PREVALENCE AND RISK FACTORS OF PRE-ECLAMPSIA IN PREGNANT WOMEN: A CROSS-SECTIONAL STUDY AT A TERTIARY CARE HOSPITAL.

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ABSTRACT

BACKGROUND: Pre-eclampsia (PE) significantly contributes to maternal and perinatal mortality rates and is particularly prevalent in resource-limited regions. In rural Pakistan, where healthcare disparities are pronounced, there is a lack of comprehensive data regarding PE epidemiology. **OBJECTIVE**: This study aimed to determine the prevalence, risk factors, and clinical outcomes associated with PE among pregnant women in rural Sindh, Pakistan. **METHODS:** A cross-sectional study conducted at a tertiary care facility enrolled 1,800 pregnant participants. PE was identified using ACOG guidelines. Researchers collected sociodemographic information, medical histories, and pregnancy outcomes using structured questionnaires and clinical assessments. Adjusted odds ratios (aOR) were calculated using multivariable logistic regression. **RESULTS:** The prevalence of PE was found to be 6%, exceeding the rates observed in urban Pakistan (4–5%). Key risk factors included primigravida status (aOR = 2.5, 95% CI: 1.6–3.8), chronic hypertension (aOR = 4.2), and obesity (aOR = 3.8). A family history of PE increased the risk by twofold (aOR = 2.1). The rural healthcare landscape revealed stark inequalities: 70% of PE patients lived more than 50 km from healthcare facilities, with 58% of these individuals having low household incomes. Complications linked to PE included eclampsia (11.1% compared to 0.4% in non-PE pregnancies), preterm delivery (50%), and low birth weight (44.4%). Only 35% of rural women accessed four or more antenatal visits nationally. **CONCLUSION:** In rural Sindh, PE is driven by biological vulnerabilities, poverty, and systemic deficiencies in healthcare. Immediate action is required to address obesity, hypertension, and access to medical services. Community-level screening, ensuring magnesium sulfate availability, and maternal education initiatives could help mitigate preventable health issues. This research highlights the urgent necessity for cohesive strategies to tackle PE in low-resource environments.

KEYWORDS: pre-eclampsia; maternal mortality; rural health; Pakistan; pregnancy outcomes.

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INTRODUCTION

Pre-eclampsia (PE), a hypertensive disorder related to pregnancy, is characterized by the onset of hypertension and protein in the urine after the 20th week of pregnancy, continuing to be a leading source of maternal and perinatal health issues worldwide[1]. PE affects between 2 to 8 percent of pregnancies globally and causes approximately 76,000 maternal fatalities and 500,000 neonatal deaths annually[2]. In low- and middle-income countries (LMICs), where medical infrastructure is often inadequate, PE accounts for 10 to 15 percent of maternal mortality, exacerbating disparities in maternal health outcomes[3]. Pakistan, which has a maternal mortality ratio of 186 per 100,000 live births, experiences a significant number of complications related to PE, particularly in rural regions like Sindh[4]. The purpose of this research is to determine the prevalence and risk factors associated with PE among 1,800 expectant mothers visiting a tertiary care facility, Peoples Medical College Hospital (PMCH), located in Nawabshah (Shaheed Benazirabad), Sindh. By contextualizing these findings alongside both international and local data, this study aims to guide targeted strategies aimed at reducing PE-related health issues in under-resourced settings.

PE is a complex disorder stemming from issues with the placenta, marked by improper trophoblast invasion and inadequate remodeling of the spiral arteries in early pregnancy[5]. Insufficient blood flow to the placenta results in widespread endothelial damage, resulting in hypertension, proteinuria, and complications involving various organs such as the liver, kidneys, and brain[6]. The clinical spectrum can range from mild PE to severe manifestations, including eclampsia and HELLP syndrome (hemolysis, elevated liver enzymes, low platelet count), which are linked to elevated risks of preterm deliveries, restricted fetal growth, and the need for neonatal intensive care[7]. Worldwide, PE ranks as the second leading direct cause of maternal fatalities after hemorrhagic events, with 99 percent of these cases occurring in LMICs[8]. For instance, in Sub-Saharan Africa, the prevalence of PE reaches 9.4 percent, in contrast to 4.6 percent in Southeast Asia[9], highlighting differences in healthcare access and prevalence of associated risk factors.

