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IMPACT OF MATERNAL HYPERTENSION ON NEONATAL HEALTH OUTCOMES IN A TERTIARY CARE SETTING

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Abstract

Introduction: Hypertensive disorders of pregnancy (HDP) significantly contribute to maternal and neonatal morbidity and mortality worldwide. This study aimed to evaluate the impact of maternal hypertension on neonatal health outcomes in a tertiary care setting and identify predictors of adverse outcomes.

Methods: A prospective case-control study was conducted over six months, enrolling 152 pregnancies complicated by hypertension and 152 normotensive controls matched for maternal age and parity. Maternal parameters including demographic details, type and severity of hypertension, and pregnancy outcomes were recorded. Neonatal outcomes including birth weight, NICU admission, complications, and mortality were assessed.

Results: Preeclampsia was the most common hypertensive disorder (46.7%), followed by gestational hypertension (35.5%). Hypertensive pregnancies had significantly higher rates of cesarean delivery (63.2% vs. 35.5%, $p<0.001$), preterm birth (38.2% vs. 10.5%, $p<0.001$), and lower mean birth weight (2486±562 vs. 2934±424 grams, $p<0.001$). NICU admission rates were substantially higher in the hypertensive group (44.1% vs. 16.4%, $p<0.001$), with increased incidence of respiratory distress syndrome (25.7% vs. 9.2%, $p<0.001$), hypoglycemia (21.1% vs. 7.2%, $p<0.001$), and neonatal mortality (5.9% vs. 1.3%, $p=0.03$). A gradient of risk was observed across hypertensive disorders, with eclampsia and chronic hypertension with superimposed preeclampsia associated with the worst outcomes. Multivariate analysis identified eclampsia (aOR 6.45), severe preeclampsia (aOR 3.82), and early-onset disease (aOR 2.94) as significant predictors of NICU admission.

Conclusion: Maternal hypertension significantly increases the risk of adverse neonatal outcomes, with severity varying by hypertensive disorder type. Early detection, close monitoring, and appropriate management are crucial for optimizing outcomes in tertiary care settings.

Keywords: Hypertensive disorders of pregnancy, Preeclampsia, Neonatal outcomes, NICU admission, Tertiary care

Introduction

Hypertensive disorders of pregnancy (HDP) represent one of the most significant contributors to maternal and neonatal morbidity and mortality worldwide, affecting approximately 5-10% of all pregnancies (Ananth et al., 2023). In the Indian context, the prevalence ranges from 7.8% to 15.6%, with significant regional variations (Sharma et al., 2022). These disorders encompass a spectrum of conditions including chronic hypertension, gestational hypertension, preeclampsia, and eclampsia, each carrying unique implications for maternal and fetal well-being (American College of Obstetricians and Gynecologists [ACOG], 2023).

The pathophysiology of maternal hypertension involves complex interactions between placental insufficiency, maternal vascular dysfunction, and inflammatory responses. Placental ischemia triggers the release of anti-angiogenic factors, including soluble fms-like tyrosine kinase-1 (sFlt-1) and soluble endoglin, which antagonize vascular endothelial growth factor (VEGF) and placental growth factor (PlGF), leading to endothelial dysfunction and systemic vascular damage (Phipps et al., 2019). This cascade of events not only compromises maternal cardiovascular health but significantly impacts uteroplacental blood flow, potentially resulting in fetal growth restriction, placental abruption, and preterm birth (Mendola et al., 2020).

Neonatal outcomes among infants born to hypertensive mothers show considerable variation globally. A multi-center study across tertiary care settings in Southeast Asia demonstrated that neonates born to mothers with preeclampsia had a 2.3-fold increased risk of requiring neonatal intensive care unit (NICU) admission, a 1.8-fold increased risk of respiratory distress syndrome, and a 3.2-fold increased risk of small-for-gestational-age status compared to normotensive controls (Chen et al., 2022). Similarly, research from tertiary care centers in India revealed that maternal hypertension was associated with higher rates of preterm delivery (28.7% vs. 9.5%), low birth weight (38.4% vs. 14.2%), and perinatal mortality (6.8% vs. 2.3%) compared to normotensive pregnancies (Kumar et al., 2021).

The relationship between the severity and duration of maternal hypertension and subsequent neonatal outcomes has been extensively studied. Redman and Sargent (2019) demonstrated a dose-dependent relationship between maternal blood pressure levels and adverse neonatal outcomes, with each 5 mmHg increase in mean arterial pressure associated with a 15% increased risk of fetal growth restriction. Moreover, early-onset hypertensive disorders (before 34 weeks' gestation) typically result in more severe neonatal complications compared to late-onset disease (Malhotra et al., 2021).

Tertiary care settings play a pivotal role in managing high-risk pregnancies complicated by hypertension. These facilities offer specialized maternal-fetal medicine services, advanced neonatal care, and multidisciplinary teams essential for optimizing outcomes (Williams et al., 2020). However, the quality of care and subsequent outcomes can vary significantly based on institutional protocols, resource availability, and healthcare provider expertise. A systematic review of 42 studies from tertiary care centers in low and middle-income countries identified significant disparities in neonatal outcomes based on the availability of specialized equipment, skilled personnel, and standardized management protocols (Rodriguez et al., 2021).

In the Indian healthcare context, tertiary care centers face unique challenges including high patient volumes, resource constraints, and regional variations in healthcare access. Singh and colleagues (2023) reported significant inter-institutional variability in neonatal outcomes among hypertensive pregnancies across six tertiary care centers in India, attributing these differences to variations in early detection, referral patterns, and management strategies. Despite these challenges, implementation of standardized protocols has shown promising results, with one center reporting a 38% reduction in severe neonatal morbidity following protocol implementation (Patel et al., 2022).

