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Original Research

Relationship between Maternal Diseases and Placental Morphology among Parturient's in Port Harcourt, River State: A Multi-Centre Study.

Alerechi Emeka-Ogbugo[1], Simeon Chijioke Amadi[2*], Jane Dumle Gbobie[3], Abbey Mkpe[2], Paul Ledee Kua[2], Ada Nkemagu Okocha[4], Oluwagbemiga Adewale[5].

[1]Department of Human Anatomy, Rivers State University, Port Harcourt, Nigeria.,[2]Department of Obstetrics and Gynaecology, Rivers State University/Rivers State University Teaching Hospital, Port Harcourt, Nigeria.
[3]Department of Paediatrics and Child Health, University of Calabar Teaching Hospital, Calabar, Nigeria.
[4]Department of Family Medicine, Rivers State University/Rivers State University Teaching Hospital, Port Harcourt, Nigeria.
[5]Ultimate Specialist Hospital, Port Harcourt, Nigeria.

Abstract

Background Maternal diseases that complicate pregnancies such as Pregnancy induced hypertension (PIH) or Gestational Diabetes Mellitus (GDM) etc are markedly impressed on the placenta microscopically and macroscopically resulting in in defective placental development and perinatal morbidity and mortality. This study aimed to study the gross anatomy of the placenta and its relationship with maternal medical illnesses.

Methodology: This study was a multi-centre hospital-based prospective cross-sectional study of 250 parturient who had term deliveries in Port Harcourt. The socio-demographic data and the medical history of the parturient were collected using a proforma. The placenta was collected after delivery and examined, and the morphometric features were noted. Data analysis was done with SPSS IBM version 23. Correlation and Regression analysis were employed in investigating the relationship between maternal/neonatal characteristics and placental morphology. Statistical significance was at a p-level of less than 0.05.

Results: The mean age of the women ± SD = 30.44±4.1years and the median parity was para-2. Gestational Hypertension was the most common medical condition among participants. There was a statistically significant association between the maternal medical conditions and the placental shape with a preponderance of the oval shape among the women with hypertensive disorders. There was also, a statistically significant association between maternal medical conditions in pregnancy and other placental measurements such as weight, number of cotyledons, diameter, thickness, and cord insertion.

Conclusion: Maternal medical conditions in pregnancy was found to have significant macroscopic imprints on the placental morphology and these can help in the diagnosis and management of medical illnesses that complicate pregnancies in our environment. More research is needed to establish causation.

Keywords: Maternal Medical Diseases; Parturient; Placental Morphology; Port Harcourt; Relationship.

***Correspondence:** Dr Simeon Chijioke Amadi, Department of Obstetrics and Gynaecology, Rivers State University/Rivers State University Teaching Hospital, Port Harcourt, Nigeria. **Email:** simeon.amadi@ust.edu.ng

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Introduction:

The placenta is an organ formed during pregnancy with contributions from both the mother and the foetus and allows the exchange of oxygen, nutrients, waste products, and other factors between the mother and the foetus. [1] The placenta has a discoid appearance with a diameter ranging between 15–20 centimeters and weighs about 1/6th of the neonatal birth weight. It provides a protective milieu for the development of the foetus.[2] The placenta develops alongside the foetus and is usually expelled within 30 minutes postpartum. Thus, an alteration from the normal placental function could affect the foetal well-being. [3]

The placenta has been implicated in many unfavourable pregnancy outcomes. Preeclampsia (PE) and Intra-uterine growth retardation (IUGR) are implicated with defective placental development often resulting in perinatal morbidity and mortality.[4, 5] Researchers have inferred that the placenta gives mirror images of foetal development and gives an approximate account of foetal developmental events and maternal well-being.[6,7] Pregnancy complications such as pregnancy-induced hypertension (PIH) or Gestational Diabetes Mellitus (GDM) are markedly impressed on the placenta microscopically and macroscopically.[8] Pregnancy-associated with hypertension is usually linked with placental insufficiency, which often results in foetal growth restriction.[9] The placental morphology at birth can be a tool for the management of the mother and the newborn.[10] Hence, the placenta should be meticulously examined at birth.

From the foregoing, findings from placenta examination are not only useful to the Obstetrician but may be helpful to the physicians who co-manage the parturient with the Obstetricians when medical complications in pregnancy arise. A study of the clinical correlation between placental morphology and maternal conditions can indirectly provide valuable insight into the well-being of the woman and impact clinical practice positively.

