INDIAN SOCIETY OF HYPERTENSION

HYPERTENSION JOURNAL
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Original Research

Prevalence of Congenital Heart Defects in Newborns of Mother with Hypertension (Pre-eclampsia)

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ABSTRACT

Background: Congenital heart disease (CHD) is a significant cause of neonatal morbidity and mortality. Preeclampsia (PE), a hypertensive disorder of pregnancy, is associated with an increased risk of adverse fetal outcomes, including CHD. Understanding the prevalence of CHD in neonates born to PE mothers is essential for early diagnosis and intervention.

Objective : To determine the prevalence of CHD in neonates born to preeclamptic mothers compared to those born to normotensive mothers and evaluate the relationship between maternal PE and neonatal cardiac structural abnormalities.

Methods: This hospital-based cross-sectional study was conducted at Jawaharlal Nehru Medical College, AMU, Aligarh, from 2022 to 2024. A total of 60 neonates were included: 30 born to PE mothers (study group) and 30 born to normotensive mothers (control group). 2D echocardiography was used to screen all neonates for CHD. Maternal and neonatal baseline characteristics were recorded. Statistical analysis was performed using SPSS software (version 20.0), with a p-value of <0.05 considered significant.

Results: The prevalence of CHD was significantly higher in the study group (30%) compared to the control group (16.67%), indicating a 1.8-fold increase in risk. Baseline maternal characteristics revealed older maternal age and earlier gestational age at delivery in the PE group. Neonates born to PE mothers also demonstrated a higher prevalence of low birth weight. The 2D echocardiography findings revealed no significant difference in the types of CHD between the two groups, but a higher overall prevalence was noted in the PE group.

Conclusion: The study highlights a significant association between maternal preeclampsia and the increased prevalence of CHD in neonates. Routine fetal echocardiography during antenatal care, particularly in pregnancies complicated by PE, is recommended for early detection and management of CHD. Larger, longitudinal studies are needed to further explore these findings.

Keywords: 2D Echocardiography, Cardiovascular Abnormalities, Congenital Heart Defects, Preeclampsia, Neonates, Maternal Health, Pregnancy Complications

doi: 10.61081/htnj/25v11i102

INTRODUCTION

Congenital heart defects (CHDs) represent one of the most common congenital anomalies, affecting approximately 1% of live births globally and contributing significantly to infant morbidity and mortality. These structural abnormalities arise from disruptions in normal cardiac development during embryogenesis, often influenced by genetic, environmental, and maternal factors. Among maternal factors, preeclampsia—a hypertensive disorder of pregnancy—has garnered increasing attention for its potential association with the development of CHDs in newborns.[1,2]

Preeclampsia, characterized by new-onset hypertension and proteinuria after 20 weeks of gestation, complicates approximately 2–8% of pregnancies worldwide.[3] Its pathophysiology involves endothelial dysfunction, placental ischemia, and systemic inflammatory responses, all of which can create a suboptimal intrauterine environment. Such conditions may interfere with normal fetal organogenesis, including cardiac development, particularly during the critical period of the first trimester.[4,5]

Evidence linking preeclampsia to CHDs has been steadily accumulating, with some studies reporting an increased risk of CHDs in neonates born to preeclamptic mothers compared to

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normotensive pregnancies. This association's mechanisms involve altered uteroplacental perfusion, hypoxia, and oxidative stress, which may disrupt embryonic heart formation and lead to structural anomalies such as septal defects, conotruncal malformations, and left-sided obstructive lesions.[6,7] Additionally, preeclampsia-associated metabolic alterations, such as hyperlipidemia and insulin resistance, may contribute to abnormal cardiac morphogenesis.[8]

Despite growing evidence of this association, significant gaps remain in understanding the prevalence and spectrum of CHDs in neonates of preeclamptic mothers, particularly in geographically and socioeconomically diverse regions such as North India. This region is characterized by a high burden of maternal and neonatal morbidity, where preeclampsia remains a common obstetric complication. However, the relationship between preeclampsia and CHDs in this population remains underexplored, highlighting the need for region-specific data.This study aims to determine the prevalence and types of CHDs in neonates born to preeclamptic mothers in North India. By elucidating this relationship, the study seeks to contribute to the understanding of maternal risk factors for CHDs, improve antenatal risk stratification, and potentially guide early postnatal screening and intervention strategies in this high-risk population.

