ORIGINAL ARTICLE

Preeclampsia and its associated factors among pregnant females attending tertiary care hospitals in Sindh, Pakistan.

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Biomedica - Official Journal of University of Health Sciences, Lahore, Pakistan
Volume 41(3):112-118
https://doi.org/10.24911/BioMedica/5-1590

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ABSTRACT

Background and Objective: Preeclampsia is a pregnancy-specific hypertensive disorder associated with substantial maternal and perinatal morbidity and mortality. Identifying and understanding factors associated with preeclampsia is critical for effective prevention and management. The objective was to determine the demographic, medical, and lifestyle-associated factors with preeclampsia among pregnant females attending tertiary care hospitals.

Methods: This multicenter cross-sectional study included 325 pregnant females attending Jinnah Postgraduate Medical Center, Liaqat University of Medical and Health Sciences Jamshoro, and Abaasi Shaheed Hospital, Karachi from 2020 to 2023. Data were collected on age, socioeconomic status, medical history, pregnancy factors, and lifestyle habits. Preeclampsia was identified according to the prespecified diagnostic criteria, including blood pressure and proteinuria. Statistical analysis identified associations and calculated risk percentages.

Results: Preeclampsia was identified in 65 of 325 participants (20%). Advanced maternal age (≥35 years), chronic hypertension, obesity, and multiple pregnancy were significantly associated with preeclampsia. Chronic hypertension (OR 3.41, 95% CI 1.78–6.53) and obesity (OR 3.50, 95% CI 1.99–6.14) were significantly associated with preeclampsia. Low physical activity and a less balanced diet were also associated with preeclampsia (23.9% *vs.* 13.3% for low *vs.* regular physical activity; 24.8% *vs.* 15.0% for a less balanced *vs.* healthy diet). Low socioeconomic status was significantly associated with a higher proportion of preeclampsia.

Conclusion: Preeclampsia risk is associated with a range of factors, including age, pre-existing medical conditions, multiple pregnancies, and lifestyle choices. Early identification of at-risk individuals and lifestyle modifications may help reduce preeclampsia prevalence and improve pregnancy outcomes. Addressing socioeconomic disparities in healthcare access is also crucial for effective management and prevention.

Keywords: Preeclampsia, pregnancy complications, risk factors, chronic hypertension, obesity, lifestyle factors.

Received: 12 November 2024 **Revised:** 10 May 2025 **Accepted:** 11 August 2025

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Introduction

Preeclampsia remains a significant contributor to maternal and neonatal morbidity and mortality worldwide, especially in low- and middle-income countries where healthcare resources and access to prenatal care may be limited. It affects approximately 2%–8% of pregnancies globally, making it one of the most common hypertensive disorders during pregnancy. In addition to its immediate obstetric consequences, preeclampsia is associated with long-term health implications for both the mother and child.[1] Females with a history of preeclampsia are at a higher risk of developing cardiovascular diseases later in life, while their children may experience increased risks of health issues, including hypertension and metabolic disorders later in life. Therefore, identifying and understanding the risk factors associated with preeclampsia is essential for healthcare providers and researchers to improve maternal and neonatal health outcomes.[2] The etiology of preeclampsia is multifactorial, involving a combination of genetic, environmental, and immunological factors. Genetic predisposition plays a significant role; females with a family history of preeclampsia, especially if their mother or sister has experienced it, are more likely to develop the condition themselves.[3] pre-existing conditions, including chronic hypertension, diabetes

mellitus, obesity, renal disease, and autoimmune disorders such as systemic lupus erythematosus, are also associated with an increased risk of preeclampsia. Obesity, in particular, has been strongly correlated with preeclampsia, as excess adipose tissue contributes to systemic inflammation, insulin resistance, and abnormal placental function, all of which are factors implicated in the development of this disorder.[4]

