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Maternal and neonatal complications of fetal macrosomia: cohort study

J. BETA[1], N. KHAN[1], M. FIOLNA[1], A. KHALIL[1], G. RAMADAN[2] and R. AKOLEKAR[1,3]

[1]*Fetal Medicine Unit, Medway Maritime Hospital, Gillingham, UK;* [2]*Oliver Fisher Neonatal Unit, Medway Maritime Hospital, Gillingham, UK;* [3]*Institute of Medical Sciences, Canterbury Christ Church University, Chatham, UK*

KEYWORDS: brachial plexus injury; large-for-gestational age; macrosomia; obstetric sphincter injury; pregnancy complications; shoulder dystocia

ABSTRACT

Objective *To estimate the risks of maternal and neonatal complications in pregnancies with macrosomia.*

Methods *This was a retrospective cohort study conducted at a large maternity unit in the UK between January 2009 and December 2016. The incidence of maternal and neonatal complications in pregnancies with macrosomia, defined as birth weight (BW) > 4000 g, and in those with severe macrosomia, defined as BW > 4500 g, was compared with that in pregnancies with normal BW (2500–4000 g). Regression analysis was performed to determine odds ratios (ORs) for complications in macrosomic pregnancies compared to those with normal BW.*

Results *The study population of 35 548 pregnancies included 4522 (12.7%) with macrosomia, of which 643 (1.8%) had severe macrosomia, and 31 026 (87.3%) with normal BW. In the macrosomia group, the adjusted OR was 3.1 (95% CI, 2.6–3.6) for Cesarean section for failure to progress, 2.4 (95% CI, 2.0–3.0) for severe postpartum hemorrhage, 2.3 (95% CI, 1.9–2.8) for obstetric anal sphincter injury, 10.4 (95% CI, 8.6–12.6) for shoulder dystocia, 28.5 (95% CI, 8.9–90.7) for obstetric brachial plexus injury, 32.3 (95% CI, 3.8–278.2) for birth fractures and 4.4 (95% CI, 2.2–8.8) for hypoxic-ischemic encephalopathy. The respective values in pregnancies with severe macrosomia were 4.3 (95% CI, 3.1–6.1), 2.9 (95% CI, 1.9–4.4), 3.1 (95% CI, 1.9–5.1), 28.7 (95% CI, 20.8–39.8), 73.9 (95% CI, 15.1–363.2), 87.2 (95% CI, 7.7–985.0) and 13.8 (95% CI, 5.2–36.8).*

Conclusion *Macrosomia is associated with serious adverse perinatal outcomes. This study provides accurate estimates of risks to aid in pregnancy management.* Copyright © 2019 ISUOG. *Published by John Wiley & Sons Ltd.*

INTRODUCTION

Fetal macrosomia is commonly defined as a neonate with a birth weight (BW) of more than 4000 g[1–3]. This cut-off corresponds to the 90th percentile at 40 weeks' gestation, therefore the prevalence of macrosomia is approximately 10%[3,4]. Fetal macrosomia is associated with maternal complications such as emergency Cesarean section (CS), postpartum hemorrhage (PPH), perineal trauma and neonatal complications, including shoulder dystocia, obstetric brachial plexus injury (OBPI), birth fracture of the humerus or clavicle and birth asphyxia[5–7]. However, there is considerable variation in the reported literature with regard to study design, sample size and type of complications reported and there is often a lack of adjustment for confounding factors affecting the outcome measures, which introduces significant bias to estimates of the risk of these complications[5,6,8–14].

The objectives of this study were, first, to estimate the absolute risks of maternal and neonatal complications in pregnancies with macrosomia; second, to determine odds ratios (ORs) for these complications, after adjusting for maternal and pregnancy characteristics; and, third, to determine absolute risks and relative risks for each complication as well as composite maternal and neonatal outcomes, according to BW.

METHODS

Study population

This was a retrospective cohort study of data obtained at a large obstetric and neonatal unit at Medway NHS Foundation Trust, Gillingham, UK, during the period 1st January 2009 to 31st December 2016. At our hospital, all women attend the fetal medicine unit at 11–13 weeks' gestation for an ultrasound examination. At this visit, maternal demographic characteristics and medical history are recorded in an electronic database (Viewpoint version

Correspondence to: Prof. R. Akolekar, Institute of Medical Sciences, Canterbury Christ Church University, Rowan William's Court, Chatham, Kent ME4 4UF, UK (e-mail: ranjit.akolekar@canterbury.ac.uk)

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5.6; GE Healthcare, Buckinghamshire, UK). Details of intrapartum and neonatal care in pregnancies admitted to the neonatal intensive care unit (NICU) are recorded in separate electronic databases (Euroking Maternity Software, Wellbeing software, Mansfield, UK; BadgerNet Neonatal Electronic Patient Record, Edinburgh, UK). A common database was constructed, which contained information about maternal demographics, obstetric and medical history and antenatal, intrapartum and neonatal details, by combining electronic searches of each of these databases. This study was approved by the NHS Research Ethics Committee in the UK (Reference number 19/LO/0502).

Inclusion and exclusion criteria

The inclusion criteria were a singleton pregnancy booked and delivered at our hospital, and birth of a phenotypically normal neonate at ≥ 24 weeks' gestation. Multiple pregnancies, miscarriages, stillbirths, terminations of pregnancy, pregnancies with major fetal defects and those that were lost to follow-up were excluded.

