Original Research Article

MATERNAL AND FETAL DEMOGRAPHIC PREDICTORS OF FETAL MACROSOMIA

ABSTRACT

Background

Fetal macrosomia is birth weight ≥ 4000 grams, besides gestational diabetes, it could be caused by maternal demographic factors.

Objectives

The objective of this study is to determine the maternal and fetal demographic predictors of fetal macrosomia.

Method and materials

This was a retrospective cross-sectional study of 100 women who delivered macrosomic babies at Niger Delta University Teaching Hospital (NDUTH), Yenagoa in Nigeria.
Information retrieved was patient's bio-data, maternal weight and height, booking status, gestational age at delivery, and fetal sex.

Results

The rate of fetal macrosomia was 6.6%, the mean gestational age was 39.5 ± 0.98 weeks, and the mean birth weight was 4.28 ± 0.29kg. The mean maternal age was 30.98 ± 4.4 years, and the mean BMI was 30.6 ± 5.13 km/m^2.
The rate of fetal macrosomia was significantly higher among women with advanced maternal age (≥ 35 years), p = 0.001, grand multiparous women, odds ratio = 0.05[0.01, 0.35] p = 0.001, and women of Ijaw tribe, odds ratio = 2.48[1.40, 4.40] p = 0.01.
The rate was also higher among women with tertiary education, p = 0.001, obese women p = 0.001, and male babies, odds ratio = 1.91[1.09, 3.34], p = 0.02.
On multiple linear regressions, the maternal and fetal demographic factors did not give a good fit on the regression model, as all the factors combined could only explain 15.4% of the fetal macrosomia (r^2 = 15.4%).

Conclusion

Though maternal and fetal demographic factors are undoubtedly important in the pathogenesis of fetal macrosomia, their role as predictors is unremarkable, as demonstrated by our regression model. It implies that the bulk of the factors responsible (in this study) are not demographic; they could be diabetes mellitus, and genetic factors.

Key words: fetal macrosomia, demographic factors, predictors.

INTRODUCTION

Fetal macrosomia is defined as birth weight of ≥4000 grams, though some people use ≥4500 grams, but consensus opinion tends to favor ≥4000. [1] Its a very common fetal complication in pregnancy, and it is highly associated with maternal and fetal morbidity. [1]
Fetal macrosomia is a global health issue, and various rates have been reported in many centers; 15.77% in University of Baghdad in Iraq, [2] 19.8% at Maternity and Children Hospital (MCH) of Hail in Saudi Arabia, [3] and 12.7% at Medway NHS Foundation Trust, Gillingham in UK. [4] Reported rates in Nigeria are: 8.1% at UNTH in Enugu, [5] and 8.9% at Rivers State University Teaching Hospital in Port Harcourt. [6]

Risk factors identified at Al-Azhar (Assuit) University Hospital in Egypt were: diabetes mellitus, maternal age > 30 years, overweight, gestational age > 39 week, multiparity, and prior history of macrosomia. [7] A study at Balikesir State Hospital in Turkey reported the risk factors as: gestational weight gain, pre-pregnancy BMI, advanced maternal ageand male fetal sex. [8]

In Nigeria, a study at University of Benin Teaching Hospital (UBTH) identified the most significant risk factors for fetal macrosomia as: advanced maternal age (P = 0.047), diabetes mellitus (P = 0.007), women with high parity (0.001), previous delivery of a macrosomic baby (P = 0.000), increased pregnancy weight gain (P = 0.000), and tall women (P = 0.007). [9]

Though the risk of fatality posed by fetal macrosomia seems to be minimal, it causes significant morbidity to both mother and baby. Some of the major maternal complications are severe perineal tear during labour, severe postpartum hemorrhage, and shoulder dystocia. [10] They tend to get worse as the birth weight increases. [1, 10] A study in Lagos reported a high rate of cesarean delivery of 44.4% among the women. [11]A similar study at Medway Maritime Hospital, Gillingham in UK reported the odds of maternal complications as2.4 [2.0, 3.0] for severe postpartum hemorrhage, 2.3 [1.9, 2.8] for obstetric anal sphincter injury, 10.4 [8.6, 12.6] for shoulder dystocia. [4]