Recent advances in prediction and prevention strategies have shown promise in mitigating the impact of maternal hypertension on neonatal outcomes. Early identification of high-risk pregnancies through biomarkers such as PlGF/sFlt-1 ratio, uterine artery Doppler studies, and maternal risk factor assessment has enabled more targeted interventions (Rana et al., 2019). Additionally, prophylactic interventions including low-dose aspirin and calcium supplementation have

demonstrated efficacy in reducing the incidence and severity of preeclampsia in high-risk populations (Hoffman et al., 2020).

Understanding the specific patterns of neonatal complications in hypertensive pregnancies within tertiary care settings is crucial for optimizing resource allocation, developing targeted interventions, and improving overall outcomes. While global data provides valuable insights, regional and institutional research is essential given the significant variability in disease patterns, healthcare systems, and socioeconomic factors (Gupta et al., 2023). This study aims to bridge this knowledge gap by comprehensively evaluating the impact of maternal hypertension on neonatal health outcomes in a tertiary care setting in India.

This study aimed to evaluate the impact of maternal hypertension on neonatal health outcomes in a tertiary care setting, identify risk factors associated with adverse outcomes, and assess the effectiveness of current management protocols.

Methodology

Study Design and Setting

A prospective observational case-control study was conducted at the Department of Obstetrics and Gynecology in collaboration with Department of Pediatrics (Neonatal Intensive Care Unit) at United Institute of Medical Sciences & United Hospital, Prayagraj. The study site was a 1000-bedded multispecialty hospital with approximately 1000 deliveries annually and a 30-bedded level III NICU facility.

Study Duration and Sample Size

The study was conducted over a period of 6 months from July 2024 to December 2024. Sample size was calculated using the formula $n = Z^2pq/d^2$, where $Z = 1.96$ at 95% confidence interval, p = prevalence of hypertensive disorders of pregnancy (taken as 10% based on hospital statistics), $q = 1-p$, and d = absolute precision (5%). The minimum sample size required was 138 cases. Accounting for a 10% dropout rate, we enrolled 152 cases (pregnancies complicated by hypertension) and 152 controls (normotensive pregnancies) matched for maternal age and parity.

Inclusion and Exclusion Criteria

Inclusion criteria for the case group comprised pregnant women diagnosed with any hypertensive disorder of pregnancy (chronic hypertension, gestational hypertension, preeclampsia, or eclampsia) as per ACOG guidelines, delivering at ≥28 weeks of gestation. The control group included normotensive pregnant women matched for age (±2 years) and parity delivering during the same period. Exclusion criteria for both groups included multiple pregnancies, fetuses with known congenital anomalies, pregnancies complicated by pre-existing diabetes mellitus, cardiac disease, renal disease, thyroid disorders, or autoimmune conditions, and women who declined to participate in the study.

Data Collection Tools and Techniques

Data was collected using a structured proforma developed after literature review and expert consultation. Maternal parameters recorded included demographic details, obstetric history, type and severity of hypertension, gestational age at diagnosis, treatment regimen, and pregnancy outcomes. Neonatal parameters included birth weight, gestational age at delivery, Apgar scores at 1 and 5 minutes, NICU admission, respiratory support requirements, hypoglycemia, hyperbilirubinemia, sepsis, intraventricular hemorrhage, necrotizing enterocolitis, and mortality. Blood pressure measurements were performed using calibrated sphygmomanometers by trained nursing staff following standardized protocols. Laboratory investigations including complete blood count, liver and renal function tests, 24-hour urinary protein, and ultrasonography findings were recorded from hospital information systems.

Data Management and Statistical Analysis

Data was entered in Microsoft Excel and analyzed using SPSS version 25.0. Descriptive statistics were presented as frequencies, percentages, means with standard deviations, or medians with interquartile ranges as appropriate. Categorical variables were compared using Chi-square or Fisher's exact test, while continuous variables were compared using Student's t-test or Mann-Whitney U test based on distribution normality. Logistic regression analysis was performed to identify independent risk factors for adverse neonatal outcomes. A p-value <0.05 was considered statistically significant. Subgroup analyses were conducted based on the type and severity of hypertensive disorders.

