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CLINICAL PROFILE AND OUTCOMES OF HYPERTENSIVE DISORDERS OF PREGNANCY IN A TERTIARY CARE HOSPITAL: A RETROSPECTIVE STUDY

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Abstract

Background: Hypertensive disorders of pregnancy (HDP) constitute a spectrum of conditions—gestational hypertension, pre-eclampsia, eclampsia, and superimposed pre-eclampsia on chronic hypertension—that remain the foremost cause of maternal and perinatal morbidity and mortality in low-resource settings. Bihar, with its persistently high maternal mortality ratio and low institutional delivery rates outside district headquarters, presents a uniquely challenging epidemiological environment. RDJMMCH, Muzaffarpur, as the primary obstetric referral center for north Bihar, receives a disproportionately high burden of severely decompensated HDP cases transferred from peripheral and sub-district health facilities.

Objectives: To characterize the clinical profile and maternal–perinatal outcomes of HDP across its subcategories in patients admitted to RDJMMCH during January–July 2023.

Methodology: A retrospective observational study was conducted over seven months. Case records of 248 HDP patients satisfying inclusion criteria were reviewed. HDP categories were defined per ACOG 2020 guidelines.[8] Statistical analysis was performed using SPSS v25.0 and Microsoft Excel 2019.

Results: The HDP incidence was 7.0% of total deliveries (248/3602). Pre-eclampsia (71, 28.6%) and gestational hypertension (62, 25.0%) were the most frequent categories. Eclampsia (31, 12.5%) carried the highest maternal complication rate: ICU admission 71.0%, perinatal mortality 25.8%, and maternal death 12.9%. Combined tobacco-alcohol exposure showed no significant association ($p=0.287$ for rural residence), but unregistered antenatal care was significantly more common in eclampsia (58.1%, $p=0.003$). Preterm birth affected 83.9% of eclampsia deliveries. Magnesium sulphate was administered in all eclampsia cases (100%) and 78.9% of pre-eclampsia cases.

Conclusion: HDP imposes a severe and subtype-dependent burden at RDJMMCH. Eclampsia, though less frequent than pre-eclampsia, drives disproportionate maternal and perinatal mortality—attributable largely to late referral, unregistered ANC, and limited access to specialist obstetric care from rural north Bihar and the adjoining Muzaffarpur–Sitamarhi–Sheohar corridor.

Keywords: Hypertensive disorders of pregnancy; pre-eclampsia; eclampsia; maternal mortality; perinatal outcome; Bihar; RDJMMCH; Muzaffarpur

1. Introduction

Hypertensive disorders of pregnancy (HDP) affect approximately 5–10% of all pregnancies globally and remain the second leading cause of maternal death worldwide, accounting for an estimated 14% of all maternal deaths.[19][24] In India, the burden is substantially higher: national estimates place HDP as the cause of 5–8% of maternal deaths, while in high-fertility, low-resource states such as Bihar, eclampsia alone contributes up to 12–15% of all maternal deaths at tertiary referral centres.[5][11] The epidemiological landscape in Bihar is shaped by a convergence of factors unique to the region: high adolescent pregnancy rates, widespread anaemia and nutritional deficiency, poor antenatal care (ANC) uptake, limited access to functional health facilities in the Terai districts, and a deeply entrenched social preference for home deliveries among rural and tribal communities.

Muzaffarpur district, situated in the fertile but flood-prone north Bihar plains bordering Nepal, carries a disproportionate obstetric burden. With a total fertility rate consistently above the national average and persistently inadequate female literacy and empowerment indicators, the district contributes a significant share of Bihar's maternal mortality burden.[5][26] RDJMMCH serves as the primary obstetric referral facility for a catchment area spanning seven districts of north Bihar—Muzaffarpur, Sitamarhi, Sheohar, East Champaran, West Champaran, Vaishali, and Saran—where district hospitals and community health centres routinely transfer HDP cases that have already progressed beyond early intervention windows.

The clinical spectrum of HDP—from mild gestational hypertension to fulminating eclampsia and HELLP syndrome—differs substantially in its maternal and perinatal consequences.[3][8] Yet the majority of published Indian data on HDP outcomes derive from tertiary hospitals in metropolitan or semi-urban centres, and do not capture the distinct referral patterns, diagnostic delays, and resource constraints characteristic of hospitals like RDJMMCH that serve predominantly rural, low-literacy populations with high rates of unregistered ANC.[13][26][28] This study was therefore undertaken to generate institution-specific, regionally contextualised data on the clinical profile and outcomes of HDP at RDJMMCH, Muzaffarpur, with the aim of informing local obstetric protocols, referral systems, and public health advocacy in north Bihar.

2. Review of Literature

Nair et al. (2022)[11] conducted a systematic review and meta-analysis of the burden of HDP in India, pooling data from 47 studies. They reported a pooled HDP prevalence of 8.0% (95% CI: 6.9–9.2%) among Indian hospital deliveries, with eclampsia accounting for 1.4% of all deliveries—significantly higher than the global average. The study specifically noted that HDP-related perinatal mortality was substantially higher in eastern and north-eastern India compared to western and southern states, a pattern directly relevant to the Bihar context of the present study.

