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MEDICINE

The Association of High Birth Weight with Pregnancy Outcomes: a Longitudinal Study

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Abstract

To explore the adverse perinatal results associated with high birth weight (HBW) and analyse other risk factors associated with these events. This was a retrospective longitudinal study of all childbirths occurring in our maternity centre during the period of 2010–2016. A comparative analysis was performed between pregnancy outcomes of newborns with weights above the 95th percentile and newborns with normal weight. In addition, a multivariate logistic regression analysis was performed to evaluate the risk factors associated with the identified adverse perinatal events. The perinatal results of 31,576 deliveries were analysed. When the two groups were compared, the group of pregnancies with HBW newborns showed higher frequencies of maternal diabetes, induction of labour, stalled labour caesarean section, severe perineal tears, and type 3 or greater neonatal resuscitation and a higher maternal age ($p < 0.05$). The multivariate regression analysis identified HBW as an important risk factor for stalled labour caesarean section and severe perineal tears, with odds ratios (ORs) of 3.6 (95% confidence interval (CI), 3.08–4.2) and 2.06 (95% CI, 1.33–3.19), respectively. Other risk factors such as induction of labour, gestational diabetes and instrument-assisted delivery ($p < 0.001$) were identified. Deliveries of newborns with weights above the 95th percentile presented poorer perinatal results compared to deliveries of normal weight newborns. This study identified additional relevant risk factors associated with stalled labour caesarean section and severe perineal tears. These findings could be useful to provide adequate advice to pregnant women.

Keywords High birth weight · Macrosomia · Perinatal outcome · Caesarean section · Perineal tear

Abbreviations

HBW	high birth weight
AGA	weight adequate for their gestational age
CRL	crown-rump length
CTG	cardiotocography
CSAL	stalled labour/suspected cephalopelvic disproportion caesarean section

Background

Neonatal macrosomia or HBW currently represents a challenge for obstetricians due to the increased risk of perinatal complications, such as postpartum haemorrhage, shoulder dystocia, an increased risk of caesarean section (and its associated complications), perineal trauma, neonatal asphyxia, cerebral haemorrhage in the newborn or even neonatal death [1–3].

In addition, several studies have shown a greater risk of developing metabolic pathology and obesity during adult life in children who were born with HBW [4]. This complication has been worsening worldwide because the proportion of HBW deliveries has increased significantly in recent years in multiple countries. Its prevalence has increased from 0.5 to 15% of overall childbirths [5, 6]. Maternal obesity and diabetes are the main risk factors associated with neonatal macrosomia, contributing nearly 20–25% to the increase, although older maternal age and multiparity were also significant factors [7].

There is no consensus on the definition of HBW and whether birth weight should be considered in isolation or combined with other parameters such as the body composition of the newborn. The American College of Obstetricians and Gynaecologists suggest a cut-off value of 4500 g regardless

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of the gestational age at birth because newborns presenting weights above this value have shown worse perinatal outcomes [8].

Additionally, specific cut-off values with customised growth curves have been used in study populations [9]. Koyanagi et al. [7] suggested using an evaluation based on population growth curves and incorporating newborns with weights above the 90th percentile of the sample in the definition and diagnosis of macrosomia.

The delivery method for suspected foetal macrosomia is still controversial. Induction of labour has not been shown to be useful in reducing neonatal morbidity and mortality [10, 11]. Elective caesarean section has been proposed for foetuses with an estimated weight above 5000 g or for those with weights above 4500 g if risk factors associated with shoulder dystocia, such as obstetric antecedents of this complication or diabetes, are present.

An additional complication is the inaccuracy in predicting foetal weight at birth by ultrasound, fundal height and other maternal variables [12, 13].

Studies on the maternal and neonatal outcome in the delivery of HBW newborns present numerous limitations based on the type of design (in most cases retrospective), the different definitions of macrosomia and differences in management of the delivery method, delivery induction time and indication of elective caesarean section. The latter is often at the discretion and criteria of the specialist [14].

In the published literature, the cut-off value to establish a diagnosis of suspected foetal macrosomia continues to vary between 90 and 97th percentile for the gestational age [15, 16].

Objectives of the Study

The purpose of this study was to analyse the adverse perinatal outcomes associated with the newborns who presented HBW and to identify a risk model based on different variables in events that were significantly different in the sample of HBW newborns in relation to newborns who presented a weight adequate for their gestational age (AGA).