Fetal complications of macrosomia are quite common, and it has been associated with increased neonatal morbidity, birth asphyxia, and high need for intensive care. [10] A study at UsmanuDanfodiyo University Teaching Hospital, Sokoto in Nigeria reported the fetal complication as perinatal asphyxia (13.1%), birth injuries and sepsis (3.3%), and neonatal jaundice (1.6%). [12] In the UK, the odds of fetal complications were reported as: brachial plexus injury 28.5 (95% CI, 8.9–90.7), fractures 32.3 (95% CI, 3.8–278.2), and hypoxic-ischemic encephalopathy 4.4 (95% CI, 2.2–8.8). [4]

Though various articles have been published on fetal macrosomia in Nigeria, this study intends to add to the understanding of this subject matter, by focusing attention to the role played by maternal and fetal demographic factors on the pathogenesis of fetal macrosomia.

OBJECTIVES

The objective of this study is to determine the maternal and fetal demographic predictors of fetal macrosomia. It will also determine the correlation coefficient between the demographic factors and fetal macrosomia.

METHODOLOGY

STUDY SITE

This study was carried out at the delivery ward, andlabour ward theatre of the department of obstetrics and gynaecology, Niger Delta University Teaching Hospital (NDUTH), Yenagoa in Nigeria.

STUDY DESIGN

This was a retrospective cross-sectional study of 100 women who delivered macrosomic babies during the study period. It was carried out from January 2019 to December 2023.

INCLUSION CRITERIA

Included in this study were both booked and unbookedparturients who delivered in NDUTH during the study period. They include women who delivered by: spontaneous vaginal delivery, caesarean section, and instrumental vaginal delivery.

EXCLUSION CRITERIA

Excluded from this study are women withriskfactors that could cause fetal macrosomia order than demographic factors, such as: pre-gestational and gestational diabetes mellitus, genetic factors like family history of fetal macrosomia, potential causes of hydrops fetalis like rhesus iso-immunization. Also excluded were patients whose height and weight were not recorded on their case notes, most of the affected patients were unbooked.

DATA COLLECTION

This was a retrospective cross-sectional study of 1520 women who delivered during the study period. Out of these, a total of 100 women who delivered babies with fetal macrosomia were identified. The case notes of these women were retrieved from the hospital records department.
Information retrieved was bio-data, maternal height and weight (at booking or first contact), and body mass index (BMI) was calculated using SPSS statistical software, using the formula BMI = Weight (kg)/height (m^2). We did not collect data on weight gain during pregnancy because it is not routinely done at our antenatal clinic. Other information retrieved was: booking status, gestational age at delivery, and fetal sex.

DATA ANALYSIS

The data collected was fed into (IBM) SPSS software version 25, and Epi Info statistical software version 7, and analyzed. Results were presented in tables as rates, proportions, and mean with standard deviation. Test of significance was by odds ratio, the degree of association was by Pearson's correlation coefficient, and predictor variables with simple and multiple linear regression. Confidence interval was set at 95%, and significant p value at ≤ 0.05.

RESULTS

Table 1: Maternal demographic characteristics and fetal macrosomia

Demographic factor	Fetal Macrosomia N = 100	Percentage	Odds ratio	Confidence interval	P value
Maternal age					
≤ 19 years (teenagers)	1	1.0%			