Pregnancies meeting the inclusion criteria were divided according to BW into macrosomia (BW > 4000 g), normal (BW 2500–4000 g) and small (BW < 2500 g). In the macrosomia group, a subgroup of severe macrosomia (BW > 4500 g) was identified. The small-BW group was excluded from further analysis to avoid confounding effects on the rate of maternal and neonatal complications due to prematurity and low BW. Outcomes in the macrosomia and severe-macrosomia groups were compared with those in the normal-BW group.

Outcome measures

Maternal complications

The maternal complications examined were prolonged first and second stages of labor, instrumental vaginal delivery, failed instrumental delivery requiring CS, emergency CS for any indication, CS for failure to progress (FTP) in labor, PPH and obstetric anal sphincter injury (OASIS). Prolonged first stage of labor was defined as first stage with a duration of > 18 h in nulliparous women and > 12 h in parous women[15]. Prolonged second stage of labor was defined as second stage with a duration of > 2 h in nulliparous women and > 1 h in parous women[15]. Instrumental vaginal delivery was defined as that requiring either vacuum extraction or forceps, and those that required CS following an unsuccessful application of either instrument were classified as failed instrumental delivery[16]. The Lucas classification was used to classify CS as elective or emergency[17]. PPH was defined as estimated blood loss of > 500 mL in the third stage of labor and was classified as minor (500–1000 mL), moderate (1001–2000 mL) or severe (> 2000 mL)[18]. OASIS encompassed third and fourth degree vaginal tears involving a perineal injury to the anal sphincter complex and anorectal mucosa[19].

Neonatal complications

Shoulder dystocia was defined as a vaginal delivery requiring an additional obstetric maneuver to deliver the fetus after delivery of the head and failure of gentle traction[20]. Shoulder dystocia was divided into two groups: the first group included any shoulder dystocia that required any maneuver and the second group included severe dystocia, defined as a need for internal obstetric manipulation, such as Wood's corkscrew, Rubin's maneuver or delivery of the posterior arm[21]. OBPI resulting from a traction injury to the nerves during delivery was diagnosed in the NICU following clinical examination by a senior neonatologist, based on evidence of upper limb weakness or paralysis[22]. Birth fracture to the clavicle or humerus was diagnosed on X-ray examination. Hypoxic-ischemic encephalopathy (HIE) was diagnosed when there was disturbed neurologic function with evidence of perinatal hypoxia, reflected in either a 5-min Apgar score of < 5, umbilical artery cord pH of < 7.0 or base deficit of > 12 mmol/L, supported by neuroimaging evidence of acute brain injury[23]. Hypoglycemia was defined as a neonatal serum glucose level of < 2.6 mmol/L[24].

Composite of maternal and neonatal complications

Emergency CS for FTP, severe PPH and OASIS were combined into a composite maternal outcome. Similarly, shoulder dystocia, birth fractures/OBPI and HIE were combined into a composite neonatal outcome. These complications are likely to occur together, so an estimate of the risk of any one of these adverse outcomes as a composite measure should potentially reduce overestimation of such risks.

Statistical analysis

Comparison of the maternal and pregnancy characteristics in the outcome groups was by the χ^2 test or Fisher's exact test for categorical variables and the Mann–Whitney *U*-test for continuous variables. Statistical significance was set at $P < 0.05$, and the Bonferroni correction was used to adjust for multiple comparisons when necessary.

Data for maternal and neonatal complications were entered into contingency tables and absolute risks for maternal and neonatal complications were estimated by determining the prevalence of these complications in the macrosomia and severe-macrosomia groups, divided by the prevalence in the normal-BW group. Logistic regression analysis was carried out for each maternal and neonatal complication to estimate unadjusted univariate ORs. Multivariate ORs were derived from logistic regression analysis with backward stepwise elimination by introducing into the regression analysis maternal demographic factors, pregnancy and labor characteristics and macrosomia or severe macrosomia as binary variables. Prior to the regression analysis, continuous variables, such as age, weight and height, were centered by subtracting the arithmetic mean from

each value to avoid effects of multicollinearity. The final model was a combination of variables that provided a significant contribution to the prediction of the maternal or neonatal complications in the regression analysis. Estimates of absolute risk were derived for severe maternal and neonatal complications and the respective composite adverse outcomes, according to BW from 4000 to 6000 g. The relative risk for each BW category was then derived by dividing the absolute risk in pregnancies with macrosomia by the absolute risk in the normal-BW group. Forest plots were constructed to express the OR for each maternal and neonatal complication in the macrosomia and severe-macrosomia groups. BW was regressed against the severe maternal and neonatal complications to demonstrate graphically the increase in risk of these complications with increasing BW.

The statistical packages SPSS 24.0 (IBM SPSS Statistics for Windows, Version 24.0, 2016; IBM Corp., Armonk, NY, USA) and MedCalc Statistical Software version 18.5 (MedCalc Software, Ostend, Belgium; http://www.medcalc.org; 2018) were used for data analysis.

