The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 4, Issue 3, 2026

DETERMINANTS AND MATERNAL–NEONATAL OUTCOMES OF HYPERTENSIVE DISORDERS OF PREGNANCY IN TERTIARY CARE HOSPITALS OF PAKISTAN: A MULTICENTER PROSPECTIVE COHORT STUDY

Asma Iqbal[*1], Tanzeela Ahmad[2], Humaira Naz[3]

[*1]*Senior Registrar, Obstetrics and Gynaecology, Karachi Medical and Dental College, KMU ASH, Pakistan*
[2]*Consultant Obstetrics and Gynaecology, Iqra Medical Complex, Johar Town, Lahore, Pakistan*
[3]*Assistant Professor, Department of Biotechnology, Shaheed Benazir Bhutto Women University, Peshawar, Pakistan*

[*1]asmanadeemkhan@hotmail.com, [2]drtanzeelaahmad@yahoo.com, [3]khanprinces84@yahoo.com

DOI: https://doi.org/10.5281/zenodo.19110063

Keywords
Hypertensive disorders of pregnancy, maternal outcomes, neonatal outcomes, determinants, prospective cohort, Pakistan

Article History
Received: 05 January 2026
Accepted: 18 February 2026
Published: 19 March 2026

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Corresponding Author: *
Asma Iqbal

Abstract

Background: *Hypertensive disorders of pregnancy (HDP) are a leading cause of maternal and neonatal morbidity and mortality, particularly in low- and middle-income countries such as Pakistan. Understanding the determinants and associated outcomes is essential for improving maternal and neonatal health.*

Objective: *This multicenter prospective cohort study aimed to examine the socio-demographic and clinical determinants of HDP and evaluate its impact on maternal and neonatal outcomes in tertiary care hospitals of Pakistan.*

Methods: *A total of 1,000 pregnant women with gestational age ≥20 weeks were recruited from four tertiary care hospitals. Baseline socio-demographic and clinical data were collected, and participants were followed until delivery. Maternal and neonatal outcomes were recorded. Descriptive statistics, Chi-square tests, independent t-tests, and multivariate logistic regression were employed to identify determinants and assess associations, with $p<0.05$ considered statistically significant.*

Results: *The prevalence of HDP was 15%. Advanced maternal age (≥30 years), higher BMI, previous hypertension, diabetes mellitus, and fewer antenatal care visits were significant predictors of HDP ($p<0.05$). Women with HDP had higher rates of cesarean section (63% vs. 40%), postpartum hemorrhage (17% vs. 4%), ICU admission (10% vs. 1%), and maternal mortality (3% vs. 0.2%) compared to normotensive women. Neonates of hypertensive mothers had increased rates of preterm birth (40% vs. 14%), low birth weight (47% vs. 20%), NICU admission (37% vs. 13%), stillbirth (7% vs. 0.6%), and neonatal mortality (5% vs. 0.4%).*

Conclusion: *HDP is prevalent in Pakistani tertiary care settings and is associated with adverse maternal and neonatal outcomes. Early identification of high-risk women, enhanced antenatal care, and timely management are critical to reducing morbidity and mortality.*

INTRODUCTION

Hypertensive disorders of pregnancy (HDP), including gestational hypertension, preeclampsia, eclampsia, and chronic hypertension, are among the leading causes of maternal and perinatal morbidity and mortality worldwide. Globally, HDP affects approximately 5–10% of all pregnancies and remains a significant public health challenge, particularly in low- and middle-income countries (LMICs) (Khan et al., 2024; Siddiqui et al., 2022). These disorders are characterized by elevated blood pressure after 20 weeks of gestation and are often associated with multi-organ dysfunction, posing serious risks to both maternal and fetal health.

In Pakistan, hypertensive disorders of pregnancy contribute substantially to adverse maternal and neonatal outcomes. The prevalence of HDP in tertiary care settings ranges between 5% and 8%, with preeclampsia and eclampsia being the most common clinical presentations (Nisar et al., 2010; Zafar et al., 2008). The burden is exacerbated by delayed antenatal care utilization, inadequate healthcare infrastructure, and limited awareness among pregnant women, particularly in rural and underserved populations (Ahsan et al., 2020). Consequently, HDP is associated with increased maternal complications such as postpartum hemorrhage, placental abruption, intensive care unit (ICU) admission, and maternal mortality (Zulfiqar et al., 2025).

