setting, as our population perfectly represents the target for any intervention strategies.

MATERIALS AND METHODS

The Maternity and Gynaecology Healthcare Database at St Thomas' Hospital contains all prospectively collected data on the women admitted to the hospital. All women that delivered at St Thomas' during 2005 with a normal and high BMI were included in the study. Low weight (BMI < 19) has been shown to be associated with increased risk of preterm delivery, low birth weight and a decreased incidence of preeclampsia, gestational diabetes, obstetric intervention and postpartum haemorrhage.⁴ As a result, the women in this category were not included in the analysis. Prepregnancy BMI could not be

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Table 1 World Health Organization definition of normal and abnormal body weight using body mass index (BMI)²⁵

BMI (kg/m ²)	Description
<18.5	Underweight
18.5–24.9	Healthy weight
25.0–29.9	Overweight (Grade 1 obesity)
30.0–39.9	Obese (Grade 2 obesity)
>40	Morbidly obese (Grade 3 obesity)

reliably obtained, as in our population patients do not commonly weigh themselves, have poor recall and some of the pregnancies are unplanned. The booking BMI was chosen because it could be verified in the context of obstetric practice.³ Three groups were identified in this cohort: those with normal BMI at booking, those who were overweight and those who were obese. BMI categories were defined as follows: normal (19–24.9), overweight (25–29.5) and obese (>30). The investigated outcome variables included rates of gestational diabetes, rates of hypertension in pregnancy including preeclampsia (defined as blood pressure >140/90 on 2 occasions, 6 hours apart and proteinuria of >300 mg in 24 hours), preterm rupture of membranes (PROM) and rates of caesarean sections (CS), spontaneous labour, preterm delivery and extreme preterm delivery. Preterm delivery was defined as birth before 37 completed weeks and extreme preterm delivery was defined as birth before 34 completed weeks. Logistic regression modelling was used to examine the effects of BMI on obstetric outcomes. ORs, together with 95% confidence intervals (CI), were calculated to approximate relative risks of adverse outcomes for three BMI categories (normal 19–24.9, overweight BMI 25–29.9 and obese BMI > 30). Stata statistical software was used for data analysis. A *P* value <0.05 was considered significant.

RESULTS

There were 6050 pregnancies in 2005 at St Thomas' Hospital, South East London, UK. Of these, 2168 (36%) women had

Figure 1 Body mass index distribution in the cohort

incomplete BMI compared with 3864 (64%) who had complete BMI data. Missing BMI was often the consequence of missing height, weight or antenatal care outside the institution. Two hundred and twenty-two women with a BMI <19 were excluded from the study. Of the remaining 3642 women

Table 3 Ethnic characteristics of the cohort compared with body mass index

Ethnicity	Mean BMI	Frequency (%)
Caucasian	24.08	1669 (46)
Black	26.9	1267 (35)
Asian	23.41	276 (8)
Other	24.9	430 (12)

Table 4 Antenatal, intrapartum and neonatal outcomes

Outcome	N (%)	OR	95% CI	P value
Gestational diabetes	43 (1)			
Normal weight	7	1.00		
Overweight	17	5.68	2.34–13.75	<0.001
Obese	19	11.58	4.84–27.69	<0.001
Hypertension in pregnancy	48 (1)			
Normal weight	24	1.00		
Overweight	9	1.47	1.04–2.09	0.029
Obese	15	2.37	1.64–3.43	<0.001
CS delivery	757 (21)			
Normal weight	389	1.00		
Overweight	224	1.41	1.17–1.70	<0.001
Obese	144	1.71	1.37–2.13	<0.001
Spontaneous labour	2352 (65)			
Normal weight	389	1.00		
Overweight	224	0.97	0.83–1.15	0.804
Obese	144	0.93	0.76–1.13	0.478
PROM	19 (0.5)			
Normal weight	5	1.00		
Overweight	8	3.71	1.21–11.37	0.022
Obese	6	4.99	1.51–16.43	0.008
Preterm delivery <37	334 (9)			
Normal weight	170	1.00		
Overweight	103	1.43	1.11–1.86	0.006
Obese	61	1.55	1.14–2.12	0.005
Preterm delivery <34	140 (4)			
Normal weight	71	1.00		
Overweight	45	1.47	1.00–2.15	0.046
Obese	24	1.42	0.88–2.27	0.145
Neonatal ITU admission	231 (6)			
Normal weight	153	1.00		
Overweight	65	1.10	0.81–1.49	0.537
Obese	13	0.92	0.62–1.39	0.722

