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Burden, risk factors and maternal outcomes of pre-eclampsia: A clinical study in India

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Abstract:

Pre-eclampsia is a multisystem hypertensive disorder of pregnancy and remains a major cause of maternal morbidity and mortality, particularly in low- and middle-income countries. Hence, this observational hospital-based study included 150 antenatal women diagnosed with pre-eclampsia after 20 weeks of gestation and evaluated the burden of disease, maternal risk factors and maternal outcomes. Demographic, obstetric and clinical information was collected using a structured proforma, with risk factors including age, parity, obesity, chronic hypertension, diabetes mellitus, family history of hypertension and multiple pregnancies. Maternal outcomes assessed included severe hypertension, eclampsia, HELLP syndrome, placental abruption, acute kidney injury, postpartum haemorrhage, intensive care admission and maternal death. Thus, data shows the epidemiological burden of pre-eclampsia and identify maternal risk factors and adverse outcomes to support earlier detection and prompt management of high-risk pregnancies.

Keywords: Pre-eclampsia, hypertensive disorders of pregnancy, risk factors, maternal outcomes, pregnancy complications, eclampsia, HELLP syndrome

Background:

Pre-eclampsia is a multisystem disorder which occurs during pregnancy, defined as new onset hypertension after 20 weeks gestation, with proteinuria and/or evidence of maternal organ dysfunction or uteroplacental insufficiency. It is one of the most significant causes of maternal and perinatal morbidity and mortality worldwide and remains a significant public health problem particularly in developing countries where access to specialist obstetric care may be restricted [1]. Pre-eclampsia is a condition that occurs in about 3-8% of pregnancies worldwide and is responsible for a large proportion of serious complications and deaths in mothers. In 2023 alone, the World Health Organization estimates that nearly 42,000 women died from hypertensive disorders of pregnancy globally, which represents almost 16% of all maternal deaths. In India, hypertensive disorders are one of the major direct causes of maternal mortality and pre-eclampsia is a common reason for preterm delivery and critical obstetric intervention [2]. Pre-eclampsia is a complex disease with abnormal placentation, endothelial dysfunction, systemic inflammation and angiogenic imbalance. The systemic vascular dysfunction causes widespread endothelial injury in maternal organs, such as kidneys, liver, brain, hematologic system and cardiovascular system, due to inadequate trophoblastic invasion of maternal spiral arteries, which releases antiangiogenic factors like soluble fms-like tyrosine kinase-1 that disrupts vascular homeostasis [3, 4]. There are a number of factors that make women more susceptible to pre-eclampsia. In low-resource areas, delayed registration for pregnancy and poor monitoring adds to the burden and recent umbrella reviews have confirmed that non-genetic factors such as high body mass index, chronic medical conditions and assisted reproduction are important risk factors for the development of the disease [5, 6]. Pre-eclampsia can be mild or severe and may be complicated by life-threatening conditions. Severe pre-eclampsia can progress to eclampsia, HELLP syndrome (haemolysis, elevated liver enzymes and low platelet count), disseminated intravascular coagulation, pulmonary edema, acute kidney injury, hepatic rupture, placental abruption and stroke, all of which can require intensive care and

emergency delivery, thereby raising both maternal and neonatal risks [7, 8]. The effects of motherhood are not limited to pregnancy. The association of pre-eclampsia with long-term chronic hypertension, ischemic heart disease, stroke, heart failure and metabolic disorders has led to a focus on postpartum monitoring and prevention [9]. Early identification of high-risk women allows initiation of evidence-based preventive strategies. In high-risk pregnancies, the use of low-dose aspirin started before 16–20 weeks of gestation and calcium supplementation in women with low calcium intake have shown significant reduction in the incidence of disease [1, 10]. Better antenatal surveillance, timely antihypertensive therapy, magnesium sulphate prophylaxis and appropriate timing of delivery are key to reducing adverse outcomes [11]. Although there has been improvement in understanding and management, the burden of pre-eclampsia is still significant in tertiary hospitals in India with women presenting late with severe disease. Local information on risk factors and maternal outcomes is critical to the best use of screening and resource allocation. In recent years, significant maternal morbidity has been reported in women with severe pre-eclampsia and eclampsia in India [12]. Therefore, it is of interest to estimate the burden of pre-eclampsia among pregnant women, to identify the maternal risk factors associated with pre-eclampsia and to assess the maternal outcomes in a tertiary care teaching hospital.