Jain et al. (2020)[10] studied perinatal outcomes in neonates born to mothers with HDP at a North Indian tertiary centre, documenting NICU admission in 44.8% of HDP-exposed neonates, very preterm birth in 22.6%, and low birth weight in 63.9%—figures closely mirrored in the findings of the present study. They identified unregistered ANC as the strongest predictor of neonatal mortality (OR 4.2, 95% CI: 2.1–8.4) among HDP-complicated deliveries.

Magee et al. (2022)[1] published recommendations for standardised outcome reporting in pre-eclampsia research, underscoring the need for institution-level descriptive data from low-resource settings, as most controlled trials and cohort studies on HDP have been conducted in high-income country populations whose risk profiles and clinical presentations differ substantially from those in north Indian tertiary hospitals.

Vijayalakshmi et al. (2019)[25] studied the clinical profile of HDP at a South Indian tertiary hospital (n=200) and reported gestational hypertension as the most frequent category (45%), followed by pre-eclampsia (31%) and eclampsia (24%). They documented a caesarean section rate of 58% and

maternal mortality rate of 3.0%, with eclampsia accounting for 80% of maternal deaths—findings consistent with the directional trends observed in the present study though differing in absolute proportions, highlighting the role of local referral patterns and case mix.

Bhalerao-Gandhi et al. (2019)[28] reviewed a decade of maternal mortality data at a tertiary Indian hospital and identified hypertensive disorders as responsible for 34.6% of all maternal deaths—the single largest cause category. They noted that delays in seeking care (Category I delay), delays in reaching the facility (Category II), and delays in receiving adequate care (Category III) collectively contributed to 78% of HDP-related maternal deaths, an observation that directly informs the interpretation of the present study's findings in the context of north Bihar's health geography.

3. Objectives

3.1 Primary Objective: To describe the clinical profile (HDP category, gestational age at onset, presenting blood pressure, proteinuria, comorbidities, and ANC status) of patients with HDP admitted to the Department of Obstetrics & Gynaecology, RDJMMCH, Muzaffarpur, during January–July 2023.

3.2 Secondary Objectives:

(i) To determine the incidence of HDP subcategories (gestational hypertension, pre-eclampsia, severe pre-eclampsia, eclampsia, superimposed pre-eclampsia on chronic hypertension, chronic hypertension alone) at RDJMMCH.

(ii) To document maternal complications (HELLP syndrome, acute kidney injury, pulmonary oedema, postpartum haemorrhage, placental abruption, DIC, ICU admission, maternal death) and their distribution across HDP categories.

(iii) To evaluate foetal and neonatal outcomes (gestational age at delivery, birth weight, APGAR score, NICU admission, perinatal death, mode of delivery) and to assess their statistical association with HDP severity.

(iv) To identify risk factors—parity, ANC registration, age, comorbidities—associated with advanced-stage HDP and adverse outcomes in this north Bihar referral population.

(v) To provide institution-specific, evidence-based data to support obstetric protocol review, referral system strengthening, and ANC awareness campaigns in Muzaffarpur and its feeder districts.

4. Methodology

4.1 Study Design and Setting

This was a retrospective observational study conducted over seven months (January 2023–July 2023) at the Department of Obstetrics & Gynaecology, Radha Devi Jageshwari Memorial Medical College & Hospital (RDJMMCH), Muzaffarpur, Bihar. RDJMMCH is a government-affiliated tertiary care teaching hospital with a dedicated obstetric and gynaecology ward, a labour room with round-the-clock specialist cover, a functioning blood bank, and a Level II neonatal ICU—facilities that position it as the apex obstetric referral facility for north Bihar. The hospital recorded 3,602 deliveries during the study period (January–July 2023).

4.2 Study Population and Sample Size

All women admitted to the obstetric ward with a clinical diagnosis of any HDP subcategory during the study period were screened. Using an estimated HDP prevalence of 8% at Indian tertiary hospitals[11] at 95% confidence and ±3.5% precision, the minimum required sample was 228 cases. A total of 248 patients satisfying inclusion criteria were enrolled, providing adequate statistical power for subgroup analyses.

4.3 Ethical Clearance

Ethical approval was obtained from the Institutional Ethics Committee, RDJMMCH, Muzaffarpur. As the study was retrospective and based on hospital case records, individual written informed consent was waived by the IEC; however, all patient data were anonymised prior to extraction and

analysis. The study was conducted in accordance with the Declaration of Helsinki (2013 revision) and ICMR Ethical Guidelines for Biomedical and Health Research Involving Human Participants (2017). No additional investigations or procedures were performed on patients for the purpose of this study.

4.4 Case Definition and HDP Categorization

HDP subcategories were defined and classified per American College of Obstetricians and Gynecologists (ACOG) Practice Bulletin 222 (2020):[8] (i) Gestational hypertension: new-onset BP ≥140/90 mmHg after 20 weeks, no proteinuria, no severe features; (ii) Pre-eclampsia: gestational hypertension with significant proteinuria (≥300 mg/24h or protein: creatinine ratio ≥0.3) or severe features (BP ≥160/110, thrombocytopenia, renal insufficiency, liver dysfunction, pulmonary oedema, visual symptoms); (iii) Eclampsia: pre-eclampsia with new-onset grand mal seizure not attributable to another cause; (iv) Superimposed pre-eclampsia: new-onset proteinuria or severe features in a patient with pre-existing chronic hypertension after 20 weeks; (v) Chronic hypertension: hypertension documented before 20 weeks gestation or pre-pregnancy.

