



**THE IMPACT OF BODY MASS INDEX IN PREGNANT WOMEN AND THEIR
OBSTETRIC OUTCOMES IN A TERTIARY CARE HOSPITAL OF SOUTH INDIA
FROM AUGUST 2013-2015**

**Dr. Roya Rozati¹, Dr. Akhila Reddy^{1*}, Dr. Surayya Tahseen², Dr. Nazima Allaudin³, Dr. Fatima Tahniyath⁴,
Dr. Fatima Hafeez⁴ and Ayyapathi Mehdi Gautam⁵**

¹MBBS, MD, FRCOG (London), AIIMS (Delhi) HOD, Department of Obstetrics and Gynecology, Owaisi Hospital and Research Centre, Hyderabad, Telangana, India.

^{1*}MBBS, MS (Final Year Student), Department of Obstetrics and Gynecology, Owaisi Hospital and Research Centre, Hyderabad, Telangana, India.

²MBBS, MS (Final year student), Department of Obstetrics and Gynecology, Owaisi Hospital and Research Centre, Hyderabad, Telangana, India.

³Asst. Professor, Department of Obstetrics and Gynecology, Deccan College of Medical Sciences, Hyderabad, Telangana, India.

⁴B.Pharmacy, Pharm D (PB), Clinical pharmacist, Owaisi Hospital and Research Centre, Hyderabad, Telangana, India.

⁵MBBS, 2 Year Student, Deccan College of Medical Sciences, Hyderabad, Telangana, India.

***Author for Correspondence: Dr. Akhila Reddy**

MBBS, MS (Final Year Student), Department of Obstetrics and Gynecology, Owaisi Hospital and Research Centre, Hyderabad, Telangana, India.

Article Received on 29/12/2015

Article Revised on 20/01/2016

Article Accepted on 11/02/2016

ABSTRACT

OBJECTIVE To assess the prevalence of overweight and obesity, and the impact of body mass index (BMI) on maternal and neonatal outcomes, in a UK obstetric population. **STUDY DESIGN:** A retrospective study was conducted and data was collected from births between August 2013 to August 2015 within a tertiary referral unit, with over 3600 births per year. **STUDY PERIOD:** August 2013 – August 2015 **STUDY SITE:** This study was carried out in OWAISI HOSPITAL AND RESEARCH CENTRE as a clinical audit and therefore did not require approval from a Research Ethics Committee. Women were categorised according to World Health Organization classification: underweight (BMI < 18.50 kg/m²); normal weight (BMI 18.50–24.99 kg/m²; reference group); Over weight (BMI 25.00–29.99 kg/m²); obese class I (BMI 30.00– 34.99 kg/m²); obese class II (BMI 35–39.99 kg/m²); and obese class III (BMI ≥ 40 kg/m²). Maternal and neonatal outcomes were examined using logistic regression, adjusted for confounding variables. **RESULTS :** The study highlights a relationship between increasing BMI (from overweight to obese class III) and increasing risk of adverse outcomes, including gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy, caesarean section, macrosomia, and neonatal unit admission, with women in the highest obesity group at risk of additional adverse out-comes, including stillbirth, a longer postnatal stay, and wound problems following caesarean section. By categorising women into overweight and obesity sub classifications (classes I –III), this study clearly demonstrates an increasing risk of adverse outcomes across BMI categories, with women who are overweight also at significant risk both in terms of maternal and neonatal outcomes.

KEYWORDS: Body mass index, maternal and neonatal outcomes, obesity, pregnancy.