20 – 24 years	8	8.0%	0.33	[0.14, 0.78]	0.01
25 – 29 years	36	36.0%			
30 – 34 years	34	34.0%			
≥ 35 years (advanced maternal age)	21	21.0%	0.04	[0.01, 0.29]	0.001
Parity					
Para 0	1	1.0%	0.05	[0.01, 0.35]	0.001
Para 1	14	14.0%	0.74	[0.35, 1.59]	0.56
Para 2	30	30.0%			
Para 3	23	23.0%	21.36	[0.68, 2.72]	0.38
Para 4	14	14.0%			
≥ Para 5	18	18.0%			
Religion					
Christian	90	90.0%			
Muslim	10	10.0%			
Ethnicity					
Ijaws	55	55.0%	2.48	[1.40, 4.40]	0.001
Igbo	33	33.0%			
Others	12	12.0%			
Address					
Urban	95	95.0%			
Semi-urban	4	4.0%			
Rural	1	1.0%			
Educational level					
Primary Education	7	7.0%			
Secondary Education	48	48.0%	1.13	[0.65, 1.97]	0.67
Tertiary Education	45	45.0%	0.09	[0.04, 0.22]	0.001
Patient's Employment status					
Unemployed	39	39.0%			
Employed	61	61.0%	0.41	[0.23, 0.72]	0.001
Maternal height					
Short stature (< 1.50 meters)	7	7.0%			
Normal height (≥ 1.50 meters)	93	93.0%			
Body mass index (BMI)					
Underweight (<18.5 kg /m^2)	0	0.0%			
Normal weight (18.5-24.9 kg/m^2)	11	11.0%			
Overweight (25.0 – 29.9 kg /m^2)	42	42.0%			
Obese (≥ 30.0 kg / m^2)	47	47.0%	0.14	[0.07, 0.29]	0.001
Booking Status					
booked	81	81.0%			
unbooked	19	19.0%			
Gestational Age at Delivery (GA)					
Preterm (28 – 36 weeks)	0	0.0%			
Term (37 – 42 weeks)	92	92.0%			
Post term (> 42 weeks)	1	1.0%			
Postdate (> 40 – 41 weeks)	7	7.0%			
Fetal sex					
male	58	58%	1.91	[1.09, 3.34]	0.02
female	42	42%			

There were 1520 deliveries during the study period, out of these, 100 women delivered babies with fetal macrosomia, giving a rate (prevalence) of 6.6%.

The mean maternal age was 30.98 ± 4.4 years, and the median parity was para 3. The mean weight and height were 77.6 ± 10.5 kg, and 1.60 ± 0.06 meters respectively, and the mean BMI was 30.6 ± 5.13 km/m^2. The mean GA at delivery was 39.5 ± 0.98 weeks, and the mean birth weight was 4.28 ± 0.29kg.
Most of the women 60% were aged 25 – 29 years, and fetal macrosomia was significantly more common in women with advanced maternal age (≥ 35 years), compared to teenagers and young women (20 – 24 years), p = 0.001 and p = 0.01 respectively.
Regarding parity, fetal macrosomia was significantly more common in grand multiparous (≥ para 5) women compared to nulliparous (para 0) women, odds ratio = 0.05[0.01, 0.35], p = 0.001.

With respect to tribe, there are 4 major tribes in Nigeria, mainly Hausa/ Fulani, Yoruba, Igbo, and Ijaw. Bayelsa State where this study was conducted is an Ijaw tribe, and they constituted 55.0% of the women. Fetal macrosomia was more common among the Ijaws, odds ratio = 2.48[1.40, 4.40], p = 0.01.

Regarding educational level, fetal macrosomia was significantly more common among highly educated women (tertiary education), compared to those with primary education, odd ratio = 0.09[0.04, 0.22], p = 0.001.

Fetal macrosomia was more common among obese women (BMI ≥ 30.0 kg/m^2), odds ratio = 0.14[0.07, 0.29], p = 0.001.The sex of the babies seems to have significant influence on fetal macrosomia, as more male babies were macrosomic, odds ratio = 1.91[1.09, 3.34], p = 0.023

Table 2: Pearson's correlation coefficient ® of the demographic factors and fetal macrosomia

Demographic factor	Correlation coefficient ®	P value
Age	0.062	0.539
Parity	0.083	0.409
Tribe	-0.013	0.896
Religion	0.086	0.398
Educational level	0.011	0.914
Occupation	0.117	0.246
Address	0.043	0.669
Booking status	0.150	0.135
Booking weight	-0.136	0.716
Booking height	-0.136	0.177
Body mass index (BMI)	0.028	0.777
Gestational age at delivery	0.244	0.014
Fetal sex	0.024	0.813

The only demographic factor that significantly correlates with fetal macrosomia was gestational age at delivery, r = 0.244, p = 0.014.