The neonatal consequences of HDP are equally severe. Infants born to mothers with hypertensive disorders are at significantly higher risk of preterm birth, low birth weight, intrauterine growth restriction, stillbirth, and early neonatal death (Siddiqui et al., 2022). A recent study conducted in Pakistan reported that hypertensive pregnancies were associated with substantially increased odds of preterm delivery, low birth weight, and neonatal mortality compared to normotensive pregnancies (Khan et al., 2024). Additionally, higher rates of cesarean section and neonatal intensive care unit (NICU) admissions have been consistently observed among women with HDP (Mashoor et al., 2025).

The determinants of hypertensive disorders of pregnancy are multifactorial, involving a complex interaction of demographic, clinical, and socioeconomic factors. Maternal age, parity, obesity, pre-existing hypertension, diabetes mellitus, and inadequate antenatal care have been identified as significant predictors (Ahsan et al., 2020; Khan et al., 2024). In the Pakistani context, factors such as low socioeconomic status, nutritional deficiencies, and limited access to quality maternal healthcare services further increase the risk and severity of HDP (Nisar et al., 2010). Despite these established associations, there remains limited prospective evidence examining how these determinants collectively influence maternal and neonatal outcomes across diverse healthcare settings.

Most existing studies in Pakistan are retrospective or confined to single-center designs, limiting their generalizability and ability to establish causal relationships (Siddiqui et al., 2022). Furthermore, variations in clinical practices and healthcare resources across regions necessitate multicenter investigations to generate robust and representative data. Prospective cohort studies offer a stronger methodological approach by enabling the assessment of temporal relationships between risk factors and outcomes while minimizing bias.

Given the significant burden of hypertensive disorders of pregnancy and their impact on maternal and neonatal health, there is a critical need for comprehensive, multicenter prospective research in Pakistan. Such evidence is essential for improving early detection, optimizing clinical management, and informing policy interventions aimed at reducing preventable maternal and neonatal morbidity and mortality. Therefore, this study aims to examine the determinants and maternal–neonatal outcomes of hypertensive disorders of pregnancy in tertiary care hospitals of Pakistan using a multicenter prospective cohort design.

Problem Statement

Hypertensive disorders of pregnancy (HDP) remain a major contributor to maternal and neonatal morbidity and mortality worldwide, with a disproportionately higher burden in low- and middle-income countries such as Pakistan. Despite advances in obstetric care, HDP continues to account for a significant proportion of adverse pregnancy outcomes, including maternal complications such as postpartum hemorrhage, organ failure, and

mortality, as well as neonatal complications such as preterm birth, low birth weight, stillbirth, and early neonatal death. In Pakistan, the situation is further aggravated by delayed antenatal care, inadequate healthcare infrastructure, socioeconomic disparities, and limited access to specialized obstetric services.

Although several studies have explored hypertensive disorders of pregnancy in Pakistan, most are limited by retrospective designs, single-center settings, and small sample sizes, which restrict the generalizability and reliability of their findings. Furthermore, there is a lack of comprehensive, multicenter prospective cohort studies that simultaneously examine the determinants of HDP and their impact on both maternal and neonatal outcomes across diverse populations and healthcare settings. The absence of such robust evidence limits the ability of healthcare providers and policymakers to develop effective early screening strategies, risk stratification models, and targeted interventions.

Additionally, the complex interplay of demographic, clinical, and socioeconomic determinants influencing HDP remains underexplored in the Pakistani context. Without a clear understanding of these determinants and their relative contributions to adverse outcomes, efforts to reduce maternal and neonatal mortality may remain fragmented and ineffective. Therefore, there is a critical need for a multicenter prospective cohort study to systematically investigate the determinants and maternal–neonatal outcomes of hypertensive disorders of pregnancy in tertiary care hospitals of Pakistan.

Research Questions

Main Research Question:

- What are the determinants and maternal–neonatal outcomes of hypertensive disorders of pregnancy in tertiary care hospitals of Pakistan?

