

Study of Impact of Hypertensive Disorders and Elevated Homocysteine on Maternal and Fetal Outcomes

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ABSTRACT

Introduction: Hypertensive disorders of pregnancy, including severe preeclampsia and eclampsia, are major contributors to maternal and perinatal morbidity and mortality. Elevated homocysteine has been implicated as a biochemical marker of adverse outcomes. **Aim:** To evaluate maternal and fetal outcomes in women with pregnancy complications compared to normotensive controls. **Methods:** A comparative study was conducted among 50 pregnant women with hypertensive disorders and 50 normotensive pregnant controls. Demographic, clinical, and laboratory parameters were assessed. Hemoglobin and serum homocysteine levels were measured, and maternal and fetal outcomes were documented. Statistical analysis was performed using the Student's t-test and chi-square test, with $p < 0.05$ considered statistically significant. **Results:** Women in the hypertensive disorder group had significantly higher rates of preterm delivery (58% vs. 2%), lower mean fetal birth weight (1.64 ± 0.94 kg vs. 2.87 ± 0.89 kg), and adverse fetal outcomes (82% vs. 2%) compared with normotensive controls. Serum homocysteine levels were significantly higher in the case group, with 12% having severely elevated levels compared with none in the control group ($p < 0.0001$). Hemoglobin levels did not differ significantly between the groups. **Conclusion:** Hypertensive disorders of pregnancy and elevated homocysteine levels were significantly associated with adverse maternal and fetal outcomes in the present study. Further studies with larger sample sizes are required to determine the clinical significance of homocysteine assessment in high-risk pregnancies.

Keywords: Hypertensive disorders of pregnancy; Severe preeclampsia; Eclampsia; Homocysteine; Fetal outcomes; Preterm birth.

INTRODUCTION

Hypertensive disorders of pregnancy, including severe preeclampsia and eclampsia, are among the leading causes of maternal and perinatal morbidity and mortality worldwide. They complicate approximately 2–8% of pregnancies and are associated with serious risks such as preterm birth, intrauterine growth restriction (IUGR), placental abruption, and intrauterine death (IUD) (1). These conditions not only endanger maternal health but also profoundly affect neonatal survival and long-term development. Recent systematic reviews have demonstrated that preeclampsia is strongly predictive of adverse maternal and perinatal outcomes, with increased

risks of preterm delivery, low birth weight, and perinatal death compared to normotensive pregnancies (2). Evidence from low- and middle-income countries further shows that delayed diagnosis and inadequate antenatal care amplify the burden of eclampsia and related complications, making it a critical public health challenge (3). Biochemical markers such as homocysteine have also been implicated in adverse pregnancy outcomes. Elevated homocysteine levels are linked to endothelial dysfunction, placental insufficiency, and poor fetal growth, reinforcing the need for laboratory monitoring in high-risk pregnancies (4). Although hypertensive disorders of pregnancy and

maternal hyperhomocysteinemia have been studied individually, their relationship with maternal and fetal outcomes remains clinically relevant, particularly in high-risk pregnancies. Comparative assessment of women with hypertensive pregnancy disorders and normotensive controls may help to identify differences in clinical characteristics, homocysteine levels, and pregnancy outcomes. Therefore, the present study was undertaken to compare demographic, clinical, and laboratory parameters, with particular emphasis on serum homocysteine levels, and to evaluate maternal and fetal outcomes between the two groups.

Aim & Objectives

Aim

- To evaluate the impact of hypertensive disorders and elevated serum homocysteine levels on maternal and fetal outcomes.

Objectives

1. To compare the demographic characteristics of women with hypertensive disorders of pregnancy and normotensive controls.
2. To compare the clinical parameters between the case and control groups.
3. To compare hemoglobin and serum homocysteine levels between the case and control groups.
4. To compare maternal and fetal outcomes between the case and control groups.

MATERIALS AND METHODS

Study Population:

The study included 100 pregnant women, comprising 50 women with hypertensive disorders of pregnancy as the case group and 50 normotensive pregnant women as the control group.

The case group included women diagnosed with hypertensive disorders of pregnancy, including severe preeclampsia and eclampsia. Associated pregnancy complications such as placental abruption, intrauterine growth restriction (IUGR), intrauterine fetal death (IUFD), and abortion were recorded when present.

The control group consisted of 50 normotensive pregnant women without hypertensive disorders or other major medical complications.

- The **control group** consisted of 50 normotensive women without any medical complications.

Inclusion Criteria

Case Group

Pregnant women were included in the case group if they:

- Were diagnosed with a hypertensive disorder of pregnancy, including severe preeclampsia or

eclampsia, according to the predefined clinical criteria.