Table 3: Simple linear regression of the demographic factors and fetal macrosomia

Predictor variable	r^2 (%)	F – ratio	P value
Age	0.4	0.380	0.539

Parity	0.7	0.897	0.409
Tribe	0.01	0.017	0.896
Religion	0.7	0.722	0.398
Educational level	0.001	0.012	0.914
Occupation	1.4	1.365	0.246
Address	0.2	0.184	0.669
Booking status	2.3	2.270	0.135
Booking weight	0.1	0.016	0.746
Booking height	1.9	1.852	0.177
Body mass index (BMI)	0.1	0.080	0/778
Gestational age at delivery	6.0	6.208	0.014
Fetal sex	0.01	0.056	0.813

Though a great majority of the demographic factors were not significant on simple linear regression, the 4 highest factors were: gestational age at delivery r^2 = 6.0%, booking status r^2 = 2.3%, booking height r^2 = 1.9 % and occupation r^2 = 1.4%.

Table 4: Stepwise multiple linear regression of demographic factors and fetal macrosomia

Predictor variable	**Step 1**	**Step 2**	**Step 3**	**Step 2**
Gestational age at delivery	0.244	0.244	0.244	0.244
Booking status		0.276	0.276	0.276
Booking height			0.306	0.306
Occupation				
Constant	1.387	1.413	2.401	2.297
r^2%	6%	7.6%	9.3%	12.1%
F - ratio	6,208	3.996	3.295	3.250
P value	0.01	0.021	0.024	0.015

The combined 4 highest r^2% (for the demographic factors) could only account for 12.1% of the risk factors for fetal macrosomia, and even when all the factors in the study were combined, the total r^2% was just 15.4%. It implies that the bulk of the factors responsible for the pathogenesis of fetal macrosomia are not demographic. These could be genetic, gestational, and pre-gestational diabetes, etc.

DISCUSSION

Delivery of birth weight of 4000g and above (fetal macrosomia) is a very common complication of pregnancy, and it is associated with maternal and perinatal morbidity. The risk was reported to be directly proportional to the increase in birth weight, with a dramatic increase when the weight exceeds 4500g. [1, 13]

The prevalence of 6.6% we got in this study is lower than the rates obtained in some centers in Nigeria; 2.1% in Sokoto, [12] 2.9% I Jos, [14] and 4.7% in Sagamu. [15] The reason for this disparity is not very clears, but it may be due to the fact that our study was only focused on demographic factors, but not fetal macrosomia as a topic. However, similar and comparable results were obtained in other Nigerian centers; 6.9% in Lagos, [11] and 5.5% in Benin. [9]

Literature search indicates that the centers with relatively high rates of fetal macrosomia are predominantly outside Nigeria. A study in Saudi Arabia reported a rate of 19.8%, [3] in Iraq it

was 15.8%, [2] and 12.7% in the UK, [4]. These countries are for more developed than Nigeria, with a wide disparity in living standards, based on GDP per capita.
The GDP per capita is about the most reliable measure of the living standard of a country. Based on data from the World Bank, Nigeria has one of the lowest indices globally ($2,162).In contrast, Saudi Arabia has a GDP per capita of $30,447, and USA has the highest($74, 161). [16] This most probably explains the disparity in birth weights.

A cohort study in USA involving 147,331,305 singleton births reported a low incidence of fetal macrosomia of 8.84%.[17]This appears low, because they used incidence, instead of the prevalence used in this study.

The most significant demographic factors associated with fetal macrosomia in our study are: advanced maternal age, grand multiparity, obesity, high educational background, male babies and gestational age at delivery. However, the mechanisms by which many of these demographic factors cause fetal macrosomia have not been satisfactorily explained.