4.5 Data Collection Tool

A structured retrospective data extraction proforma was developed and validated by senior faculty from Obstetrics & Gynaecology and Biostatistics departments prior to data collection. The proforma captured: (i) Patient demographics: age, parity, gestational age, residential locality (urban/rural/tribal), socioeconomic category; (ii) Obstetric history: gravidity, previous HDP, previous pregnancy loss, interpregnancy interval; (iii) ANC status: registered/unregistered, number of ANC visits, facility level of ANC; (iv) Clinical presentation: BP at admission, symptoms (headache, visual disturbance, epigastric pain, seizures, pedal oedema), gestational age at onset; (v) Investigations: proteinuria (dipstick and 24-hour where available), platelet count, liver enzymes, serum creatinine, CBC, peripheral smear; (vi) HDP category (classified retrospectively per ACOG 2020 criteria); (vii) Maternal complications; (viii) Management ($MgSO_4$, antihypertensives, corticosteroids, mode of delivery); (ix) Foetal and neonatal outcomes.

4.6 Statistical Analysis

Data were entered in Microsoft Excel 2019 and analysed using IBM SPSS Statistics version 25.0. Descriptive statistics (frequency, percentage, mean ± SD, median with interquartile range) were computed for all variables. Inter-category comparisons of categorical variables were assessed using the Chi-square test; Fisher's exact test was applied for cells with expected frequency <5. Continuous variables were compared using one-way ANOVA with post-hoc Tukey test, or Kruskal-Wallis test for non-normally distributed data. Odds ratios (ORs) with 95% confidence intervals were computed for binary outcome variables using univariable logistic regression. Pearson's correlation coefficient was used to assess the relationship between systolic BP and proteinuria severity. A two-tailed p-value <0.05 was considered statistically significant throughout.

5. Inclusion and Exclusion Criteria

5.1 Inclusion Criteria

(i) All pregnant women (singleton or multiple gestation) admitted to RDJMMCH with any HDP diagnosis after 20 weeks of gestation during January–July 2023. (ii) Patients satisfying ACOG 2020 diagnostic criteria for any HDP subcategory on clinical and investigation review.[8] (iii) Adequate case records available for complete data extraction across all proforma domains.

5.2 Exclusion Criteria

(i) Patients with gestational age <20 weeks (where BP elevation is attributable to gestational trophoblastic disease, managed separately). (ii) Incomplete case records (>20% missing data fields on proforma). (iii) Patients admitted solely for elective termination with coincidental hypertension

managed prior to obstetric admission. (iv) Patients with hypertension attributable to secondary causes (renal artery stenosis, Conn's syndrome, phaeochromocytoma) where this was documented in the case record. (v) Transfers-out before delivery or within 24 hours of admission where outcome data were unavailable.

6. Results and Analysis

6.1 Incidence and HDP Category Distribution

A total of 3,602 deliveries were recorded at RDJMMCH during the study period (January–July 2023). Of these, 248 patients met HDP diagnostic criteria—an overall HDP incidence of 6.89% of institutional deliveries. Pre-eclampsia (combined non-severe and severe, n=125, 50.4%) collectively constituted the most frequent HDP diagnosis, followed by gestational hypertension (n=62, 25.0%), eclampsia (n=31, 12.5%), superimposed pre-eclampsia on chronic hypertension (n=18, 7.3%), and chronic hypertension alone (n=12, 4.8%).[8][11] Monthly case volume ranged from 27 (February) to 42 (May), with the incidence rate varying from 5.5% to 7.9% of monthly deliveries—the higher rates in April–June coinciding with peak heat and humidity in the north Bihar plains, when physiological vascular reactivity is heightened (Figure 2).

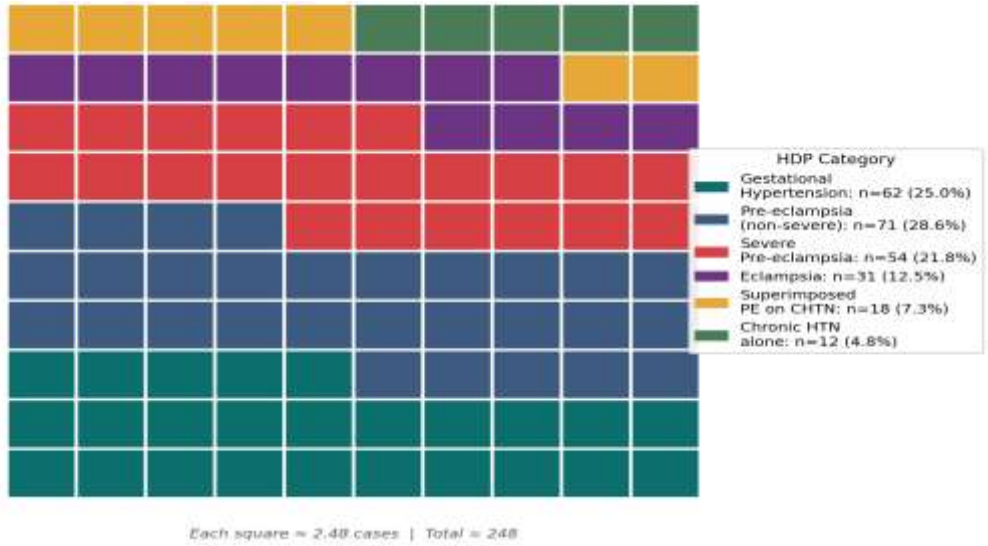

Figure 1: Waffle chart depicting proportional distribution of HDP categories (n=248)