RESULTS

Study population

During the study period (January 2009 to December 2016), 41 774 women were booked for delivery at our hospital. Of these, 4121 pregnancies were excluded; reasons for exclusion were multiple pregnancy ($n = 1346$), miscarriage, stillbirth, fetal defect or termination of pregnancy ($n = 1106$), pregnancy delivered elsewhere ($n = 1026$) and loss to follow-up ($n = 643$). In total, 37 653 singleton pregnancies fulfilled the entry criteria, including 31 026 (82.4%) with normal BW, 4522 (12.0%) with macrosomia and 2105 (5.6%) with low BW. The macrosomia group included 643 (14.2%) with severe macrosomia. The group with a small neonate was not considered for further analysis, thus leaving a study population of 35 548 pregnant women.

The maternal and pregnancy characteristics of the women in the study groups are compared in Table 1. In the macrosomia group, compared with the normal group, there was a higher median maternal age, weight

Table 1 Maternal and pregnancy characteristics in pregnancies delivering non-macrosomic fetus and those with fetal macrosomia

Maternal and pregnancy characteristics	*Normal BW (2500–4000 g)* (n = *31 026*)	*Macrosomia*	
		BW > 4000 g (n = *4522*)	*BW > 4500 g* (n = *643*)
Age (years)	28.6 (24.3–32.7)	29.4 (25.5–33.2)*	30.0 (26.1–34.0)*
Weight (kg)	66.0 (58.0–78.0)	73.1 (63.9–86.0)*	77.0 (66.0–90.0)*
Height (m)	1.64 (1.60–1.68)	1.67 (1.62–1.70)*	1.68 (1.63–1.72)*
Ethnicity			
Caucasian	28 036 (90.4)	4253 (94.1)	600 (93.3)
Afro-Caribbean	999 (3.2)	122 (2.7)	21 (3.3)
South Asian	1475 (4.8)	94 (2.1)*	13 (2.0)†
East Asian	132 (0.4)	15 (0.3)	2 (0.3)
Mixed	384 (1.2)	38 (0.8)†	7 (1.1)
Conception			
Spontaneous	30 796 (99.3)	4485 (99.2)	638 (99.2)
Assisted	230 (0.7)	37 (0.8)	5 (0.8)
Cigarette smoker	5736 (18.5)	462 (10.2)*	57 (8.9)*
History of medical disorder			
Chronic hypertension	265 (0.9)	25 (0.6)	7 (1.1)
Pre-existing diabetes mellitus	197 (0.6)	30 (0.7)	2 (0.3)
Gestational diabetes mellitus	839 (2.7)	136 (3.0)	32 (5.0)*
Asthma	1826 (5.9)	243 (5.4)	37 (5.8)
Epilepsy	199 (0.6)	22 (0.5)	1 (0.2)
Parity			
Nulliparous	15 948 (51.4)	1999 (44.2)	259 (40.3)
Parous without previous macrosomia	13 419 (43.3)	1621 (35.8)*	179 (27.8)
Parous with previous macrosomia	1659 (5.3)	902 (19.9)*	205 (31.9)
Gestational age at delivery (weeks)	39.6 (39.6–40.5)	40.6 (40.0–41.3)*	41.0 (40.2–41.4)*
Onset of labor			
Spontaneous	20 728 (66.8)	2751 (60.8)	343 (53.3)
No labor, elective CS	3192 (10.3)	412 (9.1)	71 (11.0)
Induction of labor	7106 (22.9)	1359 (30.1)*	229 (35.6)*
Mode of delivery			
Spontaneous vaginal	20 832 (67.1)	2781 (61.5)*	356 (55.4)
Instrumental vaginal	2795 (9.0)	452 (10.0)	54 (8.4)
Elective CS	3192 (10.3)	412 (9.1)	71 (11.0)
Emergency CS	4207 (13.6)	877 (19.4)*	162 (25.2)
Estimated blood loss (mL)	300 (250–500)	400 (300–600)*	450 (300–700)*

Data are given as median (interquartile range) or *n* (%). Adjusted Bonferroni significance level, $P = 0.025$. For comparison with normal birth-weight (BW) group: *$P < 0.0001$; †$P < 0.01$. CS, Cesarean section.

and height, a lower incidence of women of South Asian origin and cigarette smokers and, in those with severe macrosomia, a higher incidence of gestational diabetes mellitus. With regard to pregnancy characteristics, in the macrosomia group compared to the normal group, there was a higher median gestational age at delivery and estimated blood loss and a higher proportion of women undergoing induction of labor.

Maternal complications

In the macrosomia group, there was a significantly higher prevalence of all maternal complications (Table 2), with a 3-fold increased risk of CS for FTP and an almost 2.5-fold increased risk of severe PPH and OASIS (Table 3 and Figure 1a). In the severe-macrosomia group, there was a significantly increased risk for all adverse outcomes except

Table 2 Absolute risk of maternal and neonatal complications in pregnancies delivering non-macrosomic fetus and those with fetal macrosomia