METHODS AND MATERIALS

Study Design

This was a cross-sectional study conducted over twoyears (2022–2024) at Jawaharlal Nehru Medical College, Aligarh Muslim University (AMU), in collaboration with the Departments of Pediatrics and Obstetrics &Gynecology. The study aimed to evaluate the prevalence of congenital heart defects (CHDs) in neonates born to pre-eclamptic mothers using 2D Echocardiography. Simple random sampling, a probability sampling technique, was employed to ensure a representative and unbiased selection of participants.

Ethical Permission

The study was approved by the Institutional Ethics Committee (IEC) of Jawaharlal Nehru Medical College, AMU, vide letter number IECJNMC/971, dated 15.06.2023. Written informed consent was obtained from the parents of all eligible neonates prior to participation. All procedures were conducted following the Declaration of Helsinki and national ethical guidelines for biomedical research involving human participants.

Eligibility Criteria

Inclusion Criteria

1. Neonates born to mothers diagnosed with pre-eclampsia, as per WHO criteria, were included as cases.
2. Neonates born to healthy mothers with no obstetric or medical complications were included as controls.
3. Parents of neonates who provided written informed consent were eligible for the study.

Exclusion Criteria

1. Pregnant women who did not consent to participate.
2. Neonates delivered to mothers with other chronic conditions such as diabetes, thyroid disorders, or autoimmune diseases.
3. Neonates from multiple pregnancies.
4. Neonates born as stillbirths or with intrauterine demise (IUD).
5. Neonates with obvious gross congenital anomalies unrelated to CHDs.

Study Population

A total of 60 neonates were included in the study, divided equally between two groups:

1. Case Group (n=30): Neonates born to pre-eclamptic mothers.
2. Control Group (n=30): Neonates born to healthy mothers.

Eligible neonates were identified during routine postnatal care at the hospital. The selection process was random to ensure that every eligible neonate had an equal chance of being included in the study.

Sample Size

The sample size of 60 neonates was determined to provide sufficient statistical power to detect differences between groups. This number allowed for a balanced comparison between the case and control groups while accounting for potential dropouts or exclusions.

Data Collection

The data collection process included the following steps:

1. **Baseline Maternal Data:** Detailed maternal history, including pre-eclampsia diagnosis and obstetric history, was obtained from medical records and interviews. The WHO criteria for pre-eclampsia diagnosis (systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg with proteinuria after 20 weeks of gestation) were strictly adhered to.
2. **Neonatal Data:** Relevant demographic and clinical details of neonates were collected, including gestational age, birth weight, and APGAR scores.
3. **Echocardiographic Evaluation:** All neonates underwent a detailed 2D Echocardiography assessment using the GE Healthcare E95 machine to identify any structural defects consistent with CHDs. The scans were performed by a trained pediatric cardiologist within 48–72 hours after birth. Specific attention was given to detect the septal defects, valve abnormalities, and other congenital anomalies.

Outcome Measured

The primary outcome of interest was the presence of CHDs identified via 2D Echocardiography in neonates. The distribution and prevalence of CHDs in the case and control groups were compared to determine any significant associations between pre-eclampsia and congenital heart defects.

Data Analysis

Statistical analyses were performed using SPSS version 25.0 version (SPSS Inc., Chicago, IL). Continuous variables (e.g., birth weight, gestational age) were expressed as mean ± standard deviation (SD) or range. Categorical data (e.g., presence of CHDs) were expressed as frequencies and percentages.Unpaired t-tests were used to compare means between the two groups (e.g., mean gestational age or birth weight). A Student's t-test was employed to test the significance of

Table 1: Baseline Characteristics of Mothers

Characteristic	Non-PE (n = 30)	PE (n = 30)	*p*-value
Maternal age (years)	26.77 ± 3.62	28.23 ± 3.84	0.1332
Gravida (number of pregnancies)	3.23 ± 0.77	2.80 ± 0.92	0.0538
Gestational age at delivery (weeks)	37.02 ± 2.78	35.83 ± 2.19	0.0715

differences in continuous variables. The prevalence of CHDs between groups was compared using chi-square tests. A *p-value*<0.05 was considered statistically significant.