There is a paucity of research on this subject matter in our setting. This research aimed to determine the relationship between placenta characteristics and maternal diseases at term. The findings from this study will contribute to the existing body of knowledge and help to improve maternal and perinatal/neonatal health in our setting.

Materials and Method

Study Area

The study was conducted at the maternity units of Rivers State University Teaching Hospital in Port Harcourt City Local Government Area; Obio Cottage Hospital Rumubiakani situated at Obio/Akpor Local Government Area and General Hospital Omoku in Onelga, in River's state.

Study Design

This study was a hospital-based prospective cross-sectional study.

Study Population

The population for this study included mothers who had term delivery in the facilities mentioned above within the period of this study.

Sample and Sampling Technique

The study sample size was derived using the formula for quantitative variables [11.]

$$n = \frac{(Z)^2(s)^2}{(e)^2}$$

n = minimum sample size when total population >10,000

Z = percentage of the normal distribution corresponding to the 2–-sided significance; 95% significance level corresponds to 1.96

s = standard deviation of outcome variable from the similar study; the standard deviation of placental weight among term neonates in a Nigerian study was 0.084kg.[12]

e = level of precision ± 0.01

$n = \frac{(1.96)^2 (0.084)^2}{(0.01)^2} = 271$

Allowance for non-response of 10%

$= \frac{n}{1 - \text{non-response}}$

Where n=minimum sample size (271); non-response =10% (0.1), thus adjusted sample size =300

Adjustment for population <10,000 using finite population correction.

Adjusted sample size = $\frac{n_0 N}{n_0 + (N-1)}$ where n_0 is sample size; N=total sampling population

n_0 = 300; N = 1500

Adjusted sample size =$\frac{300 \times 1500}{300 + (1500-1)} = 250$

Hence final sample size of 250 placentae from term neonates participated in the study.

Sampling Technique
Proportionate to size allocation was used to deduce the number of women with term placentae to be sampled from each study centre to ensure adequate representation.

The systematic random sampling method was used in the selection of women with the term placentae from the three study centres. This sampling technique required the determination of the sampling interval (n^{th}). The sampling interval was obtained by dividing the estimated number of women in the facility over the study period of three months by the size of the sample.

Proportionate to size allocation.

$$\frac{x_i}{\sum x} X\, n$$

n is sample size (250), x_i= the number of term deliveries for a 3-month data collection period at the facility.

RSUTH 240 = $\frac{240}{792} X\ 250 = 76$

Obio Cottage 480 = $\frac{480}{792} X\ 250 = 152$

General Hospital Omoku 72 = $\frac{72}{792}\ X\ 250 = 22$

Sampling interval = $\frac{x_i}{n}$

RSUTH =$\frac{240}{76} = 3.2{\sim}3$

Obio Cottage Hospital = $\frac{480}{152} = 3.2\ {\sim}3$

General Hospital Omoku = $\frac{72}{22} = 3.3\ {\sim}3$

The sampling interval of three (3) for each centre was therefore deduced. Hence, every 3rd woman with term delivery was sampled. The random start was selected by simple random sampling via balloting after which the sampling interval was followed as with systematic random sampling technique.

Nature/Source of Data

The study involved primary data. Information was collected directly from the parturient and the product of conception (placenta) was assessed immediately after delivery.

Method of Data Collection/Instrumentation

Samples (placentae) were collected immediately after delivery, washed under running water, and examined for completeness. The attached umbilical cord was cut leaving a stump of about 5cm from its insertion. Relevant maternal medical history was recorded.

The following features of the placenta were observed and recorded:
Shape: by inspection. **Number of cotyledons:** By inspection and palpation; the placenta was put on a flat tray with the maternal surface facing upwards with a gentle pressure on the centre of the foetal surface to make obvious the cotyledons. Counting was done from one end to the other, and the total number of cotyledons was recorded. **Cord attachment:** By inspection and palpation; the placenta was placed on a flat tray with the foetal surface facing upward. The cord attachment was observed and recorded. **Thickness:** the toothpick method was used.[13] A toothpick was inserted through the placenta and measured at five points on each placenta to the nearest centimetre. Each placenta was placed on a flat tray on the foetal surface and divided arbitrarily into three zones by drawing two circles on the foetal surface. These circles cut the radius of the placenta into three equal parts. One measurement was taken from the middle of the central zone while two measurements were taken from the middle zone and another two from the peripheral zone. The mean of all five measurements was calculated and considered the thickness of the placenta. **Weight:** after trimming with running water, the placenta was placed on a sensitive weighing scale with readings taken in kilograms. **Diameter:** the placenta was placed on a flat tray and measured in three planes with a plastic meter rule. The mean of the three planes was considered the diameter of the placenta.