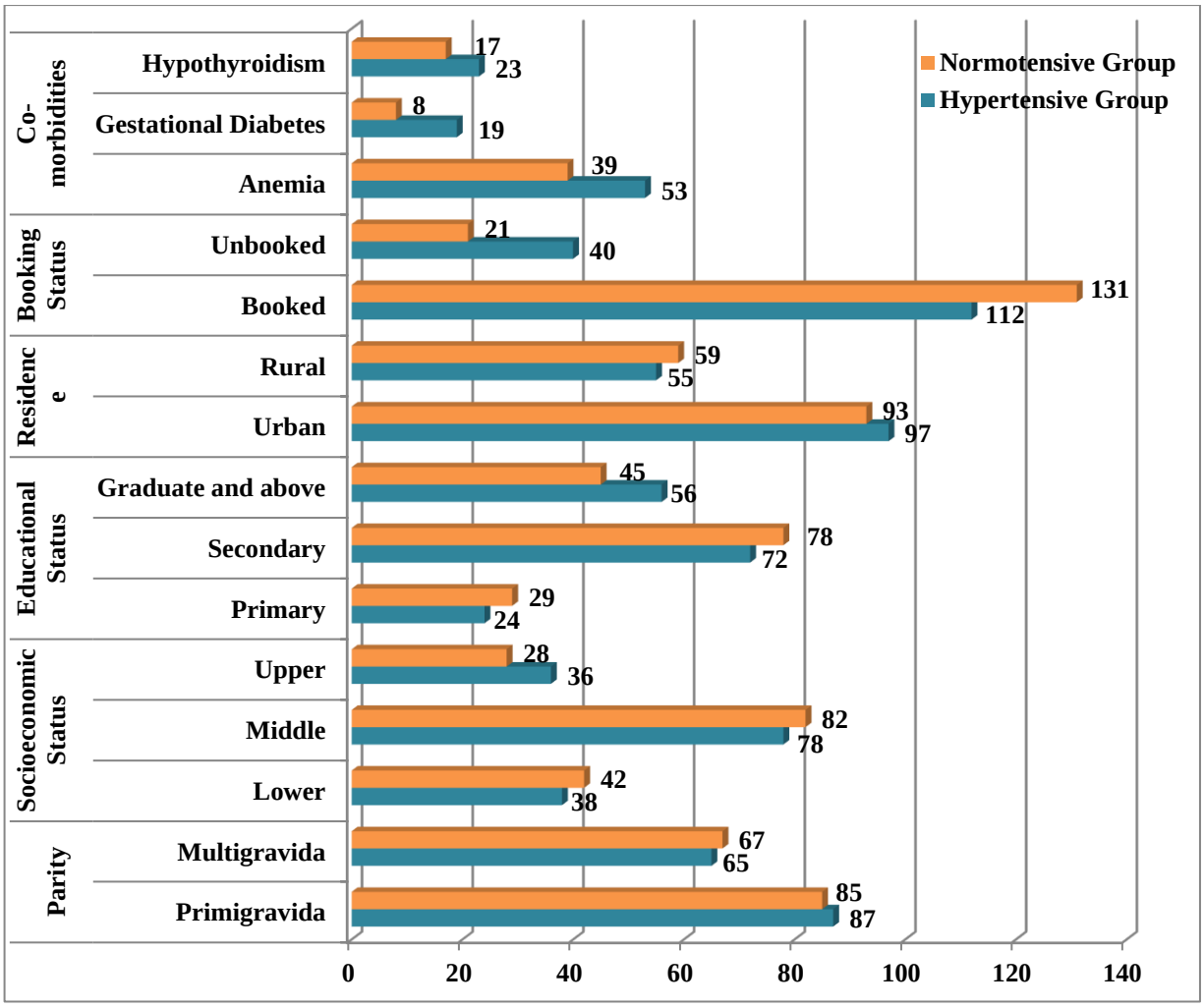
Ethical Considerations

The study received institutional ethics approval. Participants provided written informed consent after receiving information in their preferred language. Participation was voluntary with the right to withdraw without consequences. All data was de-identified to maintain confidentiality.

Results

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristics	**Hypertensive Group (n=152)**	**Normotensive Group (n=152)**	***p-value****
Maternal Age (years)			
Mean ± SD	28.4 ± 5.6	28.2 ± 5.3	0.82
Parity			
Primigravida	87 (57.2%)	85 (55.9%)	0.91
Multigravida	65 (42.8%)	67 (44.1%)	
BMI (kg/m²)			
Mean ± SD	27.3 ± 4.2	25.8 ± 3.6	0.003
Socioeconomic Status			
Lower	38 (25.0%)	42 (27.6%)	0.42
Middle	78 (51.3%)	82 (53.9%)	
Upper	36 (23.7%)	28 (18.4%)	
Educational Status			
Primary	24 (15.8%)	29 (19.1%)	0.38
Secondary	72 (47.4%)	78 (51.3%)	
Graduate and above	56 (36.8%)	45 (29.6%)	
Residence			
Urban	97 (63.8%)	93 (61.2%)	0.64
Rural	55 (36.2%)	59 (38.8%)	
Booking Status			
Booked	112 (73.7%)	131 (86.2%)	0.008
Unbooked	40 (26.3%)	21 (13.8%)	
Co-morbidities			
Anemia	53 (34.9%)	39 (25.7%)	0.07
Gestational Diabetes	19 (12.5%)	8 (5.3%)	0.028
Hypothyroidism	23 (15.1%)	17 (11.2%)	0.298



Statistically significant (p<0.05)

Fig: 1

Table 2: Distribution of Hypertensive Disorders of Pregnancy in Study Group (n=152)

Type of Hypertensive Disorder	Number (n)	Percentage (%)
Gestational Hypertension	54	35.5
Preeclampsia (total)	71	46.7
Mild Preeclampsia	37	24.3
Severe Preeclampsia	34	22.4
Chronic Hypertension	12	7.9
Chronic Hypertension with Superimposed Preeclampsia	9	5.9
Eclampsia	6	3.9
Total	**152**	**100.0**