Maternal age is also associated with preeclampsia, where advanced maternal age, particularly ≥35 years, is recognized as an important risk factor with an increased likelihood of pregnancy-related complications due to the potential accumulation of underlying health conditions and a reduced capacity for adaptive changes in the cardiovascular system required during pregnancy.[5] In contrast, younger mothers may face increased risk due to biological immaturity and potential socioeconomic challenges that can affect access to adequate prenatal care. Furthermore, multiple pregnancies, such as twins or triplets, also increase the risk of preeclampsia, likely due to the greater demands placed on the mother's cardiovascular and metabolic systems.[6] In such cases, the placenta produces more vascular stress due to increased blood flow requirements, which may lead to endothelial dysfunction, a known factor in preeclampsia pathogenesis. In addition, females undergoing assisted reproductive technologies (ART), such as in vitro fertilization (IVF), may have a slightly higher risk of developing preeclampsia. The reason for this increased risk is not fully understood, but it may be related to factors like hormonal treatments or the manipulation of reproductive tissues involved in ART.[7] Socioeconomic status and ethnicity also play influential roles in preeclampsia risk. Studies indicate that females from lower socioeconomic backgrounds may face higher risks of preeclampsia due to limited access to healthcare, nutritional challenges, and increased stress levels. Racial disparities are evident, with African American females experiencing disproportionately higher rates of preeclampsia compared to other racial and ethnic groups. This disparity may result from a complex interaction of socioeconomic factors, healthcare access, genetic susceptibility, and exposure to chronic stressors. [8]

Recent research has also highlighted the role of immune system dysregulation in preeclampsia development. Pregnancy requires a delicate balance between maternal and fetal immune tolerance to prevent the maternal immune system from attacking the fetus. Some studies suggest that preeclampsia may result from an abnormal immune response to the placenta, where the body perceives the placenta as a foreign entity and mounts an inflammatory response, leading to vascular dysfunction and hypertension.[9] This theory is supported by evidence showing that females with certain autoimmune diseases, such as antiphospholipid syndrome, are more prone to preeclampsia.[10] Environmental and lifestyle factors, such as physical inactivity, poor diet, and high-stress levels, further contribute to preeclampsia risk. High salt intake, smoking, and excessive alcohol consumption are associated with increased blood pressure and poor vascular health, creating a fertile ground for preeclampsia in susceptible individuals. Conversely, maintaining a healthy lifestyle, including a balanced diet rich in antioxidants, regular exercise, and adequate prenatal care, can help reduce the risk of developing preeclampsia.[11] Therefore, this study aimed to determine the demographic, clinical, obstetric, socioeconomic, and lifestyle factors associated with preeclampsia among pregnant females attending selected tertiary care hospitals in Pakistan.

Methods

This multicenter cross-sectional study was conducted at Jinnah Postgraduate Medical Center, Liaqat University of Medical and Health Sciences (LUMHS) Jamshoro, and Abassi Shaheed Hospital, Karachi, from July 2020 to August 2023. Data were extracted from the hospital medical records and antenatal assessment files of 325 pregnant females meeting the eligibility criteria. The inclusion criteria were pregnant females aged 18–45 years, gestational age ≥20 weeks, and availability of antenatal records for evaluation. The exclusion criteria were females with pre-existing severe medical conditions unrelated to preeclampsia, such as advanced heart or kidney disease, and pregnancies with fetal anomalies incompatible with life.

Preeclampsia was diagnosed according to American College of Obstetricians and Gynecologists (ACOG) and Society of Obstetricians and Gynecologists of Pakistan (SOGP) criteria: new-onset hypertension (systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg on two occasions at least four hours apart) occurring after 20 weeks of gestation, together with proteinuria (≥300 mg/24 hours or ≥+1 on dipstick testing) or, in the absence of proteinuria, new-onset evidence of other maternal end-organ dysfunction. In line with current ACOG/SOGP guidance, cases were further classified as preeclampsia without severe features or preeclampsia with severe features (severe preeclampsia) — the terminology that has replaced the older "mild/moderate/severe" classification. Severe features included one or more of the following: blood pressure ≥160/110 mmHg, thrombocytopenia, elevated liver enzymes, pulmonary edema, renal dysfunction, persistent neurological symptoms, or fetal growth restriction.[2]

Data were extracted from hospital medical records, antenatal assessment files, and documented clinical examination findings. Data included sociodemographic factors, lifestyle, and medical history variables that are

