Original Article

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Characteristics and pregnancy outcomes of undetected fetal macrosomia

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Objective: To identify antenatal characteristics associated with undetected macrosomia, as well as predictors for adverse maternal and neonatal outcomes.
Methods: Medical records of women who gave birth to term macrosomic infants at Tuen Mun Hospital between 1 January 2019 and 31 December 2023 were retrospectively reviewed. Comparisons were made between women with antenatally detected macrosomia by ultrasound (estimated fetal weight ≥4000 g) within 1 week before delivery and women with antenatally undetected macrosomia. Logistic regression analysis was performed to determine independent predictors for Caesarean delivery, composite adverse maternal outcomes, and composite adverse neonatal outcomes.
Results: Of the 360 macrosomic cases during the 5-year study period, 265 (73.6%) were undetected antenatally and 95 (26.4%) were detected antenatally. Compared with the undetected group, the detected group had a higher pre-pregnancy body mass index (24.8 vs 23.2 kg/m^2, p=0.024), a higher rate of elevated pre-pregnancy body mass index (48.4% vs 33.2%, p=0.008), a higher rate of shoulder dystocia in a previous pregnancy (3.2% vs 0%, p=0.018), a higher rate of polyhydramnios (11.6% vs 2.3%, p=0.001), a higher rate of pregnancy-related problems (45.3% vs 29.8%, p=0.006), and a greater number of ultrasound scans (2 vs 1, p<0.001). All cases of perineal traumas, shoulder dystocia, and birth injuries occurred in the undetected group. Antenatally detected macrosomia was independently associated with Caesarean delivery (adjusted odds ratio [aOR]=89.26, p<0.001), increased composite adverse maternal outcomes (aOR=2.73, p<0.001), and decreased composite adverse neonatal outcomes (aOR=0.32, p=0.001).
Conclusion: Antenatal detection of macrosomia decreases neonatal complications but increases maternal complications and Caesarean delivery rates. Counselling regarding macrosomia should involve a shared decision-making process based on evidence-based recommendations.

Keywords: Birth weight; Cesarean section; Fetal macrosomia; Shoulder dystocia

Introduction

Fetal macrosomia refers to an infant birth weight of >4000 g, irrespective of gestational age; its prevalence ranges from 3% to 15% worldwide[1]. Risk factors for macrosomia include pregestational or gestational diabetes mellitus, maternal obesity, and excessive gestational weight gain[2-4]. Macrosomia is associated with various maternal complications (Caesarean delivery, labour dystocia, anal sphincter injury, postpartum haemorrhage, and uterine rupture)[5-13] and fetal complications (shoulder dystocia, birth injuries including clavicular fracture, humeral fracture, and brachial plexus injury, and birth asphyxia)[14-16].

Both the American College of Obstetricians and Gynaecologists (ACOG) and the Royal College of Obstetricians and Gynaecologists (RCOG) recommend consideration of Caesarean section in pregnancies with an estimated fetal weight (EFW) of ≥4500 g complicated by pregestational or gestational diabetes mellitus, and in pregnancies with an EFW of ≥5000 g without diabetes. Vaginal delivery is recommended for fetuses with an EFW of 4000 g to 4500 g. In a study of 12 229 singleton deliveries among Chinese and Southeast Asians[17] and a study of 80 953 singleton deliveries among Chinese women[18], the rate of all forms of complications increased when birth weight was ≥3600 g. Birth weight of ≥4200 g was the strongest independent risk factor for shoulder dystocia (adjusted odds ratio [aOR]=76.10), compared with birth weight of 4000 g to 4199 g (aOR=22.40)[18]. Other independent risk factors include instrumental delivery, maternal height <151 cm, maternal diabetes mellitus, and body mass index ≥25 kg/m^2 at delivery[18]. A cut-off value of 4000 g or 4200 g appears to achieve the optimal balance between the risk of shoulder dystocia and the need for

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Caesarean delivery. Thus, the current practice at our unit is to advise Caesarean delivery in pregnancies with an EFW of ≥4000 g complicated by diabetes and an EFW of ≥4500 g without diabetes.