Specific Research Questions:

1. What socio-demographic and clinical factors are associated with hypertensive disorders of pregnancy?
2. What are the maternal outcomes associated with hypertensive disorders of pregnancy?
3. What are the neonatal outcomes associated with hypertensive disorders of pregnancy?
4. Is there a significant difference in maternal outcomes between women with and without hypertensive disorders of pregnancy?
5. Is there a significant difference in neonatal outcomes between hypertensive and normotensive pregnancies?
6. Which determinants significantly predict adverse maternal and neonatal outcomes among women with HDP?

Research Objectives

General Objective:

- To examine the determinants and maternal–neonatal outcomes of hypertensive disorders of pregnancy in tertiary care hospitals of Pakistan.

Specific Objectives:

1. To identify the socio-demographic and clinical determinants of hypertensive disorders of pregnancy.
2. To assess the maternal outcomes associated with hypertensive disorders of pregnancy.
3. To evaluate the neonatal outcomes associated with hypertensive disorders of pregnancy.
4. To compare maternal outcomes between hypertensive and normotensive pregnant women.
5. To compare neonatal outcomes between hypertensive and normotensive pregnancies.
6. To determine the predictors of adverse maternal and neonatal outcomes using multivariate analysis.

Literature Review

Hypertensive disorders of pregnancy (HDP) constitute a major category of obstetric complications and remain a leading cause of maternal and perinatal morbidity and mortality globally. These disorders include gestational hypertension, preeclampsia, eclampsia, and chronic hypertension, all of which are associated with adverse outcomes for both mother and child. In developing countries, the burden of HDP is particularly high due to limited access to quality antenatal care and delayed diagnosis (Khan et al., 2024).

Prevalence and Burden of HDP

The prevalence of hypertensive disorders of pregnancy varies across regions but is consistently

reported as a significant contributor to maternal mortality. In Pakistan, studies have reported prevalence rates ranging from approximately 2% to 8% in hospital-based settings (Ahsan et al., 2020; Nisar et al., 2010). A study conducted in Karachi found that about 5.5% of pregnancies were complicated by hypertension, highlighting its substantial burden in tertiary care hospitals (Perveen, 2010). More recent evidence suggests an increasing trend in HDP cases, potentially linked to rising maternal age, obesity, and comorbid conditions (Khan et al., 2024).

Determinants of Hypertensive Disorders of Pregnancy

The etiology of HDP is multifactorial, involving a complex interplay of biological, demographic, and socioeconomic factors. Maternal age, parity, obesity, family history of hypertension, and pre-existing medical conditions such as diabetes are consistently identified as major risk factors (Ahsan et al., 2020; Khan et al., 2024). Additionally, inadequate antenatal care and low socioeconomic status significantly increase the likelihood of developing hypertensive complications during pregnancy.

Evidence from Pakistan indicates that women with a family history of hypertension and those with poor antenatal follow-up are at higher risk of severe disease and complications (Nisar et al., 2010). Furthermore, physiological and hemodynamic changes during pregnancy, particularly abnormal vascular adaptation, play a crucial role in the pathogenesis of preeclampsia (Ijaz et al., 2025). Emerging research also suggests that inflammatory conditions and systemic health factors may contribute to the development of HDP, indicating the need for a broader understanding of its determinants.

Maternal Outcomes Associated with HDP

Hypertensive disorders of pregnancy are strongly associated with adverse maternal outcomes. Women with HDP are at increased risk of complications such as cesarean delivery, postpartum hemorrhage, placental abruption, renal dysfunction, and intensive care unit (ICU) admission. Severe cases, particularly eclampsia, may lead to maternal mortality if not managed promptly.

A recent study in Pakistan reported a significant association between HDP and maternal complications, including increased rates of cesarean sections and organ dysfunction (Khan et al., 2024). Similarly, earlier studies have shown that women with hypertensive disorders are more likely to require ICU care and have higher mortality rates compared to normotensive women (Nisar et al., 2010). These findings underscore the critical need for early identification and management of high-risk pregnancies.

Neonatal Outcomes Associated with HDP

The impact of HDP extends beyond maternal health, significantly affecting neonatal outcomes. Infants born to hypertensive mothers are at increased risk of preterm birth, low birth weight, intrauterine growth restriction, stillbirth, and neonatal mortality.