Table 2 Patient characteristics based on booking body mass index (BMI)

Characteristics	Booking BMI		
	Normal (n = 2169)	Overweight (n = 945)	Obese (n = 528)
Age	30.14 (± 5.91)	30.98 (± 5.95)	31.70 (± 6.11)
Gestational age at delivery (weeks)	39.62 (± 2.95)	39.38 (± 3.16)	39.18 (± 3.85)
Ethnicity			
Caucasian	1177 (54%)	330 (35%)	162 (31%)
Black	520 (24%)	448 (47%)	299 (57%)
Asian	207 (9%)	54 (6%)	15 (3%)
Other	265 (12%)	113 (12%)	52 (10%)
Parity			
Primip	1324	450	190
Multip	854	495	338

analysed, 2169 (60%) were of normal BMI, 945 (26%) were of overweight category and 528 (15%) were obese (Figure 1). Demographic characteristics are shown in Table 2. Ethnic origins of the cohort along with average BMI are shown in Table 3, demonstrating the ethnic diversity of the cohort. The age distribution was as follows: the average age was 30.6 ± 5.98 , range 16–47 years and median 31. There were 58 (1.6%) pregnancies that resulted in pregnancy loss (miscarriage, $n = 28$; still birth, $n = 18$; termination of pregnancy <24 weeks $n = 11$ and termination of pregnancy >24 weeks $n = 1$). The mean prepregnancy weight was 67.6 kg (range 39–196) and the mean BMI was 24.7 (range 19–68). No differences in the rates of spontaneous labour and neonatal Intensive Care Unit (ICU) admission were observed between the three BMI groups. Compared with women with a normal BMI, overweight women had a significantly increased risk of gestational diabetes, hypertension in pregnancy, caesarean delivery, prolonged rupture of membranes, preterm delivery and extreme preterm delivery (Table 4). Women classified as obese by their BMI were significantly more likely to have gestational diabetes, hypertension in pregnancy, CS, PROM and preterm delivery than those with a normal BMI (Table 4). An increased incidence of extreme preterm delivery was observed in the overweight group compared with the normal BMI group.

DISCUSSION

It has been reported that women categorized as overweight and obese are at an increased risk of obstetric complications during their pregnancy compared with women who are of normal weight. A majority of studies have described an increased risk for gestational diabetes, gestational hypertension and pre-eclampsia associated with obesity.^{5–10} Our results show a very significant likelihood of gestational diabetes in mothers who are both overweight (OR 5.68 [CI 2.34–13.75]) and obese (OR 11.58 [CI 4.84–27.69]).

There was also a significant association with hypertensive diseases for overweight (OR 1.47 [CI 1.04–2.09]) and obese mothers (OR 2.37 [CI 1.64–3.43]).

The rate of CS was significantly higher in women who were overweight (OR 1.41 [CI 1.17–1.70]) and obese (OR 1.71 [CI 1.37–2.13]), compared with women with a normal BMI; similar results have been reported by other investigators.^{5,9,11–14} Several suggestions have been proposed for this relationship: obese patients have been reported to have a higher incidence of cephalopelvic disproportion and failure to progress during labour.¹⁵ In addition, there is the difficulty in monitoring the fetus. External fetal heart monitoring by continuous cardiotocography using external abdominal transmitters can be technically difficult particularly during early labour, as the depth of the maternal adipose tissue can interfere with the Doppler signal.¹⁶ The finding of increased CS rates in obese women has serious implications for their intraoperative and postoperative management,¹⁷ such as increased operative time,¹⁸ increased incidence of postoperative wound infection and increased anaesthesia associated risks.³

There was no difference in the rates of spontaneous labour in the three groups. This suggests that overweight and obese women were just as likely to start labouring, but were less likely to deliver vaginally compared with women with a normal BMI.

The intrapartum outcomes assessed were PROM, preterm delivery and extreme preterm delivery. It was found that overweight (OR 3.71 [CI 1.21–11.37]) and obese (OR 4.99 [CI

1.51–16.43]) women were more likely to have PROM when compared with mothers with a normal weight.

There have been conflicting results regarding the risk of preterm delivery and its association with obesity. Sebire *et al.*,⁶ Kumari¹⁰ and Cnattingius *et al.*¹¹ found a significantly decreased risk for preterm labour in obese patients, whereas Baeten *et al.*⁷ found an increased risk and Bianco *et al.*⁸ and Doherty *et al.*⁹ found no association.