INTRODUCTION

Obesity has become an epidemic throughout the world with doubling rates in last 30 year.^[1] Rate of incidence in pregnant women has also increased.^[2,3] Maternal obesity significantly contributes to increase in morbidity and mortality of both mother and baby. A higher proportion of women who die due to pregnancy or postpartum are obese.^[4,5]

Gestational diabetes mellitus (GDM), gestational

hypertension, thromboembolism, and pre-eclampsia are few risks associated with obesity during pregnancy.^[6] Obesity is associated with poor labor outcomes, as obese women are less likely to go into labor spontaneously and more likely to have prolonged pregnancies and have their labor induced, as chances for a normal delivery are less and that of caesarean section are more.^[2,7-13] Obese women are less likely to breastfeed due to longer postnatal stay in hospital, and risk of postnatal infections.^[7-10, 14] Obesity is also associated with a higher

risk of adverse neo- natal outcomes, including stillbirth, congenital anomalies, neonatal intensive care admission, and neonatal death.^[2, 7-9]

Additionally there are long-term consequences in pregnancy due to obesity as these women tend to be heavier with every pregnancy^[15] and remain obese adults, with all the associated increased risks of obesity.^[16, 17] Many studies demonstrate that having an obese mother increases the risk of a child growing up to be obese themselves.^[18,19] The impact that obesity in pregnancy has long-term health of society on the whole, is therefore immeasurable.

Several studies have revealed adverse outcomes in pregnancy due to obesity.^[2, 10,20-25] However, none of these studies have looked at adverse outcomes in relation to each of the World Health Organisation (WHO) body mass index (BMI) classifications, where obesity is subdivided into obese class I, II, and III (morbid obesity). The objective of this study was to assess the prevalence of over- weight and obesity, and to investigate the impact of rising BMI using the WHO classification on maternal and neonatal outcomes.

METHODOLOGY

STUDY DESIGN: A retrospective study was conducted and data was collected from births between August 2013 to August 2015 within a tertiary referral unit, with over 3600 births per year.

STUDY PERIOD: August 2013 – August 2015.

STUDY SITE: This study was carried out in OWAISI HOSPITAL AND RESEARCH CENTRE as a clinical audit and therefore did not require approval from a Research Ethics Committee.

INCLUSION CRITERIA: Anonymised data on 2600 babies were collated with data retrieved relating to each baby delivered within the 2 year study period.

EXCLUSION CRITERIA: Births at less than 24 weeks of gestation ;multiple pregnancies; BMI recorded after 16 weeks of gestation; and patients with no BMI data were excluded from the study.

STUDY SAMPLE: The final cohort consisted of 2600 cases.

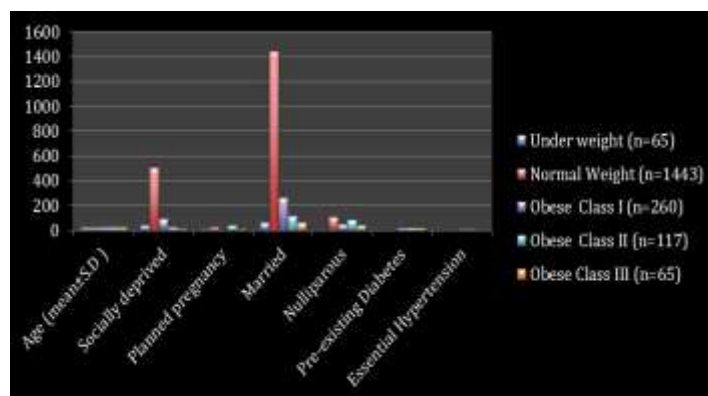
PLAN OF WORK: The BMIs (kg/m²) were calculated from the heights and weights measured during the antenatal booking visits. Women were categorized using the WHO classification: underweight (BMI < 18.50 kg/m²); normal weight (BMI 18.50–24.99 kg/m²; reference group); overweight (BMI 25.00–29.99 kg/m²); obese class I (BMI 30–34.99 kg/ m²); obese class II (BMI 35–39.99 kg/m²); and obese class III (BMI ! 40 kg/m²).^[26] Data are expressed as frequency (n) and percentages (%) or means and standard deviations (SDs). Logistic regression was used to calculate chi square values for categorical variables, with the normal BMI group as the standard reference population and P < 0.01 was considered significant. All variables were adjusted for age, parity, year of birth. In addition, induction of labour, emergency caesarean section, elective caesarean section, and preterm and post-term birth were adjusted for pre-gestational diabetes mellitus and essential hypertension; birthweight was adjusted for gestational age and gender.