Complication	*Normal BW (2500–4000 g)* (n = *31 026*)	*Macrosomia*	
		BW > 4000 g (n = *4522*)	*BW > 4500 g* (n = *643*)
Maternal			
Prolonged first stage of labor	1895/26 200 (7.2)	408/3882 (10.5)*	63/513 (12.3)*
Prolonged second stage of labor	1533/24 838 (6.2)	306/3694 (8.3)*	43/486 (8.8)†
Instrumental delivery[1]	2795/23 627 (11.8)	452/3233 (14.0)*	54/410 (13.2)
Failed instrumental delivery[2]	103/2898 (3.6)	31/483 (6.4)†	3/57 (5.3)
All emergency CS[3]	4207/27 834 (15.1)	877/4110 (21.3)*	162/572 (28.3)*
Emergency CS for FTP[4]	832/24 459 (3.4)	295/3528 (8.4)*	52/462 (11.3)*
All PPH	2098/31 026 (6.8)	587/4522 (13.0)*	99/643 (15.4)*
Severe PPH	344/31 026 (1.1)	137/4522 (3.0)*	26/643 (4.0)*
OASIS[1]	478/23 627 (2.0)	121/3233 (3.7)*	19/410 (4.6)*
Neonatal			
All shoulder dystocia[1]	247/23 627 (1.0)	256/3233 (7.9)*	70/410 (17.1)*
Severe shoulder dystocia[1]	26/23 627 (0.1)	60/3233 (1.9)*	24/410 (5.9)*
OBPI[1]	4/23 627 (0.02)	12/3233 (0.4)*	3/410 (0.7)*
Birth fractures[1]	1/23 627 (0.004)	5/3233 (0.2)*	2/410 (0.5)*
HIE[1]	21/23 627 (0.1)	13/3233 (0.4)*	5/410 (1.2)*
Hypoglycemia	413/31 026 (1.3)	77/4522 (1.7)†	20/643 (3.1)*

Data are given as *n*/*N* (%). Adjusted Bonferroni significance level, $P = 0.025$. For comparison with normal birth-weight (BW) group: *$P < 0.0001$; †$P < 0.01$. Absolute risk calculated as proportion of: [1]vaginal deliveries only; [2]all instrumental deliveries attempted; [3]all deliveries excluding elective CS; [4]all deliveries excluding elective CS and those for fetal distress. CS, Cesarean section; FTP, failure to progress; HIE, hypoxic-ischemic encephalopathy; OASIS, obstetric anal sphincter injury; OBPI, obstetric brachial plexus injury; PPH, postpartum hemorrhage.

Table 3 Univariate and multivariate odds ratios (OR) for risk of maternal or neonatal complications in pregnancies with fetal macrosomia

Complication	*Macrosomia (BW > 4000 g)*		*Severe macrosomia (BW > 4500 g)*	
	Univariate OR (95% CI)	*Multivariate OR (95% CI)*	*Univariate OR (95% CI)*	*Multivariate OR (95% CI)*
Maternal				
Prolonged first stage of labor	1.51 (1.35–1.69)	1.55 (1.37–1.76)	1.80 (1.37–2.35)	1.75 (1.29–2.37)
Prolonged second stage of labor	1.37 (1.21–1.56)	1.28 (1.12–1.48)	1.48 (1.07–2.03)	1.30 (0.92–1.83)
Instrumental delivery	1.21 (1.09–1.35)	1.51 (1.33–1.71)	1.13 (0.85–1.51)	1.51 (1.09–2.10)
Failed instrumental delivery	1.86 (1.23–2.82)	1.87 (1.24–2.85)	1.51 (0.46–4.90)	—
All emergency CS	1.52 (1.40–1.65)	1.54 (1.40–1.68)	2.22 (1.85–2.67)	2.12 (1.72–2.60)
Emergency CS for FTP	2.59 (2.26–2.97)	3.07 (2.62–3.59)	3.60 (2.77–4.84)	4.32 (3.05–6.13)
All PPH	2.06 (1.87–2.27)	1.82 (1.64–2.01)	2.51 (2.02–3.12)	1.99 (1.59–2.50)
Severe PPH	2.79 (2.28–3.41)	2.40 (1.95–2.96)	3.76 (2.50–5.64)	2.93 (1.93–4.44)
OASIS	1.88 (1.54–2.31)	2.29 (1.86–2.82)	2.35 (1.47–3.76)	3.12 (1.92–5.08)
Neonatal				
All shoulder dystocia	8.14 (6.81–9.73)	10.37 (8.57–12.55)	19.49 (14.64–25.95)	28.74 (20.75–39.79)
Severe shoulder dystocia	17.17 (10.82–27.24)	20.27 (12.62–32.56)	56.44 (32.12–99.19)	75.64 (41.28–138.62)
OBPI	22.00 (7.09–68.26)	28.48 (8.94–90.67)	45.53 (9.71–195.12)	73.92 (15.05–363.16)
Birth fractures	36.56 (4.27–313.33)	32.33 (3.76–278.15)	115.81 (10.48–1279.77)	87.17 (7.72–984.96)
HIE	4.54 (2.27–9.07)	4.40 (2.20–8.82)	13.88 (5.21–36.99)	13.77 (5.16–36.75)
Hypoglycemia	1.28 (1.01–1.64)	2.04 (1.54–2.69)	2.38 (1.51–3.75)	4.17 (2.50–6.94)

BW, birth weight; CS, Cesarean section; FTP, failure to progress; HIE, hypoxic-ischemic encephalopathy; OASIS, obstetric anal sphincter injury; OBPI, obstetric brachial plexus injury; PPH, postpartum hemorrhage.

