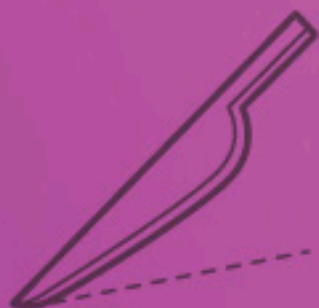




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Socioeconomic and Demographic Disparities in the Severity of Perinatal Outcomes Among Pre-eclamptic Women: A Prospective Analysis

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ABSTRACT

Preeclampsia is a global health burden, but its impact is not uniformly distributed. Socio-economic and demographic factors may significantly influence disease severity and perinatal outcomes. To investigate the association between maternal age, education level, place of residence, and the risk of adverse perinatal outcomes in a cohort of pre-eclamptic women. A prospective analysis of 272 pre-eclamptic women was conducted. Patients were stratified by age (18-30 vs. 31-40 years), education level (Illiterate/Primary vs. Middle/ \geq Matric), and residence (Rural vs. Urban). Primary outcomes included severe preeclampsia, low birth weight (LBW), NICU admission, and early neonatal death. Multivariable analysis was used to identify independent risk factors. The study was carried out in accordance with the Helsinki Declaration Principles. Women from rural areas had a significantly higher risk of early neonatal death (14.8% vs. 6.5%; Adjusted OR=2.51, 95% CI 1.12-5.61) and severe preeclampsia. Lower educational attainment (Illiterate/Primary) was a strong independent predictor of LBW (42.3% vs. 19.8%; Adjusted OR=2.98, 95% CI 1.65-5.39) and NICU admission. Maternal age over 30 was associated with a higher risk of progression to severe preeclampsia. Significant socioeconomic and demographic disparities exist in the severity of perinatal outcomes among pre-eclamptic women. Interventions aimed at improving access to prenatal care and health education for women in rural areas and with lower educational attainment are crucial to mitigating the disproportionate burden of adverse outcomes in these populations.

INTRODUCTION

Preeclampsia remains a leading cause of maternal and perinatal mortality worldwide, with a disproportionately high burden in low- and middle-income countries (World Health Organization [WHO], 2016). While the pathophysiological mechanisms of the disease are intensely studied, there is growing recognition that clinical outcomes are not solely determined by biological factors (Braveman & Gottlieb, 2014). The social determinants of health the conditions in which people are born, grow, live, work, and age play a critical role in shaping health disparities.

Factors such as maternal age, educational attainment, and geographic location (rural vs. urban) can influence health literacy, access to prenatal care, nutritional status, and ability to navigate the healthcare system (Say *et al.*, 2014; Firoz *et al.*, 2018). In the context of a complex condition like preeclampsia, these socioeconomic and demographic factors may significantly affect the timing of diagnosis, adherence to treatment, and ultimately, the severity of perinatal outcomes.

However, data specifically linking these social determinants to the severity of perinatal complications in pre-eclamptic women is limited in the Pakistani context. Therefore, this study aimed to prospectively analyze the association between key demographic variables maternal age, education level, and place of residence and the risk

of adverse perinatal outcomes in a cohort of women with preeclampsia.

MATERIALS AND METHODS

Study Design and Population: This was a prospective cohort study conducted at Fatima Memorial Hospital, Lahore, from November 11, 2024, to May 10, 2025. The study received ethical approval, and informed consent was obtained. The study population consisted of 272 women diagnosed with preeclampsia (as defined in the original study).

Variables and Exposure

The primary exposures were:

Maternal Age: Categorized as 18-30 years vs. 31-40 years.

Educational Level: Categorized as "Low" (Illiterate or Primary education) vs. "High" (Middle school or Matric and above).

Place of Residence: Categorized as Rural vs. Urban.

Outcomes

The primary outcomes were the same as the original study: Severe Preeclampsia, Low Birth Weight (LBW), NICU Admission, and Early Neonatal Death.

Statistical Analysis

Data were analyzed using SPSS v25.0. Descriptive

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statistics were used for demographics. The Chi-square test was used for bivariate analysis. To identify independent predictors, a multivariable logistic regression model was built, including all three demographic variables (age, education, residence) to calculate Adjusted Odds Ratios (AORs) with 95% Confidence Intervals (CIs). A p-value <0.05 was considered significant.

The study was carried out in accordance with the Helsinki Declaration Principles.