RESULTS

An early pregnancy BMI (at 16 weeks of gestation) was available for 80% of women who met other inclusion criteria. Within this cohort, women were categorized as underweight (2.5%), normal weight (55.5%), overweight (25%), obese class I (10%), obese class II (4.5%), and obese class III (2.5%). Demographic and clinical characteristics are outlined in Table 1. Compared with women of normal weight, a higher proportion of underweight women were younger, nulliparous, unmarried, smokers, and socially deprived. By contrast, as BMI increased, so did maternal age and parity.

Table I: Demographic and clinical characteristics by BMI category(kg/m²)

Characters	Under weight (n=65)	Normal Weight	Over	Obese	Obese	Obese
		(n=1443)	Weight (n=650)	Class I (n=260)	Class II (n=117)	Class III (n=65)
Age (mean±S.D)	22.23	23.77	25.95	26	26.05	24.76
Socially deprived	40	500	250	90	25	12
Planned pregnancy	10	25	12	5	38	9
Married	65	1443	650	260	117	65
Nulliparous	1	104	180	47	82	38
Pre-existing Diabetes	0	2	10	20	22	20
Essential Hypertension	0	0	5	10	8	6



Antenatal outcomes are outlined in Table ii. The risk for GDM increased by 7.6% across the overweight and obese categories, for women classified as obese class III. Likewise, the risk of hypertensive disorders of pregnancy also increased by 4.6% in relation to an increase in BMI classification, for women in obese class III. Only the women who were underweight were at increased risk of anaemia, and there was no statistically significant association between being underweight and any other antenatal outcome. There was no statistically significant association between any of the BMI categories and the following antenatal outcomes: placenta praevia, antepartum haemorrhage, placental abruption, or thromboembolism.

The intranatal outcomes are outlined in Table ii. The rate of induction of labour increased with each BMI category from 16.9% in underweight women to 21.5% in obese class III. Similarly caesarean section rate, both emergency and elective was Likewise, women who were overweight were at increased risk of caesarean section, and this risk increased with an increase in BMI to an for women in

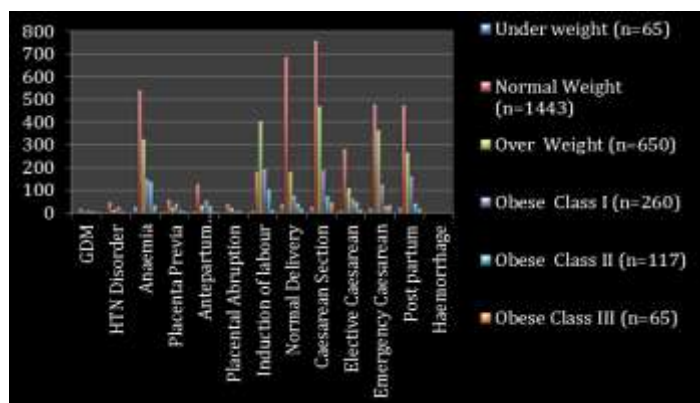
obese class III. This increased risk exists for both emergency caesarean section and elective caesarean section. Conversely, overweight and obese women were less likely to have a normal delivery or an instrumental delivery. The for normal delivery and for instrumental delivery decreased with an increase in BMI to and , respectively, for women in obese class III. The risk of post-partum haemorrhage (PPH) increased as BMI increased There was no statistically significant risk of shoulder dystocia or third- or fourth-degree perineal tear in relation to BMI.

Postnatal outcomes are included in Table ii. Women who were overweight or obese were less likely to breastfeed, and the for this variable decreased as BMI increased, such that women who were morbidly obese had an. There was an increased risk of wound problems following caesarean section for women in obese class II and in obese class III Women in obese class III were at higher risk of a postnatal stay greater than 5 days Maternal antenatal, intranatal, and postnatal outcomes are depicted in Table ii along with their p values.

