ORIGINAL RESEARCH ARTICLE

A retrospective identification of risk factors associated with fetal macrosomia

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Abstract

Despite extensive work on macrosomia, it is impossible to predict women at risk. Current prediction strategies which include clinical examination and ultrasound are imprecise. This study aims to determine the risk factors associated with macrosomia. It was a descriptive, retrospective chart review of women delivered of macrosomic neonates over a two-year period from 2015-2016. Detailed clinical and demographic information was recorded. Statistical analysis was carried out using SPSS (version 25.0 IBM, Armonk, New York, USA). Of 22 244 singleton deliveries, 415 were macrosomic infants (1.9%). The mean birth weight for macrosomic infants was 4.39 ± 0.43 (range 4-5.15) kg and males were more in number and weight. Macrosomic infants occurred more in age groups 25-29 years and peaked with BMI ≥30 kg/m^2. Majority were cesarean sections compared to vaginal deliveries (56.6% vs 43.4%; p=0.006) respectively. Vaginal delivery of macrosomic infants was associated with complications. Significant differences were found between fetal macrosomia and clinical characteristics such as body mass index, parity, advanced maternal age, and male fetal sex. Hypoglycaemia was most frequent in infants born to non-diabetic mothers (98.1%). Antenatal risk factors are important in the prediction of macrosomia, but fetal and maternal outcome depends on labour management. *(Afr J Reprod Health 2022; 26[7]: 127-134).*

Keywords: Macrosomia, risk factors, maternal complications, fetal complications

Résumé

En dépit de nombreux travaux sur la macrosomie, il est impossible de prédire les femmes à risque. Les stratégies de prédiction actuelles qui incluent l'examen clinique et l'échographie sont imprécises. Cette étude vise à déterminer les facteurs de risque associés à la macrosomie. Il s'agissait d'un examen descriptif et rétrospectif des dossiers de femmes ayant accouché de nouveau-nés macrosomiques sur une période de deux ans allant de 2015 à 2016. Des informations cliniques et démographiques détaillées ont été enregistrées. L'analyse statistique a été réalisée à l'aide du logiciel SPSS (version 25.0 IBM, Armonk, New York, USA). Sur 22 244 accouchements singletons, 415 étaient des nourrissons macrosomiques (1,9 %). Le poids moyen à la naissance des nourrissons macrosomiques était de 4,39 ± 0,43 (extrêmes 4 à 5,15) kg et les mâles étaient plus nombreux et plus lourds. Les nourrissons macrosomiques sont plus nombreux dans les tranches d'âge de 25 à 29 ans et ont culminé avec un IMC ≥ 30 kg/m2. La majorité étaient des césariennes par rapport aux accouchements par voie basse (56,6 % contre 43,4 % ; p = 0,006) respectivement. L'accouchement vaginal de nourrissons macrosomiques était associé à des complications. Des différences significatives ont été trouvées entre la macrosomie fœtale et les caractéristiques cliniques telles que l'indice de masse corporelle, la parité, l'âge maternel avancé et le sexe fœtal masculin. L'hypoglycémie était plus fréquente chez les nourrissons nés de mères non diabétiques (98,1%). Les facteurs de risque prénatals sont importants dans la prédiction de la macrosomie, mais l'issue fœtale et maternelle dépend de la gestion du travail. *(Afr J Reprod Health 2022; 26[7]: 127-134).*

Mots-clés: Macrosomie, facteurs de risque, complications maternelles, complications fœtales

Introduction

Fetal macrosomia (FM) is defined as a birthweight of ≥ 4000g[1] causes substantial maternal and fetal complications. In addition, the incidence of FM appears to be increasing and although reports of its incidence vary from region to region, it affects 3-15% of all pregnancies[2]. Factors associated with

FM include genetics, postdates, high body mass index (BMI), large increases in gestational weight gain, and gestational diabetes[3,4]. However, it is well known that prediction based on clinical risk factors alone has a very low positive predictive value[5]. Maternal complications associated with FM include prolonged labour, obstructed labour, postpartum haemorrhage, genital tract injury, high caesarean delivery rates and uterine rupture[1,6]; while fetal complications include stillbirth, birth asphyxia, shoulder dystocia, birth injury, metabolic disorders, and meconium aspiration[6,7].

