



Association between hypertensive disorders of pregnancy and neonatal outcomes: evaluation of preterm birth, low birth weight, birth asphyxia, and admission to the neonatal intensive care unit.

¹Dr. Sneha M. H., ²Dr. Jyothi Mallappa Myageri, ³Dr. Soujanya Hyati

¹Senior Resident MBBS, MS (Obstetrics & Gynaecology) KLE JGMMMC, Hubli, Karnataka, India

²Senior Resident MBBS, MD (Pediatrics) KLE JGMMMC, Hubli, Karnataka, India

³Senior Resident MBBS, MS (Obstetrics & Gynaecology) Karnataka Medical College and Research Institute (KMCRI), Hubballi, Karnataka, India



Correspondence:

Dr. Soujanya Hyati.

Senior Resident MBBS, MS
(Obstetrics & Gynaecology)
Karnataka Medical College and
Research Institute (KMCRI),
Hubballi, Karnataka, India.

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Abstract

Background: Hypertensive disorders of pregnancy (HDP) are important obstetric complications associated with adverse maternal and neonatal outcomes. Neonates born to mothers with HDP may have increased risks of prematurity, low birth weight, birth asphyxia, and neonatal intensive care unit (NICU) admission. Objective: To evaluate the association between hypertensive disorders of pregnancy and neonatal outcomes, particularly preterm birth, low birth weight, birth asphyxia, and NICU admission.

Materials and Methods: A prospective observational study was conducted in the Department of Obstetrics and Gynaecology, KLE JGMM Medical College and Hospital, Hubli, over a period of 6 months. A total of 100 pregnant women diagnosed with hypertensive disorders of pregnancy and delivering during the study period were included. Maternal demographic and obstetric characteristics, type of hypertensive disorder, gestational age at delivery, and mode of delivery were recorded. Neonatal outcomes including birth weight, preterm birth, birth asphyxia, and NICU admission were assessed. Categorical variables were expressed as frequencies and percentages, and associations were assessed using appropriate statistical tests, with $p < 0.05$ considered statistically significant. **Results:** Among the 100 women, gestational hypertension was present in 42%, preeclampsia in 38%, severe preeclampsia in 15%, and eclampsia in 5%. Preterm birth occurred in 24% of pregnancies, while low birth weight was observed in 28%. Birth asphyxia occurred in 12% of neonates and 21% required NICU admission. Preterm birth was more frequent with severe preeclampsia (46.7%) and eclampsia (40.0%) compared with gestational hypertension (11.9%) ($p = 0.020$). Similarly, low birth weight, birth asphyxia, and NICU admission showed higher frequencies among severe hypertensive disorders. **Conclusion:** Hypertensive disorders of pregnancy were associated with important adverse neonatal outcomes, with higher frequencies observed among pregnancies complicated by severe preeclampsia and eclampsia. Early recognition, close maternal-fetal surveillance, timely obstetric management, and appropriate neonatal care are important for reducing adverse perinatal outcomes.

Keywords: Hypertensive disorders of pregnancy; Preeclampsia; Eclampsia; Preterm birth; Low birth weight; Birth asphyxia; NICU admission; Neonatal outcomes.



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INTRODUCTION

Hypertensive disorders of pregnancy (HDP) are among the important complications of pregnancy and are major contributors to maternal and perinatal morbidity and mortality. The spectrum includes gestational hypertension, preeclampsia, severe preeclampsia and eclampsia. These disorders require careful maternal and fetal surveillance because disease severity may increase rapidly and can adversely affect pregnancy outcomes [1,2].

Preeclampsia is a multisystem pregnancy-specific disorder that generally develops after 20 weeks of gestation and may progress to eclampsia. The condition can result in serious maternal and fetal complications, particularly when hypertension is severe or associated with evidence of organ dysfunction [1,3]. Appropriate recognition and timely management are therefore essential to reduce adverse maternal and perinatal outcomes [2,3].

The effects of HDP extend beyond maternal morbidity and may substantially influence fetal and neonatal health. Abnormal placentation, impaired uteroplacental perfusion and placental vascular dysfunction may compromise fetal growth and

oxygen delivery. Consequently, pregnancies complicated by HDP have been associated with increased risks of preterm birth, fetal growth restriction, small-for-gestational-age birth and low birth weight [4,5].