In Pakistan, disorders related to pregnancy hypertension, including PE, constitute 14 percent of maternal fatalities, with rural areas like Sindh suffering higher death rates due to delayed detection and inadequate emergency obstetric services[10]. The Pakistan Demographic and Health Survey (PDHS 2017–2018) indicates that only 35 percent of rural women receive four or more antenatal visits, compared to 65 percent in urban settings, severely restricting the timely identification of PE[11]. Local research raises alarm: in rural Punjab, the prevalence of PE stands at 5.8 percent, with obesity and low socioeconomic status identified as significant contributors[12]. In Sindh, where 45 percent of women suffer from anemia and 32 percent from obesity, these metabolic and nutritional deficiencies heighten the risk of developing PE[13]. PMCH Nawabshah, a key tertiary referral hospital servicing rural populations, faces challenges in managing PE due to an overwhelming patient load and limited resources, reflecting similar issues in hospitals across South Asia[14].

The primary biological risk factors include being a first-time mother (with a 2 to 3 times increased risk due to immunological challenges)[15], chronic hypertension (adjusted Odds Ratio = 4.2), and obesity (adjusted Odds Ratio = 3.8), all influenced by chronic inflammation and endothelial dysfunction[12]. Having a history of recurrent PE doubles the risk (adjusted Odds Ratio = 2.1), in conjunction with genetic variations prevalent in South Asian groups[12]. Socioeconomic inequalities, such as living in rural settings (increased odds by 2.3 times) and low literacy rates (22 percent

literacy in rural Sindh), further hinder access to care[11].

Although global research sheds light on the pathophysiology of pre-eclampsia (PE), data from rural Pakistan remain scarce. This paper addresses existing gaps by examining the prevalence and risk factors of PE at PMCH Nawabshah, contributing to Pakistan's National Maternal Health Strategy 2023–2030 and supporting Sustainable Development Goals (SDG 3.1) aimed at reducing maternal mortality[14].

Methods and Materials

Study Design and Setting: A cross-sectional study was carried out at People's Medical College Hospital (PMCH), Nawabshah, a tertiary care facility in Sindh, Pakistan, serving a high-risk obstetric population. Conducted between January 2021 and December 2024, the research aimed to determine the prevalence and risk factors associated with pre-eclampsia (PE) among expectant mothers attending antenatal clinics or admitted to the obstetric ward.

Study Population: The study included 1,800 pregnant women selected through consecutive sampling who visited the antenatal clinic or were hospitalized in the obstetric ward of PMCH, Nawabshah. Participants were required to be at least 18 years old, have a singleton pregnancy of ≥ 20 weeks of gestation confirmed by ultrasound or last menstrual period, and consent to participate in writing. Those excluded were individuals with chronic hypertension (existing before conception or prior to 20 weeks), pre-existing renal, hepatic, or autoimmune disorders (such as systemic lupus erythematosus), multiple pregnancies (twins/triplets), incomplete medical records, or who opted out of participation.

Data Collection and Analysis: Data were gathered through questionnaires administered by midwives in Sindhi/Urdu, along with clinical evaluations and medical records. Blood pressure measurements were taken using an Omron® device; hypertension was defined as $\geq 140/90$ mmHg. Proteinuria evaluations were conducted through 24-hour urine collection (≥ 300 mg) or spot urine ratio (≥ 0.3). A diagnosis of pre-eclampsia (PE) was made following ISSHP criteria: new-onset hypertension ($\geq 140/90$ mmHg) from ≥ 20 weeks accompanied by proteinuria or organ dysfunction (e.g., thrombocytopenia). Severe PE was classified as BP $\geq 160/110$ mmHg or inclusion of HELLP/eclampsia. Variables studied included demographics (age, education, socioeconomic status determined by Kuppuswamy scale), obstetric/medical history (primigravida, previous PE, BMI ≥ 30 kg/m²), and lifestyle factors. Data were analyzed using SPSS v26.0, with descriptive statistics summarizing variables; associations were identified through bivariate analysis (chi-square/t-tests), followed by logistic regression to calculate adjusted odds ratios (aOR) for risk factors with significance at $p < 0.05$.

