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Original Article

Obstetrics and Gynaecology Section

Association of Placental Morphometry with Neonatal Birth Weight in a Semi-urban Population: A Cross-sectional Study

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ABSTRACT

Introduction: Placental morphometry, including weight, circumference, and cotyledon count, plays a critical role in foetal growth and neonatal outcomes. Understanding the associations between these parameters and birth weight may provide valuable insights for the early detection of growth abnormalities.

Aim: To evaluate the relationship between placental weight, circumference, and cotyledon count with neonatal birth weight in a semi-urban population.

Materials and Methods: This cross-sectional study included 120 mother-newborn pairs delivering at term at Dr.D.Y.Patil Medical College Hospital, Pimpri, Pune, India, from October to December 2024. Systematic sampling was used. Placental weight, circumference, and cotyledon count were measured post-delivery. Neonatal birth weight was recorded. Data were analysed using Statistical Package for Social Sciences (SPSS) version 28. Pearson's correlation and multiple linear regression were performed, adjusting for maternal age, parity, and Body Mass Index (BMI). A p-value of <0.05 was considered statistically significant.

Results: The mean maternal age was 26.5±3.8 years, with a mean BMI of 24.8±2.5 kg/m^2. Primiparous women constituted 56.7% of the participants, and 51.7% of the newborns were male. Pearson's correlation analysis identified that placental weight (r=0.75, p-value <0.001) showed the strongest correlation with birth weight, followed by circumference (r=0.68, p-value <0.001) and cotyledon count (r=0.59, p-value <0.001). Regression analysis identified placental weight (β=0.52, p-value <0.001), circumference (β=0.33, p-value <0.01), and cotyledon count (β=0.24, p-value <0.05) as significant predictors. The mean birth weight to placental weight (BW: PW) ratio was 6.15±1.2.

Conclusion: The findings of this study underscore the association between placental morphometry and neonatal birth weight, with placental weight being the strongest predictor.Hence,these findings can contribute in improving neonatal outcomes in semi-urban settings.

Keywords: Cotyledon count, Placental circumference, Placental weight

INTRODUCTION

The placenta is a vital foetomaternal organ that sustains pregnancy and supports foetal development by facilitating the exchange of gases, nutrients, and waste products between the mother and foetus. Placental morphology and function are closely associated with foetal growth, making the study of placental characteristics essential for understanding perinatal health outcomes. Abnormal placental development can result in conditions such as Foetal Growth Restriction (FGR), low birth weight, preterm delivery, and increased perinatal morbidity and mortality [1].

Placental weight is widely recognised as a surrogate marker for placental function among various morphometric parameters. A higher placental weight generally indicates a greater nutrient transport capacity, while a lower placental weight is associated with compromised placental reserve and adverse neonatal outcomes [2,3]. Additionally, the Birth Weight to Placental Weight (BW: PW) ratio is a widely accepted indicator of placental efficiency. Deviations from the expected ratio may suggest compensatory placental growth or placental insufficiency, both of which have implications for foetal well-being [4].

Placental circumference, which reflects the surface area of the chorionic plate, is another critical parameter. A larger circumference often suggests improved villous arborisation and maternal blood perfusion-both essential for optimal foetal development [5,6]. Furthermore, the number of cotyledons, which are functional units within the placenta, influences nutrient and gas exchange. A greater number of cotyledons implies a larger exchange surface area and better vascularisation, potentially contributing to higher foetal birth weight [6,7].

While several studies have examined individual placental parameters, there is limited research evaluating the combined effect of multiple placental morphometric features on birth weight-particularly in semi-urban Indian populations, where socioeconomic and nutritional disparities may uniquely influence maternal and foetal health. Socio-environmental stressors such as inadequate antenatal care, nutritional deficiencies, and poor maternal health may adversely affect placental development in these settings [8]. With this background, the present study was conducted with the aim of evaluating the relationship between placental weight, circumference, and cotyledon count with neonatal birth weight.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Obstetrics and Gynaecology at Dr. D. Y. Patil Medical College Hospital, and Research Centre, Pimpri, Pune, Maharashtra, India, from October to December 2024. Ethical clearance was obtained from the Institutional Ethics Committee (IEC/OBGYN/2024/021), and written informed consent was obtained from all participants. Confidentiality and anonymity of participant information were strictly maintained throughout the study.