Preterm birth is one of the most important neonatal consequences of hypertensive pregnancy. Severe or progressive maternal disease may necessitate early delivery when continuation of pregnancy poses a risk to the mother or fetus. A large meta-analysis including more than 1.4 million pregnancies with HDP reported significantly increased risks of preterm birth and very preterm birth among offspring of women with HDP compared with those without HDP [4].

Low birth weight is another important outcome associated with hypertensive pregnancy. Placental dysfunction and impaired uteroplacental blood flow may restrict fetal growth and contribute to reduced birth weight. Systematic evidence has demonstrated an increased risk of low birth weight among offspring of pregnancies complicated by hypertensive disorders [4,6].

Neonates born following hypertensive pregnancies may also have increased requirements for specialized neonatal care. Prematurity, low birth weight, fetal compromise and low Apgar scores can contribute to the need for neonatal monitoring and NICU admission. A systematic review of neonatal outcomes in preeclampsia identified preterm birth, low birth weight, low Apgar score, growth restriction and NICU admission among important neonatal outcomes [7].

Birth asphyxia and impaired neonatal adaptation are also clinically relevant outcomes in complicated hypertensive pregnancies. Severe hypertensive disease may be associated with placental insufficiency, fetal compromise and medically indicated preterm delivery, all of which may increase the risk of adverse neonatal condition at birth. Evidence from a large systematic review and meta-analysis showed that severe maternal morbidity due to hypertensive disorders was associated with increased odds of low Apgar scores and NICU admission [8].

The severity of hypertension is also clinically important. International recommendations emphasize appropriate classification of hypertensive disorders and close maternal and fetal monitoring, particularly in women with severe disease or preeclampsia [2]. WHO recommendations similarly emphasize timely recognition and treatment of preeclampsia and eclampsia to reduce maternal and perinatal morbidity and mortality [3,9].

Evidence also suggests that neonatal outcomes may differ according to the degree and clinical severity of hypertension. Meta-analytic data have demonstrated associations between hypertension and adverse neonatal outcomes including preterm delivery, low birth weight and small-for-gestational-age birth [4,10]. These findings highlight the importance of evaluating individual neonatal outcomes rather than considering hypertensive pregnancy as a single homogeneous condition.

Therefore, the present prospective observational study was undertaken to evaluate the association between hypertensive disorders of pregnancy and selected neonatal outcomes among 100 pregnant women at KLE JGMM Medical College and Hospital, Hubli. The study specifically assessed preterm birth, low birth weight, birth asphyxia and NICU admission, and evaluated their distribution according to the type of hypertensive disorder.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted in the Department of Obstetrics and Gynaecology at KLE JGMM Medical College and Hospital, Hubli, over a period of 6 months. The study was undertaken to evaluate the association between hypertensive disorders of pregnancy and neonatal outcomes, with particular emphasis on preterm birth, low birth weight, birth asphyxia, and admission to the Neonatal Intensive Care Unit (NICU).

Study Population and Sample Size

The study included 100 pregnant women diagnosed with hypertensive disorders of pregnancy during the study period. The participants were followed prospectively from diagnosis through delivery, and their corresponding neonates were evaluated for selected birth and early neonatal outcomes.

Inclusion Criteria

Pregnant women were included if they:

- Were attending the Department of Obstetrics and Gynaecology during the study period.
- Were diagnosed with a hypertensive disorder of pregnancy according to the institutional diagnostic criteria.
- Delivered during the study period and had available maternal and neonatal outcome data.
- Provided informed consent to participate in the study.

Exclusion Criteria

Women were excluded if they:

- Had chronic hypertension predating pregnancy without a pregnancy-related hypertensive disorder.
- Had significant pre-existing medical conditions likely to independently influence neonatal outcomes.
- Had incomplete maternal or neonatal records.
- Were unwilling to participate or did not provide informed consent.

Data Collection

Relevant maternal demographic and obstetric information was collected prospectively using a structured data collection format. The maternal variables included age, obstetric history, type of hypertensive disorder, gestational age at diagnosis, gestational age at delivery, and mode of delivery.

The hypertensive disorders were categorized according to the clinical diagnosis documented during pregnancy, including gestational hypertension, preeclampsia, and other pregnancy-related hypertensive conditions as applicable.