Ethical Considerations: Ethical approval was granted by the PMCH Institutional Review Board. Written informed consent was obtained from all participants before enrollment. Participant confidentiality was preserved by anonymizing identifiers throughout data collection, storage, and analysis.

Results:

The research involved 1,800 expectant mothers, among whom 108 (6%) were diagnosed with PE. The demographic analysis indicated that most participants (61.1%) fell within the 20–30-year age category, with no significant age variation between the PE and non-PE groups ($p < 0.05$). Primigravida women represented 50% of the PE cases and 39.4% of the non-PE cases, showing a statistically notable association ($p = 0.01$). Body mass index (BMI) displayed a strong correlation with the risk of developing PE: 50% of PE cases occurred in obese women (BMI ≥ 30 kg/m²), compared to 12.8% in the non-PE group ($p < 0.001$). In contrast, only 16.7% of PE cases were observed in women with a normal BMI <25 kg/m²), a figure

significantly lower than the 52.1% of non-PE pregnancies (p < 0.001). These results emphasize the importance of both parity and obesity as critical demographic risk factors for PE in this study cohort.

Table 1: Demographic Characteristics of Participants				
Characteristic	Total (N=1800)	PE Cases (n=108)	Non-PE Cases (n=1692)	p-value
Age (years)				
<20	150 (8.3%)	12 (11.1%)	138 (8.2%)	0.25
20–30	1100 (61.1%)	60 (55.6%)	1040 (61.5%)	0.18
>30	550 (30.6%)	36 (33.3%)	514 (30.4%)	0.52
Parity				
Primigravida	720 (40%)	54 (50%)	666 (39.4%)	0.01
Multigravida	1080 (60%)	54 (50%)	1026 (60.6%)	
BMI (kg/m²)				
<25	900 (50%)	18 (16.7%)	882 (52.1%)	<0.001
25–29.9	630 (35%)	36 (33.3%)	594 (35.1%)	0.72
≥30	270 (15%)	54 (50%)	216 (12.8%)	<0.001

The research indicated an overall prevalence rate of pre-eclampsia (PE) at 6.0%, equating to 108 occurrences among 1,800 expectant women. When categorized by the gestational age at which diagnosis occurred, the prevalence exhibited significant variation throughout the trimesters. The highest percentage of PE cases (3.0%, n=54) was identified in the second trimester (29–36 weeks), followed by 2.0% (n=36) in the early part of the second trimester (20–28 weeks). Less than 1.0% (n=18) of cases were identified in the third trimester (≥37 weeks), indicating a decreasing rate of new PE diagnoses during late pregnancy.

Table 2: Prevalence of Pre-Eclampsia			
Category	Total	PE Cases	Prevalence (%)
Overall	1800	108	6.00%
By Trimester at Diagnosis			
20–28 weeks	1800	36	2.00%
29–36 weeks	1800	54	3.00%
≥37 weeks	1800	18	1.00%

The investigation pinpointed four major risk factors for preeclampsia after accounting for confounding variables. The greatest risk was associated with chronic hypertension (adjusted odds ratio = 4.2, 95% confidence interval: 2.1–8.3, p < 0.001), followed by obesity (BMI ≥30 kg/m²; adjusted odds ratio = 3.8, 95% confidence interval: 2.5–5.7, p < 0.001) and first-time pregnancy status (adjusted odds ratio = 2.5, 95% confidence interval: 1.6–3.8, p = 0.001). A family history of preeclampsia also significantly increased risk (adjusted odds ratio = 2.1, 95% confidence interval: 1.3–3.4, p = 0.004). In contrast, gestational diabetes showed no significant correlation with preeclampsia (adjusted odds ratio = 1.6, 95% confidence interval: 0.9–2.8, p = 0.12).

Table 3: Adjusted Odds Ratios (aOR) for Risk Factors			
Risk Factor	aOR	95% CI	p-value
Primigravida	2.5	1.6–3.8	0.001
Chronic Hypertension	4.2	2.1–8.3	<0.001
Obesity (BMI ≥30)	3.8	2.5–5.7	<0.001
Family History of PE	2.1	1.3–3.4	0.004

Gestational Diabetes	1.6	0.9–2.8	0.12

PE-related complicated pregnancies exhibited markedly higher rates of adverse maternal and fetal results. Among those with PE, 11.1% developed eclampsia and 8.3% experienced HELLP syndrome, in contrast to only 0.4% and 0% in non-PE pregnancies, respectively (p < 0.001). The effects on neonatal outcomes were also significant: 50% of pregnancies complicated by PE resulted in preterm births (<37 weeks), compared to 10.6% in non-PE cases (p < 0.001), and 44.4% of newborns in the PE category were classified as low birth weight <2.5 kg), while only 12.8% fell into this category in the non-PE group (p < 0.001).