- Were willing to participate in the study and provided informed consent.
- Had sufficient clinical, laboratory, and pregnancy outcome information available for analysis.

Control Group

Pregnant women were included in the control group if they:

- Were normotensive during pregnancy.
- Had no history or evidence of hypertensive disorders of pregnancy.
- Had no major medical complications that could significantly affect pregnancy outcomes.
- Were willing to participate in the study and provided informed consent.
- Had sufficient clinical, laboratory, and pregnancy outcome information available for analysis.

Exclusion Criteria: Women with diabetes mellitus, chronic hypertension, pre-existing renal disorders, liver disorders, or immunovascularitis were excluded to eliminate confounding factors.

Procedure

After application of the predefined eligibility criteria, eligible participants were enrolled into the study. Relevant demographic, clinical, laboratory, and pregnancy outcome data were collected using a structured study proforma.

1. **Demographic assessment:** Maternal age, area of residence, education level, and body mass index (BMI) were recorded.
2. **Clinical assessment:** Gestational age at delivery, parity, booking status, blood pressure-related clinical diagnosis, and relevant pregnancy complications were documented.
3. **Laboratory assessment:** Hemoglobin concentration and serum homocysteine levels were measured and recorded.
4. **Pregnancy and fetal outcomes:** Relevant maternal and fetal outcomes, including gestational age at delivery, fetal birth weight, intrauterine fetal death, abortion, and other documented adverse outcomes, were recorded.

Statistical Analysis:

All collected data were tabulated and analyzed using appropriate statistical tests. Continuous variables were compared using the Student's t-test, while categorical variables were analyzed using the chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 100 pregnant women were included in the study, comprising 50 women with hypertensive disorders of pregnancy in the case group and 50 normotensive pregnant women in the control group. Demographic, clinical, laboratory, and pregnancy outcome parameters were compared between the two groups.

Table 1: Demographic Variables

Sr No	Variables	Case Group 50 (50 %)	Control Group 50 (50 %)	t value/ chi square value	P value
1	Maternal age	24.62 ± 3.92	23.54 ± 3.11	1.54	0.131 (NS)
2	Area Rural Urban	34 (68 %) 16 (32 %)	32 (64 %) 18 (36 %)	0.178	0.673 (NS)
3	Religion Hindu Muslim	36 (72 %) 14 (28 %)	47 (94 %) 3 (6 %)	8.58	0.003 (S)
4	Education Illiterate Higher education Graduation & above	2 (4 %) 35 (70 %) 13 (26 %)	0 (0 %) 39 (78 %) 11 (22 %)	2.38	0.304 (NS)
5	BMI	24.98 ± 3.04	25.54 ± 2.56	2.12	0.174 (NS)

The average maternal age was slightly higher in the case group (24.62 years) compared to the control group (23.54 years), but this difference was not statistically significant. The distribution of participants by area (rural vs. urban) was similar between groups, showing no meaningful difference. Religion, however, showed a statistically significant variation: 72% of the case group were Hindu and 28% Muslim, while in the control group 94% were Hindu and only 6% Muslim. Education levels and BMI did not differ significantly between the two groups, indicating comparable backgrounds in these aspects.

Table 2: Clinical Variables

Sr No	Variables	Case Group 50 (50 %)	Control Group 50 (50 %)	Chi square/t value	Total 60 (100 %)
1	Gestational age Preterm Term	29 (58 %) 21 (42 %)	1 (2 %) 49 (98 %)	37.27	<0.0001 (S)
2	Parity Primigravida Multigravida	25 (50 %) 25 (50 %)	24 (48 %) 26 (52 %)	0.012	0.841 (NS)
3	Booking status Booked Unbooked	25 (50 %) 25 (50 %)	24 (48 %) 26 (52 %)	1.46	0.227 (NS)
4	Fetal birth weight	1.64±0.94	2.87±0.89	5.34	0.001 (S)

Gestational age revealed a striking difference: 58% of women in the case group delivered preterm compared to only 2% in the control group, a highly significant finding. Parity (primigravida vs. multigravida) and booking status (booked vs. unbooked) were nearly identical between groups, showing no statistical difference. Fetal birth weight was significantly lower in the case group (mean 1.64 kg) compared to the control group (mean 2.87 kg), highlighting the adverse impact of pregnancy complications on neonatal outcomes.