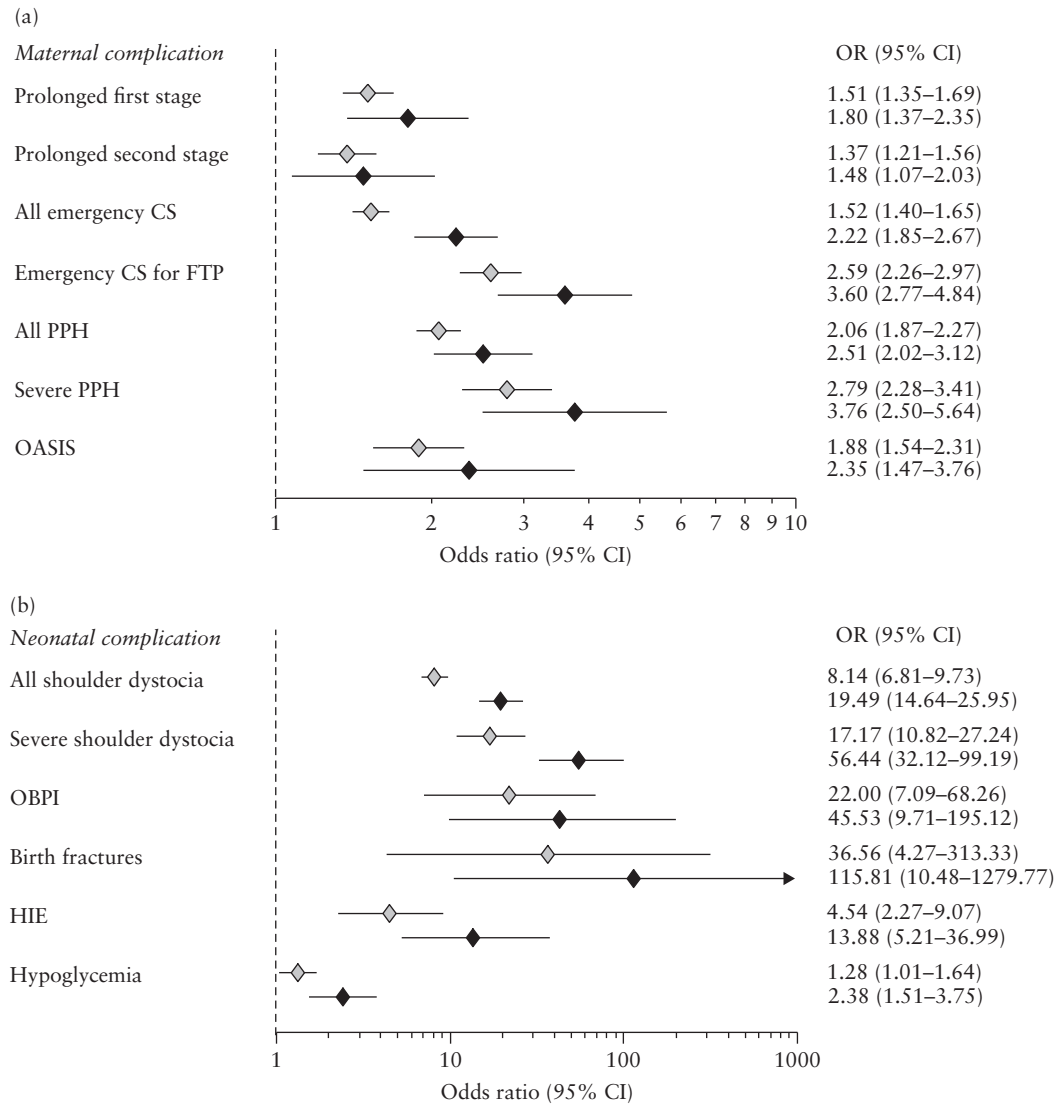

Figure 1 Forest plots of odds ratios (OR) for maternal (a) and neonatal (b) complications in pregnancies with macrosomia (birth weight > 4000 g) (◇) and those with severe macrosomia (birth weight > 4500 g) (◆). CS, Cesarean section; FTP, failure to progress; HIE, hypoxic-ischemic encephalopathy; OASIS, obstetric anal sphincter injury; OBPI, obstetric brachial plexus injury; PPH, postpartum hemorrhage.

failed instrumental delivery, with a 4-fold increased risk of CS for FTP and a 3-fold increased risk for severe PPH and OASIS (Table 3, Figure 1a). The risks of adverse maternal outcomes increased exponentially with increasing BW (Table 4, Figure 2a).

Neonatal complications

In the macrosomia group, there was a significantly higher prevalence of all neonatal complications (Table 2), with a 10-fold increased risk of shoulder dystocia, a 20-fold increased risk of severe shoulder dystocia, a 30-fold increased risks of OBPI and birth fractures and a 4-fold increased risk of HIE (Table 3, Figure 1b). In the severe-macrosomia group, there was a significantly higher prevalence of all adverse outcomes, with a 70- to 90-fold increased risk of severe shoulder dystocia, OBPI and birth fractures and a 14-fold increased risk of HIE (Table 3, Figure 1b). The risk of adverse neonatal outcomes increased exponentially with increasing BW after 4000 g (Table 4, Figure 2b).