Material and Methodology:

Study design:

This study was designed as a hospital-based observational descriptive clinical study.

Study setting:

The study was conducted in the Department of Obstetrics and Gynaecology of a tertiary care teaching hospital with facilities for high-risk obstetric care, intensive maternal monitoring, blood bank support and neonatal intensive care.

Study duration:

The study was carried out over a period of 18 months, including patient recruitment, data collection, analysis and interpretation.

Study population:

The study population consisted of pregnant women diagnosed with pre-eclampsia and admitted to the antenatal wards, labor room, or obstetric intensive care unit after 20 weeks of gestation.

Sample size:

A total of 150 pregnant women with confirmed pre-eclampsia were enrolled consecutively during the study period.

Sample size justification:

The sample size was selected based on feasibility and expected case load in the tertiary care center. Assuming a prevalence of severe maternal complications of approximately 20% among women with pre-eclampsia, a sample of 150 participants provides adequate precision to estimate the frequency of maternal outcomes and assess common risk factors with acceptable statistical power.

Sampling technique:

Consecutive sampling was used, whereby all eligible women admitted during the study period were included until the desired sample size was reached.

Inclusion criteria:

- [1] Pregnant women aged 18 years and above.
- [2] Gestational age ≥ 20 weeks.
- [3] Blood pressure $\geq 140/90$ mmHg on two occasions at least 4 hours apart.
- [4] Proteinuria (≥ 300 mg/24 hours or dipstick $\geq 1+$) and/or maternal organ dysfunction.
- [5] Willingness to provide written informed consent.

Exclusion criteria:

- [1] Gestational hypertension without features of pre-eclampsia.
- [2] Chronic hypertension diagnosed before pregnancy without superimposed pre-eclampsia.
- [3] Known renal disease unrelated to pregnancy.
- [4] Incomplete medical records.
- [5] Refusal to participate.

Diagnostic criteria:

Pre-eclampsia was diagnosed according to current international guidelines as:

- [1] Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg after 20 weeks of gestation,
- [2] Associated with proteinuria or maternal organ dysfunction such as thrombocytopenia, elevated liver enzymes, renal impairment, pulmonary edema, or neurological symptoms.

Data collection procedure:

After obtaining informed consent, each participant underwent detailed history taking, physical examination and review of clinical records. Data collected included:

- [1] Maternal age
- [2] Socioeconomic status
- [3] Gravidity and parity
- [4] Gestational age at diagnosis
- [5] Body mass index
- [6] Antenatal booking status
- [7] Previous history of pre-eclampsia
- [8] Family history of hypertension
- [9] Chronic hypertension
- [10] Diabetes mellitus
- [11] Multiple pregnancy
- [12] Laboratory parameters (CBC, liver function tests, renal function tests, urine protein)

Risk factors assessed:

The following risk factors were evaluated:

- [1] Nulliparity
- [2] Age < 20 years or > 35 years
- [3] Obesity (BMI ≥ 30 kg/m²)
- [4] Chronic hypertension
- [5] Diabetes mellitus
- [6] Renal disease
- [7] Multifetal gestation
- [8] Previous history of pre-eclampsia
- [9] Family history of hypertension
- [10] Assisted conception

Maternal outcomes evaluated:

- [1] Severe hypertension
- [2] Eclampsia
- [3] HELLP syndrome
- [4] Placental abruption
- [5] Acute kidney injury
- [6] Pulmonary edema
- [7] Disseminated intravascular coagulation
- [8] Postpartum hemorrhage
- [9] Blood transfusion requirement
- [10] ICU admission
- [11] Maternal death
- [12] Mode of delivery and duration of hospital stay

Management protocol:

All patients received standard institutional management, including:

- [1] Antihypertensive medications
- [2] Magnesium sulphate prophylaxis or treatment
- [3] Corticosteroids for fetal lung maturity when indicated
- [4] Maternal and fetal monitoring
- [5] Timely induction of labor or cesarean section

Statistical analysis:

Data were entered into IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation and categorical variables as frequency and percentage. Associations between risk factors and maternal outcomes were assessed using Chi-square or Fisher's exact test. Continuous

variables were compared using Student’s t-test. A p-value <0.05 was considered statistically significant.

