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PLACENTA MORPHOLOGY AND MORPHOMETERY AS A FACTOR OF INFANT'S BIRTH WEIGHT IN PORT HARCOURT, NIGERIA

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ABSTRACT

Objectives: The placenta is the connection between the intrauterine foetus and the mother. To a large extent, the physiologic state of the placenta influences foetal development, which in turn could affect the new-borns birth weight. This study, therefore, evaluated the placenta morphological variations and morphometric associations with neonatal birth weight.**Materials and methods:** This study was a hospital-based retrospective cross-sectional study involving an estimated 250 new-born. The data were obtained directly from parturients and the products of conception (foetus and placenta) assessed immediately after delivery. The number of cotyledons, placenta thickness, weight, and diameter, and the new-born birth weights were determined. Differences in mean, distribution, and correlation of variables were evaluated using SPSS (version 23), Minitab® 18.1 (Minitab, Inc. 2017), and GraphPad Prism (version 8.4.3). The confidence level was set at 95% and a p-value less than 0.05 was considered significant. **Results:** There was no significant difference in the mean measurements of the different placental shape (P>0.05). All measured placenta variables; number of cotyledons (R^2=0.240, p<0.0001; BW = 0.09195*No. cotyl + 1.693), placenta thickness (R^2=0.274, p<0.0001; BW = 0.7305*PT + 1.951), weight (R^2=0.344; p<0.0001, BW = 1.563*PW + 2.355), and diameter (R^2=0.345, p<0.0001; BW = 0.1153*PD + 1.035) were significantly positively correlated with birth weight.**Conclusions:** Our findings strongly support the hypothesis that morphometric attributes of the placenta are a better determinant of the neonatal birth weight than the morphological characteristics.

KEYWORDS: Correlate, Placenta, Morphometry, Morphology, Birth weight.

1. INTRODUCTION

The placenta develops with contributions from the maternal uterine bed (decidua basalis), which is fused to the foetal membranes of the developing embryo. The placenta gains functionality at about 12-13weeks of gestation;[1,2] and acts as an exchange medium (permeating oxygen, nutrients, metabolic waste products, and other factors) between the mother and the foetus through the umbilical cord.[3] The placenta has a discoid appearance[4,5] with a diameter ranging between 15 – 20cm, weighs about 1/6th of the neonatal birth weight and provides a protective milieu for the development of the foetus.[1] The placenta develops alongside the foetus and is usually expelled within 30 minutes postpartum.[6,7] Thus, an alteration from the normal placental function could affect the foetal development,[2,8] and in turn the infant's birth weight.

Birthweight is an important clinical parameter that can be used to determine the health of the newborn and may be associated with complications during labour.[9–11] Increases in birth weight is parallel to the gestational age.[9,11] The birth weight of an infant is a reliable index of foetal growth and development.[12] Additionally, it is a sensitive predictor of the survival, growth, and development of Newborns.[12,13]

The placental morphology at birth can be a tool for the management of mother and Newborn.[14] The placental function has been reported to be altered in pregnancies with small for gestational age (SGA) or large for gestational age (LGA) outcomes.[15,16] Researchers have inferred that the placenta provides mirror images of foetal development and gives an approximate account of foetal developmental events.[17] Changes in placental function may occur due to changes in placental structure,[15] as small placentae are more likely to be dysfunctional, and several studies have linked placenta morphology and morphometry to the gestational age and birth weight.[2,15,16,18–21] This study, therefore, evaluated the placental morphological variation and morphometric associations with neonatal birth weight.

2. MATERIALS AND METHODS

2.1 Study Design

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

2.2 Study Population

The population for this study encompassed mothers of/and term neonates delivered in the facilities mentioned below within the period of this study.

2.3 Sample and Sampling Technique

The study sample size was derived using the formula $n = \frac{(Z)^2 (s)^2}{(e)^2}$[22] for quantitative variables

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 a similar study; the standard deviation of placental weight among term neonates from a previous study in Nigerian was 0.084kg.[23]

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 of 271; non-response =10% (0.1), thus adjusted sample size =300.