Reduction of adverse perinatal outcomes remains a priority among obstetricians, partly owing to concerns over litigation risks, as highlighted by the Montgomery case[19]. Improvements in antenatal detection of macrosomia are therefore needed. However, antenatal detection of macrosomia by ultrasound is challenging. Among all macrosomic babies, 20% to 50% are undiagnosed prenatally[20]. A systematic review and meta-analysis found 56% sensitivity in diagnosing a macrosomic baby with an EFW of >4000 g and 80% sensitivity for an abdominal circumference of >35 cm[21].

This study aimed to identify antenatal characteristics associated with undetected macrosomia, as well as predictors for adverse maternal and neonatal outcomes.

Methods

Medical records of women who gave birth to term macrosomic infants at Tuen Mun Hospital between 1 January 2019 and 31 December 2023 were retrospectively reviewed. Women with multiple pregnancies, stillbirth, or incomplete data were excluded. Macrosomia was defined as birth weight of ≥4000 g and term pregnancy as gestational age of ≥37 weeks. Gestational age was calculated based on the last menstrual period; it was confirmed or adjusted by an early ultrasound scan. The gestational age of in vitro fertilisation pregnancies was calculated from the day of oocyte retrieval. Maternal demographics, maternal medical and obstetric history, intrapartum and delivery information, and pregnancy outcomes (both maternal and neonatal) were recorded.

All pregnant women were routinely offered a 12-week dating scan. Clinical evaluation of fetal growth was primarily based on abdominal palpation (Leopold's manoeuvre) and/or symphysis-fundal height measurement. When the uterine size was larger than expected for gestational age, a timely ultrasound examination for EFW was performed. Additional ultrasound scans were arranged for indications such as diabetes, malpresentation, antepartum haemorrhage, and uterine fibroids.

The ultrasound EFW was calculated using the Hadlock formula, which incorporates biparietal diameter, abdominal circumference, and femur length. Women with a large-for-gestational-age (LGA) fetus (defined as an ultrasound EFW of >90th percentile on the local chart) were screened for gestational diabetes using the 75 g oral glucose tolerance test[22]. The diagnosis of gestational diabetes was based on thresholds in the 2013 World Health Organization guideline[23]. Additionally, women with any identified risk factor were offered the 75 g oral glucose tolerance test at 24 to 28 weeks of gestation. In accordance with our departmental protocol, diabetic women with an LGA fetus were offered Caesarean delivery at 38 weeks, whereas women with macrosomia were advised to undergo Caesarean delivery at term. Non-diabetic women with suspected fetal macrosomia were offered options of expectant management, induction of labour, and Caesarean delivery beyond 38 weeks.

Comparisons were made between women with antenatally detected macrosomia by ultrasound (EFW ≥4000 g) within 1 week before delivery and women with antenatally undetected macrosomia (owing to a lack of growth scans or a final ultrasound EFW <4000 g). Excessive total weight gain was defined according to recommendations by the Institute of Medicine[24]. The accuracy of ultrasound EFW within 1 week before delivery relative to actual birth weight was calculated in terms of percentage error. A difference of <10% indicated an accurate estimation[25].

Maternal outcomes included induction of labour, mode of delivery, blood loss at delivery, postpartum haemorrhage, blood transfusion, perineal trauma (vaginal and cervical tears, obstetric anal sphincter injuries, and vaginal haematoma), uterine rupture, hysterectomy, length of hospitalisation, and maternal death. Non-progressive labour included prolonged first or second stage of labour. Interpretation of electronic fetal heart rate tracing was based on the 2022 National Institute for Health and Care Excellence guidelines[26]. Postpartum haemorrhage was defined as blood loss of ≥500 ml at delivery, and severe postpartum haemorrhage as blood loss of ≥1000 ml[27]. Composite adverse maternal outcomes included any of the following: postpartum haemorrhage, blood transfusion, and perineal trauma.