Composite adverse outcomes

The background risk of composite maternal morbidity in the normal-BW group was 6.0%, increasing to 10.4% at a BW of 4000 g, 15.8% at a BW of 4500 g and 23.4% at a BW of 5000 g (Table 4). The background risk of composite neonatal morbidity in the normal-BW group was 1.1%, increasing to 3.9% at a BW of 4000 g, 12.6% at a BW of 4500 g and 33.6% at a BW of 5000 g (Table 4).

DISCUSSION

Principal findings

The results of this study demonstrate that pregnancies with macrosomia are associated with a significantly

Table 4 Estimates of increased risk for complications in pregnancies with, compared to those without, fetal macrosomia

	Maternal complication (absolute risk (%) (relative risk))				*Neonatal complication (absolute risk (%) (relative risk))*			
BW (g)	*CS-FTP*	*Severe PPH*	*OASIS*	*Composite*	*SD*	*OBPI*	*HIE*	*Composite*
Background*	3.4 (1.0)	1.1 (1.0)	2.0 (1.0)	6.0 (1.0)	1.0 (1.0)	0.01 (1.0)	0.1 (1.0)	1.1 (1.0)
4000	6.3 (1.8)	2.1 (1.9)	3.2 (1.6)	10.4 (1.7)	3.7 (3.7)	0.1 (7.7)	0.2 (2.2)	3.9 (3.6)
4100	6.9 (2.0)	2.3 (2.1)	3.4 (1.7)	11.3 (1.9)	4.8 (4.8)	0.1 (10.0)	0.2 (2.4)	5.0 (4.5)
4200	7.7 (2.3)	2.5 (2.3)	3.7 (1.9)	12.3 (2.1)	6.1 (6.1)	0.1 (12.9)	0.3 (2.6)	6.3 (5.8)
4300	8.5 (2.5)	2.7 (2.5)	4.0 (2.0)	13.4 (2.2)	7.8 (7.8)	0.2 (16.7)	0.3 (2.8)	8.0 (7.3)
4400	9.4 (2.8)	3.0 (2.7)	4.3 (2.2)	14.6 (2.4)	9.9 (9.9)	0.2 (21.7)	0.3 (3.0)	10.1 (9.1)
4500	10.3 (3.0)	3.3 (3.0)	4.7 (2.3)	15.8 (2.6)	12.4 (12.4)	0.3 (28.1)	0.3 (3.3)	12.6 (11.4)
4600	11.4 (3.4)	3.6 (3.3)	5.0 (2.5)	17.2 (2.9)	15.6 (15.6)	0.4 (36.5)	0.4 (3.6)	15.6 (14.2)
4700	12.6 (3.7)	4.0 (3.6)	5.4 (2.7)	18.6 (3.1)	19.3 (19.3)	0.5 (47.2)	0.4 (3.9)	19.2 (17.5)
4800	13.8 (4.1)	4.4 (4.0)	5.8 (2.9)	20.1 (3.4)	23.7 (23.7)	0.6 (61.2)	0.4 (4.2)	23.4 (21.3)
4900	15.2 (4.5)	4.8 (4.4)	6.3 (3.1)	21.7 (3.6)	28.8 (28.8)	0.8 (79.2)	0.5 (4.6)	28.3 (25.7)
5000	16.7 (4.9)	5.3 (4.8)	6.8 (3.4)	23.4 (3.9)	34.4 (34.4)	1.0 (102.5)	0.5 (5.0)	33.6 (30.6)
5100	18.2 (5.4)	5.8 (5.3)	7.3 (3.6)	25.2 (4.2)	40.5 (40.5)	1.3 (132.6)	0.5 (5.4)	39.5 (35.9)
5200	19.9 (5.9)	6.4 (5.8)	7.8 (3.9)	27.1 (4.5)	47.0 (47.0)	1.7 (171.3)	0.6 (5.9)	45.6 (41.5)
5300	21.7 (6.4)	7.0 (6.4)	7.4 (4.2)	29.0 (4.8)	53.5 (53.5)	2.2 (221.1)	0.6 (6.4)	51.9 (47.2)
5400	23.7 (7.0)	7.7 (7.0)	9.1 (4.5)	31.1 (5.2)	59.9 (59.9)	2.9 (285.0)	0.7 (6.9)	58.2 (52.9)
5500	25.7 (7.6)	8.4 (7.6)	9.7 (4.9)	33.2 (5.5)	66.0 (66.0)	3.7 (366.5)	0.8 (7.5)	64.1 (58.3)
5600	27.9 (8.2)	9.2 (8.3)	10.4 (5.2)	35.4 (5.9)	71.6 (71.6)	4.7 (470.4)	0.8 (8.2)	69.7 (63.4)
5700	30.1 (8.9)	10.0 (9.1)	11.2 (5.6)	37.6 (6.3)	76.6 (76.6)	6.0 (601.7)	0.9 (8.8)	74.8 (68.0)
5800	32.5 (9.6)	11.0 (10.0)	12.0 (6.0)	39.9 (6.7)	81.0 (81.0)	7.7 (766.9)	1.0 (9.6)	79.2 (72.0)
5900	34.9 (10.3)	12.0 (10.9)	12.9 (6.4)	42.3 (7.1)	84.7 (84.7)	9.7 (972.6)	1.0 (10.4)	83.1 (75.5)
6000	37.5 (11.0)	13.0 (11.9)	13.8 (6.9)	44.7 (7.5)	87.8 (87.8)	12.3 (1226.6)	1.1 (11.3)	86.3 (78.5)

*Background risk of complications in neonates with birth weight (BW) between 2500 and 4000 g. CS-FTP, emergency Cesarean section for failure to progress; HIE, hypoxic-ischemic encephalopathy; OASIS, obstetric anal sphincter injury; OBPI, obstetric brachial plexus injury; PPH, postpartum hemorrhage; SD, shoulder dystocia.