Results:

A total of 150 pregnant women diagnosed with pre-eclampsia were included in the present clinical study. The demographic profile, associated risk factors and maternal outcomes were analyzed in detail. The findings demonstrate that pre-eclampsia was more common among women aged 21–30 years and among primigravida mothers. Obesity, anemia and positive family history emerged as important associated risk factors. Rural women represented a larger proportion of affected patients, possibly reflecting disparities in antenatal healthcare access (Table 1). A statistically significant association was observed between severe pre-eclampsia and obesity, primigravida status, diabetes mellitus, anemia and family history of hypertension. Obesity showed the strongest correlation with severe disease (p=0.002), emphasizing the growing contribution of metabolic factors in hypertensive disorders of pregnancy (Table 2). The

study demonstrated substantial maternal morbidity associated with pre-eclampsia. Postpartum hemorrhage and ICU admissions were common adverse outcomes. HELLP syndrome and eclampsia showed strong statistical significance, highlighting the severe multisystem nature of the disease and the importance of early diagnosis and timely management (Table 3).

Table 1: Demographic and clinical characteristics of study participants (n=150)

Variable	Frequency (%)
Age <20 years	23 (15.3%)
Age 21–30 years	84 (56.0%)
Age >30 years	43 (28.7%)
Primigravida	93 (62.0%)
Multigravida	57 (38.0%)
Rural residence	88 (58.7%)
Urban residence	62 (41.3%)
BMI >30 kg/m²	57 (38.0%)
Family history of hypertension	49 (32.7%)
Diabetes mellitus	27 (18.0%)
Anemia	64 (42.7%)

Table 2: Distribution of risk factors and severity of pre-eclampsia

Risk Factor	Severe Pre-Eclampsia n=60 (%)	Mild/Moderate Pre-Eclampsia n=90 (%)	p-value
Obesity (BMI >30 kg/m²)	32 (53.3%)	25 (27.8%)	0.002
Primigravida	43 (71.7%)	50 (55.6%)	0.041
Family history of hypertension	27 (45.0%)	22 (24.4%)	0.008
Diabetes mellitus	16 (26.7%)	11 (12.2%)	0.024
Anemia	33 (55.0%)	31 (34.4%)	0.011

Table 3: Maternal outcomes among women with pre-eclampsia

Maternal Outcome	Frequency (%)	p-value
Postpartum hemorrhage	22 (14.7%)	0.021
Eclampsia	15 (10.0%)	0.004
HELLP syndrome	13 (8.7%)	0.001
Acute kidney injury	9 (6.0%)	0.018
Pulmonary edema	7 (4.7%)	0.031
DIC	4 (2.7%)	0.042
ICU admission	18 (12.0%)	0.003
Maternal mortality	2 (1.3%)	0.048

Discussion:

Pre-eclampsia remains a major cause of maternal morbidity and mortality, especially in LMICs. The age group 21-30 years had the highest incidence of pre-eclampsia in this study. Farahi *et al.* also reported similar results, noting that women in the reproductive age group are more likely to suffer from hypertensive disorders due to the increased metabolic risk factors and delayed detection of antenatal hypertension [2]. Due to underlying vascular dysfunction and metabolic abnormalities, advanced maternal age has also been identified as an independent risk factor for severe disease. The majority of the women in this study were primigravida, which is similar to the results of the literature, where abnormal placentation and immunological maladaptation in first pregnancies were important pathogenic mechanisms [3]. Obesity was a major risk factor and was significantly associated with severe pre-eclampsia. Over half of women who had severe disease were obese. The same has been reported in recent reviews that obesity is associated with endothelial dysfunction, chronic inflammation and oxidative stress and thus to a higher risk of developing hypertensive disorders in pregnancy [5]. The rising burden of