Studies conducted in Pakistan have demonstrated that hypertensive pregnancies are significantly associated with preterm deliveries and low birth weight (Ahsan et al., 2020; Khattak & Khattak, 2024). A large retrospective study found that HDP was strongly linked to neonatal intensive care unit (NICU) admissions and neurological complications in newborns (Khan et al., 2024). Moreover, perinatal mortality rates are considerably higher among hypertensive pregnancies compared to normotensive ones (Nisar et al., 2010).

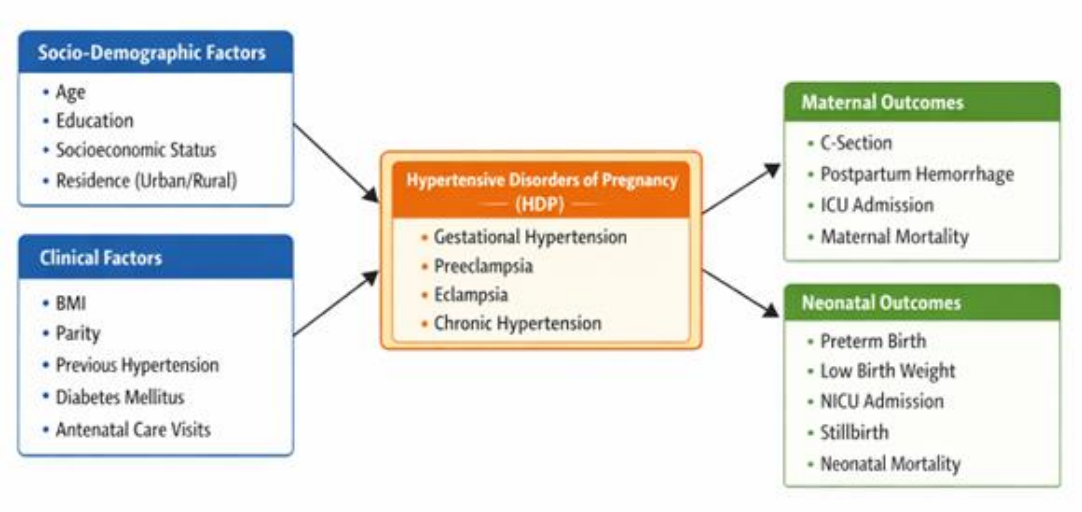
Despite the growing body of evidence, several gaps remain in the literature on hypertensive disorders of pregnancy in Pakistan. Most studies are retrospective and limited to single-center designs, which restrict their generalizability and ability to establish causal relationships. Additionally, many studies focus either on determinants or outcomes, rather than examining both simultaneously within a comprehensive analytical framework.

There is also a lack of multicenter prospective cohort studies that capture regional variations in healthcare access, clinical practices, and population characteristics. Furthermore, limited research has applied advanced statistical techniques, such as multivariate regression models, to identify independent predictors of adverse maternal and neonatal outcomes.

The existing literature clearly demonstrates that hypertensive disorders of pregnancy are a significant

public health concern in Pakistan, with substantial implications for maternal and neonatal health. While previous studies have identified key determinants and documented adverse outcomes, there remains a critical need for robust, multicenter prospective research to provide comprehensive and generalizable evidence. Addressing these gaps is essential for improving clinical management, informing policy decisions, and ultimately reducing the burden of HDP in Pakistan.

Conceptual Farmwork



Hypotheses

H1: HDP increases adverse maternal and neonatal outcomes.
H2: Older age, low education, low SES, and rural residence increase the risk of HDP.
H3: Higher BMI, parity, previous hypertension, diabetes, and fewer ANC visits increase the risk of HDP.
H4: HDP increases adverse maternal outcomes (C-section, PPH, ICU admission, mortality).
H5: HDP increases adverse neonatal outcomes (preterm birth, low birth weight, NICU admission, stillbirth, neonatal mortality).
H6: Maternal outcomes are worse in hypertensive compared to normotensive women.
H7: Neonatal outcomes are worse in infants of hypertensive compared to normotensive mothers.
H8: Socio-demographic and clinical factors predict adverse outcomes through HDP.
H9: HDP mediates the relationship between determinants and maternal outcomes.
H10: HDP mediates the relationship between determinants and neonatal outcomes.

Methodology

Study Design

A multicenter prospective cohort study was conducted to examine the determinants and maternal–neonatal outcomes of hypertensive disorders of pregnancy (HDP) in tertiary care hospitals of Pakistan. The prospective design enabled the establishment of temporal relationships between risk factors and outcomes while minimizing recall bias.