Methods

This is a retrospective longitudinal study of cases and controls including all deliveries with single pregnancies from 37 weeks of gestation at our maternity centre (O'Donnell's Maternity, General Hospital of the University of Gregorio Marañon of Madrid) during the period of 2010–2016. The deliveries of newborns with weights below the 5th percentile for gestational age in our sample were excluded from the analysis. Normal weight was defined for all newborns between the 5th and the 95th percentile.

In most cases, the gestational age of each pregnancy was determined by the measurement of the crown-rump length (CRL) of the foetus through an ultrasound examination conducted during the first trimester. Some patients did not have ultrasound data; in those cases, ultrasound measurements performed before 20 weeks were used to date the pregnancy.

The corresponding weight of the newborns was calculated based on a value of 95th percentile per gestational age at birth in our population. Newborns above this value were defined as HBW. However, newborns with weights corresponding to or below this percentile who were not excluded from the study due to low weight were defined as AGA.

First, a descriptive comparative study was performed to detect significant differences in maternal characteristics, gestation characteristics and perinatal and neonatal outcomes between the HBW newborns and AGA newborns. The Chi-Square test was used to evaluate categorical variables, and the *T* test was used to evaluate quantitative variables.

All maternal demographic data and the medical and obstetric history were collected during patient admission in the delivery room. The medical staff reviewed these data. The information on the delivery outcome was obtained from the centre's own database.

Finally, a multivariate logistic regression analysis was performed with backwards variable elimination to determine the magnitude of the differences for perinatal outcomes that were initially significant and to identify the risk factors associated with adverse events in our population.

The present study was approved by the Ethics Committee of the General Hospital of Universitario Gregorio Marañon de Madrid (reference number OBS05042016).

All statistical analyses were performed with STATA version 15.0 (Stata Corp, College Station, TX). Results with *p*-values < 0.05 were considered significant.

Results

This study included 31,576 deliveries that occurred at our maternity centre and met the inclusion criteria during the 7-year period. Table 1 shows the weights of newborns corresponding to 95th percentile of the population studied by gestational age at birth.

Statistically significant differences ($p < 0.01$) were found when performing an initial comparative analysis between HBW and AGA newborns in terms of maternal and pregnancy characteristics and perinatal outcomes. The details are shown in Table 2.

No statistically significant differences were found between the two groups regarding the proportions of instrument-assisted deliveries, deliveries requiring epidural or intradural anaesthesia, episiotomies, foetuses with non-reassuring cardiotocography (CTG), caesarean due to non-reassuring

Table 1 95th percentile birth weight by gestational age at delivery in the studied population

Gestational age (weeks)	*N*	Percentile	Birth weight (gr)	CI 95%
37	2849	95	3655	3620–3720
38	6478	95	3822	3800–3840
39	10,230	95	3930	3910–3950
40	10,477	95	4070	4054–4100
41	5733	95	4170	4150–4200
42	57	95	4346	4093–4730

CTG, newborns with pH < 7.10, newborns with an Apgar score ≤ 7at 5 min, preeclampsia or perinatal death.

Adverse perinatal events with a significantly higher frequency in the HBW group included type 3 or greater neonatal resuscitation, stalled labour/suspected cephalopelvic disproportion caesarean section (CSAL) and third degree or higher perineal tears (severe perineal tears).

The multivariate logistic regression analysis for adverse events including CSAL and third degree or higher perineal tears was used to generate the final models described in Tables 3 and 4. In addition, different risk factors were identified as associated with these perinatal outcomes, and parity ≥ 1 was identified as a common protective factor in both cases, with odds ratios (ORs) of 0.36 (95% confidence interval (CI) 0.33–0.39) and 0.54 (95% CI 0.43–0.68), respectively.

Discussion

Study Findings

The present study showed that in a large sample of patients, deliveries of HBW newborns resulted in a higher proportion of labour induction, CSAL, severe perineal tears and type 3 or greater neonatal resuscitation.

Regarding the characteristics of the sample, maternal age was significantly higher in women with HBW newborns, although this difference was not clinically significant. Other studies have shown the same result [17].

