

Original Article

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A Study on the Role of Ultrasonography in Management of High-Risk Pregnancy in a Tertiary Care Centre of West Bengal – A Cross-Sectional Study

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ABSTRACT

Background: High-risk pregnancy is an important cause of maternal and perinatal morbidity in India. Ultrasonography with Doppler velocimetry helps in identifying the fetus at risk and in timing intervention. **Objectives:** To assess the role of ultrasonography and Doppler in the management of high-risk pregnancy and to correlate Doppler findings with fetal outcome. **Methods:** A hospital-based cross-sectional study was conducted over twelve months in a tertiary care centre of West Bengal. A total of 104 high-risk pregnant women beyond 28 weeks of gestation were enrolled by consecutive sampling. Umbilical artery (UA), middle cerebral artery (MCA) and uterine artery (UtA) Doppler, amniotic fluid index and fetal biometry were recorded, and women were followed up until delivery. Data were analysed using chi-square test and odds ratios with 95% confidence intervals. **Results:** The mean age was 26.8 ± 5.2 years. Anaemia (65.4%) and hypertensive disorders (32.7%) were the commonest risk factors. Abnormal UA, MCA and UtA Doppler were found in 30.8%, 25.0% and 38.5% of women respectively. Adverse fetal outcome occurred in 36.5%. Abnormal UA Doppler (OR 12.43; 95% CI 4.62–33.44), abnormal MCA Doppler (OR 11.11; 95% CI 3.87–31.9) and abnormal UtA Doppler (OR 8.05; 95% CI 3.26–19.87) were significantly associated with adverse outcome ($p < 0.001$). **Conclusion:** Doppler-guided ultrasonography is a simple and reliable tool for stratifying risk and planning antenatal surveillance and delivery in high-risk pregnancy. Its routine use in tertiary care settings should be strengthened.

Keywords: High-risk pregnancy; ultrasonography; Doppler; umbilical artery; fetal outcome; West Bengal.

INTRODUCTION

A considerable proportion of pregnant women develop complications that threaten the mother, the fetus or both; these are called high-risk pregnancies. In India, the maternal mortality ratio was reported as 97 per 100,000 live births during 2018–20 [20], and a large share of maternal and perinatal deaths is linked to conditions such as anaemia, hypertensive disorders,

diabetes and fetal growth restriction (FGR) [19,20,33]. The Pradhan Mantri Surakshit Matritva Abhiyan has therefore emphasised early identification and tracking of high-risk pregnancies at every level of care [18].

Ultrasonography is now an essential part of antenatal care. It confirms gestational age and assesses anomalies, fetal growth, liquor volume and placental location [15-17]. Doppler ultrasonography adds a functional assessment of the uteroplacental and fetal circulation. A Cochrane review of Doppler ultrasound in high-risk pregnancies showed a reduction in perinatal deaths and fewer unnecessary obstetric interventions [1]. International guidelines now recommend Doppler for the diagnosis and surveillance of FGR [2-4,32].

West Bengal has a large rural population, and its tertiary care hospitals receive many referred women with complications from district and sub-divisional hospitals. Published data on how Doppler influences management and outcome in our setting are limited. The present study was therefore undertaken to describe the profile of high-risk pregnancies and to assess the role of ultrasonography, particularly Doppler, in their management.

Objectives

General objective: To study the role of ultrasonography in the management of high-risk pregnancy in a tertiary care centre of West Bengal.

Specific objectives:

1. To describe the socio-demographic profile and risk factors of women with high-risk pregnancy.
2. To determine the distribution of abnormal umbilical artery, middle cerebral artery and uterine artery Doppler findings.
3. To correlate Doppler findings with fetal outcome.
4. To estimate the strength of association (odds ratio) between abnormal Doppler and adverse fetal outcome.
5. To describe Doppler-guided clinical management and mode of delivery.

METHODOLOGY

Study design and setting: This was a hospital-based, descriptive cross-sectional study conducted in the Department of Obstetrics and Gynaecology and the Department of Radiodiagnosis of a tertiary care teaching hospital in West Bengal. Reporting followed

Study period: Twelve months, from August 2025 to August 2026.

Study population: Pregnant women with at least one recognised high-risk factor, attending the antenatal outpatient department or admitted to the antenatal ward.

Inclusion criteria: (a) singleton pregnancy or twin pregnancy with a recognised high-risk factor; (b) gestational age of 28 weeks or more; (c) willingness to give written informed consent.