Adjustment for population <10,000 using finite population correction

Adjusted sample size (n_a)= $\frac{n_0 \times N}{n_0 + (N-1)}$, where n_0 is sample size; N=total sampling population, n_0= 300; N=1500

$$n_a = \frac{300 \times 1500}{300 + (1500 - 1)} = 250$$

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

2.4 Sampling Technique

Proportionate to size allocation was used to deduce the number of term neonates to be sampled from each study centre to ensure adequate representation. A systematic random sampling method was then used in the selection of term neonates from the three study centers. This sampling technique required the determination of the sampling interval (n^{th}). The sampling interval was obtained by dividing the estimated number of neonates in the facility over the study period of three months by the size of the sample.

Proportionate to size allocation

$$\frac{x_i}{\sum x} \times n$$

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

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

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

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 of centre was therefore deduced. Hence, every 3rd term neonate was sampled. The random start was selected by simple random sampling via balloting after which the sampling interval was achieved using a systematic random sampling technique.

2.5 Nature/source of Data

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

2.6 Method of Data Collection/Instrumentation

Samples 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 birth weight was checked with a weighing device. APGAR score and other relevant features of the new-born were noted. The following features of the placenta were observed and recorded:

A. **Morphology:** The shape and the cord attachment were determined by inspection and/or palpation.

- The shape was obtained by inspection and categorised into; round, oval, triangular, or irregular.
- The cord attachment was determined 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 as either central or eccentric.

B. Morphometry: The number of cotyledons was determined by counting while the thickness, weight, and diameter were obtained by measuring instruments.

- The number of cotyledons was examined 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, the total numbers of cotyledons were recorded.
- The thickness was determined using the toothpick method. 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.
- The weight was obtained using a sensitive weighing scale after trimming with running water. The reading was taken in kilograms.
- The diameter was obtained by placing the placenta 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.

2.7 Ethical Considerations

Approval for this study was sought from the Research Ethics Committee of the University of Port Harcourt. Clearance was also sought from Obio Cottage Hospital Rumubiakani and Rivers State Hospitals Management Board and approval obtained before the commencement of the study. Written informed assent from the mothers of the neonates 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 line with ethical principles.

2.8 Data Analysis

Data analysis was with Statistical Package for Social Sciences (SPSS) version 23, Minitab® 18.1 (Minitab, Inc. 2017), and GraphPad prism (version 8.4.3). Tables and charts were used for data presentation as appropriate. SPSS ANOVA (Dunnett's T3) multiple and Student's t-test were used to compare the dimension differences for the placenta shape and cord attachment respectively, while the K-sample Median test evaluated the difference in the number of cotyledons for the placenta shape and cord attachment. Correlation (with regression equations) of placenta parameters to new-born birth weight was carried out using GraphPad. Minitab multiple regression analysis with graphic presentations was used to determine birth weight estimation from multiple placenta variables. The confidence level was set at 95% and a p-value less than 0.05 was considered significant.

3. RESULTS AND DISCUSSION

The descriptive characteristics of the determined placenta and the new-born variables are presented in Table 1. The dimensional differences in the placenta morphology are present in Fig. 1, while the difference in the number of cotyledons for the placenta shape and cord attachment is presented in Fig. 2. Correlations between placenta morphometry and BW are presented in Fig. 3.

