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Original Research Article

Sociodemographic and clinical characteristics associated with perinatal outcome in high and low cerebro-umbilical ratio groups

Mahzabin Husain[1], Rubab Sarmin[2], Sheikh Imran Alam[3], Maliha Tasnim[4], Salma Akter[5], Jannatul Ferdous Chowdhury[6]*, Effat Aziz[7], Tasnia Sultana[8]

[1]National Institute of Burn and Plastic Surgery, Dhaka, Bangladesh
[2]Department of Obstetrics and Gynecology, Sir Salimullah Medical College, Mitford Hospital, Dhaka, Bangladesh
[3]Department of Anaesthesia, Analgesia and ICM, Bangladesh Medical University, Dhaka, Bangladesh
[4]Department of Obstetrics and Gynecology, Chittagong Medical College and Hospital, Chittagong, Bangladesh
[5]Department of Obstetrics and Gynecology, 250 Bedded General Hospital, Sirajganj, Bangladesh
[6]Department of Obstetrics and Gynecology, Sarkari Karmachari Hospital, Dhaka, Bangladesh
[7]Department of Obstetrics and Gynecology, East West Medical College, Dhaka, Bangladesh
[8]Department of Obstetrics and Gynecology, Ad-Din Akij Medical College, Khulna, Bangladesh

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***Correspondence:**
Dr. Jannatul Ferdous Chowdhury,
E-mail: jannatulchowdhury2005@gmail.com

ABSTRACT

Background: Perinatal morbidity and mortality are largely driven by preterm birth, intrauterine asphyxia from placental insufficiency, and complications related to operative deliveries and medication use. Therefore, this study aimed to assess the association between sociodemographic and clinical characteristics and perinatal outcomes across high and low cerebro-umbilical ratio groups. The aim of the study was to assess the association between sociodemographic and clinical characteristics and perinatal outcomes across high and low cerebro-umbilical ratio groups.
Methods: This prospective cohort study at the department of obstetrics and gynecology, BIRDEM General Hospital, Dhaka (November 2022-February 2024) included 106 women at 29-38 weeks gestation undergoing third-trimester Doppler. Maternal (gestational age, delivery) and fetal outcomes (birth weight, APGAR, respiratory distress, FGR) were assessed in relation to C/U ratio (cutoff 1.01). Data were collected via questionnaire, examination, and ultrasound, analyzed in SPSS 26.0 ($p<0.05$).
Results: C/U<1.01 was associated with lower education (24.0% versus 57.1% higher secondary), lower income (79,800 versus 68,357 BDT), higher BMI (35.1 versus 33.1 kg/m^2), earlier delivery (33.9 vs 36.6 weeks), lower birth weight (1.9 versus 2.6 kg; 96% versus 12.5% LBW), more complicated outcomes (84.0% versus 21.4%), APGAR<7 (68.0% versus 19.6%), NICU admission (74.0% versus 21.4%), respiratory distress (60.0% versus 12.5%), and FGR (18.0% versus 0%). Maternal age, parity, and occupation were similar between groups.
Conclusions: A low cerebro-umbilical ratio is strongly associated with adverse perinatal outcomes, including lower birth weight, earlier delivery, and increased neonatal complications.

Keywords: Cerebro-umbilical ratio, Perinatal outcomes, Sociodemographics

INTRODUCTION

Perinatal morbidity and mortality primarily result from preterm birth, intrauterine asphyxia due to placental insufficiency, trauma associated with operative deliveries, and adverse effects of medications used to control convulsions.[1-3] Globally, pre-eclampsia and eclampsia account for 10-25% of perinatal deaths and 25% of low birth weight infants, with perinatal mortality reaching up to 40% in developing countries.[4,5] Poor neonatal outcomes,

including stunting, wasting, and preterm delivery, substantially contribute to morbidity and mortality, with growth and developmental impairments often beginning in utero and persisting throughout life.[6]

As part of the physiological response to hypoxic stress, cerebral blood flow redistribution is one of the earliest compensatory mechanisms in the fetus.[7] This adaptation can be assessed through the middle cerebral artery (MCA) pulsatility index (PI) and its ratio to the umbilical artery (UA) PI, known as the cerebroplacental ratio (CPR). The CPR serves as an indicator of insufficient fetal growth potential, independent of fetal size, and provides insight into fetal hemodynamics, reflecting cerebral redistribution in response to hypoxemia across all fetal weight centiles.[8]