Exclusion criteria: (a) fetuses with major congenital anomalies; (b) women who delivered elsewhere and could not be followed up; (c) women who refused consent.

Sample size calculation

The sample size was calculated using the formula for estimating a single proportion [34,35]:

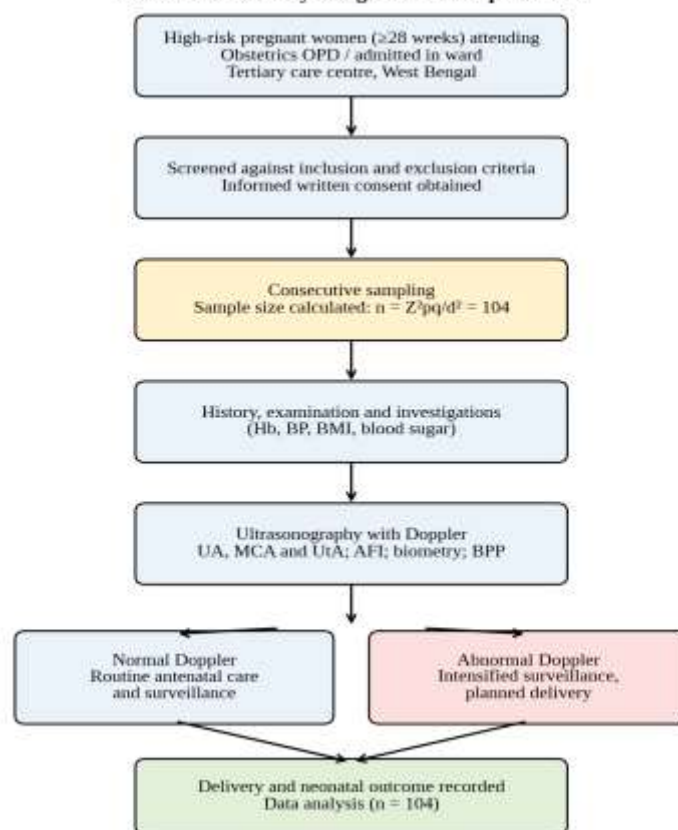
$$n = Z^2 \times p \times q / d^2$$

where $Z = 1.96$ (95% confidence level), $p = 20\%$ (assumed proportion of high-risk pregnancies with abnormal Doppler findings, taken from earlier reports), $q = 1 - p = 80\%$, and $d = 7.7\%$ (absolute precision). Thus, $n = (1.96)^2 \times 0.20 \times 0.80 / (0.077)^2 = 0.6147 / 0.005929 = 103.7$, which was rounded to 104 participants.

Method of sampling

Non-probability consecutive sampling was used. Every eligible high-risk pregnant woman who attended during the study period was enrolled in order of presentation until the required sample of 104 was reached. The participant flow is shown in Flow Chart 1.

Flow Chart 1: Study Design and Participant Flow



Data collection and ultrasonography protocol

After consent, a pre-tested semi-structured proforma was used to record age, residence, religion, education, occupation, socio-economic status (modified B.G. Prasad scale [36]), parity, booking status, obstetric history and risk factors. Body mass index (BMI) was classified by the WHO criteria [37]. Anaemia was graded as mild (Hb 10.0–10.9 g/dL), moderate (7.0–9.9 g/dL) or severe (<7.0 g/dL) [21]. Hypertensive disorders and gestational diabetes were diagnosed by standard criteria [22,24].

All scans were performed by a single trained radiologist using a real-time ultrasound machine with a 3.5–5 MHz curvilinear probe, following ISUOG recommendations [3,39]. Fetal biometry, estimated fetal weight, amniotic fluid index (AFI) and placental location were recorded. Doppler indices were measured during fetal quiescence. The pulsatility index (PI) of the UA (free loop), MCA and UtA was recorded [7]. UA was considered abnormal when PI was above the 95th centile or when end-diastolic flow was absent (AEDF) or reversed (REDF). MCA was considered abnormal when PI was below the 5th centile (brain-sparing) [9,31]. UtA was considered abnormal when mean PI was above the 95th centile or bilateral early diastolic notching was present [5].

Outcome variable: Adverse fetal outcome was defined as any one of the following: admission to the neonatal intensive care unit (NICU), 5-minute Apgar score below 7, birth weight below 2.5 kg, or perinatal death (stillbirth or death within seven days). Absence of all of these was labelled favourable outcome.