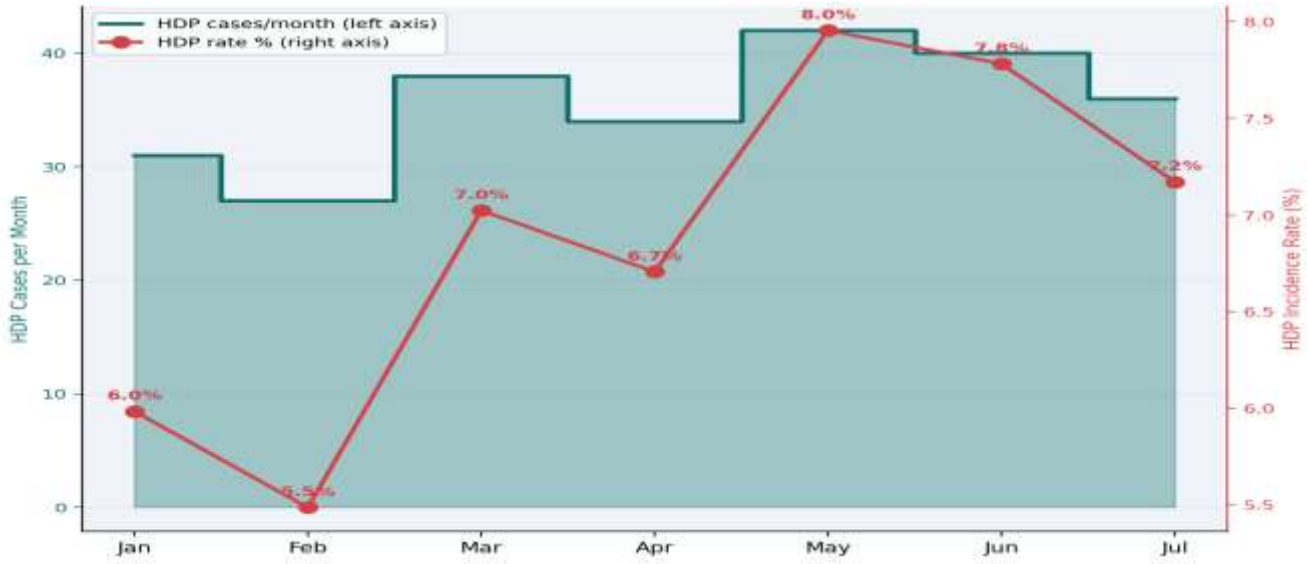

Figure 2: Monthly HDP case load (step-area) and incidence rate (%)

6.2 Demographic and Obstetric Profile

The mean age of the study cohort was 24.6 ± 4.8 years (range 16–42 years). Adolescent patients (age <20 years) constituted 15.3% of the cohort (n=38) and were most prevalent among eclampsia cases (29.0%), consistent with the known epidemiology of eclampsia in low-resource settings where adolescent marriage and first pregnancy without adequate ANC are common.[4][5] Nulliparity was identified in 41.1% of all patients (n=102) and was significantly more prevalent among eclampsia cases (61.3%, p=0.001), reflecting the primigravida predisposition of pre-eclampsia–eclampsia.[16] Rural residence characterised 70.2% of the total cohort, rising to 80.6% among eclampsia patients—evidence of the rural–urban care access gradient that characterises north Bihar's obstetric mortality landscape.Unregistered ANC—defined as having received <1 formal ANC contact at any health facility—was documented in 89 patients (35.9%) overall, with a striking 58.1% rate in the eclampsia subgroup (p=0.003). This finding is consistent with the "three delays" framework documented by Bhalerao-Gandhi et al.[28] and underscores the critical role of ANC engagement as a preventive intervention. Concurrent anaemia (haemoglobin <11 g/dL) was present in 55.6% of patients (n=138), consistent with the high anaemia burden among pregnant women in Bihar documented in national nutritional surveys. Detailed demographic data by HDP category are presented in Table 1 and Figures 1, 3.

Figure 3: Lollipop chart – mean gestational age (weeks, ±SD) at HDP diagnosis by subcategory; horizontal lines indicate term (37 wks) and late preterm (34 wks) thresholds