Risk factors for pre-eclampsia are classified as high or moderate. High-risk factors include a history of hypertension in previous pregnancies, chronic hypertension, chronic kidney disease, diabetes mellitus, and autoimmune conditions.[9,10] Moderate risk factors comprise maternal age ≥40 years, primigravidity, an interpregnancy interval of more than 10 years, BMI>35 kg/m² at presentation, multiple pregnancies, and a family history of pre-eclampsia/eclampsia.[9,11] Socio-demographic factors such as young or advanced maternal age, lower education levels, and maternal employment status also influence adverse perinatal outcomes.[12-14] Furthermore, individual-level socioeconomic indicators-including education, income, and housing- provide valuable insight into their impact on pregnancy and birth outcomes.[15]

Despite evidence linking fetal Doppler parameters and maternal sociodemographic and clinical factors to perinatal outcomes, there is limited research integrating these variables to specifically evaluate outcomes across different cerebro-umbilical (C/U) ratio groups, particularly in developing country settings. Therefore, this study aimed to assess the association between sociodemographic and clinical characteristics and perinatal outcomes across high and low cerebro-umbilical ratio groups.

Objective

To assess the association between sociodemographic and clinical characteristics and perinatal outcomes across high and low cerebro-umbilical ratio groups.

METHODS

This prospective cohort study was conducted in the department of obstetrics and gynecology, BIRDEM General Hospital, Dhaka, Bangladesh, from November 2022 to February 2024.

A total of 106 pregnant women at 29–38 weeks of gestation were enrolled, all of whom underwent at least one third-trimester ultrasonography with color Doppler and met the inclusion criteria.

Inclusion criteria

Pregnant women of 29-38 weeks of gestation who underwent third-trimester ultrasonography with color Doppler. Pregnant women diagnosed with diabetes mellitus, gestational diabetes mellitus, chronic hypertension, pre-eclampsia, or pregnancy-induced hypertension.

Exclusion criteria

Uncertainty regarding the last menstrual period. Multiple pregnancies. Pregnancy with congenital anomalies or intrauterine fetal death. Pregnancy complicated by severe comorbidities (e.g., cardiac failure, hepatic failure, renal failure, sepsis).

Maternal outcomes included gestational age and mode of delivery, while fetal outcomes included birth weight, APGAR score at 5 minutes, respiratory distress, and fetal growth restriction (FGR). The cerebroplacental ratio (C/U ratio) was considered the independent variable, with a cutoff value of 1.01 determined by ROC analysis. Birth weight <2.5 kg was considered low birth weight, APGAR <7 at 5 minutes indicated poor neonatal condition, and FGR was defined as estimated fetal weight below the 10th percentile for gestational age. Data were collected using a semi-structured questionnaire, clinical examination, and third-trimester ultrasonography with color Doppler, which included standard fetal biometric parameters (BPD, AC, FL, HC), biophysical profile, amniotic fluid index, and C/U ratio. All scans were performed by a single examiner to avoid inter-observer bias. Participants were followed up until delivery and within 48 hours postpartum. Data were analyzed using SPSS version 26.0. Descriptive statistics were presented as mean±SD, frequencies, and percentages. Chi-square test, Fisher's exact test, and unpaired t-test were applied as appropriate, with $p<0.05$ considered statistically significant. Ethical clearance was obtained from the institutional review board of BIRDEM General Hospital. Informed written consent was obtained from all participants, and confidentiality was ensured by anonymized data handling in accordance with the Helsinki Declaration.

RESULTS

In the C/U<1.01 and ≥1.01 groups, 10 (20.0%) versus 6 (10.7%) were aged <30 years, 21 (42.0%) versus 33 (58.9%) were 30-35 years, and 19 (38.0%) versus 17 (30.4%) were >35 years (mean±SD: 33.1±4.7 versus 33.6±3.1; p=0.322). Educational levels differed significantly, with 1 (2.0%) versus 1 (1.8%) up to secondary, 12 (24.0%) versus 32 (57.1%) higher secondary, and 37 (74.0%) versus 23 (41.1%) graduate/postgraduate (p=0.001). Monthly income was higher in the C/U<1.01 group (79,800±15,368.9 BDT) than in the C/U≥1.01 group (68,357.1±23,007.1 BDT; p=0.003).