Statistical analysis: Data were analysed using SPSS version 26. Categorical variables were expressed as numbers and percentages, and continuous variables as mean $\pm$ standard deviation. The chi-square test (or Fisher's exact test where expected counts were below five) was used for association. Odds ratios (OR) with 95% confidence intervals (CI) were calculated, and $p < 0.05$ was taken as significant.

RESULTS

A total of 104 high-risk pregnant women were studied. All completed follow-up until delivery.

4.1 Socio-demographic profile

The age distribution is given in Table 1 and Fig 1. Most women (67.3%) were between 20 and 29 years, with a mean age of 26.8 ± 5.2 years. Other socio-demographic characteristics are shown in Table A. More than half of the women (59.6%) were from rural areas, 86.5% were housewives, and 57.7% belonged to lower-middle or lower socio-economic classes. About one-third (32.7%) were unbooked.

Table 1: Age Distribution of Study Participants (N = 104)

Age group (years)	Frequency (n)	Percentage (%)
<20	8	7.7
20–24	34	32.7
25–29	36	34.6
30–34	18	17.3
≥35	8	7.7
Total	104	100.0

Mean age = 26.8 ± 5.2 years.

Fig 1: Age Distribution of Study Participants (N = 104)

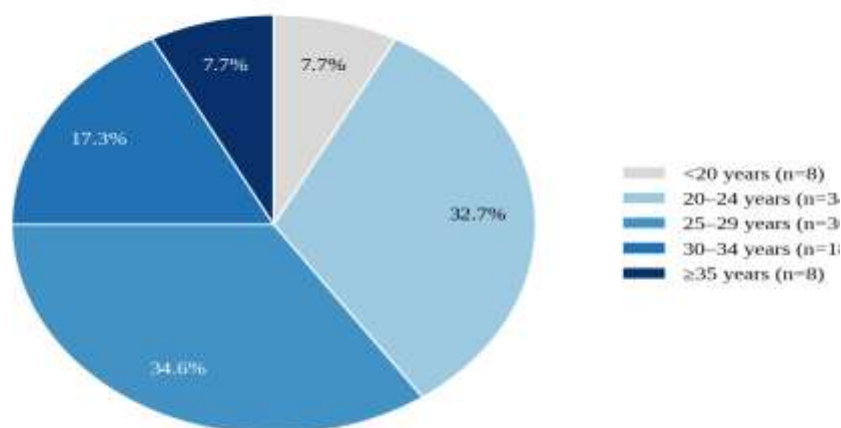


Table A: Socio-demographic Characteristics of Study Participants (N = 104)

Characteristic	Frequency (n)	Percentage (%)
Residence		
Rural	62	59.6
Urban	42	40.4
Religion		
Hindu	66	63.5
Muslim	36	34.6
Others	2	1.9
Education		
Illiterate	10	9.6
Primary	24	23.1
Secondary	40	38.5

Characteristic	Frequency (n)	Percentage (%)
Higher secondary	20	19.2
Graduate and above	10	9.6
Occupation		
Housewife	90	86.5
Working	14	13.5
Socio-economic class (modified B.G. Prasad)		
Upper and upper-middle	14	13.5
Middle	30	28.8
Lower-middle	36	34.6
Lower	24	23.1
Parity		
Primigravida	46	44.2
Multigravida	58	55.8
Booking status		
Booked	70	67.3
Unbooked	34	32.7

4.2 BMI and anaemia

Table 2 shows that 46.2% had normal BMI, 42.3% were overweight or obese and 11.5% were underweight. Table 3 shows that 65.4% were anaemic (mild 26.9%, moderate 28.8%, severe 9.6%).

Table 2: BMI Distribution of Study Participants (N = 104)

BMI category (kg/m ²)	Frequency (n)	Percentage (%)
Underweight (<18.5)	12	11.5
Normal (18.5–24.9)	48	46.2
Overweight (25.0–29.9)	30	28.8
Obese (≥30.0)	14	13.5
Total	104	100.0

Table 3: Distribution According to Anaemia Severity (N = 104)

Anaemia severity (Hb, g/dL)	Frequency (n)	Percentage (%)
No anaemia (≥11.0)	36	34.6
Mild (10.0–10.9)	28	26.9
Moderate (7.0–9.9)	30	28.8
Severe (<7.0)	10	9.6
Total	104	100.0

4.3 Risk factors

Table B lists the risk factors, several of which coexisted in the same woman (224 risk factor entries; mean 2.2 per woman). Anaemia was the leading risk factor (65.4%), followed by hypertensive disorders of pregnancy (32.7%), fetal growth restriction (23.1%), oligohydramnios (17.3%) and previous caesarean section (15.4%). Gestational diabetes mellitus affected 13.5% of women, and bad obstetric history 11.5%. Less common factors were hypothyroidism, twin pregnancy, Rh-negative status, placenta praevia and heart disease.