Likewise, the HBW group presented a higher proportion of pregestational and gestational maternal diabetes. Maternal diabetes is a risk factor for the development of foetal

Table 2 Comparative study between HBW and AGA

Variable	HBW	AGA	*p* value
Maternal age, mean (SD)	33.06 (5.4)	32.6 (5.7)	< 0.01
Parity, *n* (%)			< 0.01
0	40 (2.2)	632 (2.13)	
1	639 (35)	15,289 (51.5)	
≥ 2	1147 (62.8)	13,731 (46.3)	
Pregestational diabetes, *n* (%)	23 (1.25)	97 (0.3)	< 0.01
Birth weight (g), mean (SD)	4175.7 (251.2)	3331.1 (320.8)	< 0.01
Gestational diabetes, *n* (%)	63 (3.44)	786 (2.71)	0.04
Induced labour, *n* (%)	481 (29.1)	6839 (24.5)	< 0.01
Instrument-assisted delivery, *n* (%)	306 (23.1)	5656 (22.6)	0.66
CSAL, *n* (%)	268 (17.01)	1811 (6.76)	< 0.01
Epidural-intradural anaesthesia in vaginal delivery, *n* (%)	1093 (82.6)	20,898 (83.5)	0.39
Severe perineal tear, *n* (%)	23 (1.2)	255 (0.8)	0.03
Episiotomy, *n* (%)	778 (47.1)	14,992 (53.3)	0.99
Perinatal death, *n* (%)	0	40 (0.1)	0.99
Preeclampsia, *n* (%)	29 (1)	382 (1.3)	0.27
Abnormal CTG, *n* (%)	73 (3.9)	1122 (3.7)	0.64
CS due to abnormal CTG, *n* (%)	68 (3.7)	955 (3.2)	0.23
Ph at birth < 7.10, *n* (%)	42 (2.3)	598 (2.01)	0.39
Apgar2 ≤ 7, *n* (%)	14 (0.5)	204 (0.68)	0.47
Resuscitation ≥ type 3, *n* (%)	129 (7.04)	1573 (5.2)	< 0.01

HBW high birth weight, *AGA* appropriate for gestational age, *CSAL* caesarean section due to arrested labour/cephalopelvic disproportion, *CTG* cardiotocography, *CS* caesarean section

Table 3 Final multivariate logistic regression model for CSAL

CSAL	OR	IC 95%	*p* value
Delivery ≥ 41 weeks	1.54	1.37–1.72	0.00
Maternal age	1.03	1.02–1.04	0.00
Parity	0.36	0.33–0.39	0.00
Gestational diabetes	1.50	1.19–1.89	0.00
Macrosomia	3.60	3.08–4.2	0.00
Induction of labour	3.42	3.09–3.79	0.00
Constant	0.49	0.03–0.06	0.00

CSAL Caesarean section due to arrested labour/cephalopelvic disproportion

macrosomia and HBW [18]. Other authors have identified obesity and maternal diabetes as the most relevant risk factors for macrosomia, resulting in increased perinatal and neonatal adverse outcomes. In this sense, limitation of maternal weight gain along with exhaustive control of glycaemic levels in pregnancies complicated with diabetes could reduce the rate of HBW newborns and the associated adverse outcomes [19].

Macrosomia and Perinatal Outcome

Delivery of a macrosomic newborn increases the risk of developing additional complications that were not analysed in the studied sample, such as postpartum haemorrhage, shoulder dystocia and neonatal hypoglycaemia [20, 21].

In addition, the duration of maternal hospital admission has been shown to be greater in women delivering a macrosomic newborn, regardless of the delivery method, resulting in a twofold increased risk of a prolonged hospital stay [22].

The increased risk of caesarean section, postpartum haemorrhage and perineal laceration associated with the delivery of an HBW newborn implies an increase in the use of pharmacological measures, such as prostaglandin E1 or methylergometrine maleate, among other substances, to avoid excess blood loss. In addition, the use of surgical techniques and transfusion of blood products may be required, which increase the health cost significantly and can lead to additional complications.