Table 3: Laboratory Variables

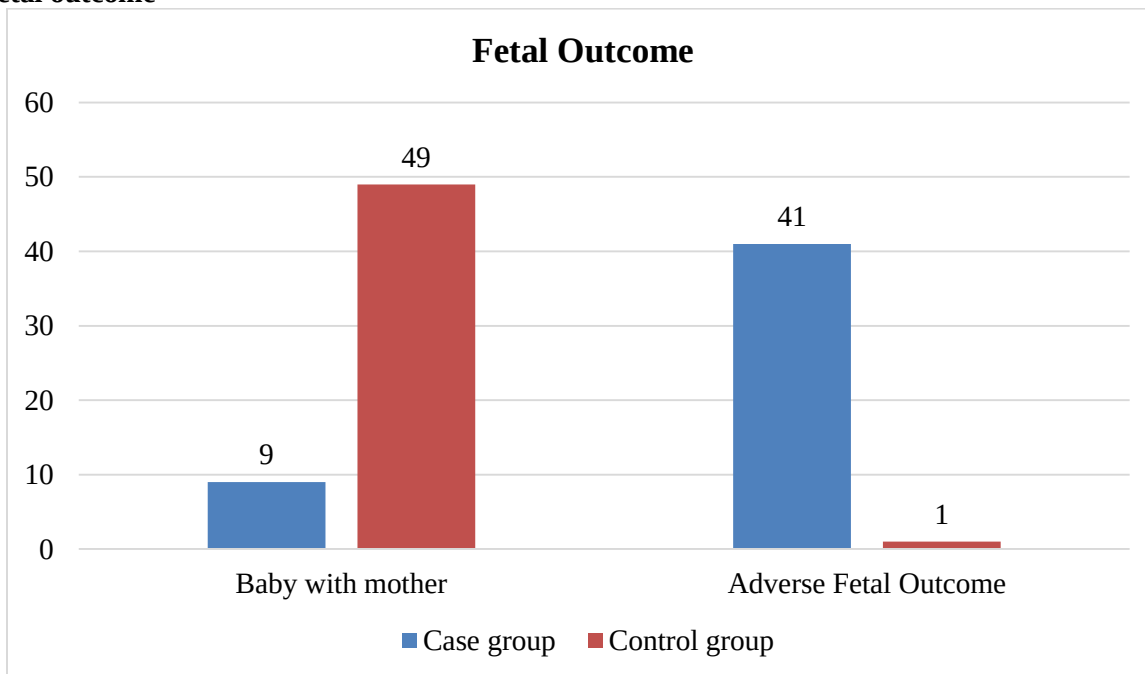
Sr No		Case Group 50 (50 %)	Control Group 50 (50 %)	t value/ chi square value	P value
1	Hb%	11.51±1.94	11.72±2.32	2.02	0.261 (NS)
2	Homocysteine level	18 (36 %)	42 (84 %)	25.01	<0.0001 (S)
	Normal (5-15 mmol)	26	8 (16 %)		
	Mildly Raised (16-50 mmol)	6 (12 %)	0 (0 %)		
	Severely Raised (>50 mmol)				

Hemoglobin levels were comparable between groups, with no significant difference. However, homocysteine levels showed a marked disparity. In the case group, 36% had normal levels, 52% had mildly raised levels, and 12% had severely raised levels. In contrast, 84% of the control group had normal levels, and none had severely raised levels. This difference was highly significant, suggesting a strong association between elevated homocysteine and pregnancy complications.

Table 4: fetal outcome

Sr No	Variable	Case Group 50 (50 %)	Control Group 50 (50 %)	chi square value	P value
1	Baby with mother	9 (18 %)	49 (98 %)	67.5	<0.0001 (S)
2	Adverse Fetal Outcome	41 (82 %)	1 (2 %)		

Fetal outcomes were dramatically different between the two groups. In the case group, only 18% of babies remained with their mothers, while 82% experienced adverse outcomes such as intrauterine death, abortion, or complications. Conversely, in the control group, 98% of babies were with their mothers, and only 2% had adverse outcomes. This difference was highly significant, underscoring the severe impact of maternal complications on fetal survival.