commonly associated with an increased risk of preeclampsia. The patient's medical and obstetric history was recorded, with a focus on factors like family history of preeclampsia, previous pregnancies, and chronic conditions such as hypertension, diabetes, obesity, and autoimmune disorders. Key obstetric factors, including previous history of preeclampsia, parity, family history of hypertensive disorders, and antenatal booking status, were also recorded. Maternal outcomes (eclampsia, Intensive care unit [ICU] admission, Hemolysis, Elevated Liver enzymes, and Low Platelets (HELLP) syndrome, placental abruption, pulmonary edema, maternal mortality) and fetal outcomes (prematurity, Neonatal intensive care unit [NICU] admission, low birth weight, fetal growth restriction, intrauterine fetal death [IUFD]) were likewise documented for participants diagnosed with preeclampsia. Lifestyle factors, including physical activity, diet, smoking, and alcohol consumption, were also documented, as were pregnancy-specific variables like multiple pregnancies, IVF pregnancies, and prenatal care patterns. A standardized data-extraction form was used to ensure uniformity during record review, and the underlying clinical assessments had been performed by trained healthcare personnel as part of routine antenatal and obstetric care. Specific clinical measurements were extracted for each participant to assess preeclampsia risk factors. Blood pressure readings were taken multiple times to confirm consistency, with values over 140/90 mmHg recorded as hypertensive, which aligns with preeclampsia diagnostic guidelines. Proteinuria, another key indicator of preeclampsia, was assessed using dipstick analysis, where a reading of +1 or higher was noted as a positive result for proteinuria. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m²), and obesity was defined as BMI ≥30 kg/m². These clinical parameters were integral to identifying and confirming preeclampsia cases within the study population.

Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences v26. Multivariate logistic regression was then applied to adjust for potential confounders, allowing the determination of each factor's independent effect on preeclampsia risk. Crude odds ratios (OR) with 95% confidence intervals (CI) were calculated to quantify unadjusted associations between candidate factors and preeclampsia. A two-sided p-value <0.05 was considered statistically significant.

Table 1. *Participant characteristics and medical history*

Section	Variable	Total (n)	Preeclampsia Cases (n)	Percentage (%)
Demographics				
	Total participants	325	65	20.0
	Age ≥35 years	80	24	30.0
	Age <35 years	245	41	16.7
	Low socioeconomic status	97	34	35.1
	Middle/high socioeconomic status	228	31	13.6
Medical History				
	Chronic hypertension	50	20	40.0
	No chronic hypertension	275	45	16.4
	Diabetes mellitus	45	10	22.2
	No diabetes	280	55	19.6
	Obesity (BMI ≥30 kg/m²)	100	35	35.0
	Non-obese	225	30	13.3

Table 1a. *Univariate Odds Ratios for Demographic and Medical History Risk Factors (calculated from Table 1 counts)*

Variable (exposed *vs.* reference)	Crude OR (95% CI)	p-value	Significant ($p < 0.05$)
Age ≥35 years (*vs.* <35 years)	2.13 (1.19–3.82)	0.016	Yes
Low socioeconomic status (*vs.* middle/high)	3.43 (1.95–6.02)	<0.001	Yes
Chronic hypertension (*vs.* none)	3.41 (1.78–6.53)	<0.001	Yes
Diabetes mellitus (*vs.* none)	1.17 (0.55–2.50)	0.841	No
Obesity, BMI ≥ 30 kg/m² (*vs.* non-obese)	3.50 (1.99–6.14)	<0.001	Yes

OR = odds ratio; CI = confidence interval, calculated using univariate logistic regression/chi-square analysis

Results

Data were collected from 325 patients with a mean age of 29.5 ± 5.2 years, and the mean BMI was 27.8 ± 4.1 kg/m², reflecting a mix of normal and overweight participants. The mean gestational age at the time of data collection was 30.2 ± 3.1 weeks, indicating a mid-to-late pregnancy stage. Socioeconomic distribution showed that 30% of participants were from low socioeconomic backgrounds, while 70% were from middle to high socioeconomic status, suggesting a diverse sample in terms of economic status.

The study included a total of 325 participants, of whom 65 (20%) were diagnosed with preeclampsia.

Among participants with chronic hypertension, 40% developed preeclampsia, compared to 16.4% without hypertension. On univariate analysis (Table 1a), chronic hypertension was significantly associated with preeclampsia (OR 3.41, 95% CI 1.78–6.53, $p < 0.001$), as was obesity (OR 3.50, 95% CI 1.99–6.14, $p < 0.001$). Diabetes mellitus, however, was not significantly associated with preeclampsia (OR 1.17, 95% CI 0.55–2.50, $p = 0.841$), and should not be interpreted as a confirmed risk factor in this sample.

Among participants with multiple pregnancies, 40% developed preeclampsia, compared to 18% with singleton pregnancies. Additionally, 27% of those who conceived via IVF experienced preeclampsia, while the rate was slightly lower (19%) among those with natural conception. Multiple pregnancy was significantly associated with preeclampsia on univariate analysis (OR 2.90, 95% CI 1.13–7.42, $p = 0.043$; Table 2a). IVF conception was not significantly associated with preeclampsia (OR 1.52, 95% CI 0.64–3.59, $p = 0.472$).