Table 2. Maternal outcomes by BMI category (kg/m²)

Maternal Outcomes	Normal Weight (n=1443)	Under weight (n=65)	Over Weight (n=650)	Obese Class I (n=260)	Obese Class II (n=117)	Obese Class III (n=65)
GDM	16	1 [1.27(0.06)]	5 [11.98(4.07)]	10 [8.42(0.30)]	8 [5.70(0.92)]	5 [1.63(0.97)]
HTN Disorder	47	2 [2.19(0.02)]	12 [20.66(3.63)]	25 [14.52(7.57)]	8 [9.83(0.34)]	3 [2.81(0.01)]
Anaemia	538	25 [28.93(0.53)]	322 [273.48(8.61)]	149 [192.19(9.71)]	134 [130.20(0.11)]	32 [37.20(0.73)]
Placenta Previa	56	6 [4.11(0.87)]	26 [38.83(4.24)]	43 [27.29(9.04)]	11 [18.49(3.03)]	8 [5.28(1.40)]
Antepartum Haemorrhage	124	8 [5.51(1.13)]	32 [52.05(7.72)]	52 [36.58(6.50)]	28 [24.78(0.42)]	6 [7.08(0.16)]
Placental Abruption	37	3 [1.90(0.63)]	21 [21.93(0.04)]	8 [10.99(0.81)]	9 [5.05(0.09)]	2 [3.12(0.40)]
Induction of labour	179	11 [31.92(13.71)]	400 [367.74(2.83)]	192 [184.29(0.32)]	104 [84.70(4.40)]	14 [52.35(28.10)]
Normal Delivery	686	38 [18.77(19.69)]	180 [216.26(0.08)]	75 [108.38(10.28)]	43 [40.81(0.93)]	18 [30.79(106.33)]
Caesarean Section	757	27 [27.00(0.00)]	470 [470.00(0.00)]	185 [185.00(0.00)]	74 [74.00(0.00)]	47 [47.00(0.00)]
Elective Caesarean	281	10 [8.04(0.48)]	107 [139.89(7.73)]	62 [55.06(0.87)]	45 [22.02(23.97)]	15 [13.99(0.07)]
Emergency Caesarean	476	17 [08.98(0.20)]	363 [330.11(3.28)]	123 [129.94(0.37)]	29 [51.98(10.16)]	32 [33.01(0.03)]

Post partum Haemorrhage	474	23 [22.40(0.02)]	263 [258.08(0.09)]	158 [129.34(0.35)]	43 [59.44(4.55)]	19 [36.74(8.57)]
-------------------------	-----	---------------------	-----------------------	-----------------------	---------------------	---------------------



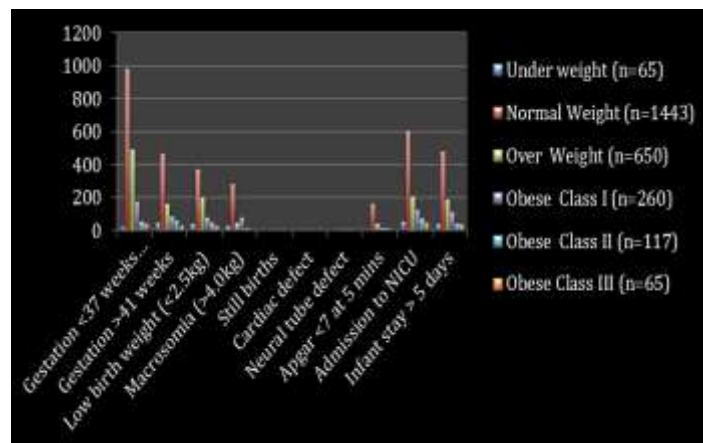
Neonatal outcomes are presented in Table iii. In relation to spontaneous preterm birth, all BMI groups were at slightly increased risk compared with women of normal weight; however, this was only statistically significant for obese class I and obese class III. When adjusted for gestational age and gender, the underweight group was at increased risk of delivering a baby of low birthweight with borderline significance ($P = 0.01$). However, all three obese groups were less likely to have a baby of low birthweight (<2.5 kg), and this risk decreased as BMI increased, such that women in obese class III had an of just below the level of significance ($P = 0.001$). There was a statistically significant association between macrosomia (birthweight 4.0 kg) and BMI categories. The underweight group was least likely to deliver a