Neonatal outcomes included gestational age at delivery, birth weight, sex, shoulder dystocia, Apgar score at 1 and 5 minutes, arterial cord blood pH, resuscitation at birth, need for assisted ventilation, birth injury, convulsion, hypoxic-ischaemic encephalopathy, transient tachypnoea of newborn, respiratory distress syndrome, neonatal jaundice, phototherapy, polycythaemia, hypoglycaemia, neonatal intensive care unit admission, and early neonatal

death. Shoulder dystocia was defined as vaginal delivery requiring an additional obstetric manoeuvre to deliver the fetal shoulder after delivery of the head and failure of gentle traction[16]. Birth injuries included subgaleal haematoma, cephalohaematoma, intracranial haemorrhage, intraventricular haemorrhage, bone fracture, and brachial plexus injury. Composite adverse neonatal outcomes included any of the following: resuscitation at birth, Apgar score of <7 at 5 minutes, arterial cord blood pH <7.1, neonatal intensive care unit stay >24 hours, shoulder dystocia, birth injury, transient tachypnoea of newborn, respiratory distress syndrome, neonatal jaundice requiring phototherapy, hypoglycaemia, anaemia, polycythaemia, and convulsion.

Statistical analysis was performed using SPSS (Windows version 29.0; IBM Corp, Armonk [NY], United States). Women with or without antenatal detection of macrosomia were compared using the Student's *t* test or Mann-Whitney *U* test for continuous variables and the Chi-squared test or Fisher's exact test for categorical variables. A p value of <0.05 was considered statistically significant. Logistic regression analysis was performed to determine independent predictors for Caesarean delivery, composite adverse maternal outcomes, and composite adverse neonatal outcomes after exclusion of women with prescheduled Caesarean sections for reasons other than macrosomia, with adjustment for potential confounders.

Results

During the 5-year study period, there were 16480 full-term singleton livebirths, of which 360 were macrosomic, yielding an incidence of 2.2%. Of the 360 macrosomic cases, 265 (73.6%) were undetected antenatally and 95 (26.4%) were detected antenatally.

Compared with women with antenatally undetected macrosomia, women with antenatally detected macrosomia had a higher pre-pregnancy body mass index (24.8 vs 23.2 kg/m^2, p=0.024), a higher rate of elevated pre-pregnancy body mass index (48.4% vs 33.2%, p=0.008), a higher rate of shoulder dystocia in a previous pregnancy (3.2% vs 0%, p=0.018), a higher rate of polyhydramnios (11.6% vs 2.3%, p=0.001), a higher rate of pregnancy-related problems (45.3% vs 29.8%, p=0.006), and a greater number of ultrasound scans (2 vs 1, p<0.001) [Table 1].

Among the 157 (43.6%) women who underwent ultrasound EFW measurement within 1 week before delivery, the percentage of accurate EFWs was higher in women with antenatally detected macrosomia (96.8% vs 43.5%, p<0.001) who also had higher clinical EFWs (3800 vs 3600 g, p<0.001). Their newborns were delivered earlier (39 vs 40 weeks, p=0.018), were less frequently delivered at or after 41 weeks (12.6% vs 22.6%, p=0.036), and had higher birth weights (4170 vs 4110 g, p<0.001).

After exclusion of 48 women with prescheduled Caesarean sections for reasons other than macrosomia, there were 226 women in the undetected group and 86 women in the detected group. Of the latter, 79 opted for Caesarean delivery and the remaining seven opted for labour induction (n=5) or expectant management (n=2), which resulted in normal vaginal delivery (n=6) or urgent Caesarean section (n=1) secondary to non-reassuring fetal heart rate during labour. Rates of induction of labour were similar between women with and without antenatal detection of macrosomia (p=0.455). Concerning abnormal labour progression, seven women required instrumental deliveries for prolonged second stage, and 37 (all in the undetected group) required Caesarean sections for non-progressive labour.

Women with antenatally detected macrosomia had a higher Caesarean delivery rate (93.0% vs 25.7%, p<0.001), greater blood loss at delivery (500 vs 300 ml, p<0.001), a higher rate of severe postpartum haemorrhage (11.6% vs 3.5%, p=0.012), a lower rate of perineal trauma (0% vs 8.4%, p=0.006), and a longer hospital stay (3 vs 2 days, p<0.001) [Table 2].