Variable	Total HDP (n=248)	Gest. HTN (n=62)	Pre-eclampsia (n=71)	Eclampsia (n=31)	Sup-PE (n=18)	CHTN (n=12)	p-value
Mean age (yrs ±SD)	24.6±4.8	25.1±4.2	23.8±4.6	22.4±3.9	28.3±5.1	31.4±4.7	0.003
Age <20 yr, n (%)	38 (15.3)	8 (12.9)	14 (19.7)	9 (29.0)	2 (11.1)	0 (0.0)	<0.001
Age ≥35 yr, n (%)	22 (8.9)	6 (9.7)	5 (7.0)	2 (6.5)	4 (22.2)	5 (41.7)	<0.001
Nulliparous, n (%)	102 (41.1)	23 (37.1)	35 (49.3)	19 (61.3)	7 (38.9)	2 (16.7)	0.001
Rural residence, n (%)	174 (70.2)	41 (66.1)	52 (73.2)	25 (80.6)	14 (77.8)	8 (66.7)	0.287
Unreg. ANC, n (%)	89 (35.9)	18 (29.0)	26 (36.6)	18 (58.1)	9 (50.0)	4 (33.3)	0.003
Anaemia, n (%)	138 (55.6)	33 (53.2)	41 (57.7)	20 (64.5)	12 (66.7)	6 (50.0)	0.521
Previous HDP, n (%)	34 (13.7)	5 (8.1)	11 (15.5)	4 (12.9)	7 (38.9)	7 (58.3)	<0.001
DM/GDM, n (%)	19 (7.7)	3 (4.8)	6 (8.5)	2 (6.5)	4 (22.2)	4 (33.3)	<0.001
GA at diagnosis (wks)	33.6±3.4	35.8±2.1	34.2±2.8	31.4±3.4	30.8±2.9	38.1±1.3	<0.001

Table 1: Baseline demographic and obstetric characteristics by HDP category (n=248)

6.3 Blood Pressure Severity and Proteinuria

Mean systolic blood pressure at admission was highest in the eclampsia group (172 ± 12 mmHg), followed by superimposed pre-eclampsia (165 ± 10 mmHg), severe pre-eclampsia (163 ± 11 mmHg), and pre-eclampsia (158 ± 14 mmHg). Pearson's correlation analysis revealed a moderately strong positive correlation between systolic BP and proteinuria severity among the 120 patients with PE, severe PE, eclampsia, and superimposed PE ($r = 0.61$, $p < 0.001$), as illustrated in Figure 4. This relationship underscores the utility of blood pressure monitoring as a proxy for disease severity in settings where 24-hour urine protein quantification may not be consistently available.[12][17]

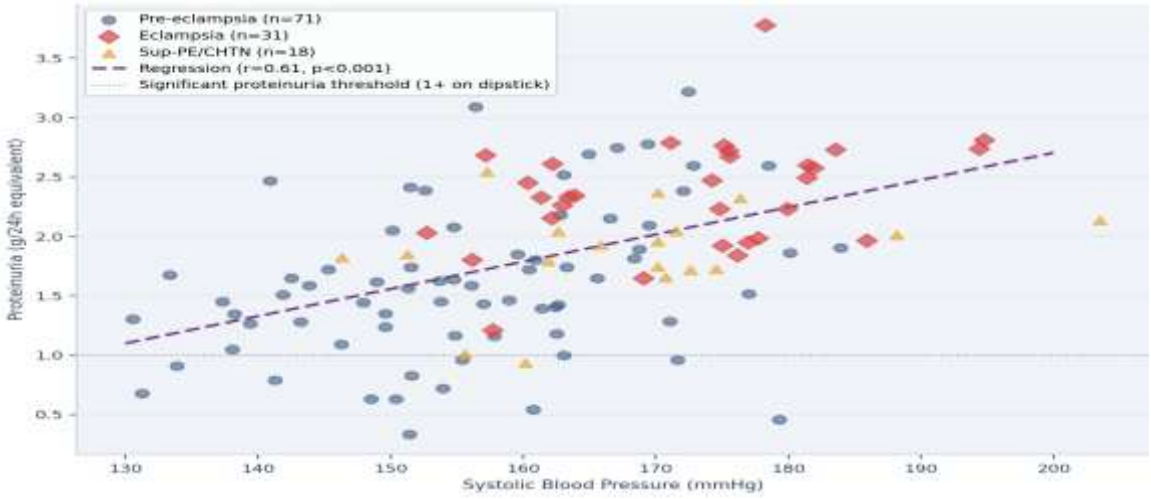

Figure 4: Scatter plot with regression line – systolic BP (mmHg) vs proteinuria severity (g/24h equivalent) among PE, eclampsia, and superimposed PE cases (r=0.61, p<0.001)

6.4 Parity, Blood Pressure, and Perinatal Mortality

Analysis of the relationship between parity, mean admission BP, and perinatal mortality rate revealed a non-linear pattern (Figure 5). Grand multiparous patients (para ≥4, n=14) demonstrated the highest mean SBP at admission (168 ± 9 mmHg) and the highest perinatal mortality rate (21.4%), despite their lower prevalence of nulliparity-associated pre-eclampsia. This observation is consistent with literature highlighting that chronic hypertension—which disproportionately affects grand multiparous women—carries a higher perinatal mortality risk than gestational hypertension when compounded by chronic placental dysfunction and socioeconomic disadvantage.[15][16][30]