macrosomic baby whereas women in obese class III were most likely to deliver a macrosomic baby. The risk of stillbirth was of borderline significance for women in obese class III. Neural tube defects were only statistically significant for women in obese class II. Only women in obese class III had a statistically significant association with low Apgar score at 5 minutes. After adjusting for pre-gestational diabetes and preterm delivery, the risk for admission to the neonatal unit was still statistically significant for the three obese groups: obese class I, obese class II, and obese class III.

The neonatal outcomes were also calculated based on p values, level of significance 0.001 shown in table iii.

Table 3. Neonatal outcomes by BMI category (kg/m²)

Neonatal Outcomes	Normal Weight (n=1443)	Under weight (n=65)	Over Weight (n=650)	Obese Class I (n=260)	Obese Class II (n=117)	Obese Class III (n=65)
Gestation <37 weeks (pre term)	980	20 [59.41(26.14)]	492 [404.97(18.71)]	175 [188.20(0.93)]	55 [80.72(8.20)]	38 [46.71(1.62)]
Gestation >41 weeks	463	45 [28.71(9.24)]	158 [195.73(7.27)]	85 [90.96(0.39)]	62 [39.02(13.54)]	27 [22.58(0.87)]
Low birth weight (<2.5kg)	373	37 [29.48(1.92)]	197 [200.92(0.08)]	76 [93.38(3.23)]	48 [40.05(1.58)]	29 [23.18(1.46)]
Macrosomia (>4.0kg)	279	28 [13.02(17.22)]	45 [88.78(21.59)]	78 [41.26(32.72)]	12 [17.70(1.83)]	8 [10.24(0.49)]
Still births	0	1 [0.38(1.01)]	1 [2.60(0.98)]	1 [1.21(0.04)]	1 [0.52(0.45)]	1 [0.30(1.64)]
Cardiac defect	1	2 [1.11(0.71)]	2 [4.71(1.56)]	3 [2.80(0.01)]	2 [1.38(0.28)]	2 [1.00(0.99)]
Neural tube defect	2	4 [3.33(0.13)]	8 [14.12(2.65)]	9 [8.41(0.04)]	5 [4.12(0.19)]	7 [3.01(5.27)]
Apgar <7 at 5 mins	158	8 [8.08(0.00)]	38 [34.23(0.42)]	16 [20.38(0.94)]	12 [10.00(0.40)]	6 [7.31(0.23)]
Admission to NICU	604	50 [50.08(0.00)]	208 [212.23(0.08)]	125 [126.38(0.02)]	69 [62.00(0.79)]	44 [45.31(0.04)]
Infant stay > 5 days	480	41 [42.40(0.05)]	189 [179.71(0.48)]	112 [107.02(0.23)]	42 [52.50(2.10)]	36 [38.37(0.15)]



DISCUSSION

Main Findings

The retrospective study carried out in our hospital setting demonstrates the risk of adverse maternal and neonatal outcomes increased among overweight or obese groups. This study highlights a relationship between increasing BMI (from overweight to obese class III) and increasing risk of adverse outcomes, including gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy, caesarean section, macrosomia, and neonatal unit admission, with women in the highest obesity group at risk of additional adverse out-comes, including stillbirth, a longer postnatal stay, and wound problems following caesarean section.