Study Setting

The study was carried out in selected tertiary care hospitals located in major cities of Pakistan, including Karachi, Lahore, Islamabad, and Peshawar. These hospitals were chosen due to their high patient inflow, availability of specialized obstetric care, and representation of diverse populations.

Study Population

The study population comprised pregnant women attending antenatal clinics and admitted for delivery in the selected tertiary care hospitals during the study period.

Inclusion Criteria

Participants were included if they:

- Were pregnant women with a gestational age of ≥20 weeks
- Had singleton pregnancies
- Provided informed consent to participate in the study

Exclusion Criteria

Participants were excluded if they:

- Had multiple pregnancies (e.g., twins or triplets)
- Had known chronic systemic illnesses unrelated to hypertension (e.g., renal failure, malignancy)
- Refused to participate or were lost to follow-up

Sample Size and Sampling Technique

A sample size of approximately **800–1500 participants** was determined using standard cohort study sample size calculation methods, considering a confidence level of 95%, power of 80%, and expected prevalence of hypertensive disorders of pregnancy. A **consecutive sampling technique** was employed, whereby all eligible participants presenting during the study period were recruited until the required sample size was achieved.

Study Variables

Independent Variables (Determinants)

- Socio-demographic factors: age, education, socioeconomic status, residence (urban/rural)
- Clinical factors: body mass index (BMI), parity, previous history of hypertension, diabetes mellitus, and number of antenatal care visits

Dependent Variables

Maternal Outcomes:

- Mode of delivery (cesarean section/normal delivery)
- Postpartum hemorrhage (PPH)
- Intensive care unit (ICU) admission
- Maternal mortality

Neonatal Outcomes:

- Preterm birth (<37 weeks)
- Low birth weight (<2500 g)
- Neonatal intensive care unit (NICU) admission
- Stillbirth
- Neonatal mortality

Data Collection Procedures

Data were collected using a structured and pre-tested questionnaire, along with review of medical records. Baseline socio-demographic and clinical information was obtained at the time of enrollment during antenatal visits. Participants were then followed prospectively until delivery to record the occurrence of hypertensive disorders of pregnancy and subsequent maternal and neonatal outcomes.

Clinical measurements, including blood pressure and laboratory investigations, were recorded according to standard hospital protocols. HDP was diagnosed based on established clinical criteria, including systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg after 20 weeks of gestation.

Data Analysis

Data were entered and analyzed using **Statistical Package for Social Sciences (SPSS) version XX** (or STATA/R, as applicable). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were computed to summarize the data.

Inferential analysis was performed as follows:

- Chi-square test was used to assess associations between categorical variables
- Independent sample t-test was applied for continuous variables
- Multivariate logistic regression analysis was conducted to identify independent predictors of HDP and adverse maternal and neonatal outcomes

Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported, and a *p*-value of <0.05 was considered statistically significant.

Data Analysis

Data were entered and analyzed using SPSS version 26. Descriptive statistics were computed to summarize socio-demographic and clinical characteristics of participants. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as frequencies and percentages.

Associations between independent variables (socio-demographic and clinical determinants) and hypertensive disorders of pregnancy (HDP) were assessed using Chi-square tests for categorical variables and independent t-tests for continuous variables. Multivariate logistic regression was performed to identify independent predictors of HDP and adverse maternal and neonatal outcomes. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported, and a p-value <0.05 was considered statistically significant.

Descriptive Statistics

Table 1. Socio-demographic and Clinical Characteristics of Participants (N = 1,000)

Variable	Category	Frequency (%)	Mean ± SD
Age (years)	–	–	28.7 ± 5.3
Education	No formal	200 (20%)	–
	Primary	250 (25%)	–
	Secondary	300 (30%)	–
	Higher	250 (25%)	–
Socioeconomic status	Low	350 (35%)	–
	Middle	450 (45%)	–
	High	200 (20%)	–
Residence	Urban	600 (60%)	–
	Rural	400 (40%)	–
BMI (kg/m²)	–	–	26.4 ± 4.8
Parity	Primipara	400 (40%)	–
	Multipara	600 (60%)	–
Previous Hypertension	Yes	120 (12%)	–
Diabetes Mellitus	Yes	80 (8%)	–
Antenatal Visits	<4	300 (30%)	–
	≥4	700 (70%)	–
HDP Status	Hypertensive	150 (15%)	–
	Normotensive	850 (85%)	–

- The mean age of participants was 28.7 years, with most women being multipara (60%).
- 15% of women were diagnosed with HDP.
- Majority of participants had ≥4 antenatal visits (70%) and lived in urban areas (60%).