Data Analysis

Data analysis was done with SPSS IBM version 23. Tables and charts were used for data presentation as appropriate. Categorical variables are expressed as frequencies and proportions; and compared for statistical differences using the Chi-square test. Normally distributed data were summarized using means and standard deviation and parametric tests such as independent t-tests were employed for determining significant differences. Numerical data that were not normally distributed were presented as medians and ranges and the non-parametric equivalent such as the Mann-Whitney U test employed accordingly. Correlation and Regression analysis were employed in investigating the relationship between maternal/neonatal characteristics and placental morphology. Statistical significance was at a p-level of less than 0.05.

Ethical Considerations

Approval for this study was obtained from the Research Ethics Committees of the University of Port Harcourt, Obio Cottage Hospital Rumuobiakani and the Rivers State Hospitals Management Board and prior to commencement of the study. Written informed consent was obtained from the mothers before their inclusion into the study. Participation in the study was voluntary, and their non-participation did not alter their medical care or treatment. Anonymity was maintained by using research numbers rather than names. Data obtained was held in confidence in keeping with ethical principles.

Results

Participants mean age was 30.44±4.1years (range 17 – 41years). The median parity was 2 with a range of 1 – 8. The majority (76.6%) of the participants had uncomplicated term pregnancies while Gestational Hypertension was the commonest complication of pregnancy noticed. (Figure 1).

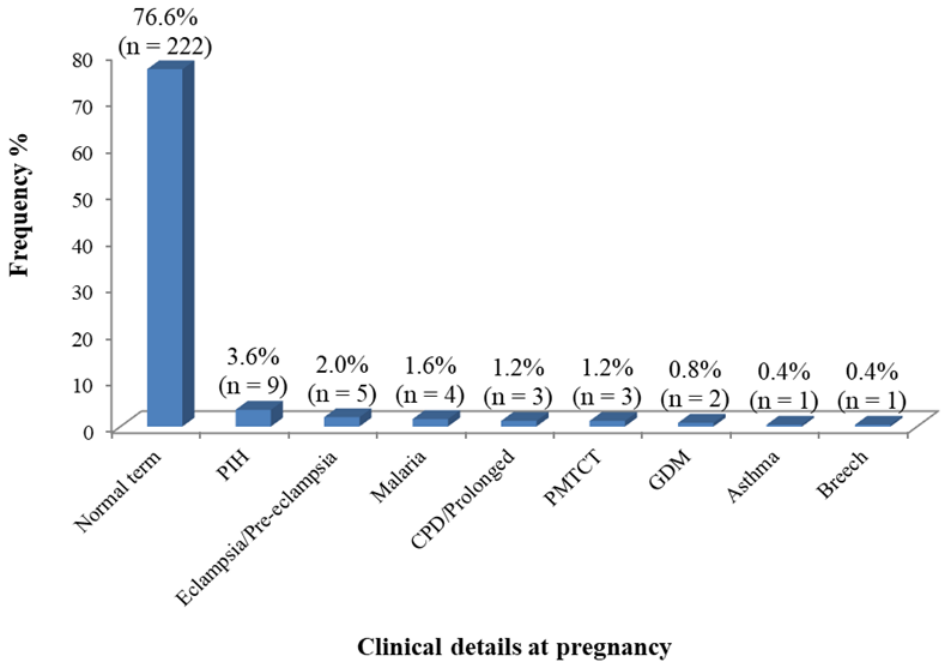

Fig 1: Clinical Details of Pregnancy

Relationship between some maternal diseases and placental shape

There was a statistically significant association between the maternal medical conditions and the placental shape with a preponderance of the oval shape among the women with hypertensive disorders. (Table 1)

Table 1: Relationship between some maternal diseases and placental shape using chi-square.