Table 4 Final multivariate logistic regression model for severe perineal tears (third and fourth degree)

Severe perineal tear	OR	IC 95%	*p* value
Episiotomy	1.48	1.02–2.16	0.03
Parity	0.54	0.43–0.68	0.00
Instrument-assisted delivery	2.49	1.9–3.27	0.00
Macrosomia	2.06	1.33–3.19	0.00
Constant	0.01	0.00–0.20	0.00

Stalled Labour/CSAL

The prevalence of maternal morbidity is higher for deliveries of a macrosomic newborns, with a higher incidence of stalled labour, instrument-assisted delivery, uterine rupture and caesarean section [23, 24]. However, an increased risk of instrument-assisted delivery by forceps, suction-cup devices or spatulas was not identified.

Siggelkow et al. [25] showed a direct correlation between HBW and increased incidences of caesarean section and instrument-assisted delivery. They also identified a significant association between maternal weight gain during pregnancy and risk of caesarean section [25].

The present study performed an evaluation of different variables using a multivariate analysis model to identify risk factors associated with CSAL. The most important factor was the delivery of an HBW newborn, with an OR of 3.6 (95% CI, 3.08–4.2). Additional risk factors associated with CSAL included delivery beyond 41 weeks, maternal age over 35 years, gestational diabetes and induction of labour. Parity ≥ 1 was identified as a protective factor against this perinatal event. After fitting by maternal age, multiparity was shown to decrease the risk of caesarean section, with an OR of 0.6 (95% CI, 0.4–0.8) in another study [26].

Severe Perineal Tears (Third and Fourth Degree)

The studied sample exhibited a significant increase in the frequency of severe perineal tears in HBW newborn deliveries compared to AGA deliveries.

The final multivariate regression model showed that the delivery of a macrosomic newborn was a significant risk factor for severe perineal tears, although the main risk factor was instrument-assisted delivery, with an OR of 2.49 (95% CI, 1.9–3.27). Another risk factor associated with perineal tears was the performance of an episiotomy.

Parity was also a protective factor against severe perineal tears. Induction of labour and delivery beyond 41 weeks were not identified as significant risk factors, with ORs of 1.03 (95% CI, 0.77–1.37) and 1.14 (95% CI, 0.82–1.57), respectively.

Interestingly, no study showed statistically significant differences regarding third and fourth degree perineal tears between AGA and HBW deliveries. Siggelkow et al. found no association between HBW and severe perineal tears. In contrast, different authors have shown higher rates of perineal tears in the delivery of macrosomic foetuses [13].

Strengths and Limitations of the Study

This study presents multiple strengths. First, the study was conducted in a very large sample of patients with wide and

complete information on pregnancy and perinatal outcomes from the database of our hospital. Each delivery occurred in the same maternity centre; therefore, homogeneous criteria were used for the indication of instrument-assisted deliveries and CSAL according to the centre's protocol. In addition, the multivariate regression analysis contributed to identifying the risk factors associated with the adverse study events and was weighted by the variables included in the initial models.

However, this study had some important limitations. First, the retrospective nature of the study implies a limited degree of evidence. Additional relevant variables were not considered with regard to the perinatal outcome, including maternal body mass index, smoking habits, conception methods or excess weight gain during pregnancy. The percentiles of the newborns were not evaluated by gender. Other interesting outcome variables, such as shoulder dystocia, postpartum haemorrhage or postpartum maternal and neonatal hospital stay, were not examined in this study.

Conclusions

In conclusion, our study aimed to provide additional information on pregnancies and deliveries of HBW newborns. The perinatal results of macrosomic newborns (weights above 95th percentile for gestational age at delivery) are less favourable than those of AGA newborns.

Additional risk factors associated with CSAL and severe perineal tears, in addition to neonatal macrosomia, were identified. This information could be useful in predicting these and other adverse perinatal events published in the literature and for providing adequate advice to patients in the third trimester of pregnancy.

Authors Contribution SGTL designed and carried out the study, performed the statistical analysis and the literature review and drafted the manuscript. FAV and MBC revised the final manuscript. All authors read and approved the final manuscript.

Data Availability All data supporting the findings of this study can be made available upon request.

Compliance with Ethical Standards

Ethics Approval and Consent to Participate The present study was approved by the Ethics Committee of the General Hospital of Universitario Gregorio Marañon de Madrid (reference number OBS05042016).

Consent for Publication The present study was approved by the Ethics Committee of the General Hospital of Universitario Gregorio Marañon de Madrid for publication (reference number OBS05042016).

Competing Interests The authors declare that they have no competing interests.

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