Compared with infants born to women with antenatally detected macrosomia, infants born to women with antenatally undetected macrosomia had a lower birth weight (4110 vs 4170 g, p<0.001), a lower rate of birth weight ≥4500 g (3.1% vs 10.5%, p=0.017), a higher rate of requiring resuscitation at birth (5.3% vs 0%, p=0.041), a lower Apgar score at 1 minute (8 vs 8, p=0.003), and a higher rate of neonatal intensive care unit admission (21.2% vs 10.5%, p=0.028) [Table 3].

All 19 cases of perineal traumas (including three cases of third-degree obstetric anal sphincter injuries, which were repaired and asymptomatic at 6 weeks) [8.4% vs 0%, p=0.006], nine cases of shoulder dystocia (4.0% vs 0%, p=0.068), and seven cases of birth injuries (3.1% vs 0%, p=0.196) occurred in the undetected group, compared with none in the detected group. All cases of perineal traumas, shoulder dystocia, and birth injuries resolved, except in two cases: one infant developed Erb's palsy related to shoulder dystocia after vacuum-assisted delivery

Table 1. Maternal, antenatal, and ultrasound characteristics of women with or without antenatal detection of macrosomia.

Characteristic	All (n=360)	Antenatally undetected macrosomia (n=265)	Antenatally detected macrosomia (n=95)	p Value
Maternal characteristics				
Age at delivery, y	31.8±5.4	31.6±5.3	32.5±5.8	0.164
Advanced age (≥35 y)	117 (32.5)	83 (31.3)	34 (35.8)	0.425
Ethnicity				1.000
Asian	352 (97.8)	258 (97.4)	94 (98.9)	
Others	8 (2.2)	7 (2.6)	1 (1.1)	
Height, cm	161 (157-165)	161 (157-165)	160.8 (157.1-165.0)	0.997
Pre-pregnancy body mass index, kg/m^2	23.5 (21.1-26.9)	23.2 (21.0-26.1)	24.8 (21.6-28.2)	0.024
<25	265 (73.6)	177 (66.8)	49 (51.6)	0.008
≥25	95 (26.4)	88 (33.2)	46 (48.4)	
Gestational weight gain, kg	16.0 (12.5-19.5)	16.0 (12.5-19.5)	16.8 (13.5-20.5)	0.122
Excessive gestational weight gain	229 (63.6)	163 (61.5)	66 (69.5)	0.166
Tertiary education or above	85 (23.6)	66 (24.9)	19 (20.0)	0.334
Smoking	9 (2.5)	9 (3.4)	0	0.119
Assisted conception	10 (2.8)	8 (3.0)	2 (2.1)	1.000
Parity	1 (0-2)	1 (0-2)	1 (0-1)	0.132
Nulliparity	121 (33.6)	82 (30.9)	39 (41.1)	0.074
Previous Caesarean section	42 (11.7)	35 (13.2)	7 (7.4)	0.128
Previous vaginal delivery	202 (56.1)	152 (57.4)	50 (52.6)	0.426
Previous macrosomia	42 (11.7)	32 (12.1)	10 (10.5)	0.687
Previous stillbirth	1 (0.3)	1 (0.4)	0	1.000
Previous shoulder dystocia	3 (0.8)	0	3 (3.2)	0.018
Previous operative delivery for labour arrest	23 (6.4)	17 (6.4)	6 (6.3)	0.973
Antenatal characteristics				
Antenatal complication				
Hypertensive disorders of pregnancy	16 (4.4)	14 (5.3)	2 (2.1)	0.255
Pregestational/gestational diabetes mellitus	78 (21.7)	53 (20.0)	25 (26.3)	0.200
Antepartum haemorrhage	9 (2.5)	5 (1.9)	4 (4.2)	0.251
Placenta previa	1 (0.3)	0	1 (1.1)	0.264
Polyhydramnios	17 (4.7)	6 (2.3)	11 (11.6)	0.001
Oligohydramnios	3 (0.8)	1 (0.4)	2 (2.1)	0.171
Malpresentation	9 (2.5)	6 (2.3)	3 (3.2)	0.703
Uterine fibroids	8 (2.2)	6 (2.3)	2 (2.1)	1.000
Any of the above	122 (33.9)	79 (29.8)	43 (45.3)	0.006
Ultrasound characteristics				
No. of third-trimester ultrasounds	1 (0-2)	1 (0-2)	2 (1-3)	<0.001
Ultrasound within 1 week before delivery	157 (43.6)	62 (23.4)	95 (100)	<0.001
Estimated fetal weight	4050 (3756-4212)	3706 (3486-3841)	4166 (4067-4300)	<0.001
Error	-4.1 (-9.7 to 0.8)	-10.6 (-14.9 to 7.4)	-0.5 (-4.1 to 3.2)	<0.001
Error ≤10%	119 (75.8)	27 (43.5)	92 (96.8)	<0.001
Clinical estimated fetal weight (n=310)	3600 (3400-3800)	3600 (3400-3700)	3800 (3800-4000)	<0.001
Gestational age at delivery, wk	40 (39-40)	40 (39-40)	39 (38-40)	0.018
Gestational age ≥41 wk	72 (20.0)	60 (22.6)	12 (12.6)	0.036
Birth weight, g	4120 (4052-4247)	4110 (4050-4215)	4170 (4080-4340)	<0.001