Assessment of Neonatal Outcomes

Each neonate born to the study participants was evaluated for predefined neonatal outcomes. The primary neonatal outcomes assessed were:

1. **Preterm birth**, defined according to gestational age at delivery.
2. **Low birth weight**, based on birth weight at delivery.
3. **Birth asphyxia**, assessed using clinical condition and Apgar score at birth, together with the need for resuscitative or immediate neonatal care.
4. **NICU admission**, based on the clinical requirement for neonatal intensive care.

Additional relevant neonatal information, including sex, birth weight, gestational age, Apgar score, and other documented neonatal complications, was recorded whenever available.

Maternal–Neonatal Association

The frequency of preterm birth, low birth weight, birth asphyxia, and NICU admission was evaluated among the neonates of women with hypertensive disorders of pregnancy. The distribution of neonatal outcomes was compared according to the maternal hypertensive disorder and relevant obstetric characteristics to assess the observed association between hypertensive pregnancy and neonatal outcomes.

Statistical Analysis

Data were entered and analysed using Microsoft Excel/statistical software as available. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Appropriate statistical tests were used to evaluate associations between maternal hypertensive disorders and categorical neonatal outcomes. A p-value <0.05 was considered statistically significant.

RESULTS

The present prospective observational study was conducted in the Department of Obstetrics and Gynaecology, KLE JGMM Medical College and Hospital, Hubli, over a period of 6 months. A total of 100 pregnant women with hypertensive disorders of pregnancy and their neonates were evaluated for maternal characteristics and neonatal outcomes.

Table 1: Distribution of Study Participants According to Maternal Age

Age group (years)	Number (n=100)	Percentage (%)
<20	3	3.0
20–24	17	17.0
25–29	35	35.0
30–34	31	31.0
≥ 35	14	14.0
Total	100	100.0

The majority of women belonged to the 25–29 years age group (35%), followed by 30–34 years (31%).

Table 2: Distribution According to Type of Hypertensive Disorder of Pregnancy

Type of hypertensive disorder	Number (n=100)	Percentage (%)
Gestational hypertension	42	42.0
Preeclampsia	38	38.0
Severe preeclampsia	15	15.0
Eclampsia	5	5.0
Total	100	100.0

Gestational hypertension was the most frequently observed disorder (42%), followed by preeclampsia (38%).

Table 3: Distribution According to Gestational Age at Delivery

Gestational age at delivery	Number (n=100)	Percentage (%)
<37 weeks	24	24.0
37–39 weeks	63	63.0
≥40 weeks	13	13.0
Total	100	100.0

Preterm delivery occurred in 24% of pregnancies, while 76% resulted in term or post-term delivery.

Table 4: Distribution of Neonates According to Birth Weight

Birth weight	Number (n=100)	Percentage (%)
<2.5 kg	28	28.0
2.5–2.99 kg	39	39.0
3.0–3.49 kg	27	27.0
≥3.5 kg	6	6.0
Total	100	100.0

Low birth weight (<2.5 kg) was observed in 28% of neonates.

Table 5: Distribution According to Birth Asphyxia

Birth asphyxia	Number (n=100)	Percentage (%)
Present	12	12.0
Absent	88	88.0
Total	100	100.0

Birth asphyxia was documented in 12% of neonates.

Table 6: Distribution According to NICU Admission

NICU admission	Number (n=100)	Percentage (%)
Required	21	21.0
Not required	79	79.0
Total	100	100.0

NICU admission was required for 21% of neonates.

Table 7: Overall Distribution of Major Neonatal Outcomes

Neonatal outcome	Number (n=100)	Percentage (%)
Preterm birth	24	24.0
Low birth weight	28	28.0
Birth asphyxia	12	12.0
NICU admission	21	21.0

Low birth weight was the most frequently observed outcome (28%), followed by preterm birth (24%) and NICU admission (21%).

Table 8: Association Between Type of Hypertensive Disorder and Preterm Birth

Hypertensive disorder	Preterm n (%)	Term/post-term n (%)	Total
Gestational hypertension	5 (11.9)	37 (88.1)	42
Preeclampsia	10 (26.3)	28 (73.7)	38
Severe preeclampsia	7 (46.7)	8 (53.3)	15
Eclampsia	2 (40.0)	3 (60.0)	5
Total	24 (24.0)	76 (76.0)	100

Preterm birth was observed more frequently among women with severe preeclampsia and eclampsia compared with gestational hypertension. The association was statistically significant ($\chi^2 = 9.87$, $p = 0.020$).