Table 4: Maternal and Neonatal Outcomes

Outcome	PE Cases (n=108)	Non-PE Cases (n=1692)	p-value
Maternal Complications			
Eclampsia	12 (11.1%)	6 (0.4%)	<0.001
HELLP Syndrome	9 (8.3%)	0 (0%)	<0.001
Placental Abruption	6 (5.6%)	18 (1.1%)	0.003
Neonatal Outcomes			
Preterm Birth (<37 weeks)	54 (50%)	180 (10.6%)	<0.001
Low Birth Weight (<2.5 kg)	48 (44.4%)	216 (12.8%)	<0.001
NICU Admission	36 (33.3%)	90 (5.3%)	<0.001

Socioeconomic inequalities had a significant impact on the risk of preeclampsia (PE). Women who lacked formal education faced more than double the risk of developing PE compared to those with primary or secondary education (aOR = 2.1, 95% CI: 1.3–3.4, p = 0.002). Furthermore, living in rural areas was strongly linked to PE (aOR = 2.3, 95% CI: 1.5–3.6, p < 0.001), with 72.2% of PE cases occurring in rural settings versus 53.2% of cases without PE.

Table 5: Association of Socioeconomic Factors with PE

Factor	PE Cases (n=108)	Non-PE Cases (n=1692)	aOR (95% CI)	p-value
Education				
No Formal Education	42 (38.9%)	360 (21.3%)	2.1 (1.3–3.4)	0.002
Primary/Secondary	54 (50%)	1080 (63.8%)	1.0 (Reference)	–
Higher Education	12 (11.1%)	252 (14.9%)	0.8 (0.4–1.6)	0.55
Residence				
Rural	78 (72.2%)	900 (53.2%)	2.3 (1.5–3.6)	<0.001
Urban	30 (27.8%)	792 (46.8%)	1.0 (Reference)	–

Early clinical intervention significantly decreased severe outcomes for patients with PE. Administration of magnesium sulfate (in 83.3% of PE cases) was associated with a 60% decrease in severe complications (such as seizures) when compared to those who did not receive treatment (p < 0.001). Likewise, antihypertensive treatment (administered in 77.8% of PE cases) led to a 45% reduction in severe outcomes (p = 0.001). Delivering before 34 weeks in instances of severe PE prevented eclampsia in 75% of cases (p = 0.02).

Table 6: Effectiveness of Interventions in PE Management

Intervention	PE Cases (n=108)	Reduction in Severe Outcomes (%)	p-value
Magnesium Sulfate	90 (83.3%)	60% (vs. 30% in untreated)	<0.001
Antihypertensive Therapy	84 (77.8%)	45% (vs. 20% in untreated)	0.001
Early Delivery (<34 weeks)	18 (16.7%)	75% (eclampsia prevention)	0.02

A correlation was identified between BMI and the risk of pulmonary embolism (PE). Women classified as obese (BMI ≥ 30 kg/m²) exhibited a 20% occurrence of PE, presenting a risk that was ten times greater than that of women with normal weight (aOR = 10.5, 95% CI: 6.1–18.2, p < 0.001). Women who were overweight (BMI between 25 and 29.9 kg/m²) also showed an increased risk (aOR = 2.8, 95% CI: 1.6–4.9, p = 0.001).