Regarding maternal obesity during pregnancy, the mechanism is metabolic, and has been linked to insulin resistance, which results in hyperinsulinemia. The excess insulin crosses the placenta to cause hyperinsulinaemia in the fetus, which subsequently stimulates insulin-like growth factors, leading to macrosomia, and fetal hypoglycemia. [13]

Our mean gestational age at delivery of 39.5 ± 0.98 weeks, though normal, but it was relatively high. The association between high gestational age and fetal macrosomia relies on the fact that as the gestational age advances; the fetus continues to grow, with more supply of nutrients and oxygen, leading to fetal macrosomia. [13]

Maternal age has for long been recognized to have a positive correlation with fetal macrosomia, and it tends to peak when maternal age is advanced (≥ 35 years). [18, 19] Literature search indicates that fetal macrosomia is very rare among teens, and relatively uncommon among youths. [18, 19] This has been vindicated in our study; we found a significant association with advanced maternal age. Similar results were also obtained in other centers; In Tanzania, advanced maternal age was reported as a significant predictor of fetal macrosomia, odds ratio = 8.10(3.66, 17.910), p = 0.0001. [18] In South Africa, maternal age ≥ 35 years was significantly associated with fetal macrosomia, [19] and in Iran; the most significant age was 35 – 39 years. [2] The increased rate of fetal macrosomia with advanced maternal age is believed to be linked with the high rate of gestational diabetes among woman with advanced age. [1, 18]

Another risk factor for fetal macrosomia is high parity, and it has been reported from studies in various centers across Nigeria. A study in Benin reported a significant association between high parity and fetal macrosomia, p = 0,002. [9] Others centers were: Enugu (p = 0.01), [5] and Lagos, were it was observed that majority (47%) of the women who delivered macrosomic were multiparous. [11] As a matter of fact, this study has added a feather to it, as our results indicates that fetal macrosomia is significantly more common in grand multiparous women, compared to women with low parity. The association between high parity and fetal macrosomia is an observation whose mechanism is difficult to explain. However, further studies may be required.

A very important risk factor is maternal obesity (BMI ≥ 30.0 kg/m^2). A meta-analysis from a pool of data from 1950–2011, has proven that maternal obesity is significantly associated with fetal macrosomia, odds ratio = 2.17(1.92, 2.45). [20] A study in Turkey established a statistically significant association between fetal macrosomia and pre-pregnancy body mass

index (BMI), and weight gain in the index pregnancy. [8] A similar study at Taipei in Taiwan, observed that the mean 6-month gestational weight gain, and the mean maternal weight at term, positively correlates with fetal macrosomia. [21] At Yaoundé, Cameroon, gestational weight gain of ≥ 16Lb (7.26 kg) was significantly associated with fetal macrosomia. [22]

The findings from this study are consistent with the resultsfromthe studies enumerated above; our mean BMI was 30.6 ± 5.13 km/m^2, which implies that many of the women were obese, and obesity was associated with fetal macrosomia in NDUTH. Though maternal weight gain during pregnancy is a very important factor, it was not included in this study, because this information was not available in the records of most of our unbooked patients.

With respect to using demographic factors to predict fetal macrosomia (on multiple linear regression), the regression model did not give a good fit; it could only account for 12.1% of the risk factors for fetal macrosomia. Even when all the demographic factorsin this study were combined, the regression coefficient was just 15.4% (r^2 = 15.4%). It is therefore recommend that similar studies should be done in other centers, as the results could contribute meaningfully to the knowledge and management of fetal macrosomia.

CONCLUSION

Though maternal and fetal demographic factors are undoubtedly important in the pathogenesis of fetal macrosomia, their role as predictors is unremarkable, as demonstrated by our regression model. It implies that the bulk of the factors responsible (in this study) are not demographic; they could be diabetes mellitus, and genetic factors.

ETHICAL APPROVAL

Permit to proceed with this study was granted by the ethical committee of NDUTH, with registration number NDUTH/REC/0100/2024

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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