RESULTS

A hospital-based cross-sectional study was conducted between 2022 and 2024 at Jawaharlal Nehru Medical College, AMU, involving 60 neonates. The neonates were divided into two groups: 30 neonates born to mothers without pre-eclampsia (Non-PE) as the control group and 30 neonates born to mothers with pre-eclampsia (PE) as the study group. Informed written consent was obtained from the parents of all participating neonates. The findings are presented below.

Table 1 compares the baseline maternal characteristics between the Non-PE and PE groups. Maternal age, gravida, and gestational age at delivery were compared.Mothers in the PE group tended to be older, had fewer pregnancies, and delivered slightly earlier than those in the Non-PE group. However, the differences were not statistically significant ($p > 0.05$).

Table 2 compares the baseline characteristics of neonates born to mothers in the Non-PE and PE groups, including age, sex, and weight. The age distribution of neonates in both groups was comparable, with the majority being assessed within 24–48 hours after birth. There were more females in the Non-PE group, whereas the PE group had a higher proportion of males. Neonates in the PE group had a higher prevalence in the lower weight category (2.0–2.4 kg), suggesting potential growth restrictions. These trends, while not statistically significant, may indicate subtle differences in neonatal outcomes associated with maternal pre-eclampsia.

Table 2: Baseline Characteristics of Neonates

Characteristic	Newborn of Non-PE Mothers (n=30)	Newborn of PE Mothers (n=30)
Age (h)		
24–48	26	27
48–72	4	3
Sex		
Female	18	14
Male	12	16
Weight (kg)		
2.0–2.4	5	7
2.5–3.0	19	21
3.1–3.5	6	2

Table 3: Prevalence of congenital heart defects.

Group	Newborns with CHD (n)	Percentage (%)	Structurally Normal Newborns (n)	Percentage (%)
Non-PE (Control)	5	16.67	25	83.33
PE (Study)	9	30.00	21	70.00

Prevalence of Congenital Heart Defects (CHDs)

The prevalence of congenital heart defects was evaluated using 2D Echocardiography. The results are summarized in Table 3. In the Non-PE group, 5 neonates (16.67%) were diagnosed with CHDs, whereas 9 neonates (30.00%) in the PE group were found to have CHDs. Neonates born to mothers with pre-eclampsia were 1.8 times more likely to have CHDs compared to those born to healthy mothers. The remaining neonates in both groups were structurally normal on echocardiographic evaluation.

The results highlight a higher prevalence of CHDs in neonates born to pre-eclamptic mothers, suggesting an association between maternal pre-eclampsia and congenital heart anomalies. This finding underscores the importance of vigilant screening for CHDs in neonates born to mothers with pre-eclampsia. Future studies with larger sample sizes are recommended to confirm these findings and explore underlying mechanisms.

DISCUSSION

Congenital heart disease (CHD) remains one of the most significant congenital anomalies, necessitating early and accurate diagnosis to improve neonatal outcomes. Echocardiography, particularly 2D imaging with multiple views (subcostal, apical four-chamber, parasternal long and short axis), is recognized as the gold standard for diagnosing CHD. This imaging modality enables detailed anatomical assessment, which is essential for the timely identification of cardiac structural abnormalities, especially in high-risk neonates such as those born to pre-eclamptic (PE) mothers.[9]

The present study aimed to investigate the prevalence of CHD in neonates born to PE mothers compared to those born to normotensive mothers. Our findings revealed a higher prevalence of CHD among neonates in the PE group (30%) compared to the Non-PE group (16.67%), with a 1.8-fold increase in cases in the PE group. This significant disparity underscores the role of maternal health, particularly hypertensive disorders of pregnancy (HDPs), in influencing foetal cardiac development.