	Placental shape				
Maternal diseases	**Round n (%)**	**Oval n (%)**	**Triangular n (%)**	**Irregular n (%)**	**Total n (%)**
Uncomplicated	125 (55.3)	96 (42.5)	4 (1.8)	1 (0.4)	226 (100.0)
Hypertensive condition	5 (35.7)	9 (64.3)	0 (0.0)	0 (0.0)	14 (100.0)
Malaria	1 (25.0)	1 (25.0)	0 (0.0)	2 (50.0)	4 (100.0)
RVD	2 (66.7)	1 (33.3)	0 (0.0)	0 (0.0)	3 (100.0)
DM	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)
Asthma	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)
Total	**135 (54.0)**	**108 (43.2)**	**4 (1.6)**	**3 (1.2)**	**250 (100.0)**

Fisher's exact test = 33.620; p-value = 0.016* *Statistically significant

Comparison of mean of other placental features with maternal disease conditions.

There is a statistically significant association between maternal medical conditions and the mean of the placental weight, diameter, thickness, and number of cotyledons. (Table 2)

Table 2: Comparison of mean of other placental features with maternal disease conditions using ANOVA.

	Placental measurements			
Maternal diseases	**Thickness - PT (cm) Mean ± SD**	**Weight -PW (Kg) Mean ± SD**	**Diameter – PD (cm) Mean ± SD**	**Number of cotyledons - PNC Mean ± SD**
No condition	1.89±0.24	0.62±0.11	19.96±1.73	17.85±2.01
Hypertensive condition	1.57±0.25	0.53±0.14	17.44±2.10	16.29±1.94
Malaria	2.15±0.44	0.95±0.52	23.00±3.56	19.00±2.16
HIV	1.93±0.42	0.63±0.15	18.63±1.42	17.00±1.00
DM	2.75±0.64	0.95±0.49	23.00±4.24	18.50±0.71
Asthma	1.60±0.00	0.55±0.00	20.00±0.00	15.00±0.00
	ANOVA = 10.408.	ANOVA = 8.966.	ANOVA = 9.189.	ANOVA = 2.456.
	p-value = 0.0001*	p-value = 0.0001*	p-value = 0.0001*	p-value = 0.034*

*Statistically significant, ANOVA – Analysis of variance, SD Standard deviation, PT – Placental Thickness, PW – Placental Weight, PD – Placental Diameter, PNC Placental Number of Cotyledons

Clinical details of pregnancy versus some placental parameters.

There was a statistically significant association between the PIH and PT and PD; the eclampsia and PT, PD, PNC and PW; the malaria and PT, PW, and PD; the GDM and the PTPW.

Table 3: Clinical details of pregnancy versus mean placental thickness, diameter, number of cotyledons, and weight

Variables	Thickness -PT(cm) Mean ± SD	Diameter -PD (cm) Mean ± SD	Number of Cotyledons - PNC Mean ± SD	Weight PW (Kg) Mean ± SD
PIH				
Yes	1.64±0.29	18.12±1.61	16.89±2.15	0.59±0.14
No	1.89±0.27	19.94±1.92	17.80±2.02	0.62±0.14
	t = -2.707	t = - 2.804	t = - 1.324	t = - 0.695
	p-value = 0.007*	p-value = 0.005*	p-value = 0.187	p-value = 0.487
Eclampsia/Preeclampsia				
Yes	1.44±0.05	16.20±2.49	15.20±0.84	0.41±0.02
No	1.89±0.27	19.95±1.86	17.82±2.01	0.63±0.14
	t = -3.768	t = - 4.443	t = - 2.905	t = - 3.421
	p-value = 0.0001*	p-value = 0.0001*	p-value = 0.004*	p-value = 0.001*
Malaria				
Yes	2.15±0.44	23.00±3.56	19.00±2.16	0.95±0.52
No	1.88±0.270	19.83±1.87	17.74±2.02	0.62±0.12
	t = 1.990	t = 3.312	t = 1.233	t = 4.855
	p-value = 0.048*	p-value = 0.001*	p-value = 0.219	p-value = 0.0001*
CPD/Prolonged labour				
Yes	2.03±0.21	20.67±3.51	16.67±3.06	0.70±0.17
No	1.88±0.27	19.87±1.92	17.78±2.01	0.62±0.14
	t = 963	t = 0.709	t = -0.945	t = 0.961
	p-value = 0.336	p-value = 0.479	p-value = 0.346	p-value = 0.337
Retroviral status				
Yes	1.93±0.42	18.63±1.42	17.00±1.00	0.63±0.15
No	1.88±0.27	19.89±	17.77±2.03	0.62±0.14
	t = 0.323	t = -1.118	t = -0.657	t = 0.146
	p-value = 0.747	p-value = 0.264	p-value = 0.512	p-value = 0.884
GDM				
Yes	2.75±0.64	23.00±4.24	18.5±0.71	0.95±0.49
No	1.88±0.26	19.85±1.91	17.76±2.03	0.62±0.14
	t = 4.709	t = 2.307	t = 0.516	t = 3.340
	p-value = 0.0001*	p-value = 0.022*	p-value = 0.606	p-value = 0.001*
Asthma				
Yes	1.60±0.00	20.00±0.00	15.00±0.00	0.55±0.00
No	1.88±0.27	19.88±1.94	17.78±2.02	0.62±0.14
	t =-1.040	t = 0.063	t = -1.371	t = -0.501
	p-value = 0.299	p-value = 0.950	p-value = 0.171	p-value = 0.617
Breech				
Yes	2.00±0.00	23.00±0.00	16.00±0.00	0.70±0.00
No	1.88±0.27	19.86±1.93	17.77±2.02	0.62±0.14
	t = 0.431	t = 1.619	t = -0.873	t = 0.552
	p-value = 0.667	p-value = 0.107	p-value = 0.383	p-value = 0.581