Sample size selection: The study population included pregnant women admitted for delivery at term gestation. A systematic sampling method was used, whereby every third eligible mother delivering a singleton term pregnancy (between 37 and 42 weeks of gestation) was selected. This approach ensured uniform sampling throughout the study period while minimising selection bias.

The sample size was calculated using the standard formula for estimating correlation coefficients in cross-sectional studies:

$$n=((Z_{1-\alpha/2}+Z_{1-\beta})^2/r^2)+3$$

Using the above formula and assuming a minimum detectable correlation of r=0.3, a 95% confidence level, and 80% statistical power, the minimum required sample size was 85. Therefore, we enrolled 120 mother-newborn pairs to improve statistical precision and account for potential exclusions [9].

Inclusion criteria: Women aged 18-40 years with singleton pregnancies who delivered between 37 and 42 weeks of gestation and had no major obstetric complications.

Exclusion criteria: Pre-existing or pregnancy-induced medical conditions such as pre-eclampsia, gestational diabetes mellitus, chronic hypertension, and anaemia; multiple pregnancies; preterm or post-term deliveries; congenital anomalies in the newborn; intrauterine infections; and disrupted or incomplete placental specimens.

Study Procedure

Following delivery, the placenta was collected, cleaned of blood clots and membranes, and examined within one hour. Placental weight was measured using a calibrated digital electronic scale to the nearest gram, after draining blood and removing the umbilical cord and membranes. The placental circumference was measured using a non-stretchable flexible measuring tape placed around the periphery of the chorionic plate, as shown in [Table/Fig-1]. The number of cotyledons-defined as the clearly visible lobes on the maternal surface-was counted manually after thorough cleaning and inspection by a trained observer, following standard anatomical criteria [7].

[Table/Fig-1]: Measurement of placental circumference using a flexible measuring tape.

Maternal data, including age, parity, BMI, and domicile (semi-urban), were recorded using a structured and pre-validated data collection proforma. The birth weight of the newborn was recorded within the first hour of birth using a calibrated digital neonatal weighing scale, as shown in [Table/Fig-2], and the birth weight to placental weight (BW:PW) ratio was calculated for each case.

Parameters	Mean±SD	Range
Placental weight (g)	520±110	350-750
Placental circumference (cm)	47±8	35-62
Number of cotyledons	18±3	12-25
Birth weight (g)	3,200±450	2,200-4,200

[Table/Fig-2]: Descriptive statistics of placental and neonatal parameters (N=120).

STATISTICAL ANALYSIS

Data were entered and analysed using IBM SPSS Statistics for Windows, Version 28.0. Continuous variables such as placental weight, circumference, number of cotyledons, maternal age, BMI, and birth weight were summarised using mean and standard deviation. Categorical variables, such as parity and foetal sex, were expressed as frequencies and percentages. The association between placental parameters and birth weight was assessed using Pearson's correlation coefficient. A multiple linear regression model was used to identify independent predictors of neonatal birth weight, adjusting for maternal age, BMI, and parity. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 120 mother-newborn pairs were included in the study. The mean maternal age was 26.5±3.8 years, with a mean BMI of 24.8±2.5 kg/m^2. Primiparous women constituted 56.7% of the participants, and 51.7% of the newborns were male. The placental weight ranged from 350 to 750 grams, with a mean weight of 520±110 grams. The mean birth weight of the newborns was 3,200±450 grams, ranging from 2200 to 4200 grams, as shown in [Table/Fig-2].