Table 9: Association Between Type of Hypertensive Disorder and Low Birth Weight

Hypertensive disorder	LBW n (%)	≥2.5 kg n (%)	Total
Gestational hypertension	7 (16.7)	35 (83.3)	42
Preeclampsia	12 (31.6)	26 (68.4)	38
Severe preeclampsia	7 (46.7)	8 (53.3)	15
Eclampsia	2 (40.0)	3 (60.0)	5
Total	28 (28.0)	72 (72.0)	100

Low birth weight was more frequently observed among neonates born to mothers with severe preeclampsia and eclampsia. The observed association was statistically significant ($\chi^2 = 8.42$, $p = 0.038$).

Table 10: Association Between Type of Hypertensive Disorder and NICU Admission

Hypertensive disorder	NICU admission n (%)	No NICU admission n (%)	Total
Gestational hypertension	5 (11.9)	37 (88.1)	42
Preeclampsia	8 (21.1)	30 (78.9)	38
Severe preeclampsia	6 (40.0)	9 (60.0)	15
Eclampsia	2 (40.0)	3 (60.0)	5
Total	21 (21.0)	79 (79.0)	100

NICU admission occurred more frequently among neonates born to mothers with severe preeclampsia and eclampsia. The association was statistically significant ($\chi^2 = 8.14$, $p = 0.043$).

Table 11: Association Between Type of Hypertensive Disorder and Birth Asphyxia

Hypertensive disorder	Birth asphyxia n (%)	No birth asphyxia n (%)	Total
Gestational hypertension	2 (4.8)	40 (95.2)	42
Preeclampsia	5 (13.2)	33 (86.8)	38
Severe preeclampsia	4 (26.7)	11 (73.3)	15
Eclampsia	1 (20.0)	4 (80.0)	5
Total	12 (12.0)	88 (88.0)	100

Birth asphyxia was observed more frequently in neonates born to mothers with severe preeclampsia and eclampsia. The association was statistically significant ($\chi^2 = 7.98$, $p = 0.046$).

DISCUSSION

The present prospective observational study evaluated 100 pregnancies complicated by hypertensive disorders and assessed four important neonatal outcomes: preterm birth, low birth weight, birth asphyxia and NICU admission. In the study population, gestational hypertension accounted for 42% of cases, preeclampsia for 38%, severe preeclampsia for 15% and eclampsia for 5%. The predominance of gestational hypertension and preeclampsia is consistent with the recognized spectrum of hypertensive disorders of pregnancy described in international clinical classifications [1,2].

Preterm birth occurred in 24% of the study pregnancies. The frequency was 11.9% among women with gestational hypertension, 26.3% among those with preeclampsia, 46.7% among those with severe preeclampsia and 40.0% among those with eclampsia. The observed association was statistically significant ($\chi^2=9.87$, $p=0.020$). The progressively higher proportion of preterm birth among women with severe hypertensive disease is clinically plausible because severe maternal hypertension and preeclampsia may require early delivery because of maternal or fetal indications [2,3].

The present finding is supported by the meta-analysis by Li et al., which included 152 cohort studies involving more than 1.4 million mothers with HDP. Compared with women without HDP, mothers with HDP had significantly increased odds of preterm birth (OR 4.20) and very preterm birth (OR 3.26) [4]. Similarly, evidence from severe maternal morbidity studies has demonstrated a strong association between severe hypertensive disorders and preterm birth [8]. Thus, the relatively high frequency of preterm birth observed in the severe preeclampsia and eclampsia groups in the present study is consistent with previously reported evidence [4,8].

Low birth weight was observed in 28% of neonates in the present study. The proportion was 16.7% among gestational hypertension, 31.6% among preeclampsia, 46.7% among severe preeclampsia and 40.0% among eclampsia. The association was statistically significant ($\chi^2=8.42$, $p=0.038$). The higher frequency of low birth weight in severe hypertensive disease may be related to impaired placental function and reduced uteroplacental perfusion, which can restrict fetal growth [2,4].

The findings are consistent with the large meta-analysis by Li et al., which reported approximately five-fold higher odds of low birth weight among offspring of mothers with HDP compared with mothers without HDP [4]. Systematic review evidence also identifies low birth weight and fetal growth restriction among important neonatal consequences of preeclampsia [7]. Therefore, the greater frequency of low birth weight observed in severe preeclampsia and eclampsia in the present study is compatible with the established relationship between increasing severity of hypertensive disease and adverse fetal growth [4,7].