*Statistically significant; PT – Placental Thickness, PW – Placental Weight, PD – Placental Diameter, PNC Placental Number of Cotyledons

Relationship between clinical details at pregnancy and placenta shape among women

There was a statistically significant association between malaria and the placental shape with a preponderance of the irregular shape. (Table 4)

Table 4: Relationship between clinical details at pregnancy and placenta shape among women

	Placenta shape				
Variables	**Round n (%)**	**Oval n (%)**	**Rectangular n (%)**	**Irregular n (%)**	**Total n (%)**
PIH					
Yes	5 (55.6)	4 (44.4)	0 (0.0)	0 (0.0)	9 (100.0)
No	130 (53.9)	104 (43.2)	4 (1.7)	3 (1.2)	241 (100.0)
	Fisher's exact test = 1.193; p-value = 1.000				
Eclampsia/Preeclampsia					
Yes	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)
No	135 (55.1)	103 (42.0)	4 (1.6)	3 (1.2)	245 (100.0)
	Fisher's exact test = 8.233; p-value = 0.062				
Malaria					
Yes	1 (25.0)	1 (25.0)	0 (0.0)	2 (50.0)	4 (100.0)
No	134 (54.5)	107 (43.5)	4 (1.6)	1 (0.4)	246 (100.0)
	*Fisher's exact test = 81.682; p-value = 0.0001**				
CPD/Prolonged labour					
Yes					
No	2 (66.7)	1 (33.3)	0 (0.0)	0 (0.0)	3 (100.0)
	133 (53.8)	107 (43.3)	4 (1.6)	3 (1.2)	247 (100.0)
	Fisher's exact test = 3.177; p-value = 1.000				
PMTCT					
Yes	2 (66.7)	1 (33.3)	0 (0.0)	0 (0.0)	3 (100.0)
No	133 (53.8)	107 (43.3)	4 (1.6)	3 (1.2)	247 (100.0)
	Fisher's exact test = 3.177; p-value = 1.000				
GDM					
Yes	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.00)
No	133 (53.6)	108 (43.5)	4 (1.6)	3 (1.2)	248 (100.0)
	Fisher's exact test = 4.916; p-value = 0.532				
Asthma					
Yes	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)
No	135 (54.2)	107 (43.0)	4 (1.6)	3 (1.2)	24 (100.0)
	Fisher's exact test = 6.191; p-value = 0.460				
Breech					
Yes	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)
No	134 (53.8)	108 (43.4)	4 (1.6)	3 (1.2)	24 (100.0)
	Fisher's exact test = 5.744; p-value = 1.000				

*Statistically significant

Relationship between clinical pregnancy details and placental cord attachment.