In our study, overweight (OR 1.43 [CI 1.11–1.86]) and obese (OR 1.55 [CI 1.14–2.12]) women are more likely to deliver a preterm baby when compared with normal weight women. An increased incidence of extreme preterm delivery was observed in both overweight and obese groups, but it was only significantly increased in the overweight women possibly due to a smaller cohort size in the obese group. These findings have implications for the transgenerational effect of obesity.¹⁹ Barker's fetal origin of adult disease hypothesis demonstrates that low-weight babies have an increased risk of developing cardiovascular disease and diabetes. As obese women are likely to deliver preterm, and coupled with the growing epidemic of obesity, this can potentiate implications for health in future generations.²⁰ This study did not find any differences in the rate of neonatal ICU admission rates between the groups, however, which could be explained by the small cohort size.

This cohort is very likely to represent the inner city population of other UK cities and possibly that of the USA and some large European cities. The ethnic distribution of the cohort was around 46% of Caucasian, 35% of Black Afro-Caribbean, 8% of Asian and 12% of other ethnic groups. Additionally, the age distribution is unique as the hospital is a high-risk referral centre with mothers of advanced maternal age and it serves as a catchment area that ranks as the highest in the UK for teenage pregnancies. It also represents a population that has great socioeconomic needs,²¹ and this has been found to be associated with increasing obesity.^{22–24}

This study has highlighted a series of public health issues. For example, during the statistical analysis, it was found that the BMIs were incorrectly assigned. The database classification was overgenerous: if a woman had a BMI over 25 but less than 26, she was still considered to be of normal weight, whereas in the WHO classification, she would be considered overweight. Additionally, a woman with a BMI over 30, but less than 31, would be considered overweight and not obese as should be. This means that there is an underestimation of women who are overweight and obese. As this database is in use nationally, it poses serious implications for the recognition of obesity and its management. Another problem identified was in the hospital database design; there were limited options to input other high-risk diagnoses. This means that various high-risk diagnoses are under-reported. The fact that in our database a third of BMI values were not recorded indicates a lack of awareness of obesity as a risk factor. Although, it is possible that a proportion of them were booked elsewhere and therefore records were not accessible at the time, this still represents a high number of unrecorded BMI. All together, these observations indicate that the standard data collection process in the UK health service is currently inadequate and needs to be reviewed.

In present day health care, there is a growing concern about resource allocation and their uses. The WHO estimates that 7% of all health care cost is associated with obesity-related morbidity.²⁵ The findings of increased rates of CS and the associated

surgical and anaesthetic complications for overweight and obese patients have vast implications for health-care providers. The average hospital stay for CS delivery is around five days when compared with one day for vaginal delivery. Moreover, it appears to increase as the maternal weight increases as well. Increased rates of preterm delivery also mean more expensive specialized care for the baby and increasing health-care costs. Therefore, it seems that strategies in primary care that encourage obesity management would achieve considerable financial rewards.

Although we are becoming more aware of the serious consequences imposed by obesity on pregnancy, there still seems to be a lack of management of obesity because once pregnant, options appear to be limited. It is not recommended that obese women lose weight during pregnancy due to the increased risk of ketosis and restricted nutrition adversely affecting the fetus. The Cochrane review revealed that energy/protein restriction has no clear effect on pregnancy-induced hypertension or pre-eclampsia, and its effect on other outcomes including maternal and perinatal morbidity and mortality has not been reported.²⁶ This study demonstrates that women labelled overweight and obese at booking need to be considered as 'high risk' and have consultant lead shared care and be appropriately counselled regarding their risks when attending antenatal clinics. As mentioned earlier, a high proportion of women who died – 78 (35%) in the triennium report (2003–2005)² – were classified as obese. Furthermore, strategies for diabetes and hypertension screening should be enforced and protocols for anaesthetic antenatal review as appropriate should be agreed. Ideally, strategies are most likely to be beneficial preconception; however, as a significant number of pregnancies are unplanned, they will need to be targeted at earlier age groups prior to the reproductive years.

CONCLUSION

In conclusion, this study demonstrates and confirms that an increased BMI increases the incidence of gestational diabetes, hypertension in pregnancy, CS rates, preterm delivery and PROM. Maternity services must recognize the importance of this, and establish strategies and reliable systems that accurately identify overweight and obese women and provide appropriate antenatal management pathways to reduce the incidence of adverse outcomes. This study also benefits from its uniqueness in that it represents the population of the UK inner city and also demonstrates relevant public health issues in a population where interventions from public health-care providers could have a significant impact.

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