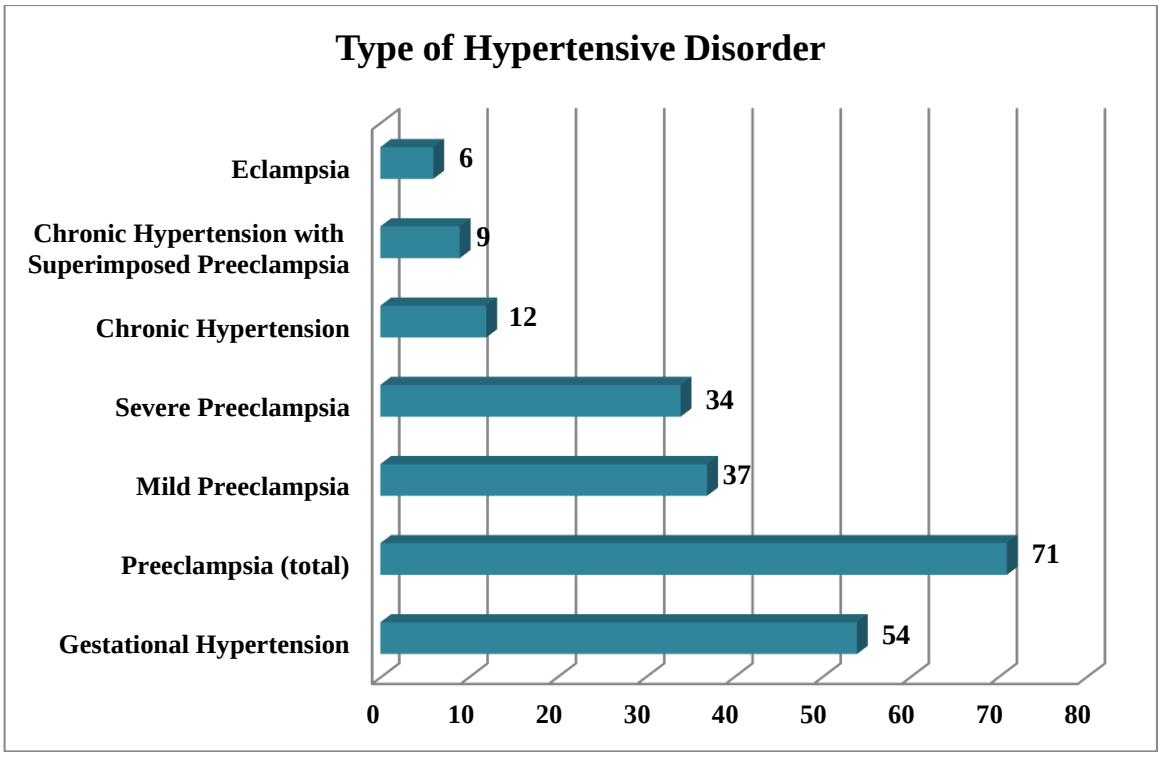


Fig: 2

Table 3: Pregnancy Outcomes in Hypertensive and Normotensive Groups

Pregnancy Outcomes	**Hypertensive Group (n=152)**	**Normotensive Group (n=152)**	***p-value****
Gestational Age at Delivery (weeks)			
Mean ± SD	36.8 ± 2.7	38.6 ± 1.4	<0.001
Mode of Delivery			
Vaginal	56 (36.8%)	98 (64.5%)	<0.001
Cesarean Section	96 (63.2%)	54 (35.5%)	
Indication for Cesarean Section	(n=96)	(n=54)	
Fetal Distress	43 (44.8%)	22 (40.7%)	0.63
Non-reassuring CTG	27 (28.1%)	12 (22.2%)	0.42
Failed Induction	16 (16.7%)	13 (24.1%)	0.26
Previous Cesarean	10 (10.4%)	7 (13.0%)	0.64
Induction of Labor	74 (48.7%)	43 (28.3%)	<0.001
Preterm Delivery (<37 weeks)	58 (38.2%)	16 (10.5%)	<0.001
Placental Abnormalities			
Placental Abruption	13 (8.6%)	2 (1.3%)	0.003
Placenta Previa	5 (3.3%)	4 (2.6%)	0.74
Postpartum Complications			
Postpartum Hemorrhage	17 (11.2%)	8 (5.3%)	0.06
Puerperal Sepsis	9 (5.9%)	4 (2.6%)	0.16
Maternal ICU Admission	14 (9.2%)	2 (1.3%)	0.002
Maternal Mortality	2 (1.3%)	0 (0.0%)	0.16