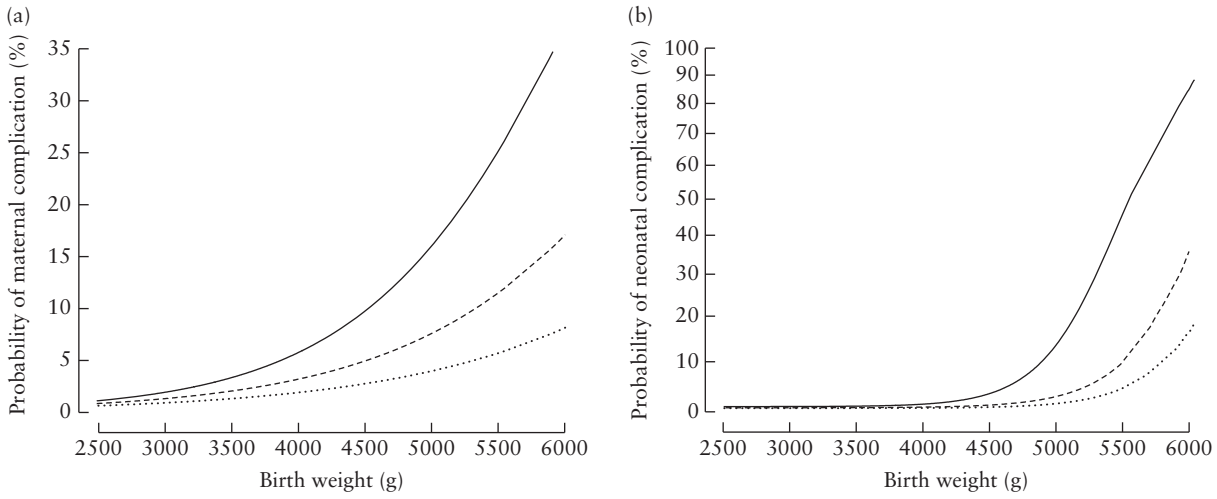

Figure 2 Predicted probability of maternal (a) and neonatal (b) complications associated with macrosomia, according to birth weight: (a) Cesarean section for failure to progress (——); obstetric anal sphincter injury (- - -); severe postpartum hemorrhage (·····); and (b) shoulder dystocia (——); obstetric brachial plexus injury (- - -); birth fractures (·····).

increased risk for serious maternal and neonatal adverse outcomes, including CS for FTP, severe PPH, OASIS, shoulder dystocia, OBPI, birth fractures and HIE. This increased risk of adverse outcomes is more marked for the neonate than for the mother, although the risk of complications is relatively low until a BW of 4000 g is reached, and it increases exponentially thereafter. The risk of a composite maternal adverse outcome increased from approximately 2-fold at a BW of 4000 g to 3-fold at a BW of 4500 g, whereas the risk of a composite neonatal adverse outcome increased from 3-fold at a BW of 4000 g to 10-fold at a BW of 4500 g.

Strengths and limitations

The strengths of this study are, first, inclusion of a large cohort of consecutively screened and delivered pregnancies in a large obstetric and neonatal unit; second,

accurate ascertainment of maternal and neonatal adverse outcomes; third, estimation of risks of adverse outcomes after adjustment for maternal, pregnancy and labor characteristics; and fourth, reporting of absolute and relative risks for adverse outcomes for BW ranging from 4000 g to 6000 g to aid in antenatal counseling for the provision of standardized information.

This is a single-center study and, to a degree, the reported incidence of maternal and neonatal complications will have been affected by the characteristics of the population and the protocols in place for antenatal and intrapartum care. However, there is no reason to believe that the absolute and relative risks of complications in the macrosomia group compared with those in pregnancies with a normal BW would vary substantially between different populations.

Comparison with other studies

Several studies have reported on the association of fetal macrosomia with adverse pregnancy outcome, but there is considerable variation between these studies with regard to design, sample size and type of adverse outcome reported[5–14]. Some studies are case–control, some are cohort studies and others are population studies in which data were extracted from electronic databases without checking the veracity of the reported outcome measures[5–7,14]. The sample size in studies ranges from as small as 100 in some to more than 100 000 in others[6,11]. A significant potential bias is related to how the maternal and neonatal outcome measures were obtained, which is reflected in the large variation, not only in the prevalence of these complications, but also in the prevalence of macrosomia, which ranges from 0.9% in one study to 29.3% in another[14,25]. The studies largely report absolute risks or unadjusted ORs based on the prevalence of complications, without adjusting for other factors that contribute to such complications, with only two reporting adjusted ORs[6,12]. Although there is an appreciation of the increased risk of adverse outcome in pregnancies with macrosomia, the variation between studies and biases resulting from such heterogeneity make it difficult to determine accurate risks of pregnancy complications from the reported literature. In this study, we examined maternal and neonatal risks in a large unselected screened population in a cohort study, with accurate determination of maternal and pregnancy characteristics, ascertaining accurately the outcome measures of complications and reporting not only unadjusted risks but also multivariate ORs by adjusting for other factors using regression analysis.