Table B: Risk Factors in Study Participants (N = 104; multiple responses)

Risk factor	Frequency (n)	Percentage (%)
Anaemia	68	65.4
Hypertensive disorders (gestational hypertension / pre-eclampsia)	34	32.7
Fetal growth restriction	24	23.1
Oligohydramnios (AFI <5 cm)	18	17.3
Previous caesarean section	16	15.4
Gestational diabetes mellitus	14	13.5
Bad obstetric history	12	11.5
Hypothyroidism	8	7.7
Twin pregnancy	6	5.8
Rh-negative pregnancy	6	5.8
Placenta praevia	6	5.8
Heart disease	4	3.8

4.4 Doppler findings and fetal outcome

Abnormal Doppler findings were recorded in the UA in 32 women (30.8%), in the MCA in 26 women (25.0%) and in the UtA in 40 women (38.5%). Overall, 38 neonates (36.5%) had an adverse outcome. These included low birth weight (32), NICU admission (26), 5-minute Apgar below 7 (14) and six perinatal deaths (three stillbirths, three early neonatal deaths). Abnormal MCA Doppler (Table 4) was associated with adverse outcome in 76.9% of cases, compared with 23.1% when MCA Doppler was normal ($p < 0.001$). Abnormal UtA Doppler (Table 5) was followed by adverse outcome in 65.0%, compared with 18.8% when normal ($p < 0.001$). The strongest association was seen with UA Doppler (Table 6 and Fig 2): 75.0% of fetuses with abnormal UA flow had adverse outcome against 19.4% with normal flow. All fetuses with AEDF (7) or REDF (3) had adverse outcomes, and all six perinatal deaths occurred among fetuses with abnormal UA Doppler.

Table 4: MCA Doppler Findings vs Fetal Outcome (N = 104)

MCA Doppler	Favourable n (%)	Adverse n (%)	Total	p-value
Normal	60 (76.9)	18 (23.1)	78	<0.001
Abnormal (low PI)	6 (23.1)	20 (76.9)	26	
Total	66 (63.5)	38 (36.5)	104	

Chi-square = 24.38, df = 1.

Table 5: Uterine Artery Doppler Findings vs Fetal Outcome (N = 104)

UtA Doppler	Favourable n (%)	Adverse n (%)	Total	p-value
Normal	52 (81.3)	12 (18.8)	64	<0.001
Abnormal (high PI / notch)	14 (35.0)	26 (65.0)	40	
Total	66 (63.5)	38 (36.5)	104	

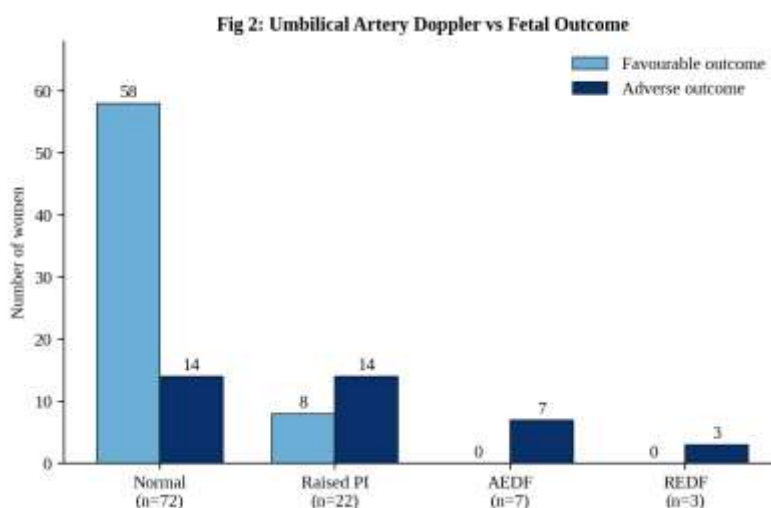
Chi-square = 22.71, df = 1.