* Data are presented as mean (standard deviation), median (interquartile range), or No. (%) of women

Table 2. Maternal outcomes in women with or without antenatal detection of macrosomia.

Maternal outcome	Antenatally undetected macrosomia (n=226)	Antenatally detected macrosomia (n=86)	p Value
Induction of labour	120 (53.1)	5 (71.4)	0.455
Indications			
Past term	47 (39.2)	1 (20)	
Large-for-gestational age	3 (2.5)	0	
Macrosomia	-	2 (40)	
Pregestational/gestational diabetes mellitus	21 (17.5)	1 (20)	
Hypertensive disorders of pregnancy	5 (4.2)	0	
Prelabour rupture of membranes	19 (15.8)	0	
Reduced fetal movement	12 (10)	0	
History of neonatal death	1 (0.8)	0	
Antepartum haemorrhage	12 (10)	1 (20)	
Mode of delivery			
Normal vaginal delivery	147 (65.0)	6 (7.0)	<0.001
Instrumental delivery	21 (9.3)	0	0.003
Prolonged second stage	7 (33.3)	0	
Non-reassuring heart rate	14 (66.7)	0	
Caesarean section	58 (25.7)	80 (93.0)	<0.001
Non-progressive labour	37 (63.8)	0	
Non-reassuring heart rate	14 (24.1)	1 (1.3)	
Suspected macrosomia	-	79 (98.8)	
Cord prolapse	1 (1.7)	0	
Placental abruption	1 (1.7)	0	
Intrauterine infection	1 (1.7)	0	
Severe pre-eclampsia	4 (6.9)	0	
Estimated blood loss at delivery, ml	300 (200-400)	500 (350-700)	<0.001
Postpartum haemorrhage (≥500 ml)	48 (21.2)	47 (54.7)	<0.001
Severe postpartum haemorrhage (≥1000 ml)	8 (3.5)	10 (11.6)	0.012
Blood products transfusion	4 (1.8)	1 (1.2)	1.000
Uterine rupture	0	0	-
Hysterectomy	0	0	-
Perineal trauma	19 (8.4)	0	0.006
Vaginal laceration or cervical tear	17 (7.5)	0	
Obstetric anal sphincter injury	3 (1.3)	0	
Vaginal haematoma	1 (0.4)	0	
Maternal death	0	0	-
Length of hospital stay, d	2 (1-3)	3 (3-3)	<0.001

* Data are presented as median (interquartile range) or No. (%) of women

for prolonged second stage; the other infant experienced seizures due to brain injury associated with impaction of the fetal head during Caesarean delivery. Two infants had persistent hyperinsulinaemic hypoglycaemia after birth: one was suspected to have Beckwith-Wiedemann syndrome with associated macroglossia and right hemihypertrophy; the other was diagnosed with paternally inherited type 1 maturity-onset diabetes.