There was no statistically significant association between maternal medical illnesses and the placental cord insertion. (Table 5)

Table 5: Relationship between clinical details at pregnancy and placenta cord attachment among women

Variables	Placenta cord attachment		Total n (%)
	Normal	Abnormal	
PIH			
Yes	7 (77.8)	2 (22.2)	9 (100.0)
No	141 (58.5)	100 (41.5)	241 (100.0)
	Fisher's exact p-value = 0.317		
Eclampsia/Preeclampsia			
Yes	3 (60.0)	2 (40.0)	5 (100.0)
No	145 (59.2)	100 (40.8)	245 (100.0)
	Fisher's exact p-value = 1.000		
Malaria			
Yes	1 (25.0)	3 (75.0)	4 (100.0)
No	147 (59.8)	99 (40.2)	246 (100.0)
	Fisher's exact p-value = 0.307		
CPD/Prolonged labour			
Yes			
No	2 (66.7)	1 (33.3)	3 (100.0)
	146 (59.1)	101 (40.9)	247 (100.0)
	Fisher's exact p-value = 1.000		
PMTCT			
Yes	2 (66.7)	1 (33.3)	3 (100.0)
No	146 (59.1)	101 (40.9)	247 (100.0)
	Fisher's exact p-value = 1.000		
GDM			
Yes	2 (100.0)	0 (0.0)	2 (100.00)
No	146 (58.9)	102 (41.1)	248 (100.0)
	Fisher's exact p-value = 0.515		
Asthma			
Yes	0 (0.0)	1 (100.0)	1 (100.0)
No	148 (59.4)	101 (40.5)	24 (100.0)
	Fisher's exact p-value = 0.408		
Breech			
Yes	1 (100.0)	0 (0.0)	1 (100.0)
No	147 (59.0)	102 (41.0)	24 (100.0)
	Fisher's exact p-value = 1.000		

Discussion

The majority of mothers sampled had uncomplicated deliveries which may have been accounted for by antenatal care (ANC) services provided in the respective health facilities. However, the recorded maternal diseases were observed to be significantly related to the shape of the placenta with more of the parturient with hypertension having oval-shaped placenta while half of those that experienced malaria were observed to have irregular placenta. This agrees with Vandana *et al*[14] and Soma *et al*[15] who found significant relationships between maternal diseases and the shape of the placentae.[14,15] Also, Kajantie *et al* reported predominance of oval-shaped placenta in mothers with pre-eclampsia.[16] The regularity of the shape has been reported to be a function of placental stress by another study.[17] These maternal conditions could compromise the vascular structure of the placenta as earlier reported by Evers et al.[18]

Additionally, varying mean numbers of cotyledon occurred in the various maternal disease conditions. Higher mean numbers of cotyledon were observed in women with Malaria and those with Diabetes Mellitus while a reduction was observed in other conditions such as HIV, Hypertension, and Asthma. The observed maternal conditions were significantly related to the number of cotyledons when applied with Analysis of Variance (ANOVA). The pattern of mean numbers of cotyledon across the observed maternal diseases may be related to placental size. This association agrees with studies by other researchers.[1], The reduced mean numbers of placental cotyledons as observed in mothers with Asthma may be due to altered placental vascular morphology noticed in Asthma.[20]

Furthermore, in relation to mean placental morphometric values, mothers with Gestational Diabetes Mellitus were observed to have the highest mean thickness of placenta, weight, and diameter while mothers with hypertensive conditions had the lowest mean values for thickness, weight, and diameter. The association between maternal disease state and placental morphometry was statistically significant and consistent with the findings made by [8, 15,21-25] This profound relationship between hypertension and placental morphometry may be due to histological and ultra-structural abnormalities in hypertension where there is the reduction of the utero-placental vasculature in concert with placental ischemia. Consequently, there is reduced syncytial microvilli and thicker trophoblastic basement membrane; hence decreased placental size.[9] On the other hand, prolonged duration of diabetic insult weakens the placental capacity to mount adequate responses which often results in excessive fetal growth.[26] Moreso, in Gestational Diabetes Mellitus, it has been reported that there is increased expression of insulin-like growth factor (IGF-1) which in turn has a strong linear correlation with placental mass.[27]

Conclusion

Maternal medical conditions in pregnancy had significant macroscopic imprints on the placental morphology and these can help in the diagnosis and management of medical illnesses that complicate pregnancies in our environment. Further research is needed to establish the cause-effect relationship.

Limitations

This was a hospital-based study. But the findings can be generalisable to the public because Port Harcourt is a metropolitan city with people from different socio-economic statuses and tribes utilizing the health facilities used for the study.

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