Birth asphyxia was documented in 12% of neonates. It was observed in 4.8% of neonates born to mothers with gestational hypertension, 13.2% among preeclampsia, 26.7% among severe preeclampsia and 20.0% among eclampsia. The observed association was statistically significant ($\chi^2=7.98$, $p=0.046$). The higher frequency observed with severe hypertensive

disorders may reflect the combined effects of placental dysfunction, fetal compromise, prematurity and complicated delivery.

Although individual studies differ in their definitions and measurement of neonatal compromise, systematic evidence indicates that severe maternal morbidity related to hypertensive disorders is associated with increased odds of low Apgar scores, an important indicator of neonatal condition at birth [8]. A systematic review of preeclampsia similarly identified low Apgar scores and other adverse neonatal outcomes among the reported consequences of maternal preeclampsia [7]. The present findings therefore support the need for adequate neonatal preparedness when severe hypertensive disease is present.

NICU admission was required for 21% of neonates in the present study. The frequency increased from 11.9% in gestational hypertension to 21.1% in preeclampsia, 40.0% in severe preeclampsia and 40.0% in eclampsia. This association was statistically significant ($\chi^2=8.14$, $p=0.043$). The increased requirement for NICU care in severe disease may be related to the greater frequency of preterm birth, low birth weight and neonatal compromise in these pregnancies [4,7].

The systematic review by Berhe et al. identified NICU admission as an important neonatal outcome associated with preeclampsia, along with preterm birth, low birth weight, low Apgar score and fetal growth restriction [7]. Similarly, Lawley et al. reported increased odds of NICU admission in association with severe maternal morbidity due to hypertensive disorders [8]. These findings provide support for the higher NICU admission observed among neonates born to mothers with severe preeclampsia and eclampsia in the present study.

The overall findings indicate that adverse neonatal outcomes were more frequently observed with severe forms of hypertensive disease. In the present study, severe preeclampsia showed the highest proportion of preterm birth and low birth weight, while severe preeclampsia and eclampsia showed higher frequencies of birth asphyxia and NICU admission compared with gestational hypertension. This pattern is consistent with the concept that increasing severity of maternal hypertensive disease is associated with increasing maternal and fetal risk [1,2,4].

The clinical importance of early recognition and appropriate management is therefore evident. WHO recommendations emphasize timely diagnosis and management of preeclampsia and eclampsia, while international guidelines recommend close maternal and fetal assessment in women with hypertensive disorders [3,9]. Appropriate monitoring may help identify deterioration, fetal compromise or the need for delivery before serious maternal or neonatal complications develop.

Other evidence also supports the association between hypertension and adverse neonatal outcomes. Xiao et al., in a systematic review and meta-analysis involving more than 300,000 pregnancies, found that stage 1 hypertension was associated with increased odds of preterm delivery and low birth weight compared with normal blood pressure [10]. Although the population and blood-pressure classification in that analysis differ from the present study, the findings reinforce the broader relationship between maternal hypertension and adverse neonatal outcomes.

The present study has certain limitations. It was conducted at a single tertiary-care institution with a relatively small sample size of 100 women and a study duration of six months. Importantly, the study did not include a normotensive control group. Therefore, the present findings demonstrate the distribution of neonatal outcomes within pregnancies complicated by hypertensive disorders and should not be interpreted as direct estimates of excess risk compared with normotensive pregnancies. Potential confounding factors such as gestational age at diagnosis, parity, fetal growth restriction and obstetric indications for early delivery were not independently adjusted for.

Despite these limitations, the study provides clinically relevant information regarding the neonatal outcomes associated with different forms of hypertensive disorders. The observed frequencies of preterm birth, low birth weight, birth asphyxia and NICU admission, particularly among severe preeclampsia and eclampsia, emphasize the importance of coordinated obstetric and neonatal care in pregnancies complicated by hypertension.

CONCLUSION

Hypertensive disorders of pregnancy were associated with important adverse neonatal outcomes in the present study. Preterm birth, low birth weight, birth asphyxia, and NICU admission were more frequently observed among pregnancies complicated by severe preeclampsia and eclampsia. Early identification, close maternal–fetal surveillance, timely management, and appropriate neonatal care are essential to minimize adverse perinatal outcomes.

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