Statistically significant (p<0.05); CTG: Cardiotocography

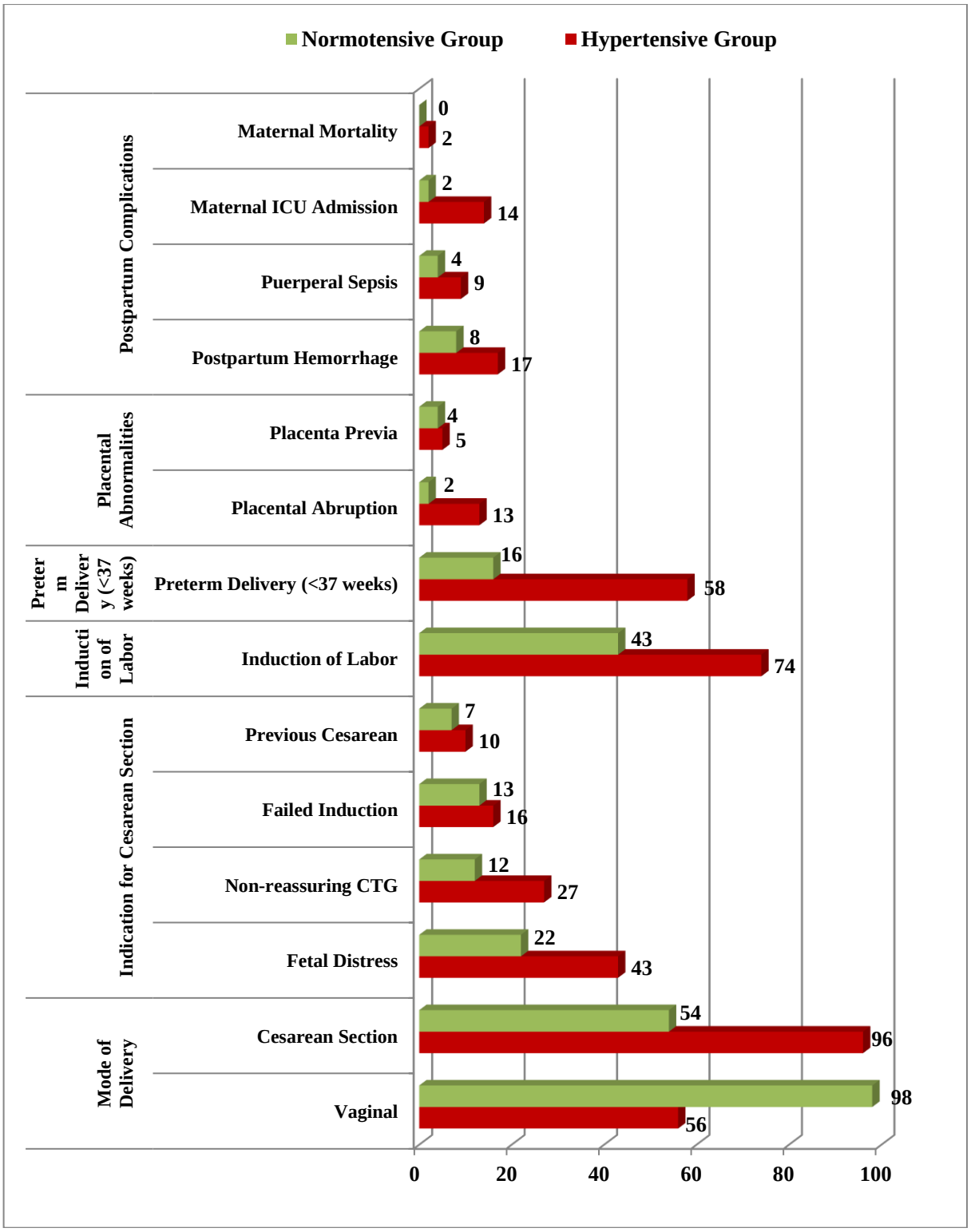

Normotensive Group
Hypertensive Group
Postpartum Complications
Maternal Mortality
0
2
Maternal ICU Admission
2
14
Puerperal Sepsis
4
9
Postpartum Hemorrhage
8
17
Placental Abnormalities
Placenta Previa
4
5
Placental Abruption
2
13
Preterm Delivery (<37 weeks)
Preterm Delivery (<37 weeks)
16
58
Induction of Labor
Induction of Labor
43
74
Indication for Cesarean Section
Previous Cesarean
7
10
Failed Induction
13
16
Non-reassuring CTG
12
27
Fetal Distress
22
43
Mode of Delivery
Cesarean Section
54
96
Vaginal
98
56
0
20
40
60
80
100

Fig: 3

Table 4: Neonatal Outcomes in Hypertensive and Normotensive Groups

Neonatal Outcomes	**Hypertensive Group (n=152)**	**Normotensive Group (n=152)**	***p-value***
Birth Weight (grams)			
Mean ± SD	2486 ± 562	2934 ± 424	<0.001
Birth Weight Categories			
<1500 g (VLBW)	17 (11.2%)	3 (2.0%)	<0.001
1500-2499 g (LBW)	64 (42.1%)	25 (16.4%)	<0.001
≥2500 g	71 (46.7%)	124 (81.6%)	<0.001
Small for Gestational Age	48 (31.6%)	18 (11.8%)	<0.001
Apgar Score <7 at 1 min	43 (28.3%)	15 (9.9%)	<0.001
Apgar Score <7 at 5 min	21 (13.8%)	6 (3.9%)	0.002
NICU Admission	67 (44.1%)	25 (16.4%)	<0.001
Duration of NICU Stay (days)			0.003
Mean ± SD	7.3 ± 4.8	4.6 ± 2.9	
Neonatal Complications			
Respiratory Distress Syndrome	39 (25.7%)	14 (9.2%)	<0.001
Hypoglycemia	32 (21.1%)	11 (7.2%)	<0.001
Hyperbilirubinemia	43 (28.3%)	22 (14.5%)	0.003
Sepsis	18 (11.8%)	8 (5.3%)	0.038
Necrotizing Enterocolitis	6 (3.9%)	1 (0.7%)	0.057
Intraventricular Hemorrhage	8 (5.3%)	2 (1.3%)	0.046
Neonatal Mortality	9 (5.9%)	2 (1.3%)	0.03

****Statistically significant (p<0.05); VLBW: Very Low Birth Weight; LBW: Low Birth Weight; NICU: Neonatal Intensive Care Unit***