Table 1: Comparison of sociodemographic characteristics of the respondents between two groups.

Sociodemographic characteristics		C/U ratio <1.01 (n=50)	C/U ratio ≥1.01 (n=56)	P value
Age (years)	<30	10	6	0.170[a]
	30–35	21	33	
	>35	19	17	
	Mean±SD	33.1±4.7	33.6±3.1	0.322[b]
Educational qualification	Up to secondary	1	1	0.001[c]
	Higher secondary	12	32	
	Graduate/postgraduate	37	23	
	Monthly income (mean±SD, BDT)	79,800±15,368.9	68,357.1±23,007.1	0.003[b]

[a,b,c,d]statistically significant.

Table 2: Comparison of clinical characteristics of the respondents between two C/U ratio groups.

Clinical Characteristics		C/U ratio <1.01 (n=50)	C/U ratio ≥1.01 (n=56)	P value
BMI (kg/m^2)	Mean±SD	35.1±2.5	33.1±2.1	<0.0001[b]
Parity	Multipara	38 (76.0%)	38 (67.9%)	0.313[a]
	Primipara	12 (24.0%)	18 (32.1%)	
Gestational age at delivery (weeks)	Mean±SD	33.9±1.5	36.6±1.4	<0.0001[b]

[a,b]statistically significant.

Table 3: Comparison of perinatal complications between two C/U ratio groups.

Perinatal complications		C/U ratio <1.01 (n=50)	C/U ratio ≥1.01 (n=56)	P value
APGAR score (at 5th minute)	≥7	16 (32.0%)	45 (80.4%)	<0.0001[a]
	<7	34 (68.0%)	11 (19.6%)	
NICU admission	Needed	37 (74.0%)	12 (21.4%)	<0.0001[a]
	Not needed	13 (26.0%)	44 (78.6%)	
Respiratory distress	Present	30 (60.0%)	7 (12.5%)	<0.0001[a]
	Absent	20 (40.0%)	49 (87.5%)	
FGR	Present	9 (18.0%)	0 (0.0%)	0.003[c]
	Absent	41 (82.0%)	56 (100.0%)	

[a,c]statistically significant.

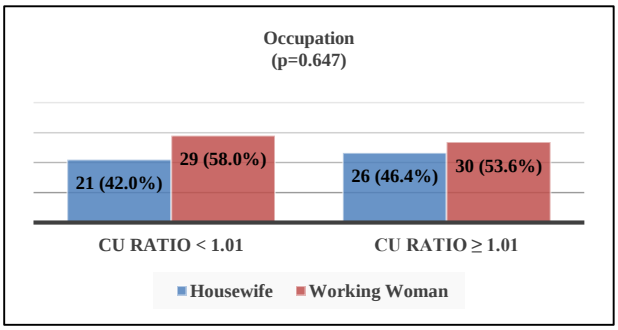

Figure 1: Comparison of occupation of the respondents between two C/U ratio groups.

In the C/U<1.01 group, 29 (58.0%) participants were working women and 21 (42.0%) were housewives, whereas in the C/U≥1.01 group, 30 (53.6%) were working women and 26 (46.4%) were housewives.

The mean BMI was significantly higher in the C/U<1.01 group (35.1±2.5 kg/m^2) compared to the C/U≥1.01 group (33.1±2.1 kg/m^2; p<0.0001). Regarding parity, 38 (76.0%) versus 38 (67.9%) were multipara and 12 (24.0%) versus 18 (32.1%) were primipara in the C/U<1.01 and ≥1.01 groups, respectively, with no significant difference (p=0.313). Gestational age at delivery was significantly lower in the C/U<1.01 group (33.9±1.5 weeks) compared to the C/U≥1.01 group (36.6±1.4 weeks; p<0.0001) (Table 2).

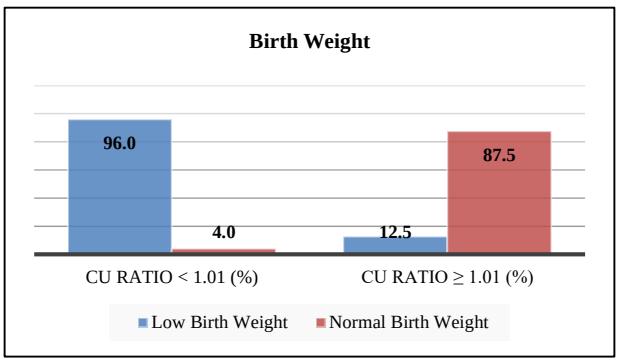

Figure 2: Comparison of birth weight of newborns between two C/U ratio groups.