Table 6: Umbilical Artery Doppler vs Fetal Outcome (N = 104)

UA Doppler	Favourable n (%)	Adverse n (%)	Total	p-value
Normal	58 (80.6)	14 (19.4)	72	<0.001
Raised PI only	8 (36.4)	14 (63.6)	22	
Absent end-diastolic flow	0 (0.0)	7 (100.0)	7	

UA Doppler	Favourable n (%)	Adverse n (%)	Total	p-value
Reversed end-diastolic flow	0 (0.0)	3 (100.0)	3	
Total	66 (63.5)	38 (36.5)	104	

Chi-square (normal vs abnormal) = 29.49, df = 1.



4.5 Odds ratio analysis

Table C shows the unadjusted odds of adverse outcome. A woman with abnormal UA Doppler had about 12 times higher odds of an adverse outcome than one with normal UA Doppler. The odds were about 11 times higher with abnormal MCA Doppler and 8 times higher with abnormal UtA Doppler. Oligohydramnios and moderate-to-severe anaemia were also significant, though with lower odds. The diagnostic values for predicting adverse outcome were as follows: UA Doppler sensitivity 63.2%, specificity 87.9%, positive predictive value 75.0%; MCA Doppler sensitivity 52.6%, specificity 90.9%; UtA Doppler sensitivity 68.4%, specificity 78.8%.

Table C: Odds Ratio Analysis for Adverse Fetal Outcome

Exposure	Odds ratio	95% CI	Chi-square	p-value
Abnormal UA Doppler	12.43	4.62–33.44	29.49	<0.001
Abnormal MCA Doppler	11.11	3.87–31.90	24.38	<0.001
Abnormal UtA Doppler	8.05	3.26–19.87	22.71	<0.001
Oligohydramnios (AFI <5 cm)	9.04	2.70–30.2	—	<0.001
Moderate/severe anaemia	2.56	1.12–5.83	—	0.026

Reference category for each exposure: absence of the factor.

4.6 Clinical management

Management was individualised and guided by the ultrasound and Doppler findings together with the maternal condition (Table D).

Normal Doppler (n = 72): Women continued routine antenatal care with growth scan and AFI every three to four weeks, kick-count charting and non-stress test (NST) when clinically indicated. Delivery was planned at term.

Raised UA PI with positive end-diastolic flow (n = 22): These women were evaluated weekly, using growth scan, Doppler, AFI and NST. Admission was advised if PI rose, growth slowed or oligohydramnios developed. Antenatal corticosteroids were given if delivery was anticipated before 34 weeks, and delivery was planned at 37 weeks, in line with ISUOG recommendations [2,3].

AEDF and REDF (n = 10): These women were admitted and monitored with daily NST and Doppler examination twice weekly or more often. Corticosteroids, and magnesium sulphate for fetal neuroprotection below 32 weeks, were given [26,27]. Delivery by caesarean section was planned at 32–34 weeks for AEDF and at 30–32 weeks for REDF, or earlier if the NST became abnormal [6,11,12].

Abnormal MCA Doppler: Low MCA PI was taken as a sign of fetal brain-sparing and was treated as an indicator for closer surveillance and earlier delivery planning, particularly at term, when it predicts NICU admission [30,31].

Abnormal UtA Doppler: Women were advised low-dose aspirin 75–150 mg at night, serial growth scans every two to three weeks and strict blood pressure monitoring, because of the risk of pre-eclampsia and FGR [13,25,28].

Maternal conditions: Hypertensive women received labetalol or nifedipine and magnesium sulphate for severe disease [22,23]. Gestational diabetes was managed with medical nutrition therapy, and insulin was added when targets were not met [24]. Oral iron was given for mild anaemia, intravenous iron sucrose for moderate anaemia, and packed cell transfusion for severe anaemia with decompensation or near term [21]. Rh-negative women received anti-D prophylaxis, with MCA peak systolic velocity used for suspected fetal anaemia [14].

Delivery: Fifty-eight women (55.8%) delivered by caesarean section (22 elective and 36 emergency), mainly for abnormal Doppler with non-reassuring fetal status, previous scar, severe pre-eclampsia, placenta praevia or malpresentation. Forty-six women (44.2%) delivered vaginally, of whom 16 required induction of labour with continuous cardiotocography.