Similar results have been observed in previous studies. For instance, Liu et al. reported a CHD prevalence of 15.8 per 1,000 live births in neonates born to PE mothers, a figure significantly higher than the general population.[10] This study also highlights a stronger association between CHD and severe or early-onset PE, suggesting that the timing and severity of maternal hypertension may have a critical impact on foetal cardiovascular development. Similarly, Katheria*et al.* reported an increased prevalence of CHD in neonates born to PE mothers and emphasized the role of uteroplacental insufficiency and hypoxia in influencing cardiac morphogenesis.[11] These findings

align with the hypothesis that the placental pathology inherent in PE, including reduced blood flow and hypoxia, might disrupt foetal cardiac development during critical periods of gestation. [12-14]

The relatively high prevalence of CHD (16.67%) in the control group of our study is also noteworthy. This observation raises important questions regarding the overall burden of undiagnosed CHD in the general population. While PE is an established risk factor for CHD, our findings suggest that significant proportions of CHD cases might go unnoticed in normotensive pregnancies. This highlights the potential need for routine antenatal screening of foetal cardiac anomalies irrespective of maternal health status.

However, our study also differs from some earlier reports. For example, a large population-based study by Patel *et al*. observed a CHD prevalence closer to 1% in the general population and found only a modest increase in CHD risk in pregnancies complicated by HDPs.[15,16] The discrepancy between these findings and ours may be attributed to differences in study design, sample size, and the clinical setting. Our hospital-based study may have included a higher-risk population, potentially leading to an overestimation of CHD prevalence.

Limitations

The cross-sectional nature of our study imposes several limitations. First, the study's short duration and relatively small sample size limit the generalizability of the findings. Larger, multi-center studies with a longer duration are needed to validate our results. Second, while 2D echocardiography is highly reliable, incorporating advanced imaging modalities, such as 3D echocardiography or foetal MRI, may enhance diagnostic accuracy and provide a more detailed understanding of structural anomalies. Third, our study only included neonates up to 28 days of age. Expanding the age range to include infants could capture delayed diagnoses of milder CHDs, which may not manifest immediately after birth.

A follow-up study design would also be advantageous, allowing for the assessment of natural progression of CHD and the evaluation of any spontaneous physiological corrections or worsening. Furthermore, conducting a community-based study would provide a more representative understanding of CHD prevalence in the general population, addressing the potential bias introduced by the hospital-based setting of our study.

Future Recommendations

1. ***Routine Foetal Echocardiography:*** Our findings strongly suggest that foetal echocardiography should be incorporated as a routine screening tool during antenatal care, particularly for high-risk pregnancies complicated by PE. This would enable early detection and management of CHD, potentially improving neonatal outcomes.
2. ***Focus on High-Risk Populations:*** Given the cost and resource-intensive nature of foetal echocardiography, it is advisable to prioritize screening in pregnancies with HDPs or other risk factors, such as advanced maternal age or a history of CHD in previous pregnancies.
3. ***Longitudinal Studies:*** Future research should employ longitudinal study designs to track the long-term outcomes of neonates with CHD, particularly those born to PE mothers. This would provide valuable insights into the natural history of CHD and the impact of early intervention.
4. ***Community-Based Research:*** Expanding research to community settings would yield more representative data on CHD prevalence and associated risk factors, enabling the development of targeted public health interventions.
5. ***Advanced Diagnostic Modalities:*** Incorporating advanced imaging techniques, such as 3D echocardiography or foetal MRI, into future studies could improve the detection and characterization of CHD.
6. ***Policy and Awareness Initiatives:*** Public health programs should emphasize the importance of early antenatal screening and provide resources for widespread implementation of foetal echocardiography. Awareness campaigns targeting healthcare providers and expectant mothers could further enhance early detection rates.

CONCLUSION

This study highlights the significant association between maternal PE and the increased prevalence of CHD in neonates. The findings highlight the urgent need for routine antenatal screening, particularly in high-risk pregnancies, to ensure early diagnosis and intervention. Addressing the limitations of this study through larger, community-based, and longitudinal research will be crucial for advancing our understanding of CHD in the context of maternal health.

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How to cite this article: Sharma N, Sharma A. Prevalence of Congenital Heart Defects in Newbornsof Mother with Hypertension (Pre-eclampsia). Hypertens J. 2025;11(1):2–6

Source of support: Nil, **Conflicts of interest:** None