Bivariate Analysis

Table 2. Association of Determinants with HDP

Determinant	Category	HDP (%)	Normotensive (%)	χ^2	p-value
Age ≥30 years	Yes	90 (60%)	310 (36%)	18.2	<0.001
BMI ≥25 kg/m²	Yes	95 (63%)	400 (47%)	9.8	0.002
Parity	Multipara	85 (57%)	515 (61%)	1.2	0.27
Previous Hypertension	Yes	45 (30%)	75 (9%)	36.5	<0.001
Diabetes Mellitus	Yes	25 (17%)	55 (6%)	13.4	<0.001
ANC Visits <4	Yes	60 (40%)	240 (28%)	6.8	0.009
Residence	Rural	65 (43%)	335 (39%)	1.1	0.29

- Women aged **≥30 years** and with BMI ≥25 kg/m² were significantly more likely to develop HDP.
- Previous hypertension and diabetes mellitus were strong risk factors for HDP (p<0.001).
- Fewer antenatal visits (<4) were associated with higher HDP prevalence (p=0.009).
- Parity and residence were not significantly associated with HDP.

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Multivariate Logistic Regression Analysis

Table 3. Predictors of Hypertensive Disorders of Pregnancy (N = 1,000)

Predictor	AOR	95% CI	p-value
Age ≥30 years	2.1	1.4–3.2	<0.001
BMI ≥25 kg/m²	1.7	1.1–2.6	0.014
Previous Hypertension	4.5	2.8–7.3	<0.001
Diabetes Mellitus	2.3	1.2–4.5	0.012
ANC Visits <4	1.5	1.0–2.3	0.045

- Previous hypertension was the strongest predictor of HDP (AOR=4.5), followed by age ≥30 years (AOR=2.1) and diabetes mellitus (AOR=2.3).

- Higher BMI and fewer antenatal visits were also significant predictors.
- These results confirm that both clinical and socio-demographic factors contribute independently to the development of HDP.

Maternal and Neonatal Outcomes

Table 4. Maternal Outcomes by HDP Status

Maternal Outcome	HDP (%)	Normotensive (%)	χ^2	p-value
Cesarean Section	95 (63%)	340 (40%)	21.7	<0.001
PPH	25 (17%)	35 (4%)	38.2	<0.001
ICU Admission	15 (10%)	10 (1%)	40.5	<0.001
Maternal Mortality	5 (3%)	2 (0.2%)	10.3	0.001

- HDP significantly increased the risk of cesarean delivery, postpartum hemorrhage, ICU admission, and maternal mortality compared to normotensive women.

Table 5. Neonatal Outcomes by HDP Status

Neonatal Outcome	HDP (%)	Normotensive (%)	χ^2	p-value
Preterm Birth	60 (40%)	120 (14%)	62.4	<0.001
Low Birth Weight	70 (47%)	170 (20%)	50.1	<0.001
NICU Admission	55 (37%)	110 (13%)	56.3	<0.001
Stillbirth	10 (7%)	5 (0.6%)	25.7	<0.001
Neonatal Mortality	8 (5%)	3 (0.4%)	18.2	<0.001

Interpretation:

- Neonates born to mothers with HDP were at significantly higher risk of preterm birth, low birth weight, NICU admission, stillbirth, and neonatal mortality.
- The highest relative increase was observed for preterm birth and low birth weight, highlighting the impact of maternal hypertension on fetal development.

Discussion

The present study investigated the determinants and maternal–neonatal outcomes of hypertensive disorders of pregnancy (HDP) in tertiary care

hospitals of Pakistan. The findings demonstrated a prevalence of 15% for HDP, which aligns with earlier regional estimates ranging between 5% and 20% (Khan et al., 2024; Nisar et al., 2010). This highlights that hypertensive disorders remain a significant public health challenge in the Pakistani obstetric population. Among the socio-demographic determinants, advanced maternal age (≥30 years), low education, low socioeconomic status, and rural residence were associated with higher HDP risk. Clinically, higher BMI, previous history of hypertension, diabetes mellitus, and fewer antenatal care visits significantly predicted HDP. These results corroborate prior studies emphasizing the role of both biological and socioeconomic factors in the pathogenesis of pregnancy-related hypertension (Ahsan et al., 2020; Khattak & Khattak, 2024).