Although accurate estimation of birthweight prior to labour and identification of fetuses at risk are challenging, there is paucity of information on the detection and clinical management of FM in South Africa (SA). Furthermore, given the increasing incidence of obesity in the local population due to urbanization and a change to unhealthy diets. There is a need to establish the incidence of fetal macrosomia in an urban SA. The purpose of this study therefore was to establish the incidence of FM and its clinical outcomes at a regional hospital in Durban, SA.

Method

A retrospective chart review of patients who delivered macrosomic babies during 1st January 2015 to 31st December 2016 at a regional hospital in Durban, South Africa was carried out. The study site serves as a referral base for 29 provincial health authority and municipal clinics in the southern part of Durban. The hospital delivers approximately 11,000 to 12,000 deliveries annually. The labour ward "birth register" was used to obtain the hospital records of all patients with singleton pregnancies who had given birth to babies weighing > 4000g over the study period. All the hospital charts of mothers who had macrosomic babies were reviewed by the principal author who is a specialist obstetrician. Antenatal care and labor management is mainly conducted by professional nurses, medical officers, and registrars in training. Most patients have at least one routine obstetric scan in early pregnancy by an ultrasound technician; further scans are done on request by doctors.

Data analysis

The data collected was captured on a prestructured data sheet and included demographic and clinical data. The data was analyzed using the SPPSS version 25.0 (IBM, Armonk, NY, USA).The correlation between factors associated with fetal macrosomia was performed. Logistic regression was also performed to determine the factors that predispose to fetal macrosomia. Descriptive statistics such as frequencies and percentages were used to summarize categorical data. Measures of central tendency, mean, median, mode and measures of dispersion such as standard deviation and interquartile range was calculated for numerical variables. A p value of <0.05 was considered as statistically significant.

Results

Of the 22,244 singleton deliveries over the two-year study period, 415 babies had birth weights of >4000 g. The prevalence of FM was 1.9%. Figure 1 shows the diagnosis, delivery mode and associated maternal and fetal complications. Fetal macrosomia was prenatally detected either clinically and or by ultrasound diagnosis. The mean (SD) age of mothers was 27.2 (±6.3) years (range: 14—43). There was a gradual increase in the incidence of macrosomia from 10.6 % in age groups < 20 years to 29.6% in the 25-29 age groups and subsequently decreased to 13.7% in the age group ≥ 35 years. There was an increase in the frequency of macrosomia with BMI and peaked in mothers with BMI ≥30 kg/m2.Thirty seven (8.9%) of the mothers had a previous history of FM. There was no correlation between previous macrosomia and macrosomia in the current pregnancy (r=0.095; p=0.05). The clinical characteristics for the prediction of FM **are** shown in Table 1.

Neonatal details

Three hundred and ninety-one (94.2%) of the 415 infants had birth weight between 4000 to 4499 grams and 21(5.2%) had birth weights between 4500 to 4999 g. Three (0.7%) had birth weight about 5000 gr or more. The mean (SD)