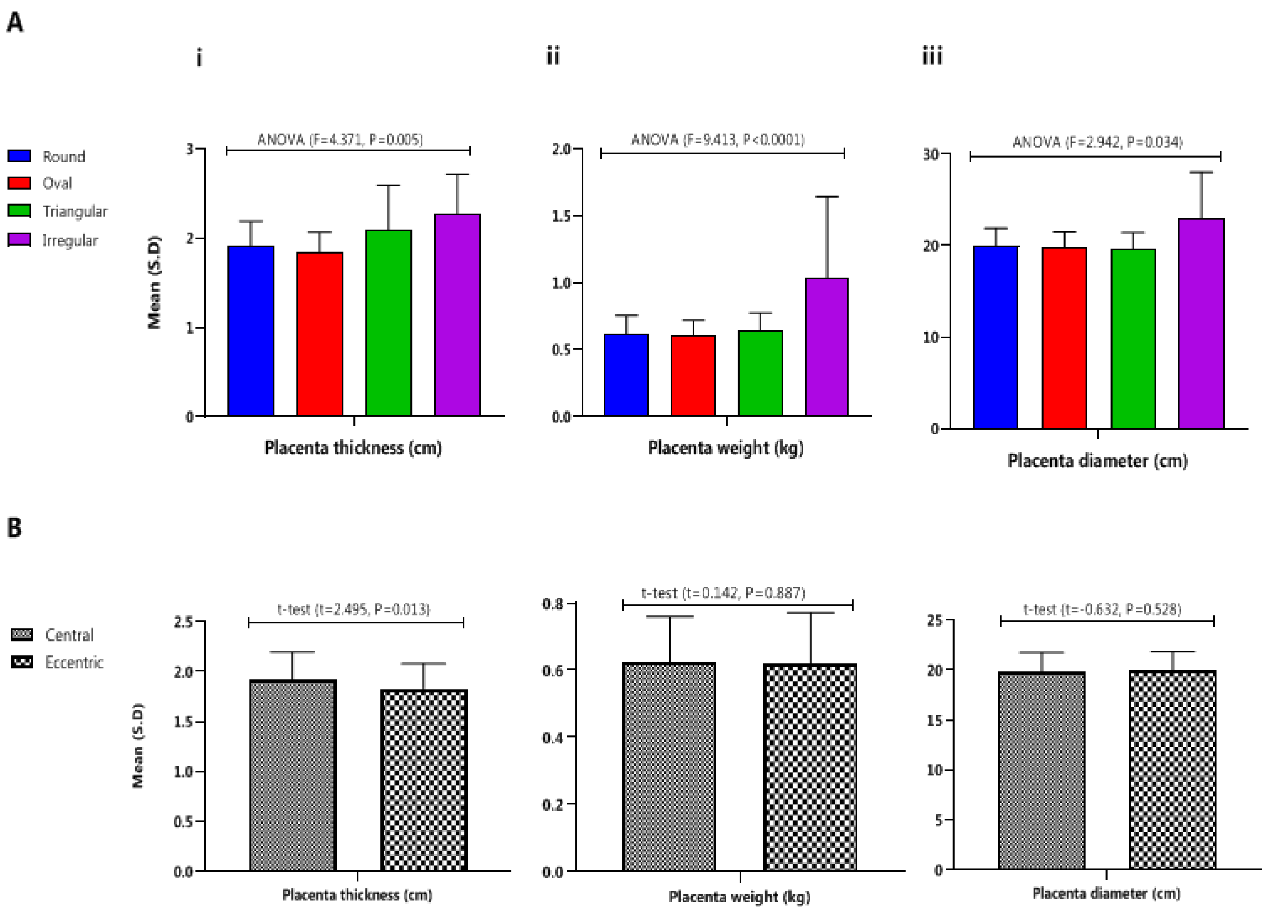

Figure 1: Mean difference in placenta (i) thickness [PT], (ii) weight [PW], and (iii) dimension [PD] of (A) placenta shape and (B) cord attachment.

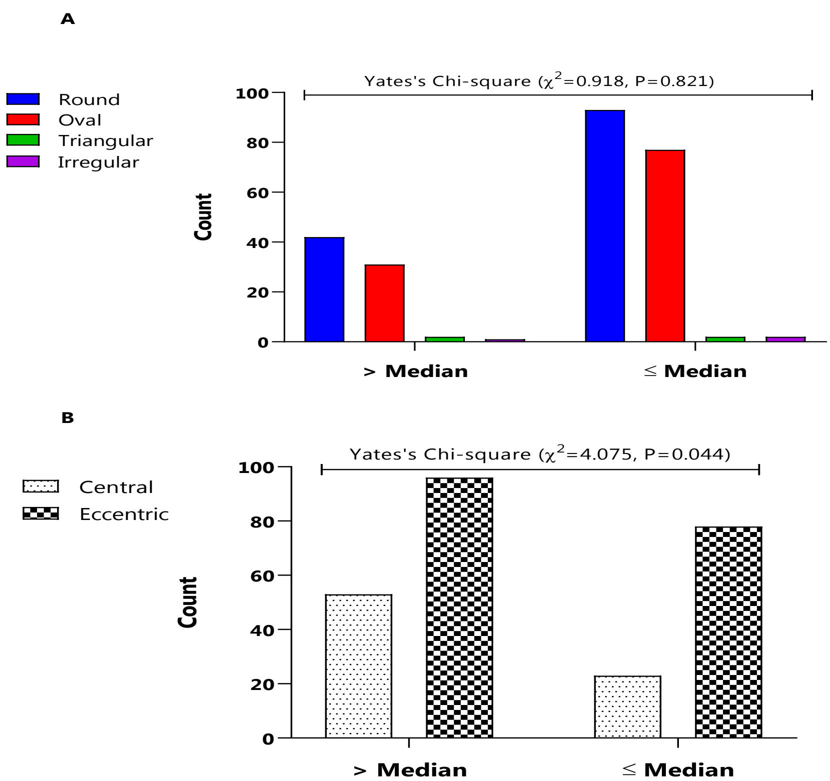

Figure 2: Distributional difference in the number of cotyledons of (A) placenta shape and (B) cord attachment.