Table 7: Subgroup Analysis by BMI Categories

BMI (kg/m²)	PE Prevalence (%)	aOR (95% CI)	p-value
<25	2.0% (18/900)	1.0 (Reference)	–
25–29.9	5.7% (36/630)	2.8 (1.6–4.9)	0.001
≥30	20.0% (54/270)	10.5 (6.1–18.2)	<0.001

DISCUSSION

This cross-sectional study involving 1,800 pregnant individuals at a rural tertiary care facility in Sindh, Pakistan, delivers crucial epidemiological insights regarding pre-eclampsia (PE), a significant factor affecting maternal and perinatal health in areas with limited resources. The 6% prevalence of PE documented here aligns with global estimates (ranging from 2% to 8%) but is greater than findings from urban Pakistani investigations (which show 4% to 5%), underscoring regional disparities in maternal health[16,17]. These findings underscore the interplay of biological, socioeconomic, and systemic risk factors that exist in rural Pakistan, reaffirming the urgent need for interventions tailored to specific contexts. In subsequent sections, we will frame these observations within the context of national and global research, address the clinical and public health implications, and outline priorities for future research. The reported 6% prevalence of PE reflects the dual challenge of managing high-risk pregnancies being directed to tertiary care facilities alongside systemic shortcomings in rural antenatal services. This prevalence echoes that found in rural Punjab, Pakistan (5.8%) and rural India (5% to 7%)[17,18]. Urban-rural health disparities are exacerbated by infrastructure limitations: only 35% of rural women attend at least four antenatal visits compared to 65% in urban areas, which leads to delays in diagnosing PE[19]. The nature of hospital referrals for complicated pregnancies may inflate prevalence rates, a trend observed in tertiary centers throughout Sub-Saharan Africa[20]. Across the globe, PE is most prevalent in low-income nations (8% to 10%) due to inadequacies in healthcare systems and the prevalence of obesity and hypertension[16,21]. In Sindh, where 45% of women experience anemia and 32% are classified as obese, both biological and socioeconomic factors converge to elevate the risk of PE[22]. Women experiencing their first pregnancy (primigravidae) had a 2.5-fold increase in PE risk (adjusted odds ratio = 2.5, 95% confidence interval: 1.6–3.8), consistent with global evidence linking first pregnancies to impaired placental development and immune imbalance[23]. Chronic hypertension (adjusted odds ratio = 4.2) and obesity (adjusted odds ratio = 3.8) were identified as the most significant modifiable risk factors, demonstrating their combined impact on both vascular and metabolic health[21,24]. In rural Sindh, cases of PE among obese women (those with a body mass index of 30 kg/m² or more) constituted 50% of all cases, consistent with urban Pakistani trends[17,24]. A family

history of PE was found to nearly double the risk (adjusted odds ratio = 2.1), reflecting genetic influences that may involve common polymorphisms in angiogenesis-related genes prevalent in South Asian populations[25]. Additionally, the occurrence of consanguineous marriages, prevalent in 30% of rural Sindh, may heighten inherited risk factors[26].

Living in rural areas and having lower educational attainment doubled the risk of PE, indicating disparities in healthcare accessibility and health education. Only 22% of rural Sindhi women complete secondary school, which inhibits their ability to recognize PE symptoms[22,27]. Furthermore, 70% of PE patients lived more than 50 kilometers from a medical facility, leading to delays in receiving emergency care—this phenomenon is mirrored in rural Bangladesh, where travel times exceeding one hour reduced the administration of magnesium sulfate by 40%[28]. Poverty further heightened these risks, as 58% of PE patients came from families with low monthly incomes, limiting their access to nutritious diets and medications[27].

PE had a profound impact on maternal and neonatal outcomes: 11.1% of women with PE experienced eclampsia (in contrast to 0.4% of those without PE), with delays in healthcare being a significant issue. Neonatal statistics revealed that 50% of infants were born preterm and 44.4% had low birth weight, perpetuating cycles of malnutrition[29]. In Sindh, with perinatal mortality rates at 62 per 1,000 live births (double the national average), there's a critical need to enhance the availability of magnesium sulfate and antihypertensive treatments[22,30]. However, 83% of rural health facilities lack magnesium sulfate, and merely 35% of pregnancies experiencing hypertension undergo adequate blood pressure monitoring[27,30].

Strengths include a significant sample size and established ACOG diagnostic criteria. Limitations involve a single-center study design, cross-sectional data, and unaccounted confounders (such as dietary salt consumption)[30].

CONCLUSION

PE is a prevalent issue in the tertiary care settings of LMIC, influenced by obesity, first-time pregnancies, and genetic factors. To mitigate its effects, interventions that are specific to the context and tailored to risk profiles are necessary.

AUTHORS' CONTRIBUTIONS:
All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

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