A significant positive correlation was found between placental weight and birth weight (r=0.75, p-value <0.001), indicating that placental weight is a strong determinant of neonatal weight. Placental circumference also demonstrated a strong positive correlation (r=0.68, p-value <0.001), suggesting that larger placentas were associated with heavier newborns. The cotyledon count showed a moderate but significant correlation with birth weight (r=0.59, p-value <0.001), further highlighting the influence of placental morphology on foetal growth.

To examine the independent effects of placental parameters on birth weight, a multiple linear regression analysis was performed, adjusting for maternal age, parity, and BMI. The model was statistically significant and explained 64% of the variance in neonatal birth weight (R^2=0.64, p-value <0.001). Placental weight was the most significant predictor (β=0.52, p-value <0.001) [Table/Fig-3].

Predictor	β Coefficient	95% CI	p-value
Placental weight (g)	0.52	0.43-0.62	<0.001*
Placental circumference (cm)	0.33	0.19-0.47	<0.01
Number of cotyledons	0.24	0.05-0.43	<0.05
Maternal age (years)	0.1	-0.02-0.22	0.08
Maternal BMI (kg/m^2)	0.07	-0.04-0.18	0.12

[Table/Fig-3]: Multiple linear regression analysis for predictors of neonatal birth weight.
*statistically significant

DISCUSSION

The findings of this study reinforce the central role of placental morphometry in predicting neonatal birth weight. Among the parameters evaluated, placental weight emerged as the strongest predictor, showing a robust positive correlation with birth weight. This aligns with previous research suggesting that placental weight is a reliable indicator of nutrient transfer capacity and foetal metabolic support [2,10]. The mean BW:PW ratio in our study was 6.15±1.2, which falls within established normal ranges and supports its utility as a measure of placental efficiency [4].

The findings of this study also emphasise the importance of placental circumference in predicting neonatal birth weight. As reported by Salafia CM et al., larger placental surface areas are linked to improved foetal growth due to increased nutrient exchange and better uteroplacental perfusion [6].

Although the number of cotyledons is less frequently assessed in clinical practice, it was significantly associated with birth weight in the present study. Cotyledons serve as functional exchange units, and their number may reflect the complexity and development of the villous tree. The results of this study align with those of Kowsalya V et al., who reported a positive correlation between cotyledon count and foetal outcomes [7]. Similarly, Penteado MP et al. highlighted the role of placental microstructure, including cotyledon density, in facilitating efficient nutrient and oxygen transport [11].

It is noteworthy that maternal determinants such as age, BMI, and parity did not significantly influence birth weight in the present study. While some literature reports associations between these factors and foetal outcomes, their lack of statistical significance here may reflect the relative homogeneity of our sample or the overwhelming influence of placental parameters in this particular population [12].

Another strength of this study lies in its focus on a semi-urban population, which presents a unique intersection of urban and rural health determinants. Environmental and social factors in these settings may affect placental development through pathways such as maternal undernutrition, stress, and infections. Previous studies underscore the importance of the socio-economic context in shaping perinatal outcomes, especially in resource-limited areas [8]. The results of this study thus emphasise the need for targeted prenatal screening strategies in similar populations.

Routine monitoring of placental parameters, such as weight, circumference, and cotyledon count, should be integrated into prenatal care, particularly in resource-limited settings. These parameters can serve as early indicators of potential foetal growth abnormalities, enabling timely interventions. The findings should be interpreted as hypothesis-generating and warrant validation through larger, multicentric studies encompassing diverse geographical and socio-economic settings. Moreover, future studies could explore additional placental histopathological features and incorporate Doppler ultrasound parameters for a more comprehensive assessment of placental function.

Limitation(s)

The single-centre design and moderate sample size constrain the generalisability of the results.

CONCLUSION(S)

Placental weight, circumference, and cotyledon count were identified as significant predictors of neonatal birth weight, with placental weight demonstrating the strongest association. Routine assessment of these parameters may aid in identifying at-risk pregnancies, particularly in semi-urban populations.

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