Graph 1: fetal outcome

DISCUSSION

The present study highlights the significant impact of hypertensive disorders of pregnancy and elevated homocysteine levels on maternal and fetal outcomes. Our findings demonstrated that women with pregnancy

complications had markedly higher rates of preterm delivery, lower fetal birth weight, and adverse neonatal outcomes compared to normotensive controls. Elevated homocysteine levels were strongly associated with these complications, reinforcing its role as a biochemical

marker of poor prognosis. These results are consistent with earlier evidence that hypertensive disorders complicate 2–8% of pregnancies and are major contributors to maternal and perinatal morbidity (1–3). Elevated homocysteine has been implicated in endothelial dysfunction and poor fetal growth, supporting its role in adverse pregnancy outcomes (4). More recent studies have expanded on this association. Abu-Zaid et al. (2026) conducted a systematic review and meta-analysis and confirmed that maternal hyperhomocysteinemia is significantly linked to preeclampsia, preterm birth, and stillbirth (5). Similarly, Nandi and Mondal (2026) demonstrated that maternal serum homocysteine progressively rises across the spectrum of hypertensive disorders, from normotension to eclampsia, making it a severity-linked biomarker (6). The adverse fetal outcomes observed in our study, with 82% of complicated pregnancies resulting in intrauterine death, abortion, or neonatal complications, are in line with global meta-analyses. A large systematic review published in *Lancet eClinicalMedicine* (2024) found that preeclampsia significantly increases the risk of intrauterine growth restriction, preterm birth, and perinatal death (7). Similarly, a Nigerian meta-analysis (2024) reported high rates of perinatal mortality and morbidity among women with eclampsia, underscoring the global burden of these disorders (8). The mechanisms underlying these findings are multifactorial. Elevated homocysteine contributes to endothelial dysfunction by reducing nitric oxide bioavailability, impairing vasodilation, and promoting vascular injury. This leads to uteroplacental insufficiency, a hallmark of preeclampsia and intrauterine growth restriction. Homocysteine also induces oxidative stress and inflammation, generating reactive oxygen species that damage placental tissue and exacerbate syncytiotrophoblast stress. Furthermore, hyperhomocysteinemia creates a prothrombotic state, increasing the risk of placental thrombosis and abruption, which explains the high incidence of intrauterine death and abortion observed in the case group. Normally, homocysteine levels decline during pregnancy due to increased folate and vitamin B metabolism, but in complicated pregnancies this decline fails, reflecting impaired maternal adaptation. Present study and recent global evidence confirm that hypertensive disorders of pregnancy and elevated homocysteine levels are major predictors of poor maternal and fetal outcomes. The mechanisms involve endothelial dysfunction, oxidative stress, and placental insufficiency. These findings emphasize the importance of routine homocysteine monitoring and early intervention in high-risk pregnancies to improve neonatal survival.

Strengths of the Study

The study included a comparative group of women with hypertensive disorders of pregnancy and normotensive pregnant controls, allowing direct comparison of demographic, clinical, laboratory, and fetal outcome parameters. The assessment of serum homocysteine alongside pregnancy outcomes provides additional insight into the potential association between hyperhomocysteinemia and adverse pregnancy outcomes. The study also included clinically relevant outcomes such as preterm delivery and fetal birth weight.

Limitations of the Study

The study has several limitations. The sample size was relatively small, with 50 participants in each group, which may limit the generalizability of the findings. The observational design does not allow causal relationships to be established between hypertensive disorders, elevated homocysteine levels, and adverse pregnancy outcomes. Potential confounding factors, including nutritional status, folate and vitamin B12 levels, and other maternal factors, were not comprehensively assessed. In addition, the study was conducted in a single-center setting, which may limit the applicability of the findings to other populations. Further, maternal outcomes were not comprehensively documented in the available dataset.

Future Scope

Future studies should include larger, multicenter populations with prospective follow-up to validate the association between hypertensive disorders of pregnancy, serum homocysteine levels, and maternal and fetal outcomes. Assessment of related nutritional and biochemical factors, including folate and vitamin B12 status, may help clarify the mechanisms underlying elevated homocysteine levels. Further research is also needed to determine whether homocysteine measurement can improve risk stratification and clinical management of women with high-risk pregnancies.

CONCLUSION

Hypertensive disorders of pregnancy and elevated homocysteine levels significantly worsen maternal and fetal outcomes, leading to preterm birth, low birth weight, and high rates of adverse neonatal events. These findings highlight the need for routine biochemical monitoring and timely antenatal interventions to reduce morbidity.

Declarations

Ethics Approval and Consent to Participate

The study was conducted in accordance with the ethical principles applicable to research involving human

participants. Ethical approval was obtained from the Institutional Ethics Committee of the concerned institution. Written informed consent was obtained from all participants before their inclusion in the study.

Consent for Publication

Not applicable. No individual patient-identifiable information is presented in this manuscript.

Availability of Data and Materials

The data generated and/or analyzed during the present study are available from the corresponding author on reasonable request, subject to institutional and ethical restrictions.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

All authors contributed to the conception and design of the study, data collection, analysis and interpretation of the findings, manuscript preparation, critical revision of the manuscript, and approval of the final version.

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