Current guidelines recommend that women with a BMI > 30 should be offered a glucose tolerance test antenatally, and that those with a BMI > 35 should have additional monitoring for pre-eclampsia.^[28] Obese women here were at an increased risk of GDM and hypertensive disorders of pregnancy, and this risk increased as BMI increased, a finding consistent with other studies.^[2,7,9,11-13,21,23] However, women who were overweight were also at increased risk of hypertensive disorders of pregnancy and GDM, and therefore 'at risk' women who are overweight or obese (class I) may not be offered appropriate antenatal screening under the current guidelines. Intranatally, obesity contributes to poorer outcomes as found in other studies, in our study women who were obese were more likely to have their labour induced, were less likely to have a vaginal delivery, and were at increased risk of PPH.^[2,8,9,11,23,29,30] To the best of the authors' knowledge, no studies till date have investigated the role of intranatal management on outcomes for women who are overweight or obese, and thus further research is now needed to elucidate the optimal intranatal management for women who are overweight or obese. Postnatally, in our study, women who were obese were less likely to breastfeed successfully, which has been reported elsewhere.^[14] This has long-term implications for health, in particular with regard to obesity, as breastfeeding has been associated with women losing more weight postnatally, and breastfed babies are less likely to become obese.^[31,32]

In terms of neonatal outcomes, maternal BMI clearly influencing birthweight was observed in our study, with women who were underweight being more likely to deliver a baby of low birthweight, and women in obese class III being more likely to have a macrosomic baby. In a recent study by Wloch *et al.*, obesity was associated with risk of wound infection among the population reported here, with risk increasing with BMI category.^[33] In our study, women in obese class III were at higher risk in relation to stillbirth, as has been demonstrated in other larger studies.^[8,34]

Limitations and strengths

One of the major strengths of our study is the categorization of women into all WHO BMI classification categories, including the three categories of obesity. To our knowledge, this is the only Indian study to look at each separate category of obesity, thereby enabling the observation of a much clearer association in terms of risk and obesity for several outcomes. Because of the relatively large cohort in this study, it was possible to examine the outcomes for each BMI category, be selective about the deliveries included, and adjust for potentially confounding variables, yet still obtain statistically significant results for several important outcomes. Another strength of our study is the availability of BMIs for 93.3% of women, with BMIs recorded in early pregnancy (before 16 weeks of gestation), and therefore more likely to reflect pre-pregnancy BMIs, in line with current recommendations.^[28]

As with any study, there are some limitations. As a result of the data available on the NIMATS database, our study was only able to look at hypertensive disorders of pregnancy, rather than clearly distinguishing between conditions such as pre-eclampsia or gestational hypertension, and thus could not specifically assess the individual risks for these conditions. Although weight gained during pregnancy can have an impact on risk,^[17,29,35,36] the current study was unable to adjust for pregnancy weight gain, as women were not routinely reweighed during pregnancy. For outcomes where only a limited number of cases are available, such as neural tube defects and stillbirth, false negatives are possible,

and the results should be interpreted with caution. Data was not available to take into account clustering of births, and thus it is possible that a woman may have contributed more than one birth over the time period. Finally, it must be highlighted that although the current study provides a comprehensive analysis of antenatal, intranatal, and neonatal outcomes across the BMI categories over an 2-year period, this has resulted in multiple comparisons, and, given the large number of outcomes considered, further studies are needed to confirm the findings.

Interpretation

This study infers that women who are obese are more likely to require special medical care during their pregnancy, as a result of the increased risks associated with obesity. Women who were overweight or obese were less likely to labour without medical intervention, and were more likely to need a caesarean section, increasing the level of medical input, with cost implications for intranatal care. Although women in the highest BMI category were at the highest risk for an adverse outcome, these women, as expected, represented the smallest group in this study (1.9%). The largest 'at risk' groups were women who were overweight or in obese class I, representing 38.8% of the cohort studied. As national guidelines currently focus primarily on women within the highest BMI groups, and given resource allocation pressures within the health service, women who are overweight or in obese class I may not receive additional screening or management. Admittedly, these women may not have the same level of risk as women with the highest BMI; however, they are still at increased risk of several adverse outcomes, as highlighted in this study. This provides a challenge for healthcare professionals, as a substantial proportion of women they care for will be 'at risk' as a result of being overweight or obese, yet may not be identified as such, according to local policy and national guidelines.