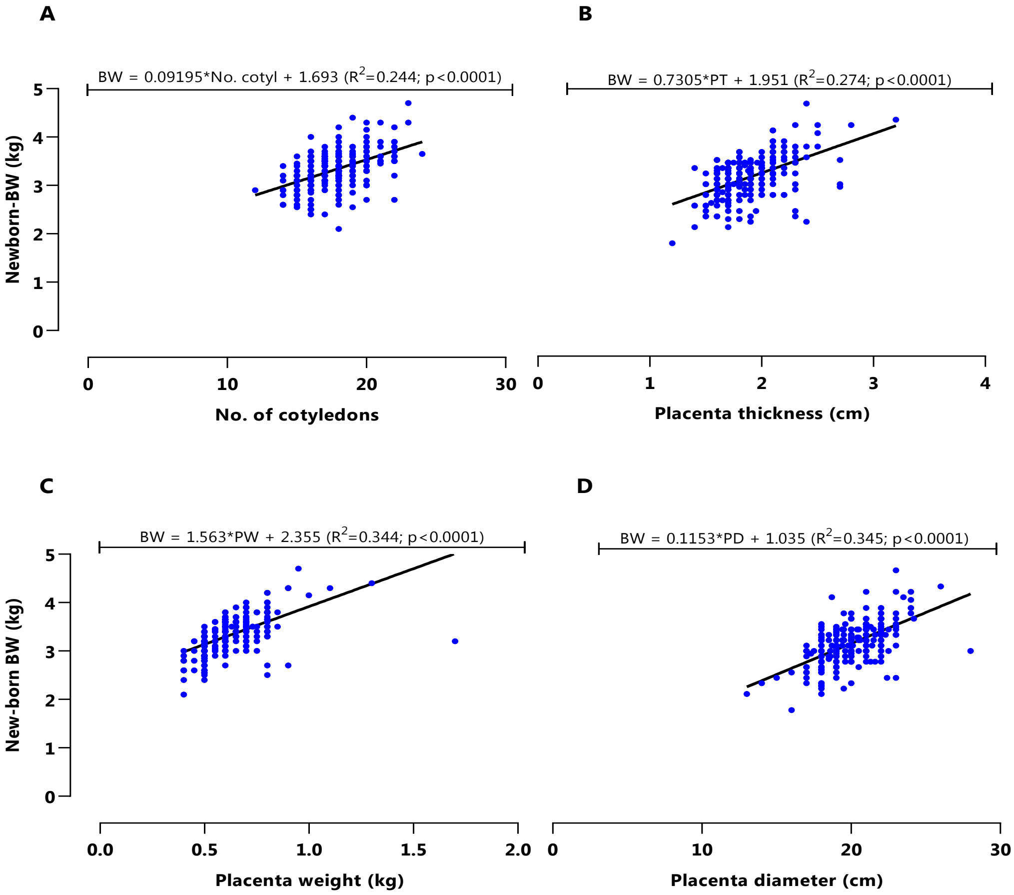

Figure 3: Correlation between new-born birth weight (BW) and (A) number of cotyledons (B) placenta thickness (C) placenta weight (D) placenta diameter.

In Table 1, of the 250 placentae examined, slightly over half (54%) were round in shape, while 43% were oval-shaped, and triangular and irregular shapes 1.6 and 1.4% respectively. A similar study by Gupta *et al.*[24]; using Indian subjects, the predominant placental shape was reported to be round. Majority of the studies on placenta with regards to shape reported a higher proportion of round shaped placentae,[25-27] while triangular and irregular shaped placentae were the least reported.[24] mean placental thickness was 1.88±0.27cm, the range 1.20cm – 3.20cm. Lakshmi *et al.*[28] reported placental thickness as ranging from 1.8cm to 3.5cm. However, Soma *et al.*[29] and Kulandaivelu *et al.*[30] reported mean thickness of placenta 1.67 cm (range; 0.9cm - 2.2 cm) and 1.42cm respectively, in southern India populations. The marked difference could be as a result of racial variation, as well as other genetic and environmental factors.[31]

Table 1: Descriptive characteristics of placenta variables and new-born birth weight.