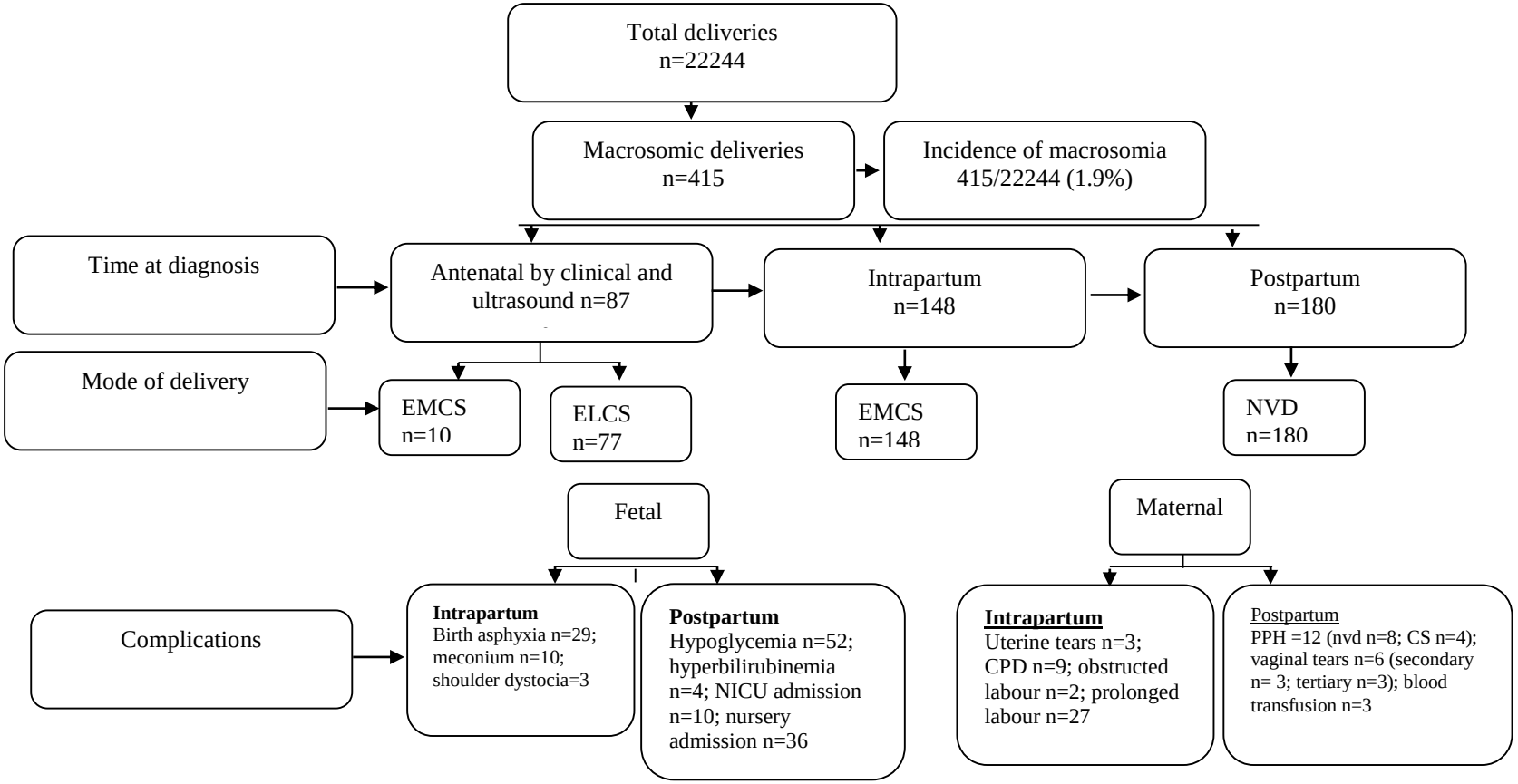

Figure 1: Flow diagram showing the diagnosis, delivery mode and associated maternal and fetal complications

Table1: The clinical and demographic data of all the study patients

Variable	Mean ±SD	Minimum	Maximum
Age (years)	27.22±6.3	14	43
Age groups			
<20	44 (10.6)		
20-24	108 (26.0)		
25-29	123 (29.6)		
30-34	83 (20.0)		
≥35	57 (13.7)		
Height (cm)	160.5 ±6.1	121	182
<160 cm	193 (48.0)		
>160 cm	222 (52.0)		
Parity	1.32±1.2	0	5
Parity groups			
0	131 (31.6)		
1	111 (26.7)		
≥2	109 (41.7)		
BMI	31.4±6.6	17.6	64.5
BMI groups			
<18.5	1 (0.2)		
18.5-24.9	54 (13.0)		
25-29	125 (30.1)		
≥30	235 (56.6)		
Previous history of macrosomia	37 (8.9)		
Diabetes	8 (1.9)		
Hypertensive disorders of pregnancy	19(4.6)		