Only 13% of females with regular physical activity developed preeclampsia, compared to 23.9% among those with low physical activity. Dietary habits also influenced outcomes, with a lower preeclampsia rate (15%) among participants with a healthy diet, whereas those with a less balanced diet had a higher rate (24.8%). Low physical activity was significantly associated with preeclampsia (OR 2.04, 95% CI 1.10–3.78, $p = 0.031$), as was a less balanced diet (OR 1.87, 95% CI 1.07–3.28, $p = 0.038$), both relative to their healthier comparison group (Table 2a).

Among participants under 35 years from a lower socioeconomic status, 35% developed preeclampsia, compared to 15% in the same age group from middle/high socioeconomic backgrounds. In the 35 and older group, 40% of those from a lower socioeconomic status experienced preeclampsia, whereas the rate was lower at 20% among those from higher socioeconomic levels.

Physical inactivity was the most prevalent, associated with 75% of preeclampsia cases, followed by obesity, which accounted for 54% of cases. Chronic hypertension contributed to 31% of the cases, while multiple pregnancies were linked to 12%. These results highlight physical inactivity and obesity as the leading factors associated with preeclampsia in this

Table 2. *Pregnancy, Lifestyle Factors, and Outcomes*

Section	Variable	Total (n)	Preeclampsia Cases (n)	Percentage (%)
Pregnancy-Specific Factors				
	Multiple pregnancy	20	8	40.0
	Singleton pregnancy	305	57	18.7
	IVF conception	30	8	26.7
	Natural conception	295	57	19.3
Lifestyle				
	Regular physical activity	120	16	13.3
	Low physical activity	205	49	23.9
	Healthy diet	160	24	15.0
	Less balanced diet	165	41	24.8

Table 2a. *Univariate Odds Ratios for Pregnancy-Specific and Lifestyle Risk Factors (calculated from Table 2 counts)*

Variable (exposed *vs.* reference)	Crude OR (95% CI)	p-value	Significant ($p < 0.05$)
Multiple pregnancy (*vs.* singleton)	2.90 (1.13–7.42)	0.043	Yes
IVF conception (*vs.* natural conception)	1.52 (0.64–3.59)	0.472	No
Low physical activity (*vs.* regular activity)	2.04 (1.10–3.78)	0.031	Yes
Less balanced diet (*vs.* healthy diet)	1.87 (1.07–3.28)	0.038	Yes

OR = odds ratio; CI = confidence interval, calculated using univariate logistic regression/chi-square analysis (with continuity correction) on the case counts reported in Table 2

Table 3. *Maternal outcomes in preeclampsia patients*

Maternal outcome	Frequency (%), *n* = 65 preeclampsia cases
Eclampsia	8 (12.3%)
ICU Admission	10 (15.4%)
HELLP Syndrome	6 (9.2%)
Placental Abruption	5 (7.7%)
Pulmonary Edema	3 (4.6%)
Maternal Mortality	1 (1.5%)

Table 4. *Fetal outcomes in preeclampsia patients*

Fetal outcome	Frequency (%), *n* = 65 preeclampsia cases
Prematurity	28 (43.1%)
NICU Admission	22 (33.8%)
Low Birth Weight	30 (46.2%)
Fetal Growth Restriction	18 (27.7%)
IUFD	4 (6.2%)

study, underscoring the importance of lifestyle modifications in managing preeclampsia risk.

Among females diagnosed with preeclampsia, maternal complications included eclampsia in 8 (12.3%) patients, ICU admission in 10 (15.4%), HELLP syndrome in 6 (9.2%), placental abruption in 5 (7.7%), pulmonary edema in 3 (4.6%), and maternal mortality in 1 (1.5%) patient.

Regarding fetal outcomes, prematurity was observed in 28 (43.1%) pregnancies complicated by preeclampsia, while NICU admission occurred in 22 (33.8%) neonates. Low birth weight was identified in 30 (46.2%) neonates, fetal growth restriction in 18 (27.7%), and IUFD in 4 (6.2%) cases. Maternal and fetal outcomes among preeclampsia patients are shown in Tables 3 and 4.