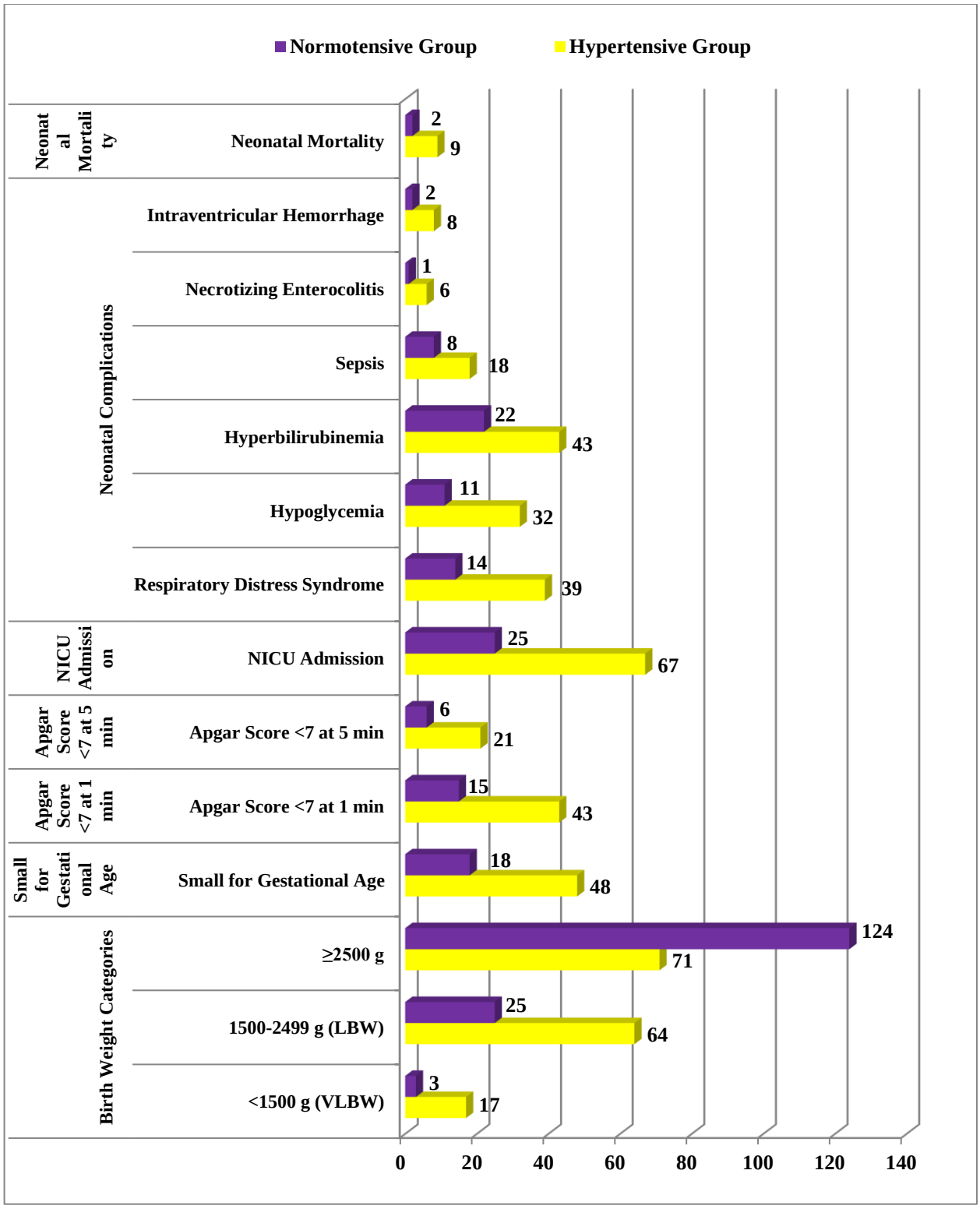

Normotensive Group
Hypertensive Group
Neonatal Mortality
Neonatal Mortality
2
9
Neonatal Complications
Intraventricular Hemorrhage
2
8
Necrotizing Enterocolitis
1
6
Sepsis
8
18
Hyperbilirubinemia
22
43
Hypoglycemia
11
32
Respiratory Distress Syndrome
14
39
NICU Admission
NICU Admission
25
67
Apgar Score <7 at 5 min
Apgar Score <7 at 5 min
6
21
Apgar Score <7 at 1 min
Apgar Score <7 at 1 min
15
43
Small for Gestational Age
Small for Gestational Age
18
48
Birth Weight Categories
≥2500 g
124
71
1500-2499 g (LBW)
25
64
<1500 g (VLBW)
3
17
0
20
40
60
80
100
120
140

Fig: 4

Table 5: Neonatal Outcomes Based on Type of Maternal Hypertension

Neonatal Outcomes	Gestational Hypertension (n=54)	Mild Preeclampsia (n=37)	Severe Preeclampsia (n=34)	Chronic Hypertension (n=12)	Chronic Hypertension with Superimposed Preeclampsia (n=9)	Eclampsia (n=6)	*p-value**
Preterm Delivery	12 (22.2%)	13 (35.1%)	17 (50.0%)	4 (33.3%)	6 (66.7%)	6 (100.0%)	<0.001
Low Birth Weight	19 (35.2%)	17 (45.9%)	23 (67.6%)	5 (41.7%)	7 (77.8%)	5 (83.3%)	<0.001
SGA	11 (20.4%)	11 (29.7%)	14 (41.2%)	3 (25.0%)	5 (55.6%)	4 (66.7%)	0.003
NICU Admission	17 (31.5%)	14 (37.8%)	19 (55.9%)	4 (33.3%)	7 (77.8%)	6 (100.0%)	<0.001
Respiratory Distress	9 (16.7%)	7 (18.9%)	12 (35.3%)	3 (25.0%)	5 (55.6%)	3 (50.0%)	0.008
Hypoglycemia	8 (14.8%)	6 (16.2%)	9 (26.5%)	2 (16.7%)	4 (44.4%)	3 (50.0%)	0.042
Hyperbilirubinemia	11 (20.4%)	9 (24.3%)	12 (35.3%)	3 (25.0%)	5 (55.6%)	3 (50.0%)	0.113
Neonatal Mortality	1 (1.9%)	1 (2.7%)	3 (8.8%)	0 (0.0%)	2 (22.2%)	2 (33.3%)	<0.001