Among the C/U<1.01 group, 48 (96.0%) newborns had low birth weight (LBW) and 2 (4.0%) had normal birth weight, whereas in the C/U≥1.01 group, 49 (87.5%) had normal birth weight and 7 (12.5%) had LBW. The mean birth weight was significantly lower in the C/U<1.01 group (1.9±0.31 kg) compared to the C/U≥1.01 group (2.6±0.39 kg; p<0.0001).

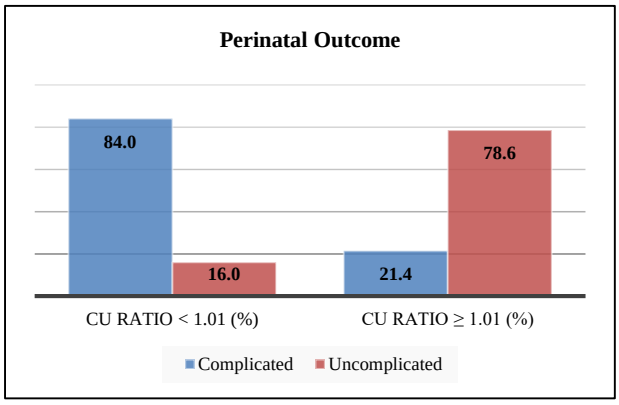

Figure 3: Comparison of perinatal outcomes between two C/U ratio groups.

In the C/U<1.01 group, 42 (84.0%) participants experienced complicated perinatal outcomes, while 8 (16.0%) had uncomplicated outcomes. In contrast, in the C/U≥1.01 group, 12 (21.4%) had complicated outcomes and 44 (78.6%) were uncomplicated, showing a significant difference between the groups (p<0.0001).

In the C/U<1.01 group, 16 (32.0%) newborns had an APGAR score ≥7 and 34 (68.0%) had <7, compared to 45 (80.4%) and 11 (19.6%), respectively, in the C/U≥1.01 group (p<0.0001). NICU admission was required in 37 (74.0%) versus 12 (21.4%) newborns, and 30 (60.0%) versus 7 (12.5%) experienced respiratory distress in the C/U<1.01 and ≥1.01 groups, respectively (all p<0.0001). Fetal growth restriction (FGR) occurred in 9 (18.0%) newborns in the C/U<1.01 group and none in the C/U≥1.01 group (p=0.003). Overall, the C/U<1.01 group had significantly higher rates of adverse perinatal complications compared to the C/U≥1.01 group (Table 3).

DISCUSSION

The distribution of sociodemographic and clinical characteristics and their association with perinatal outcomes across high and low cerebro-umbilical (C/U) ratio groups in a tertiary care hospital in Bangladesh. The C/U ratio, an important marker of fetal well-being, plays a crucial role in identifying fetuses at risk of compromised growth and adverse outcomes. The study findings reveal significant associations between maternal factors- such as BMI, education, and income- and adverse perinatal outcomes, particularly in the low C/U ratio group. High rates of low birth weight, respiratory distress, NICU admission, and fetal growth restriction in this group highlight the need for targeted antenatal monitoring and timely interventions to optimize maternal and neonatal health.

In this study, maternal age did not differ significantly between high and low C/U ratio groups, suggesting that age alone may not be a strong determinant of Doppler abnormalities, which is consistent with Dixit et al, who also observed that abnormal Doppler indices were not uniformly associated with maternal age.[16] In contrast, educational qualification and monthly income showed significant differences between groups, with lower education and income being more frequent among women with abnormal Doppler findings. These results parallel Dixit et al, who reported that adverse outcomes such as preeclampsia, intrauterine growth restriction, and fetal death were more common in women from disadvantaged socioeconomic backgrounds, and Chandra et al, who highlighted that low education and poor socioeconomic status were strongly associated with abnormal Doppler findings and small-for-gestational-age births.[16,17] Taken together, these findings reinforce the role of sociodemographic disparities, particularly education and income, as influential factors in shaping perinatal risks through their impact on Doppler indices.