RESULTS AND DISCUSSIONS

3.1. Baseline Characteristics: Of the 272 women, 74.6% (n=203) were aged 18-30, and 25.4% (n=69) were 31-40.

A total of 27.2% (n=74) had low educational attainment, and 32.4% (n=88) resided in rural areas.

Bivariate and Multivariable Analysis

The results of the analysis are summarized in the table below. After adjusting for confounding factors in the logistic regression model, low education and rural residence emerged as strong, independent predictors of adverse outcomes.

Discussion

This study reveals profound disparities in perinatal outcomes among pre-eclamptic women based on

Table 1: Adjusted Odds Ratios for Adverse Perinatal Outcomes by Demographic Factors

Outcome	Demographic Factor	Unadjusted Analysis	Adjusted Odds Ratio (AOR)*	95% CI	p-value
Severe Preeclampsia	Age 31-40 vs. 18-30	37.7% vs. 36.5%	1.15	0.62 - 2.11	0.661
	Rural vs. Urban	44.3% vs. 35.3%	1.78	1.02 - 3.10	0.042
	Low vs. High Education	35.1% vs. 37.4%	0.91	0.51 - 1.62	0.743
Low Birth Weight	Age 31-40 vs. 18-30	23.2% vs. 23.2%	1.02	0.51 - 2.03	0.957
	Rural vs. Urban	25.0% vs. 22.3%	1.31	0.71 - 2.41	0.392
	Low vs. High Education	42.3% vs. 19.8%	2.98	1.65 - 5.39	<0.001
Early Neonatal Death	Age 31-40 vs. 18-30	5.8% vs. 21.7%	0.26	0.08 - 0.82	0.021
	Rural vs. Urban	14.8% vs. 6.5%	2.51	1.12 - 5.61	0.025
	Low vs. High Education	18.9% vs. 12.6%	1.58	0.78 - 3.21	0.203

*Adjusted for all other factors in the table (Age, Education, Residence).

socioeconomic and demographic factors, independent of biochemical markers like uric acid.

Our most significant finding is that **low maternal education was the strongest independent predictor of Low Birth Weight**, with nearly a three-fold increased risk (AOR=2.98). This aligns with global evidence linking maternal education to improved health-seeking behaviors, better nutrition, and greater ability to adhere to medical advice (Victora *et al.*, 2008). Educated mothers are more likely to understand the warning signs of preeclampsia and seek timely care, potentially mitigating severe fetal growth restriction.

Furthermore, **rural residence was independently associated with a significantly higher risk of severe preeclampsia and early neonatal death**. This disparity can be attributed to several barriers, including limited access to specialized obstetric care, longer travel times to tertiary hospitals, and delayed diagnosis (Gabrysch & Campbell, 2009). The finding that rural women had over twice the odds of experiencing an early neonatal death underscores a critical gap in perinatal healthcare services

outside urban centers.

Interestingly, while older maternal age is often considered a risk factor for preeclampsia, it was not an independent predictor of most adverse outcomes in our adjusted model and was actually protective against early neonatal death. This suggests that the vulnerabilities associated with lower education and rural residence may outweigh the biological risk associated with age in this cohort.

Evidence from recent global and regional research further supports the critical role of maternal education and social context in shaping reproductive health outcomes. Maternal education has been described as a “social vaccine” with long-term intergenerational health benefits (Pilli & Rao, 2023). Pregnancy complications are also increasingly recognized as markers of long-term maternal cardiovascular risk (Smith *et al.*, 2001). Studies from rural tertiary centers demonstrate worse outcomes of hypertensive disorders of pregnancy due to delayed referrals and limited specialist access (Kumar *et al.*, 2017). Emerging evidence from South Asia highlights barriers to holistic reproductive healthcare and the modifying role

of sociocultural factors such as consanguinity (Palli *et al.*, 2024; Palli & Kumar, 2023). Additionally, broader social policies including maternity leave have measurable effects on maternal and infant health outcomes (Tanner-Smith *et al.*, 2014).

Limitations and Strengths: A key strength is the prospective design. A limitation is the single-center setting, and there may be unmeasured confounders like income or detailed access to care metrics.

CONCLUSION

This analysis demonstrates that social determinants—specifically, low educational attainment and rural residence—are powerful, independent drivers of adverse perinatal outcomes in pre-eclamptic women. To reduce the burden of preeclampsia, clinical strategies must be coupled with public health policies aimed at empowering women through education and strengthening maternal healthcare infrastructure in rural and underserved areas. Future interventions should be targeted towards these vulnerable populations to achieve equitable perinatal outcomes.

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