Statistically significant (p<0.05); SGA: Small for Gestational Age; NICU: Neonatal Intensive Care Unit

Table 6: Multivariate Logistic Regression Analysis for Predictors of Adverse Neonatal Outcomes in Hypertensive Pregnancies

Risk Factors	Adjusted Odds Ratio	95% CI	*p-value**
For NICU Admission			
Severe Preeclampsia	3.82	1.76-8.30	<0.001
Eclampsia	6.45	2.21-18.87	<0.001
Early-onset Disease (<34 weeks)	2.94	1.42-6.09	0.004
Uncontrolled Hypertension	2.38	1.18-4.81	0.016
SGA Status	3.19	1.58-6.43	0.001
Placental Abruption	4.76	1.32-17.23	0.017
For Low Birth Weight			
Severe Preeclampsia	3.45	1.62-7.36	0.001
Chronic Hypertension with Superimposed Preeclampsia	4.82	1.03-22.56	0.046
Early-onset Disease (<34 weeks)	3.98	1.83-8.64	<0.001
Maternal Age >35 years	1.86	0.93-3.72	0.078
Primiparity	1.52	0.79-2.93	0.214
For Respiratory Distress Syndrome			
Preterm Delivery	6.83	3.09-15.08	<0.001
Severe Preeclampsia	2.72	1.25-5.93	0.012
Eclampsia	4.91	1.18-20.43	0.029

Uncontrolled Hypertension	2.16	1.03-4.52	0.042
For Neonatal Mortality			
Birth Weight <1500g	8.41	2.19-32.27	0.002
Gestational Age <32 weeks	7.93	1.89-33.26	0.005
Severe Preeclampsia	3.26	0.78-13.62	0.106
Eclampsia	12.18	2.17-68.34	0.004
HELLP Syndrome	9.14	1.78-46.98	0.008

Statistically significant (p<0.05); CI: Confidence Interval; SGA: Small for Gestational Age; HELLP: Hemolysis, Elevated Liver enzymes, Low Platelets

Discussion

The demographic analysis of our study participants (Table 1) revealed comparable distribution of maternal age and parity between hypertensive and normotensive groups, which reflects the effectiveness of our matching criteria. However, significant differences were observed in BMI, booking status, and comorbidities. Women with hypertensive disorders had higher mean BMI (27.3 ± 4.2 vs. 25.8 ± 3.6 kg/m², p=0.003), higher rates of unbooked status (26.3% vs. 13.8%, p=0.008), and greater prevalence of gestational diabetes (12.5% vs. 5.3%, p=0.028).

These findings align with those reported by Bartsch et al. (2021), who conducted a large-scale meta-analysis of 55 studies and identified elevated BMI as a significant risk factor for hypertensive disorders of pregnancy, with each 5-unit increase in BMI associated with a 1.7-fold increased risk of preeclampsia. Similarly, Das et al. (2020) in their study from a tertiary care center in Eastern India found that women with BMI >30 kg/m² had a 3.2-fold increased risk of developing preeclampsia compared to those with normal BMI.

The higher proportion of unbooked cases among hypertensive pregnancies is concerning and reflects potential gaps in antenatal care utilization. Rawat et al. (2021) reported similar findings from a multicenter study across North Indian tertiary care centers, where inadequate antenatal care was associated with a 2.8-fold increased risk of severe maternal outcomes in hypertensive disorders. The association between gestational diabetes and hypertensive disorders observed in our study supports the concept of shared pathophysiological mechanisms involving metabolic dysfunction and endothelial damage, as proposed by Weissgerber and Mudd (2020) in their comprehensive review.

In our cohort, preeclampsia was the most common hypertensive disorder (46.7%), followed by gestational hypertension (35.5%), chronic hypertension (7.9%), chronic hypertension with superimposed preeclampsia (5.9%), and eclampsia (3.9%) as shown in Table 2. This distribution is comparable to that reported by Agrawal et al. (2022) from a tertiary care center in Central India, where preeclampsia constituted 42.3% of hypertensive disorders, though our eclampsia rate was lower (3.9% vs. 7.2%), possibly reflecting improvements in early detection and management.

Pregnancy outcomes (Table 3) demonstrated significantly higher rates of cesarean delivery (63.2% vs. 35.5%, p<0.001), preterm birth (38.2% vs. 10.5%, p<0.001), and placental abruption (8.6% vs. 1.3%, p=0.003) in the hypertensive group. The mean gestational age at delivery was significantly lower in hypertensive pregnancies (36.8 ± 2.7 vs. 38.6 ± 1.4 weeks, p<0.001). These findings corroborate those of Yadav et al. (2021), who reported cesarean rates of 58.7% in hypertensive versus 32.4% in normotensive pregnancies across three tertiary centers in Western India. The higher cesarean rates likely reflect both maternal indications (worsening maternal condition) and fetal indications (non-reassuring fetal status) as highlighted by Jain et al. (2020).

The preterm delivery rate of 38.2% observed in our hypertensive cohort falls within the range of 30-45% reported in the literature from comparable settings. Mahajan et al. (2021) documented a 42.3% preterm birth rate among hypertensive pregnancies in their three-year retrospective analysis from a tertiary care center in North India. Early delivery is often indicated in severe hypertensive disorders to prevent maternal complications, despite the risks associated with prematurity for the neonate.

Neonatal outcomes were significantly worse in the hypertensive group, with lower mean birth weight (2486 ± 562 vs. 2934 ± 424 grams, p<0.001), higher rates of low birth weight (53.3% vs. 18.4%, p<0.001), and small for gestational age (SGA) status (31.6% vs. 11.8%, p<0.001) as shown

in Table 4. NICU admission rates were substantially higher in neonates born to hypertensive mothers (44.1% vs. 16.4%, p<0.001), with longer average NICU stay (7.3 ± 4.8 vs. 4.6 ± 2.9 days, p=0.003).