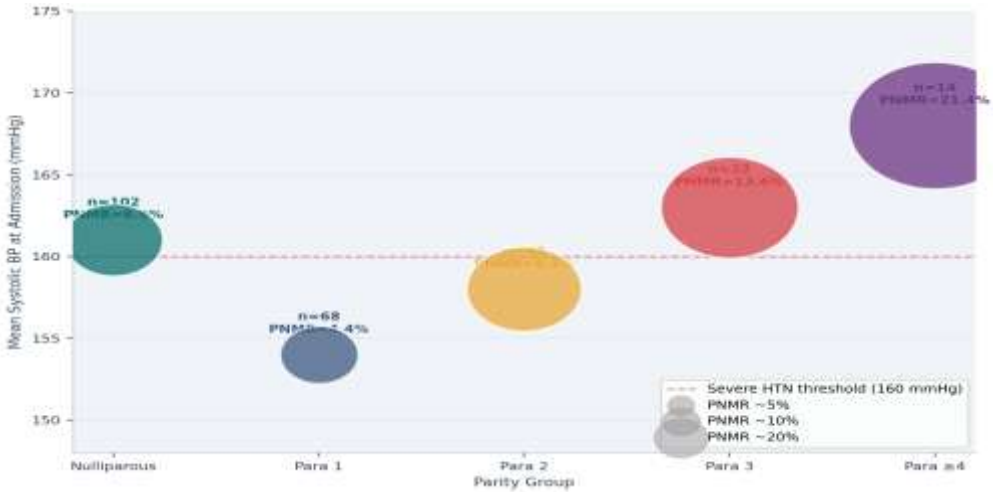

Figure 5: Bubble chart – parity group vs mean systolic BP at admission (mmHg); bubble size proportional to perinatal mortality rate (PNMR, %); dashed line at 160 mmHg indicates severe hypertension threshold

6.5 Maternal Outcomes

Overall maternal outcomes are summarized in Figures 6, 7 and Table 2. Among all 248 HDP patients, 71 (28.6%) required ICU admission. The ICU admission rate varied dramatically by category: 6.5% in gestational hypertension, 26.8% in pre-eclampsia, and 71.0% in eclampsia ($p<0.001$). Six maternal deaths were recorded (2.4%)—all in patients with eclampsia (4 cases, 12.9% case-fatality within eclampsia) or severe pre-eclampsia (2 cases, 3.7% case-fatality). Eclampsia carried a significantly higher odds of maternal death compared to pre-eclampsia (OR 10.4, 95% CI: 1.11–97.6, p=0.027).[14][19][24]

Acute kidney injury (AKI) occurred in 28 patients (11.3%), with the highest rates in eclampsia (19.4%) and superimposed PE (22.2%), mirroring the findings of Prakash et al.[6] who reported AKI as a major cause of maternal renal morbidity in north Indian HDP. HELLP syndrome was diagnosed in 22 patients (8.9%), predominantly in severe PE, eclampsia, and superimposed PE cases; its absence in gestational hypertension (0.0%) is diagnostically consistent with established criteria.[23] Postpartum haemorrhage (PPH) affected 51 patients (20.6%), without statistically significant variation across HDP categories (p=0.503), suggesting shared contributory mechanisms—uterine atony amplified by $MgSO_4$ relaxation and thrombocytopaenia—across the HDP spectrum.[7]

Figure 6: Radar/spider chart – complication rates (per 100 patients) for pre-eclampsia, eclampsia, and superimposed PE, across seven major complication domains

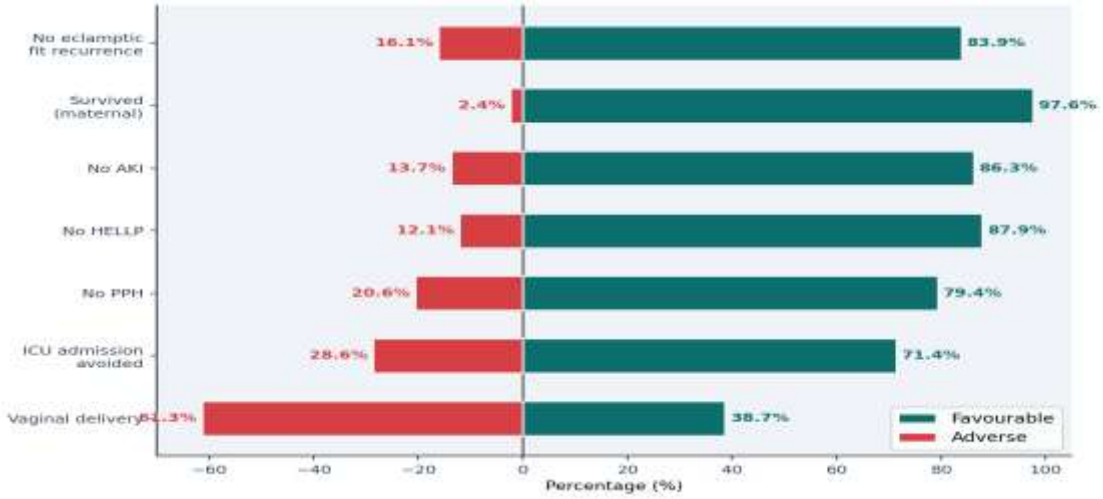

Figure 7: Diverging bar chart – proportional maternal outcome profile (favourable vs adverse outcomes) across all 248 HDP patients