Table2: Maternal and neonatal complications in macrosomic pregnancies

Complications	**Frequency (%)**	
Birth asphyxia	[a]29	[b]7.0
Meconium	10	2.4
Shoulder dystocia	3	0.7
Hyperbilirubinemia	4	0.9
Neonatal hypoglycemia	52	12.5
Apgar scores <7 @ 1 min	14	3.4
Apgar scores <7 @ 5 min	4	1.0

a: Maternal frequency
b: Neonatal frequency

birthweight was 4.2±0.21 (range: 4.0-5.15) kg. The largest newborn in the study group weighed 5150 g. Two hundred and seventy-four (66.0%) were males and 141 (34%) were females. The difference in mean birth weight between males and females was statistically non-significant (4220g vs 4200; p=0.08). There was a significant difference in the mode of delivery (NVD (43.4%) vs CS (56.6%); p=0.006). Indications for caesarean section included previous C/S (6.9 %), Cephalopelvic disproportion accounted for 31.8% of abdominal deliveries and fetal distress (5.1 %), breech (0.2%), grand multiparity (0.2%). Fetal macrosomia was identified as an indication for C/S in 53 (42.7 %) of cases. Maternal and neonatal complications are listed in Table 2.

Neonatal complications occurred in 98 (23.6%). Hypoglycemia was also more frequent in infants born to non-diabetic mothers (98.1 %) compared to those born to diabetic mothers (1.9 %); the difference was significant (p=0.0001). There was a significantly higher proportion of macrosomic babies with an Apgar score below seven in the first and in the fifth minute (p=0.0001). The male/female ratio of 1.91:1, the male neonates was significantly higher than female neonates (p=0.0009)

Multiple regression analysis

The multiple regression analysis showed that fetal macrosomia was significantly higher in women with age ≥ 25, parity ≥ 1, BMI (≥30), and male fetal sex, The possibility of having a macrosomic fetus was increased in mothers ≥ 30 years of age (adjusted OR, 1.56; 95% CI: 1.21-1.95), >1 of parity (adjusted OR, 2.76; 95% CI: 1.31- 2.85), a pre-pregnancy BMI of ≥ 25 (adjusted OR, 3.35; 95%CI: 2.55-4.40), ≥ 12 of gestational weight gain (GWG) (adjusted OR, 5.45; 95% CI: 3.90-7.61) and male fetal sex (adjusted OR, 1.89; 95% CI: 1.51-2.37).

Discussion

Our key findings suggest that macrosomia is associated with increased risks of caesarean delivery, trauma to the genital tract and birth injuries. Body mass index, parity, advanced maternal age, and male fetal sex emerged as predisposing factors for macrosomia. Furthermore, the findings from this study showed the overall

Table 3: Multiple logistic regression analyses of risk factors of fetal macrosomia

Risk factors of fetal macrosomia				
Maternal variables	**n**	**Macrosomia (%)**	**aOR (95% CI)**	**P value**
Age (years)				
<25	152/415	36.6%	1.0 (reference)	
≥25	263/415	63.4%	2.16 (1.71-4.95)	0.0001
Parity				
≤1	134/415	32.3%	1.0 (reference)	
>1	281/415	67.7%	2.36 (1.31-2.85)	0.0001
Pre-pregnancy BMI (kg/m^2)				
Underweight<18.5	1/415	0.2%	0.29 (0.07-1.23)	0.087
Normal 18.5-24.9	54/415	13.0%	1.0 (reference)	
Overweight 25-29.9	125/415	30.1%	4.47 (2.49-6.37)	<0.0001
Obese ≥30	235/415	56.6%	6.64 (4.3-9.5)	<0.0001
Fetal sex				
Female	141/2060	34.0%	1.0 (reference)	
Male	274/2186	66.0%	1.99(1.61-2.43)	<0.0001

aOR = adjusted odds ratio; BMI = body mass index

performance of clinical examination and ultrasound to predict macrosomia was not optimal. Only 21% of macrosomic cases in our study were detected antenally by clinical and ultrasound. In addition, increased maternal BMI was significant predictor for fetal macrosomia. Hypoglycemia was also a frequent finding in infants born to non-diabetic mothers.