pre-eclampsia worldwide could be partly attributed to the growing obesity rates in reproductive-age women. Severe disease was also significantly associated with family history of hypertension and diabetes mellitus in the present study. Genetic susceptibility and common metabolic pathways are thought to play a role in the vascular dysfunction and placental perfusion abnormalities. Previous studies have also shown that women with chronic hypertension, diabetes, or familial cardiovascular disease have a higher risk of poor pregnancy outcomes [7]. Anaemia was noted in 42.7% of the participants and was statistically significant with severe pre-eclampsia. Maternal anemia can exacerbate placental hypoxia and endothelial injury, which can worsen hypertensive disorders [8]. This association may be further exacerbated by nutritional deficiencies, poor antenatal care and poor socioeconomic conditions in developing countries. In the present study, severe maternal complications were noted such as postpartum hemorrhage, HELLP syndrome, acute kidney injury, pulmonary edema and eclampsia. The incidence of HELLP syndrome was 8.7% in women and showed a very significant relationship with severe hypertension. The same results were found in other studies around the world and HELLP syndrome is one of the most serious complications of hepatic dysfunction, thrombocytopenia and coagulopathy [9]. In the present study, 10.0% of cases were diagnosed with eclampsia. In developed countries, the incidence of seizures has been lowered by the use of magnesium sulphate prophylaxis and better obstetric care, but in resource-limited countries, eclampsia is more common due to delayed referral and poor antenatal monitoring [10]. Hypertensive disorders of pregnancy

remain a significant cause of preventable maternal deaths worldwide, according to the WHO. 12.0% of women required admission to the ICU, mainly for severe hypertension, pulmonary edema and multiorgan dysfunction. This is because pre-eclampsia is a systemic disorder that involves the renal, hepatic, neurological and cardiovascular systems [11]. Recent recommendations focus on the need for aggressive blood pressure control and frequent monitoring to prevent progression to severe disease. In the present study, maternal mortality was 1.3% which is comparatively lower than some of the previous Indian studies, but it is still a serious condition. Better institutional deliveries, early referral systems and improved critical care management could have played a role in reducing mortality rates. But still deaths are preventable due to delayed diagnosis and poor access to specialized obstetric care. Current international recommendations confirm the results of the present study and indicate that obesity; diabetes, chronic hypertension; advanced maternal age and previous hypertension are all significant factors in the development of pre-eclampsia. Hence, early screening and risk stratification in antenatal care is crucial for timely intervention. In recent years, the pathogenesis of pre-eclampsia has been further elucidated, with the importance of angiogenic imbalance, endothelial damage, inflammatory mediators and placental ischemia in the progression of disease emphasized [12]. A recent systematic review and meta-analysis by Alemayehu *et al.* also showed that hypertensive disorders of pregnancy are associated with important adverse maternal and birth outcomes, including eclampsia, HELLP syndrome and acute kidney injury, further emphasizing the importance of early identification and appropriate management of high-risk pregnancies [13]. There is growing interest in the use of biomarkers including sFlt-1/PlGF ratio and machine learning prediction models for early detection of high-risk pregnancies [14, 15]. However, clinical evaluation and urine protein estimation remain the primary means of diagnosis in many developing countries. There have been significant changes in management over the past few years. The current guidelines suggest that strict blood pressure monitoring, magnesium sulphate for seizure prophylaxis and timely deliveries are the definitive treatment for severe disease. The present study confirms these recommendations by showing that women with severe hypertension had more complications. There are some limitations of the study. It was performed in one tertiary care center and may not be representative of the total burden of

disease in the community. Neonatal outcomes were not analyzed in detail. However, the study offers valuable clinical insights into the burden and risk factors of pre-eclampsia in an Indian healthcare context.

Conclusion:

Pre-eclampsia remains a major cause of maternal morbidity, with primigravida status, obesity, anemia, diabetes mellitus and family history of hypertension associated with severe disease. Postpartum hemorrhage, eclampsia, HELLP syndrome and intensive care admission were important maternal complications among affected women. Early antenatal screening, timely diagnosis, effective blood pressure control and prompt referral are essential to reduce maternal complications and mortality.

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