Table D: Doppler-guided Clinical Management (N = 104; multiple responses)

Intervention	Number (n)	Percentage (%)
Hospital admission for monitoring	52	50.0
Antenatal corticosteroids	36	34.6
Magnesium sulphate (neuroprotection or eclampsia prophylaxis)	22	21.2
Low-dose aspirin	22	21.2
Antihypertensive therapy	34	32.7
Intravenous iron sucrose	22	21.2
Blood transfusion	6	5.8
Insulin for gestational diabetes	8	7.7
Caesarean section (elective 22, emergency 36)	58	55.8
Induction of labour	16	15.4

DISCUSSION

This study found that Doppler ultrasonography in high-risk pregnancy is closely related to fetal outcome and helps in planning management. Of the 104 women, nearly two-thirds were aged 20–29 years. The high proportion of rural, poor and unbooked women is typical of a referral hospital, where late presentation limits early risk detection [18,19].

Anaemia was the most frequent risk factor (65.4%), higher than the national estimate for pregnant women of about 50% [19]. This is expected in a referral cohort. In this study, moderate-to-severe anaemia more than doubled the odds of adverse fetal outcome (OR 2.56). Hypertensive disorders (32.7%) and FGR (23.1%) followed, reflecting placental causes of adverse outcome [8,22].

Abnormal UA Doppler was seen in 30.8% of women and carried the highest odds of adverse outcome (OR 12.43). This is consistent with the Cochrane review, which found fewer perinatal deaths and fewer inductions and caesareans when Doppler was used in high-risk pregnancies [1]. Progression to AEDF and REDF indicates advanced placental insufficiency [6]. In the present series all fetuses with AEDF or REDF had adverse outcomes, as in the TRUFFLE cohort, where perinatal morbidity and mortality increased with worsening Doppler [11,12]. UA Doppler had moderate sensitivity (63.2%) but high specificity (87.9%): a normal result is reassuring, and an abnormal one needs intensified surveillance.

Abnormal MCA Doppler was present in 25.0% of women and was associated with adverse outcome in 76.9% of them (OR 11.11). The PORTO study showed that brain-sparing predicts adverse outcome in growth-restricted fetuses [9,10], and

Khalil et al. reported an association between abnormal fetal Doppler and neonatal unit admission even at term [30]. MCA Doppler alone has limited accuracy and is better interpreted with UA findings [31].

Uterine artery Doppler was abnormal in 38.5% of women, and 65.0% of them had adverse outcome (OR 8.05). Uterine artery Doppler is a useful marker of defective placentation, predicting pre-eclampsia and FGR [28,29]. In our study it had the best sensitivity (68.4%) but the lowest specificity (78.8%) of the three vessels, which suggests that it is best used to identify women needing aspirin and serial growth scans rather than to decide timing of delivery. Low-dose aspirin reduces the risk of pre-term pre-eclampsia in high-risk women [13,25].

Oligohydramnios was also strongly linked to adverse outcome (OR 9.04), and AFI, biometry and Doppler are best interpreted together [2,32].

The clinical management used in the study followed a stepwise, Doppler-guided protocol. Women with normal Doppler were safely managed as outpatients, which decongests wards in a busy tertiary centre. Intensive monitoring was concentrated on the 32 women with abnormal UA flow. Timely corticosteroids, magnesium sulphate and planned delivery reduce neonatal morbidity [26,27]. The caesarean rate of 55.8% is high, but reflects a referral population with abnormal Doppler, previous scars and severe hypertension.

CONCLUSION

Anaemia, hypertensive disorders and fetal growth restriction were the main risk factors among high-risk pregnant women. Abnormal umbilical artery, middle cerebral artery and uterine artery Doppler findings, as well as oligohydramnios, were significantly associated with adverse fetal outcome, with umbilical artery Doppler showing the strongest association. Ultrasonography with Doppler therefore plays a key role in risk stratification, selection of women for intensive monitoring, and timing of delivery in high-risk pregnancy.

7. Recommendations

Doppler ultrasonography should be offered to every woman with a recognised high-risk factor, preferably from 28 weeks of gestation. District and sub-divisional hospital staff should be trained in basic Doppler for early identification and timely referral under PMSMA. Tertiary centres should adopt a written Doppler-guided protocol for surveillance and delivery timing. Early correction of anaemia and control of hypertension and diabetes should be prioritised. Larger multi-centre studies with long-term neonatal follow-up are recommended.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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Submission Declaration

We declare that this work has not been published previously, is not under consideration for publication elsewhere, and that its publication is approved by all authors and by the responsible authorities of the institution where the work was carried out. All authors have read and approved the final manuscript and take responsibility for its content. Written informed consent was obtained from all participants, and the study followed the Declaration of Helsinki.

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