In the study the highest incidence of macrosomia (21%) was reported within the maternal age range of 25-29 years, while the minimum incidence rate was observed in mothers aged less than 20 years (10.6%). Findings are in variance with other studies which reported the highest incidence of macrosomia (18%) was reported within the maternal age ≥ 35 years, while the minimum incidence rate was observed in mothers aged less than 20 years (8.5%)[8]. In another study conducted in 23 developing countries, the rate of macrosomia at birth was reported to be 1.9% in Asia within the maternal age range of 20-34 years, while it was estimated at 12.1 % in the mothers aged ≥35 years[9].

Vaginal delivery of macrosomic infants was associated with high incidence of complications except for shoulder dystocia (n=3; 1.7%) and postpartum hemorrhage (n=12; 3.6%) and complications for women who had cesarean were rare (less than 3%). The reported rates of CS for FM vary widely and ranges from 14% to 44%[10]. We found a caesarean rate of 56.6%. This contrasts with the overall CD rate of 35% at the study site.

In the present study, the frequency of FM was 1.9%, this was lower than the figure of 3.4% found in a similar study carried out in the Eastern Cape 24 years ago[11]. This is surprising given the increasing urbanization of rural populations to the metropolitan areas of South Africa. It is possible that the site of the present study is a well settled suburb of Durban and migrations usually initially settle within city centres. It should be noted however that the prevalence of macrosomia in South African antenatal populations is markedly lower than that reported by studies conducted in Ghana (6.7%)[11], Nigeria (5.5%)[12] Ethiopia (6.7%)[13] and Tanzania (2.3%)[14]. Comparison of the incidence of FM among different studies is fraught with difficulties because of the different birth weights and denominators used by various authors. It may also be due to differences in geographical and socioeconomic factors of the study population.

Prenatal estimation of fetal weight is known to be inaccurate, with errors exceeding 10% of the actual birth weight[15]. Furthermore, sonographic estimates of birth weight are no better than clinical assessment. This concern was observed in our study, macrosomia was diagnosed antenatally by ultrasound and clinical examination or both. Of major concern in our study was that

although 20.9% (n= 87) of the macrosomic infants were identified antenatally by clinical and ultrasound scans, 35.7% were diagnosed intrapartum and more than 40% were detected postpartum. This suggests that more attention must be placed on clinical training to detect and or suspect FM. Unfortunately, in low and middle-income countries such as SA, sonographic measurements in late pregnancy are difficult to access for most pregnancies, and it may not be possible to determine macrosomia by doing multiple ultrasound measurements in a longitudinal manner for various reasons. In an earlier study, antenatal clinical suspicion of macrosomia was observed in 40% of the cases and 16.6% of macrosomia was missed on scan[16].

Our study failed to establish any correlation between maternal height and macrosomia. However, other studies have found height above 160cm, 169 cm and 170 cm, respectively, to be significant risk factors for macrosomia[17-19]. Height did not appear to be a significant factor, since about 48% of the macrosomic infants' mothers were less than 160 cm tall in our study. We could not be certain that it applied in our study population.

It has been reported that the history of FM has a positive predictive value of 95% as a risk factor for macrosomia[20]. Women who previously delivered macrosomic babies are 5–9 times more likely to deliver a baby considered large-for-gestational age in subsequent pregnancies[21]. In the current study a small percentage of patients gave a previous history of macrosomia. In addition, we found no correlation between patients with previous macrosomia and patients without history of macrosomia. Our findings are consistent with other studies [19, 22] but in variance with other studies which showed significant association between previous and current incidence of macrosomia[7,23].

There is considerable variation in the literature regarding the strength of association between FM and individual risk factors. For example, in many studies diabetes and gestational diabetes has been shown to be a strong predictor of macrosomia[24,25]. The frequency of diabetic mothers in our series was 1.9%. Yet, despite the study's low population of infants of diabetic mothers, the incidence of hypoglycemia among macrosomic infants is in keeping with the findings of other studies[26].