In summary, being overweight or obese has a significant adverse impact on maternal and neonatal outcomes, with risk increasing across BMI categories. These risks have obvious implications for the management of these women during their pregnancy, labour, and postnatal period. It is important when planning care for women who are overweight or obese that resources are allocated appropriately in order to minimize the risk factors for these women. While current guidelines consider women who are obese, women who are overweight are also at an increased risk, and should therefore also be monitored closely during pregnancy and delivery to ensure optimum outcomes for women and their babies.

Ethical Statements

Disclosure of interests; No conflicts of interest to declare.

Contribution to authorship; All authors equally participated in the study, prepared the article and

approved the final version for publication.

Ethics approval; This study was designed as an audit, being a retrospective study, thus did not require ethics committee approval.

Funding; No Funding was received for the study.

REFERENCES

1. Obesity and overweight: Fact sheet 311. World Health Organisation. 2011 [www.who.int/mediacentre/factsheets/fs311/en/]. Accessed 10 May 2011.
2. Bhattacharya S, Campbell DM, Liston WA, Bhattacharya S. Effect of body mass index on pregnancy outcomes in nulliparous women delivering singleton babies. *BMC Public Health* 2007; 7: 168–76.
3. Ono T, Guthold R, Strong K. WHO Global Comparable Estimates, 2010. WHO Global Infobase. [http://apps.who.int/infobase/]. Accessed 15 June, 2011.
4. Confidential Enquiry into Maternal and Child Health. Saving Mothers' Lives: Reviewing Maternal Deaths to Make Motherhood Safer - 2003-2005. London: CEMACH, 2007.
5. Centre for Maternal and Child Enquiries (CMACE). Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer: 2006–2008. The Eighth Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. *BJOG* 2011; 118(Suppl. 1): 1–203.
6. Centre for Maternal and Child Enquiries. Maternal Obesity in the UK: Findings from a National Project. London: CMACE, 2010.
7. Callaway LK, Prins JB, Chang AM, McIntyre HD. The prevalence and impact of overweight and obesity in an Australian obstetric population. *Med J Aust* 2006; 194: 56–9.
8. Cedegren MI. Maternal morbid obesity and the risk of adverse pregnancy outcome. *ObstetGynecol* 2004; 103: 219–24.
9. Dodd JM, Grivell RM, Nguyen A, Chan A, Robinson JS. Maternal and perinatal health outcomes by body mass index category. *Aust N Z J ObstetGynaecol* 2011; 51: 136–40.
10. Kerrigan AM, Kingdon C. Maternal obesity and pregnancy: a retrospective study. *Midwifery* 2010; 26: 138–46.
11. Schrauwers C, Dekker G. Maternal and perinatal outcome in obese pregnant patients. *The Journal of Maternal-Fetal and Neonatal Medicine* 2009; 22: 218–26.
12. Sukalich S, Mingione MJ, Glantz C. Obstetric outcomes in overweight and obese adolescents. *Am J ObstetGynecol* 2006; 195: 851–5.
13. Weiss JL, Malone FD, Emig D, Ball RH, Nyberg DA, Comstock CH, et al. Obesity, obstetric complications and cesarean delivery rate – a population-based screening study. *Am J ObstetGynecol* 2004; 190: 1001–7.
14. Baker J, Michaelsen KF, Sorensen TIA, Rasmussen