In this study, there was no significant difference in occupation between the two C/U ratio groups, with 58.0% versus 53.6% of women being working and 42.0% versus 46.4% being housewives in the C/U<1.01 and ≥1.01 groups, respectively (p=0.647). This suggests that occupational status did not have a measurable impact on the C/U ratio in this cohort, indicating that both housewives and working women were equally likely to exhibit high or low C/U ratios, and that other sociodemographic or clinical factors may play a more influential role in determining perinatal outcomes.

In the present study, women with a C/U ratio <1.01 had a significantly higher BMI and delivered at an earlier gestational age compared to those with a C/U ratio ≥1.01, while parity did not differ significantly between groups. These findings are consistent with Kumar et al, who also emphasized maternal BMI and gestational age as important covariates in the interpretation of CPR, demonstrating that abnormal ratios were associated with earlier deliveries and adverse perinatal outcomes.[18] Similarly, Dall'Asta et al highlighted the importance of incorporating maternal demographic and clinical characteristics such as age, parity, and BMI into multivariable analyses to better understand the association between Doppler indices and perinatal outcomes.[19] Together, these observations reinforce that maternal factors like BMI and gestational age at delivery are key determinants influencing the predictive value of Doppler parameters, including the C/U ratio.

In the present study, birth weight was significantly lower in the C/U<1.01 group, where 96% of newborns had low birth weight and the mean weight was 1.9±0.31 kg, compared to the C/U≥1.01 group, where 87.5% had

normal birth weight with a mean of 2.6±0.39 kg (p<0.0001). These findings are in line with Mecke et al, who reported that reduced cerebroplacental ratio was strongly associated with lower birth weight and adverse neonatal outcomes even among appropriate-for-gestational-age fetuses.[20] Similarly, Sirico et al demonstrated that abnormal CPR was consistently linked with poorer perinatal outcomes, particularly lower birth weight relative to gestational age, further supporting the predictive value of a reduced C/U ratio in identifying compromised fetal growth.[21]

In the present study, complicated perinatal outcomes were observed in 84.0% of cases with a C/U ratio <1.01 compared to only 21.4% in those with a ratio ≥1.01, a highly significant difference (p<0.0001). This finding highlights the predictive value of the C/U ratio in identifying pregnancies at higher risk of adverse outcomes. Similar to our results, Bahado-Singh et al reported that fetuses with an abnormal cerebroplacental ratio had significantly higher perinatal morbidity and mortality than those with normal ratios, reinforcing that impaired fetal hemodynamics reflected by a low C/U ratio is a strong marker of compromised perinatal health.[22] Together, these findings emphasize the clinical utility of incorporating cerebroplacental Doppler indices into routine risk assessment for timely intervention.

The present study demonstrated that a low C/U ratio (<1.01) was strongly associated with adverse perinatal complications, including a significantly higher proportion of low Apgar scores at 5 minutes, increased need for NICU admission, and greater incidence of respiratory distress and FGR. These findings are consistent with those of Anand et al, who reported that an abnormal CPR was linked to higher rates of low Apgar scores, NICU admission, fetal distress, and emergency cesarean section.[23] Similarly, Khanjani et al observed that reduced CPR and related Doppler indices were significantly correlated with Apgar <7 at 5 minutes, NICU admission, and fetal distress.[24] Together, these results highlight the predictive value of a reduced C/U ratio for identifying neonates at increased risk of adverse perinatal outcomes.

The study had several limitations. The relatively small sample size may restrict the applicability of the findings to the wider population. As the study was conducted at a single hospital in Dhaka, the results may not reflect the overall national context.

CONCLUSION

The cerebro-umbilical (C/U) ratio is an important Doppler parameter used to assess fetal well-being and predict perinatal outcomes. In this study, a low C/U ratio was associated with adverse perinatal outcomes. Mothers with a low ratio had higher BMI and delivered earlier than those with a normal ratio. Newborns in this group had lower birth weights and experienced more complications, including low APGAR scores, increased NICU admissions, respiratory distress, and fetal growth restriction. Maternal age, parity, and occupation did not differ significantly between groups, highlighting that clinical factors such as C/U ratio, maternal BMI, and gestational age are key predictors of perinatal risk.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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