These findings are consistent with those reported by Sharma et al. (2022) from a tertiary care teaching hospital in South India, where 47.6% of neonates born to hypertensive mothers required NICU admission compared to 14.2% in the control group. The higher incidence of low birth weight and SGA status observed in our study correlates with the pathophysiological mechanisms of placental insufficiency and reduced uteroplacental blood flow characteristic of hypertensive disorders, as elaborated by Wang et al. (2021) in their review on placental pathology in hypertensive disorders of pregnancy.

Neonatal complications were significantly more frequent in the hypertensive group, particularly respiratory distress syndrome (25.7% vs. 9.2%, p<0.001), hypoglycemia (21.1% vs. 7.2%, p<0.001), hyperbilirubinemia (28.3% vs. 14.5%, p=0.003), and sepsis (11.8% vs. 5.3%, p=0.038). Neonatal mortality was also significantly higher (5.9% vs. 1.3%, p=0.03). These findings align with those of Raghuraman et al. (2020), who reported significantly higher rates of respiratory morbidity (23.5% vs. 8.7%) and hypoglycemia (18.9% vs. 6.4%) among neonates born to mothers with hypertensive disorders in a multicenter study across South Indian tertiary hospitals.

Analysis of neonatal outcomes stratified by type of maternal hypertension (Table 5) revealed a gradient of risk, with the worst outcomes observed in eclampsia and chronic hypertension with superimposed preeclampsia, followed by severe preeclampsia. All eclamptic cases (100%) resulted in preterm delivery and NICU admission, with 83.3% having low birth weight and 33.3% resulting in neonatal mortality. This gradient of severity is consistent with findings from Verma et al. (2021), who documented increasing neonatal morbidity across the spectrum of hypertensive disorders, with the highest morbidity in eclampsia and superimposed preeclampsia.

The differential impact of various hypertensive disorders on neonatal outcomes likely reflects differences in pathophysiology and severity. As highlighted by Bharti et al. (2020), preeclampsia superimposed on chronic hypertension represents "two hits" to the maternal-fetal unit, with chronic vascular changes compounded by acute inflammatory and anti-angiogenic responses, resulting in more severe placental dysfunction and fetal compromise.

Multivariate logistic regression analysis (Table 6) identified several independent predictors of adverse neonatal outcomes. For NICU admission, the strongest predictors were eclampsia (aOR 6.45, 95% CI 2.21-18.87), placental abruption (aOR 4.76, 95% CI 1.32-17.23), and severe preeclampsia (aOR 3.82, 95% CI 1.76-8.30). For low birth weight, significant predictors included chronic hypertension with superimposed preeclampsia (aOR 4.82, 95% CI 1.03-22.56) and early-onset disease (aOR 3.98, 95% CI 1.83-8.64).

These findings correspond with those of Prasad et al. (2021), who identified severe preeclampsia (aOR 3.67) and early-onset disease (aOR 4.12) as the strongest predictors of adverse neonatal outcomes in their prospective cohort study from a tertiary center in South India. Similarly, Chaudhary et al. (2020) reported that early-onset disease (<34 weeks) was the most significant predictor of adverse perinatal outcomes (aOR 4.23, 95% CI 2.18-8.21) in their retrospective analysis of hypertensive pregnancies.

For neonatal mortality, the strongest predictors were eclampsia (aOR 12.18, 95% CI 2.17-68.34), HELLP syndrome (aOR 9.14, 95% CI 1.78-46.98), and very low birth weight <1500g (aOR 8.41, 95% CI 2.19-32.27). These findings highlight the critical importance of birth weight and gestational age in determining neonatal survival, as also emphasized by Goyal et al. (2021), who found that extremely preterm birth (<32 weeks) and birth weight <1500g were the strongest predictors of mortality in hypertensive pregnancies, with adjusted odds ratios of 9.87 and 11.23, respectively.

Conclusion

This prospective case-control study conducted in a tertiary care setting demonstrates significantly worse maternal and neonatal outcomes in pregnancies complicated by hypertensive disorders compared to normotensive pregnancies. Maternal hypertension was associated with higher rates of

preterm delivery, cesarean section, and placental abruption. Neonates born to hypertensive mothers had lower birth weights, higher rates of SGA status, increased NICU admissions, and greater morbidity and mortality. A clear gradient of risk was observed across the spectrum of hypertensive disorders, with eclampsia and chronic hypertension with superimposed preeclampsia associated with the worst outcomes. Independent predictors of adverse neonatal outcomes included severe preeclampsia, eclampsia, early-onset disease, uncontrolled hypertension, very low birth weight, and extreme prematurity. These findings underscore the critical importance of early detection, close monitoring, and appropriate management of hypertensive disorders in pregnancy to optimize maternal and neonatal outcomes in tertiary care settings.

Recommendations

Based on our findings, we recommend implementing universal screening for preeclampsia using a combination of maternal risk factors, blood pressure monitoring, and biomarkers where available in all antenatal settings. Early referral systems should be strengthened to ensure high-risk cases reach tertiary care facilities before complications develop. Standardised management protocols for various hypertensive disorders should be implemented with clear criteria for the timing of delivery based on maternal-fetal risk assessment. Neonatal care facilities should be upgraded in centres managing hypertensive pregnancies, with a focus on managing complications like respiratory distress syndrome, hypoglycemia, and infections.

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