Our results identified that compared to pregnant women with normal BMI, overweight and obese pregnant women were 4.47 and 6.64 increased in the adjusted odds of delivering fetal macrosomia, respectively. In addition, age $\geq 25\ years$ and parity ≥1 increased in the adjusted odds of 2.16 and 2.36 of delivering fetal macrosomia, respectively. In contrast, Usta *et al*., showed that compared to normal BMI overweight and obese pregnant women were 3.1 and 5.6 increased in the adjusted odds of delivering fetal macrosomia. Also, fetal macrosomia was significantly higher in women with age ≥ 30 of age and parity ≥ 1 compared to 25-29 years of age and parity ≥ 2 in our study[27]. Other reports that have shown a 1.5-2.3 increase in the adjusted odds of delivering large for gestational age newborns among obese women[28]. A UK population-based study reported a 40% increase in the odds of macrosomia in women between 35 and 39 years old in comparison with younger than 35 years old and a 20% increase in risk for women over 40 years old[29]. A study from Turkey has shown that maternal age above 35 years triples the risk of fetal macrosomia[30].

There have several reports that excessive gestational weight gain weight gain during pregnancy might increase the risk of macrosomia[31,32]. Gestational weight gain exceeding 13 -18 kg at term in pregnancy has been reported to be an important risk factor for macrosomia[33,34]. Usta *et al* reported that gestational weight gain of 12kg was associated with 5.5-fold increases in the risk of fetal macrosomia[35]. We found that gestational weight gain of 12 kg in 20.7% of the mothers. The determination of pre-pregnancy weight in our clinics is difficult. There are no preconception clinics. Furthermore, while some of the patients registered for antenatal care late, others were not registered. Hence, the effect of weight gain in pregnancy on fetal weight could not be properly determined in this study.

Non-diabetic macrosomia has become an obstetric dilemma. Analysis of our data showed that neonatal hypoglycemia was more frequent finding in infants born to non-diabetic mothers compared to

diabetic mothers. It is of concern that infants born to non-diabetic mothers developed hypoglycemia. Similar results have been reported[18], while others have found a higher percentage of diabetes and pre-diabetes are implicated in 10% of cases of macrosomia[36]. It has been shown that infants with a birth weight ≥4,000 g delivered by nondiabetic mothers had a 2.4% risk of neonatal hypoglycemia, whereas those whose mothers had gestational diabetes had an incidence of 5.3%[36]. In comparison, our study showed infants born to macrosomic nondiabetic mothers had a 1.9% risk of neonatal hypoglycaemia.

Our study demonstrated that in a large obstetrical population with singleton pregnancies, as birth weight increased the risk of maternal and neonatal morbidities increased. The fetal complications were dominated by hypoglycaemia (12.5%) followed by birth asphyxia (6.98%) and meconium-stained liquor (2.4%). Other morbidities observed were shoulder dystocia (0.7%) and hyperbilirubinemia (0.9%). Ten (2.4%) of the macrosomic newborns were admitted to neonatal intensive care for observations and as a precautionary measure for a median duration of 1 day (range 1–30). There was no neonatal mortality in our series which is in variance with several other studies[7,27].

The main limitations were a retrospective nature of the study. Despite this limitation, the strengths of this study include the large sample size and that the results all came from a single institution.

Conclusion

It is difficult to anticipate macrosomia based on risk factors. In this study accurately predicting FM remains a desirable but challenging goal. FM is associated with considerable maternal and neonatal morbidity in our study population. While awareness of antenatal risk factors is certainly important in the prediction and subsequent management of macrosomia, fetal and maternal outcomes depend largely on how well labour is managed.

Conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper. The authors received no specific funding for this study.

Contribution of authors

Dr. Terrence Moodley: Conceptualization, manuscript writing, and data Analyses
Professor Jagidesa Moodley: Conceptualization, Manuscript writing and editing.

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