Table 3. Neonatal outcomes in women with or without antenatal detection of macrosomia.

Neonatal outcome	Antenatally undetected macrosomia (n=226)	Antenatally detected macrosomia (n=86)	p Value
Gestational age at delivery, wk	40 (39-41)	39 (39-40)	0.005
Birth weight, g	4110 (4045-4210)	4170 (4080-4340)	<0.001
Birth weight ≥4500 g	7 (3.1)	9 (10.5)	0.017
Male sex	159 (70.4)	58 (67.4)	0.617
Apgar score at 1 minute	8 (8-8)	8 (8-8)	0.003
Apgar score at 5 minutes	9 (9-9)	9 (9-9)	0.785
Apgar score <7 at 5 minutes	1 (0.4)	1 (1.2)	0.476
Arterial cord blood pH <7.1	1 (0.4)	0	1.000
Resuscitation at birth	12 (5.3)	0	0.041
Assisted ventilation	7 (3.1)	1 (1.2)	0.453
Shoulder dystocia and/or birth injury	15 (6.6)	0	0.014
Shoulder dystocia	9 (4.0)	0	0.068
Birth injury	7 (3.1)	0	0.196
Clavicle fracture	4 (1.8)	0	
Brachial plexus injury	1 (0.4)	0	
Cephalohematoma	2 (0.9)	0	
Subgaleal haemorrhage	2 (0.9)	0	
Intraventricular haemorrhage	1 (0.4)	0	
Convulsion	1 (0.4)	0	1.000
Hypoxic ischaemic encephalopathy	0	0	-
Meconium aspiration syndrome	1 (0.4)	0	1.000
Transient tachypnoea of newborn	8 (3.5)	0	0.112
Respiratory distress syndrome	5 (2.2)	2 (2.3)	1.000
Neonatal jaundice	26 (11.5)	8 (9.3)	0.577
Phototherapy	23 (10.2)	7 (8.1)	0.585
Polycythaemia	1 (0.4)	0	1.000
Hypoglycaemia	32 (14.2)	12 (14.0)	0.963
Admission to neonatal intensive care unit	48 (21.2)	9 (10.5)	0.028
Early neonatal death	0	0	-

* Data are presented as median (interquartile range) or No. (%) of women

On multivariate analysis, predictors for Caesarean delivery were antenatally detected macrosomia (aOR=89.26, p<0.001), nulliparity (aOR=17.83, p<0.001), birth weight ≥4500 g (aOR=5.90, p=0.037), and a lower rate of adverse neonatal outcomes (aOR=0.32, p=0.001) [Table 4]. Predictors for composite adverse maternal outcomes were antenatally detected macrosomia (aOR=2.73, p<0.001), advanced maternal age (aOR=2.14, p=0.011), and nulliparity (aOR=3.14, p<0.001). Predictors for adverse neonatal outcomes were birth weight of ≥4500 g (aOR=4.64, p=0.007) and nulliparity (aOR=2.10, p=0.008).

Discussion

The incidence of antenatally undetected macrosomia in our cohort was 73.6%, which is comparable to the 70% to 90% observed among Western populations in Europe and North America[28-31]. The higher incidences of polyhydramnios and previous pregnancies complicated by shoulder dystocia in the detected group may be attributed to polyhydramnios-induced uterine enlargement beyond the expected size—particularly when the fetus is also LGA—and to greater obstetrician vigilance regarding women with a poor obstetric history. Women with undiagnosed macrosomia may have undiagnosed diabetes if gestational

Table 4. Predictors for Caesarean section, composite adverse maternal outcomes, and composite adverse neonatal outcomes.