Variables		**Placenta variables**				**New-born BW (kg)**
	N (%)	**PT (cm)**	**PW (kg)**	**PD (cm)**	**No. of cotyledons**	
Placenta shape		**Mean±S.D**			**Median (n>, n ≤ median)**	**Mean±S.D**
Round	135 (50.4)	1.91±0.28	0.62±0.14	19.93±1.93	42, 93	3.37±0.41
Oval	108 (43.2)	1.84±0.23	0.61±0.11	19.73±1.79	31, 77	3.28±0.32
Triangular	4 (1.6)	2.1±0.49	0.64±0.14	19.58±1.82	2, 2	3.28±0.53
Irregular	3 (1.2)	2.27±0.45	1.03±0.61	23.0±5.00	1, 2	2.82±0.34
Cord attachment						
Central	149 (59.6)	1.92±0.28	0.62±0.14	19.81±1.97	53, 96	3.33±0.43
Eccentric	101 (40.4)	1.83±0.25	0.62±0.15	19.97±1.9	23, 78	3.32±0.29
Total	**250 (100)**	**1.88±0.27**	**0.62±0.14**	**19.88±1.94**	**17.76 (range: 12 - 24)**	**3.33±0.38**

Note: N: Distribution; PT, Placenta thickness; PW, Placenta weight; PD, Placenta diameter; BW, Birth weight S.D, Standard deviation

The average placental weight observed in this study was 0.62±0.14kg, similar to the mean placental weight of 0.637kg reported in the United Kingdom.[32] However, lower mean values of 0.503kg[24] and 0.529kg[3] in India population and 0.537kg in Mexican population have been reported.[33] Abdelrahman[34] and Tetteh[35] reported 0.535kg and 0.578kg in studies carried out in Sudan and Ghana respectively. These differences in placental weight could be associated with variations in maternal diets and physiologic state.[36,37]

The mean placental diameter in this study was19.88±1.94cm ranging from 13.00 – 28.00. Similarly, in a Sudan population, the mean placental diameter was 18.48cm while another work in Kumasi reported placental diameter ranging from 20 – 25cm.[35] Lower mean values were observed in Asian population: India 17.4cm[24] and Pakistan 14.26cm.[36] However, these mean values still fall within the observed range in this study.

The median number of cotyledons observed was 17.76 (range: 12 – 24). Close values have been reported in Tanzania 17.8 (range: 11 to 26),[38] Sudan 18.88 (range: 12 to 22) [34] and India (range; 12 – 20).[28]

Although there was significant dimension variation in PT (F=4.371, P=0.005), PW (F=9.413, P<0.0001), and PD (F=2.942, P=0.034), nevertheless, the differences in the individual shapes were not significant (P>0.05) (Fig. 1). On the other hand, the attachment of the cord varied significantly with placenta thickness (t=2.495, P=0.013) and the number of cotyledons (Yates's χ^2=4.075; P=0.044). However, the weight and diameter were not different (P>0.05) (Fig. 2).

This study evaluated the relationship between placental morphometry and new-born birth weight (Fig. 3) and observed that birth weight was significantly positively correlated with all four placenta variables; no. of cotyledons (R^2=0.240; p<0.0001), thickness (R^2=0.274; p<0.0001), weight (R^2=0.344; p<0.0001), and diameter (R^2=0.345; p<0.0001). The more the number of cotyledons, the heavier the new-born weighed Barker et al.[38] and this could be associated with the facts that cotyledons are the functional unit of the placenta (Louise, 2011).[39]

Significant correlations between birth weight and placental morphometry are consistent with previous findings;[15,16,20,24,33,36,40,41] and it has been reported that placental morphometry and morphology as well as blood flow and nutrient transport primarily determine the growth trajectory of the foetus especially with regards to foetal weight at term.[42] Tetteh[35] reported no significant correlation between placenta diameter and birth weight; however, it was noted that the placenta with larger diameter had a larger surface area for the exchange of materials which leads to an increase in neonatal weight.

4. CONCLUSION

A greater proportion of the placentae examined were round in shape and had central cord attachment. The morphological placenta attributes were not associated with the difference in birth weight. The placental morphometric values were within ranges consistent with previous studies, and the values were significant predictors of newborn birth weight.

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