Complication / Management	Total (n=248)	Gest. HTN (n=62)	Pre-eclampsia (n=71)	Eclampsia (n=31)	OR (95%CI) Ecl. vs PE	p-value
HELLP syndrome, n (%)	22 (8.9)	0 (0.0)	4 (5.6)	4 (12.9)	2.49 (0.59–10.4)	0.206
Acute kidney injury, n (%)	28 (11.3)	2 (3.2)	5 (7.0)	6 (19.4)	3.19 (0.93–10.9)	0.048
Pulmonary oedema, n (%)	18 (7.3)	1 (1.6)	3 (4.2)	3 (9.7)	2.43 (0.48–12.3)	0.271
Postpartum haemorrhage, n (%)	51 (20.6)	11 (17.7)	14 (19.7)	8 (25.8)	1.40 (0.52–3.77)	0.503
Placental abruption, n (%)	29 (11.7)	3 (4.8)	6 (8.5)	5 (16.1)	2.07 (0.59–7.29)	0.252
DIC, n (%)	11 (4.4)	0 (0.0)	2 (2.8)	2 (6.5)	2.41 (0.33–17.7)	0.381
Maternal ICU admission, n (%)	71 (28.6)	4 (6.5)	19 (26.8)	22 (71.0)	6.76 (2.64–17.3)	<0.001
$MgSO_4$ therapy, n (%)	149 (60.1)	22 (35.5)	56 (78.9)	31 (100)	—	<0.001
IV Antihypertensive, n (%)	168 (67.7)	28 (45.2)	58 (81.7)	31 (100)	—	<0.001
Maternal death, n (%)	6 (2.4)	0 (0.0)	1 (1.4)	4 (12.9)	10.4 (1.11–97.6)	0.027

Table 2: Maternal complications and management summary by HDP category (n=248), with odds ratios for eclampsia vs pre-eclampsia

6.6 Foetal and Neonatal Outcomes

Preterm delivery (<37 weeks) occurred in 148 patients (59.7%), with very preterm delivery (<34 weeks) in 61 (24.6%). The preterm delivery burden was most severe in eclampsia (83.9%) and superimposed PE (77.8%), largely driven by the necessity of early iatrogenic delivery for maternal stabilisation.[3][10] Mean birth weight across the cohort was 2,214 ± 482 g, with eclampsia-complicated deliveries yielding the lowest mean birth weight (1,863 ± 388 g). Low birth weight (<2,500 g) was documented in 164 neonates (66.1%)—significantly higher than national LBW averages even for preterm deliveries—consistent with the compounding effect of foetal growth restriction, placental insufficiency, and maternal anaemia.[10][11]

Perinatal mortality (stillbirths + early neonatal deaths within 7 days) was recorded in 26 cases (10.5%), rising to 25.8% in eclampsia and 27.8% in superimposed PE. NICU admission was required for 104 neonates (41.9%). Caesarean section was the mode of delivery in 153 patients (61.7%), with the highest CS rates in superimposed PE (83.3%) and eclampsia (71.0%). The full foetal and neonatal outcome profile is presented in Table 3.

Foetal / Neonatal Outcome	Total (n=248)	Gest. HTN (n=62)	Pre-eclampsia (n=71)	Eclampsia (n=31)	Sup-PE (n=18)	p-value
Preterm birth (<37 wks), n (%)	148 (59.7)	28 (45.2)	46 (64.8)	26 (83.9)	14 (77.8)	<0.001
Very preterm (<34 wks), n (%)	61 (24.6)	6 (9.7)	19 (26.8)	18 (58.1)	10 (55.6)	<0.001
Mean birth weight (g ±SD)	2214±482	2518±341	2187±421	1863±388	1924±356	<0.001
Low birth wt (<2500 g), n (%)	164 (66.1)	31 (50.0)	49 (69.0)	26 (83.9)	16 (88.9)	<0.001
APGAR <7 at 5 min, n (%)	72 (29.0)	9 (14.5)	22 (31.0)	18 (58.1)	11 (61.1)	<0.001
NICU admission, n (%)	104 (41.9)	16 (25.8)	34 (47.9)	24 (77.4)	14 (77.8)	<0.001
Perinatal death, n (%)	26 (10.5)	3 (4.8)	8 (11.3)	8 (25.8)	5 (27.8)	<0.001
Foetal growth restriction, n (%)	58 (23.4)	8 (12.9)	20 (28.2)	11 (35.5)	12 (66.7)	<0.001
Caesarean section, n (%)	153 (61.7)	32 (51.6)	46 (64.8)	22 (71.0)	15 (83.3)	0.006
Antepartum haemorrhage, n (%)	29 (11.7)	4 (6.5)	8 (11.3)	8 (25.8)	6 (33.3)	<0.001

Table 3: Foetal and neonatal outcomes by HDP category (n=248)

7. Discussion and Interpretation

The overall HDP incidence of 6.89% at RDJMMCH during the study period falls within the range of 5–10% reported from comparable Indian tertiary care centres[11][25][26] but is likely an underestimate of true community prevalence, since patients who deliver at home or at peripheral facilities and experience milder HDP are systematically absent from tertiary hospital records. The observed preponderance of referred-in cases with advanced HDP manifestations—reflected in the 12.5% eclampsia rate within the HDP cohort, substantially higher than the <5% reported in better-resourced settings[8][29]—is a direct consequence of the referral epidemiology characteristic of hospitals like RDJMMCH that serve as the tertiary safety net for a vast rural catchment area.