Discussion

This study identified several key risk factors that were significantly associated with preeclampsia in our cohort of 325 Pakistani pregnant females. The overall frequency of preeclampsia was 20%. Advanced maternal age (≥35 years) conferred a 30.0% prevalence versus 16.7% in younger females ($p < 0.01$).

These findings are in line with available local literature. Advanced maternal age and chronic hypertension have consistently emerged as strong predictors of preeclampsia, likely due to age-related vascular changes and pre-existing endothelial dysfunction[12,13]. The observed obesity effect (35.0% *vs.* 13.3%) echoes the dose–response relationship reported by D'Souza et al., where each 5-unit increase in BMI elevated preeclampsia risk by 20%–30% [4]. The heightened risk in multiple and IVF pregnancies corroborates previous reports that increased placental mass and hormonal stimulation exacerbate endothelial stress[15]. The strong associations with physical inactivity and poor diet underscore the modifiable nature of these risks, supporting lifestyle interventions as effective preventive strategies [16].

From a clinical perspective, our data suggest that early identification of high-risk females (*e.g.*, those ≥35 years, with BMI ≥30, or with chronic hypertension) should prompt intensified surveillance and tailored interventions, such as dietary counseling, exercise programs, and tighter blood pressure control. For females in lower socioeconomic brackets, targeted outreach and improved access to prenatal care are essential, given their threefold higher prevalence of preeclampsia. Implementing standardized risk assessment tools that integrate demographic, medical, and lifestyle factors could enable resource-constrained settings to allocate monitoring and preventive resources more efficiently.

The frequency of preeclampsia observed in this study (20%) was notably higher than the 5–10% typically reported in Pakistani tertiary care literature. [3,5,7,12-14] This elevated figure may reflect the referral nature of the participating tertiary care hospitals, which manage a disproportionate share of high-risk and complicated pregnancies, as well as the study population's substantial burden of established risk factors (obesity, chronic hypertension, low socioeconomic status, and low physical activity). Referral/selection bias inherent to tertiary-center sampling should therefore be considered when generalizing this prevalence estimate to the broader obstetric population.

Limitations of the Study: The cross-sectional design may have introduced selection bias due to recruitment from tertiary care centers, while residual confounding from unmeasured factors, including glandular biology and genetic markers, cannot be excluded. Reliance on self-reported lifestyle information may also have resulted in reporting bias. Future prospective, multicenter studies incorporating inflammatory biomarkers and genetic profiling may help improve the accuracy and predictive value of risk assessment models.

Conclusion

Preeclampsia in the studied Pakistani females was associated with a multifactorial risk profile, including advanced maternal age, pre-existing chronic hypertension, obesity, multiple gestation, and lifestyle-related factors. These findings highlight the importance of early risk assessment and comprehensive, risk-adapted antenatal care, with particular attention to modifiable risk factors and females with pre-existing medical conditions. Strengthening preventive

counselling, timely identification, and appropriate clinical monitoring may help reduce the maternal and neonatal complications associated with preeclampsia.

Acknowledgment

The authors gratefully acknowledge the support of the clinical and administrative staff at Jinnah Postgraduate Medical Center, LUMHS Jamshoro, and Abbasi Shaheed Hospital, Karachi, for their assistance in data collection and patient coordination. We also thank all the participating females for their time and willingness to contribute to this study.

List of Abbreviations

ASH	Abbasi Shaheed Hospital
BMI	Body Mass Index
HELLP	Hemolysis, Elevated Liver enzymes, and Low Platelets.
ICU	Intensive care unit
IUFD	Intrauterine fetal death
IVF	In Vitro Fertilization
JPMC	Jinnah Postgraduate Medical Center
LUMHS	Liaquat University of Medical and Health Sciences
NICU	Neonatal intensive care unit
SPSS	Statistical Package for the Social Sciences

Conflict of interest

None to declare.

Grant support and financial disclosure

All costs were covered by institutional resources at Abbassi Shaheed Hospital, Karachi, Pakistan.

Ethical approval

The study received ethical approval from the Institutional Review Board of Abbassi Shaheed Hospital (Approval No. IRB/KMDC/KMU/368/2021).368) dated 5th January, 2021.

Author's contributions

AS: Conception and design of study, acquisition of data, manuscript drafting, and data interpretation.

MS, NA, SS: participated in study design, statistical analysis, and critical intellectual input, and manuscript drafting

AB: Supervised the overall project, critically intellectual input, manuscript drafting

ALL AUTHORS: Approval and full responsibility of the final version of the manuscript to be published.

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