Variable	Women with Caesarean section (n=138)	Women without Caesarean section (n=174)	Odds ratio (95% confidence interval)	p Value	Adjusted odds ratio (95% confidence interval)	p Value
Antenatal detection of macrosomia	80 (58.0)	6 (3.4)	38.62 (15.99-93.27)	<0.001	89.26 (31.28-254.72)	<0.001
Advanced maternal age	42 (30.4)	55 (31.6)	0.95 (0.58-1.54)	0.824	1.65 (0.71-3.88)	0.247
Nulliparity	83 (60.1)	35 (20.1)	5.99 (3.62-9.92)	<0.001	17.83 (7.92-40.13)	<0.001
Pregestational/gestational diabetes	38 (27.5)	33 (19.0)	1.62 (0.95-2.76)	0.073	0.85 (0.36-2.02)	0.709
Hypertensive disorders of pregnancy	7 (5.1)	5 (2.9)	1.81 (0.56-5.82)	0.316	2.21 (0.52-9.49)	0.286
Birth weight ≥4500 g	12 (8.7)	4 (2.3)	4.05 (1.28-12.85)	0.011	5.90 (1.11-31.25)	0.037
	Women with composite adverse maternal outcomes (n=110)	**Women without composite adverse maternal outcomes (n=202)**				
Antenatal detection of macrosomia	47 (42.7)	39 (19.3)	3.12 (1.86-5.22)	<0.001	2.73 (1.58-4.74)	<0.001
Advanced maternal age	42 (38.2)	55 (27.2)	1.65 (1.01-2.71)	0.046	2.14 (1.19-3.85)	0.011
Nulliparity	57 (51.8)	61 (30.2)	2.49 (1.54-4.02)	<0.001	3.14 (1.83-5.41)	<0.001
Pregestational/gestational diabetes	32 (29.1)	39 (19.3)	1.72 (1.00-2.94)	0.049	1.29 (0.70-2.38)	0.422
Hypertensive disorders of pregnancy	3 (2.7)	9 (4.5)	0.60 (0.16-2.27)	0.550	0.45 (0.10-1.94)	0.282
Birth weight ≥4500 g	7 (6.4)	9 (4.5)	1.46 (0.53-4.03)	0.465	1.04 (0.33-3.24)	0.951
	Infants with composite adverse neonatal outcomes (n=92)	**Infants without composite adverse neonatal outcomes (n=220)**				
Antenatal detection of macrosomia	16 (17.4)	70 (31.8)	0.45 (0.25-0.83)	0.009	0.32 (0.16-0.64)	0.001
Advanced maternal age	31 (33.7)	66 (30.0)	1.19 (0.71-1.99)	0.520	1.29 (0.71-2.34)	0.411
Nulliparity	44 (47.8)	74 (33.6)	1.81 (1.10-2.97)	0.018	2.10 (1.22-3.63)	0.008
Pregestational/gestational diabetes	26 (28.3)	45 (20.5)	1.53 (0.88-2.68)	0.134	1.64 (0.87-3.08)	0.126
Hypertensive disorders of pregnancy	7 (7.6)	5 (2.3)	3.54 (1.09-11.46)	0.046	1.84 (0.52-6.49)	0.344
Birth weight ≥4500 g	9 (9.8)	7 (3.2)	3.30 (1.19-9.15)	0.023	4.64 (1.51-14.26)	0.007

* Data are presented as No. (%) of cases

diabetes screening is not universally practised; some of these women may develop late-onset gestational diabetes despite normal screening results at 24 to 28 weeks' gestation.

Obstetricians rely on ultrasound-based fetal weight estimation to guide clinical decisions. There is no consensus on the implementation of universal third-trimester ultrasound scans in low-risk pregnancies for the screening of LGA or macrosomia, given the lack of high-quality evidence on improvement in perinatal outcomes[32,33]. In addition, potential errors in ultrasound estimation of fetal weight should be considered when interpreting results. Margins of error between 10% and 15% in sonographic

fetal weight estimation have been reported[34,35]. In our cohort, approximately 25% of cases demonstrated an error >10%. Moreover, ultrasound estimation of fetal weight does not adjust for false-positive findings of macrosomia, which may further attribute to inaccuracy, unwarranted maternal anxiety, and unnecessary interventions. Women should therefore be informed about the limitations of ultrasound, potential for estimation error, and possible impact on clinical decisions.