Conclusion

This study confirms that pregnancies with macrosomia are associated with serious maternal and neonatal adverse outcomes, and provides estimates of risks that can be used for making decisions on pregnancy management.

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This article has been selected for Journal Club.

A slide presentation prepared by Dr Alessandra Familiari, one of UOG's Editors for Trainees, is available online.

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Complicaciones maternas y neonatales de la macrosomía fetal: estudio de cohorte

RESUMEN

Objetivo Estimar los riesgos de complicaciones maternas y neonatales en embarazos con macrosomía.

Methods Este fue un estudio de cohorte retrospectivo realizado en una unidad de maternidad de gran tamaño en el Reino Unido entre enero de 2009 y diciembre de 2016. La incidencia de complicaciones maternas y neonatales en los embarazos con macrosomía, definida como peso al nacer (PN) >4000 g, y en los embarazos con macrosomía grave, definida como PN >4500 g, se comparó con la de los embarazos con PN normal (2500-4000 g). Se realizó un análisis de regresión para determinar las razones de momios (RM) para las complicaciones en los embarazos macrosómicos en comparación con los que tenían un PN normal.

Resultados La población estudiada de 35 548 embarazos incluyó 4522 (12,7%) casos con macrosomía, 643 (1,8%) con macrosomía grave y 31 026 (87,3%) con PN normal. En el grupo de macrosomía, la RM ajustada fue de 3,1 (IC 95%: 2,6–3,6) para la cesárea por no progresar, 2,4 (IC 95%: 2,0–3,0) para hemorragia posparto grave, 2,3 (IC 95%: 1,9–2,8) para la lesión obstétrica del esfínter anal, 10.4 (IC 95%, 8.6–12.6) para la distocia de hombro, 28.5 (IC 95%, 8.9–90.7) para la lesión obstétrica del plexo braquial, 32.3 (IC 95%, 3.8–278.2) para las fracturas de nacimiento y 4.4 (IC 95%, 2.2–8.8) para la encefalopatía hipóxica-isquémica. Los valores respectivos en los embarazos con macrosomía grave fueron 4,3 (IC 95%: 3,1–6,1), 2,9 (IC 95%: 1,9–4,4), 3,1 (IC 95%: 1,9–5,1), 28,7 (IC 95%: 20,8–39,8), 73,9 (IC 95%: 15,1–363,2), 87,2 (IC 95%: 7,7–985,0) y 13,8 (IC 95%: 5,2–36,8).

Conclusión La macrosomía se asocia con resultados perinatales adversos graves. Este estudio proporciona estimaciones precisas de los riesgos para ayudar en el cuidado del embarazo.

巨大儿的母婴并发症：队列研究

摘要

目的：估算巨大儿在怀孕期间导致母婴并发症的风险。

方法：这是英国一家大型妇产科部门在 2009 年 1 月至 2016 年 12 月期间开展的一项回顾性队列研究。比较巨大儿（体重超过 4 千克）、严重巨大儿（体重超过 4.5 千克）和体重正常胎儿（体重为 2.5-4 千克）在怀孕期间出现母婴并发症的几率。通过回归分析得出巨大儿在怀孕期间出现并发症的各个优势比（OR），并与正常体重胎儿进行比较。

结果：研究了 35,548 例孕妇，其中 4,522 人（占 12.7%）名怀有巨大儿，643 人（占 1.8%）怀有严重巨大儿，31,026 人（占 87.3%）怀有正常体重胎儿。在巨大儿群体中，调整后的优势比为：因无法顺产而接受剖腹产术的为 3.1（95%置信区间，2.6 - 3.6）；严重产后出血的为 2.4（95%置信区间，2.0 - 3.0）；产科肛门括约肌损伤的为 2.3（95%置信区间，1.9 - 2.8）；肩难产的为 10.4 （95%置信区间，8.6 - 12.6）；分娩性臂丛神经损伤的为 28.5（95%置信区间，8.9 - 90.7）；新生儿骨折的为 32.3（95%置信区间，3.8 - 278.2）；缺氧缺血性脑病的为 4.4（95%置信区间，2.2 - 8.8）。对于严重巨大儿群体，以上各值分别为：4.3（95%置信区间，3.1 - 6.1）；2.9（95%置信区间，1.9 - 4.4）；3.1（95%置信区间，1.9 - 5.1）；28.7（95%置信区间，20.8 - 39.8）；73.9（95%置信区间，15.1 - 363.2）；87.2（95%置信区间，7.7 - 985.0）；13.8（95%置信区间，5.2 - 36.8）。

结论：巨大儿与严重不利的围产期预后有关。本研究准确估算了相应风险，为妊娠管理提供帮助。© ISUOG 2019 版权所有。John Wiley & Sons Ltd. 出版