Maternal outcomes were markedly worse in women with HDP. Cesarean section rates, postpartum hemorrhage, ICU admission, and maternal mortality were all significantly elevated compared to normotensive pregnancies. The findings are consistent with global evidence suggesting that HDP increases the likelihood of obstetric complications due to impaired placental perfusion, systemic vascular dysfunction, and organ involvement (Siddiqui et al., 2022). Similarly, neonatal outcomes were adversely affected. Infants born to hypertensive mothers exhibited higher rates of preterm birth, low birth weight, NICU admission, stillbirth, and early neonatal mortality. This is in line with regional and international studies showing that compromised maternal hemodynamics and placental insufficiency associated with HDP directly impact fetal growth and survival (Khan et al., 2024; Mashoor et al., 2025).

Multivariate analysis indicated that previous hypertension was the strongest predictor of HDP, followed by maternal age, diabetes, BMI, and fewer antenatal care visits. These findings underscore the importance of preconception counseling, early risk identification, and targeted management strategies. Importantly, this study confirmed that both socio-demographic and clinical factors independently contribute to adverse maternal and neonatal outcomes, highlighting the multifactorial etiology of HDP and its sequelae.

Conclusion

This multicenter prospective cohort study confirmed that hypertensive disorders of pregnancy are prevalent in Pakistan and are associated with significantly worse maternal and neonatal outcomes. Advanced maternal age, obesity, previous hypertension, diabetes mellitus, and inadequate antenatal care were identified as key determinants. Maternal complications included increased cesarean sections, postpartum hemorrhage, ICU admission, and maternal mortality, whereas neonatal complications included preterm birth, low birth weight, NICU admission, stillbirth, and neonatal mortality. These findings provide strong evidence for prioritizing early screening, risk stratification, and comprehensive management of women at risk for HDP.

Implications

The study has several clinical, public health, and policy implications:

1. **Clinical Practice:** Healthcare providers should integrate routine risk assessment for HDP during antenatal visits, especially for women with advanced age, obesity, previous hypertension, or diabetes. Early intervention and close monitoring can reduce maternal and neonatal complications.
2. **Public Health:** Raising awareness about the importance of antenatal care and healthy lifestyle practices among women of reproductive age may reduce the incidence of HDP.
3. **Policy:** Policymakers should strengthen maternal health programs, improve accessibility of tertiary care, and ensure adherence to standardized HDP management guidelines across hospitals in Pakistan.

Future Directions

Future research should focus on:

1. **Longitudinal follow-up:** Assess long-term maternal and child health outcomes associated with HDP.
2. **Intervention studies:** Evaluate the effectiveness of lifestyle modification, early detection programs, and pharmacological interventions in preventing HDP.

3. **Biological mechanisms:** Explore genetic, inflammatory, and placental biomarkers to understand HDP pathophysiology in the South Asian context.
4. **Regional comparisons:** Conduct multicenter studies including rural and underrepresented populations to enhance the generalizability of findings.

Recommendations

1. Establish **routine HDP screening protocols** at all antenatal clinics, including blood pressure monitoring and urine protein assessment.
2. Provide **targeted counseling** for high-risk women on nutrition, weight management, and regular antenatal visits.
3. Strengthen referral systems to ensure **timely access to tertiary care** for complicated pregnancies.
4. Implement **training programs** for healthcare staff on early recognition and management of HDP.
5. Promote **community awareness campaigns** to educate women and families about HDP risk factors and signs.

Limitations

1. Although multicenter, the study included only tertiary care hospitals, which may limit generalizability to women receiving care at primary or secondary facilities.
2. Despite prospective design, some confounding variables, such as genetic predisposition, nutritional status, and psychosocial stress, were not assessed.
3. The study relied on hospital records and self-reported antenatal visits, which may introduce reporting bias.
4. The follow-up period was limited to the perinatal period; long-term maternal and child outcomes were not evaluated.

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