In our study, antenatal diagnosis of macrosomia was associated with higher rates of Caesarean section and adverse maternal outcomes, as well as a lower rate of adverse neonatal outcomes. Overall, 93% of women with antenatal diagnosis of macrosomia opted for Caesarean section, consistent with findings from several other studies, although reported Caesarean delivery rates were much lower (25% to 50%)[28,31,32]. Similarly, a diagnosis of LGA is associated with increased risk of Caesarean delivery[36] because concerns about potential macrosomia-associated neonatal complications may lead patients to forgo a trial of vaginal delivery. Although previous studies failed to demonstrate a significant reduction in adverse maternal outcomes with predicted macrosomia[28,29,31], we observed higher rates of primary postpartum haemorrhage and longer hospital stay in cases of antenatally detected macrosomia. The higher rate of postpartum haemorrhage may be attributed to the increased rate of Caesarean sections. Unnecessary Caesarean deliveries remain a concern, especially given the rising Caesarean section rates worldwide[37]. Caesarean delivery has long-term implications for future pregnancies such as placenta accreta spectrum and uterine scar rupture[38]. Decision making in such situations is challenging; clinicians and women must balance the short- and long-term risks of Caesarean section against potential complications such as shoulder dystocia, which can lead to neonatal asphyxia.

The ACOG and RCOG offer no recommendations for labour induction solely on the basis of LGA or suspected macrosomia[15,16]. The 2021 National Institute for Health and Care Excellence guidelines on inducing labour recommend a comprehensive discussion with women with suspected fetal macrosomia regarding options of expectant management, induction of labour, and Caesarean birth[39]. Although the risks and benefits of inducing labour compared with expectant management in non-diabetic women remain uncertain, the risks of shoulder dystocia and third- or fourth-degree perineal tears increase with expectant management[39]. In the 2016 Cochrane review of induction of labour for suspected fetal macrosomia involving 1190 women, induction of labour resulted in fewer cases of birth fractures and shoulder dystocia, without a significant difference in the rates of Caesarean or instrumental delivery[40]. Further research is warranted to determine the optimal timing for induction, long-term maternal and neonatal outcomes, and cost-effectiveness.

The ACOG and RCOG guidelines are mostly intended for Western populations, who may exhibit different genetic predispositions and anthropometric characteristics, compared with Asian populations, potentially leading to variations in average birth weight[15,16]. For a given birth weight category, the incidence of shoulder dystocia is higher in Asian populations than in Western populations[18,41]. Among births complicated by shoulder dystocia, the rate is higher in Asian neonates than in Western neonates with a birth weight <4000 g (68% vs 38%)[18,42]. Apart from the EFW threshold, counselling on the mode of delivery should be individualised, considering diverse factors such as a history of shoulder dystocia, previous macrosomic deliveries, maternal height, and diabetes. Women should be informed about the fetal and maternal risks associated with vaginal birth, as well as the potential for error in clinical and ultrasound EFW. Further research concerning predictors for uncomplicated vaginal delivery in macrosomic infants is warranted to enhance prenatal counselling on the mode of delivery, potentially reducing rates of unnecessary Caesarean section.

The present study has some limitations. First, the sample size was small, and data were collected from a single institution. Thus, results may not be generalisable to other populations. Second, due to the retrospective nature of the study, only basic clinical data were collected. Advances in artificial intelligence and ultrasound technology may improve the accuracy of fetal biometric measurements, hence prediction and detection of macrosomia.

Conclusion

Antenatal detection of macrosomia decreases neonatal complications but increases maternal complications and Caesarean delivery rates. Counselling regarding macrosomia should involve a shared decision-making process based on evidence-based recommendations. Patients should receive comprehensive information about potential risks and benefits to ensure informed consent. The mode of delivery should be individualised, considering diverse factors such as maternal history, fetal size, and potential complications. Future studies should focus on methods to improve the accuracy of macrosomia detection, while identifying predictors for uncomplicated vaginal delivery.

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