- KM. High prepregnant body mass index is associated with early termination of full and any breastfeeding in Danish women. *Am J Clin Nutr* 2007; 86: 404–11.
15. Villamor E, Cnattingius S. Interpregnancy weight change and risk of adverse pregnancy outcomes: a population-based study. *Lancet* 2006; 368: 1164–70.
 16. Rooney BL, Schauburger CW. Excess pregnancy weight gain and long-term obesity: one decade later. *ObstetGynecol* 2002; 100: 245–52.
 17. Soltani H, Fraser RB. A longitudinal study of maternal anthropometric changes in normal weight, overweight and obese women during pregnancy and postpartum. *Br J Nutr* 2000; 84: 95–11.
 18. Deierlein A, Siega-Riz AM, Adair LS, Herring AH. Effects of pre-pregnancy body mass index and gestational weight gain on infant anthropometric outcomes. *The Journal of Pediatrics* 2011; 158: 221–6.
 19. Mingrone G, Manco M, Valera Mora ME, Guidone C, Iaconelli A, Gniuli D, et al. Influence of maternal obesity on insulin sensitivity secretion in offspring. *Diabetes Care* 2008; 31: 1872–6.
 20. Bergholt T, Lim LK, Jorgensen J, Robson MS. Maternal body mass index in the first trimester and risk of caesarean section in nulliparous women in spontaneous labor. *Am J ObstetGynecol* 2007; 196: 163.e1-163.e5
 21. Chereshneva M, Hinkson L, Oteng-Ntim E. The effects of booking body mass index on obstetric and neonatal outcomes in an inner city UK tertiary referral centre. *Obstet Med* 2008; 1: 88–91.
 22. Mantakas A, Farrell T. The influence of increasing BMI in nulliparous women on pregnancy outcome. *Eur J ObstetGynecolReprodBiol* 2010; 153: 43–6.
 23. Sebire NJ, Jolly M, Harris JP, Wadsworth J, Joffe M, Beard RW, et al. Maternal obesity and pregnancy outcome: a study of 287,213 pregnancies in London. *Int J ObesRelatMetabDisord* 2001; 25: 1175–82.
 24. Smith GCS, Shah I, Pell JP, Crossley JA, Dobbie R. Maternal obesity in early pregnancy and risk of spontaneous and elective preterm deliveries: a retrospective cohort study. *Am J Public Health* 2007; 97: 157–62.
 25. UshaKiran TS, Hemmadi S, Bethel J, Evans J. Outcome of pregnancy in a woman with an increased body mass index. *BJOG* 2005; 112: 768–72.
 26. IOM. *Weight Gain During Pregnancy: Re-Examining the Guidelines*. Washington DC: National Academics Press, 2009.
 27. Northern Ireland Statistics and Research Agency. [<http://www.nisra.gov.uk/index.html>]. Accessed 11 September 2011.
 28. Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists. *CMACE/RCOG joint guideline: management of women with obesity in pregnancy*. Royal College of Obstetricians and Gynaecologists. 2010 [<http://www.rcog.org.uk/files/rcog-corp/CMACERCOGJointGuidelineManagementWomenObesityPregnancy.pdf>]. Accessed 30 September 2011.
 29. Doherty DA, Magann EF, Francis J, Morrison JC, Newnham JP. Pre-pregnancy body mass index and pregnancy outcomes. *Int J GynaecolObstet* 2006; 95: 242–7.
 30. Rode L, Nilas L, Wojdemann K, Tabor A. Obesity-related complications in Danish single cephalic term pregnancies. *ObstetGynecol* 2005; 105: 537–42.
 31. Baker JL, Gamborg M, Heitmann BL, Lissner L, Sorensen TIA, Rasmussen KM. Breastfeeding reduces postpartum weight retention. *Am J Clin Nutr* 2008; 88: 1543–51.
 32. Dietz WH. Breastfeeding may help prevent childhood overweight. *JAMA* 2001; 285: 2506–7.
 33. Wloch C, Wilson J, Lamagni T, Harrington P, Charlett A, Sheridan E. Risk for surgical site infection following caesarean section in England: results from a multicentre cohort study. *BJOG* 2012; 119: 1324–33.
 34. Denison FC, Price J, Graham C, Wild S, Liston WA. Maternal obesity, length of gestation, risk of postdates pregnancy and spontaneous onset of labour at term. *BJOG* 2008; 115: 720–5.
 35. Bodnar LM, Siega-Riz AM, Simban HN, Himes KP, Abrams B. Severe obesity, gestational weight gain, and adverse birth outcomes. *Am J Clin Nutr* 2010; 91: 1642–8.
 36. Cedegren M. Effects of gestational weight gain and body mass index on obstetric outcome in Sweden. *Int J Gynaecol Obstet* 2006; 93: 269–74.