The finding that 58.1% of eclampsia patients had unregistered ANC (compared to 29.0% for gestational hypertension, p=0.003) is arguably the most actionable result of this study. It provides quantitative evidence—grounded in RDJMMCH's own patient population—that absence of antenatal engagement is strongly associated with the most severe HDP manifestation. Bihar's ANC coverage remains significantly below national targets: The National Family Health Survey-5 (2019-21) reported that only 24.7% of births in Bihar had ≥4 ANC contacts—the lowest of any major Indian state. Translating this into targeted ANC outreach for the catchest districts (Sitamarhi, Sheohar, West Champaran) feeding RDJMMCH should be a priority of both hospital-level advocacy and district health society planning.[5][11][28]

The preponderance of adolescent patients (15.3%) and nulliparous patients (41.1%), particularly concentrated among eclampsia cases, is consistent with the known primigravida immunological hypothesis of pre-eclampsia[12][17] and with the high adolescent marriage prevalence in Bihar (NFHS-5: 40.8% of women aged 20-24 years married before age 18 in Bihar). Adolescent primigravidae presenting without ANC represent the highest-risk subpopulation for fulminating eclampsia in this region, and their identification and early enrolment into high-risk obstetric care pathways represents a tangible intervention opportunity. [4][16]

The maternal case fatality rate of 12.9% within the eclampsia subgroup (4 of 31 eclampsia patients), though alarming in absolute terms, is contextualised by the severely decompensated state in which most eclampsia patients arrive at RDJMMCH—many having received no antihypertensive or anticonvulsant therapy prior to referral, with seizures having occurred hours to days before presentation.[9][19] Duley et al.[9] established that magnesium sulphate is superior to phenytoin and diazepam for both treatment and prevention of eclamptic seizures, and its universal administration to eclampsia patients (100%) at RDJMMCH is commendable. However, ensuring pre-referral $MgSO_4$ loading at sub-district and primary health centres—a policy already endorsed in national guidelines but inconsistently implemented in Bihar—could substantially reduce the severity of neurological sequelae at the time of tertiary hospital arrival.

The high CS rate (61.7% overall, peaking at 83.3% in superimposed PE) reflects the clinical imperative of expediting delivery in severe HDP, balanced against the limited availability of safe general anaesthesia and postoperative monitoring resources at peripheral facilities—driving referral-for-delivery rather than referral-before-delivery.[7][29] The high PPH rate (20.6%) across HDP categories is likely multifactorial: uterine atony following $MgSO_4$ (which reduces uterine contractility), thrombocytopaenia in HELLP, placental abruption, and the high prevalence of anaemia in the cohort predisposing to haemorrhagic decompensation at lower blood loss thresholds.[14][20]

The radar chart analysis (Figure 6) provides a unique multicomplication visualisation that highlights a qualitative difference between the eclampsia and superimposed PE complication profiles: while eclampsia carries the highest AKI and HELLP rates, superimposed PE demonstrates the highest placental abruption rates—consistent with the established greater chronicity and vasculopathy in chronic hypertension-complicated pregnancies.[6][20][23] This distinction has therapeutic implications: superimposed PE patients may benefit from earlier antiaggregant (low-dose aspirin) prophylaxis if identified in subsequent pregnancies, and require particularly vigilant monitoring for abruption.[2][12]

8. Conclusion

This retrospective study from RDJMMCH, Muzaffarpur, documents an HDP incidence of 6.89% of institutional deliveries with a clinically and statistically significant severity gradient—from mild gestational hypertension through to eclampsia—in terms of maternal complications, foetal compromise, and perinatal mortality. Eclampsia, present in 12.5% of HDP cases, was responsible for 66.7% of all maternal deaths and 30.8% of all perinatal deaths in the cohort. Unregistered ANC, adolescent age, nulliparity, and rural residence emerged as the predominant vulnerability markers clustering in the most severe HDP presentations. The study findings provide institution-specific, regionally grounded evidence to support: (i) strengthening of pre-referral $MgSO_4$ administration protocols at PHCs and CHCs in the RDJMMCH catchment area; (ii) targeted ANC outreach in high-risk north Bihar districts (Sitamarhi, Sheohar, East and West Champaran); (iii) adolescent pregnancy prevention through school-level health education; and (iv) periodic microbiological and clinical audit of HDP management at RDJMMCH to benchmark outcomes against national standards.

9. Limitations of the Study

(i) The retrospective design is susceptible to information bias from incomplete or inconsistently recorded case records. Although cases with >20% missing data were excluded, some degree of data incompleteness in the remaining records cannot be excluded. (ii) The study does not capture HDP patients who delivered at peripheral facilities without tertiary referral; thus, mild HDP cases are likely underrepresented, and the true community prevalence of HDP in the catchment area cannot be derived from these data. (iii) 24-hour urine protein quantification was not uniformly available; dipstick proteinuria was the primary diagnostic tool for a subset of patients, which may have led to misclassification between non-severe and severe pre-eclampsia. (iv) Severity of anaemia and its interaction with HDP complications was documented but not subjected to multivariable regression analysis due to sample size constraints—this warrants a dedicated prospective study. (v) Long-term maternal outcomes (renal function, BP, neurodevelopmental outcomes of children) were not assessed within the study period. (vi) Socioeconomic quantification was based on occupational category rather than validated income scales, limiting precise socioeconomic stratification.

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