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Determinants of preeclampsia/eclampsia among pregnant women: a case control study in Karnataka

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ABSTRACT

Objective. The primary objective of this study was to investigate the factors that influence the occurrence of preeclampsia and eclampsia among pregnant women.
Materials and Methods. From May 2022 to November 2022, a case-control study was conducted involving 456 pregnant women. The study employed an unmatched design, and data were gathered on a daily basis from participants visiting the Obstetrics and Gynecology department. Pretested interviewer-administered questionnaires were utilized for data collection, following ethical clearance from the Institutional Ethical Committee. The collected data underwent analysis using chi-square tests and regression analysis.
Results. The study encompassed a total of 154 cases and 302 controls. Noteworthy factors found to be significant determinants of preeclampsia included a previous history of preeclampsia, a family history of hypertension, a family history of diabetes mellitus, vegetable consumption, and the level of education. Women with a previous history of preeclampsia, a personal history of hypertension, a family history of diabetes mellitus, and a lower intake of vegetables were more likely to develop preeclampsia/eclampsia.
Conclusions. Healthcare providers should encourage mothers to have antenatal follow-up early in the pregnancy. Encouraging pregnant women's health seeking behaviour would provide a chance to diagnose preeclampsia as early as possible.

INTRODUCTION

As per the International Classification of Diseases, tenth revision (ICD-10), preeclampsia is characterized by specific diagnostic criteria. These criteria include a diastolic blood pressure reading of 90 mmHg or higher on two or more separate occasions, with a time gap of at least 4 hours between each measurement. Alternatively, if there is a diastolic blood pressure measurement of 110 mmHg or higher on any single occasion, it also fulfils the criteria. In addition to the blood pressure criteria, there should be evidence of proteinuria, indicated by a urinary protein excretion of at least 300 mg per 24 hours or a urine dipstick result of greater than or equal to I+. These diagnostic criteria apply to pregnant women who were normotensive and non-proteinuric before the 20th week of gestation [1]. Eclampsia is defined as the new onset of generalized tonic-clonic seizures in a woman with preeclampsia. Eclamptic seizures can occur antepartum, 20 weeks after gestation, intrapartum, and

postpartum. Seizures before 20 weeks are rare but have been documented in gestational trophoblastic disease [2].

Eclampsia is a known complication of preeclampsia during pregnancy, and it is associated with morbidity and mortality in both the mother and the foetus if not properly diagnosed [3]. Chronic hypertension, gestational hypertension, and pre-eclampsia superimposed on chronic hypertension are the other three categories [2, 3].

More than 80% of maternal deaths worldwide are caused by five direct causes: haemorrhage, infection, unsafe abortion, pulmonary embolism, and hypertensive disorder of pregnancy (HDP). In 2013, approximately 289,000 mothers died because of pregnancy-related causes worldwide. In developing countries, a woman's lifetime risk of dying from pregnancy-related complications is 14 times higher than in developed countries [1].

PE remains one of the leading causes of maternal mortality and morbidity, complicating an estimated 2-8% of pregnancies worldwide and up to 10% in developing countries. It is one of the top five leading causes of maternal and neonatal deaths [4, 5].

Globally, greater than 80% of maternal mortalities are due to 5 direct causes: haemorrhage, infection, unsafe abortion, pulmonary embolism, and hypertensive disorder of pregnancy (HDP). Around 289,000 mothers pass away worldwide from pregnancy-related reasons in 2013. A woman's lifetime risk of dying of pregnancy-related problems is 14 times higher in developing countries than in developed countries [1]. The morbidity and mortality of women and children associated with pre-eclampsia are major public health problems especially in low- and middle-income countries [4]. About 12% of mothers die only from preeclampsia as estimated by WHO, the occurrence of preeclampsia is seven times higher in developing countries compared to developed countries. The prevalence of preeclampsia ranges between 1.8 and 16.7% in developing countries [5].

In India the incidence of preeclampsia is reported to be 8-10% among the pregnant women. According to the study, the prevalence of hypertensive disorders of pregnant was 7.8% with preeclampsia in 5.4% of the study population in India [6]. The prevalence of preeclampsia is higher compared with the global average, which is around 2%. However, the prevalence ranges from 1.8 to 16.7% in developing countries. A study conducted in India reported the prevalence of preeclampsia about 28% with a variation in the prevalence across the states or regions [7]. A comprehensive review encompassing larger data sets has provided prevalence rates of preeclampsia across different regions. In Asia, the reported prevalence ranges from 0.2% to 6.7%. Africa has a prevalence ranging from 0.5% to 2.3%, while Europe reports a range of 2.8% to 5.2%. Oceania shows a prevalence range of 2.8% to 9.2%. South America and the Caribbean have a prevalence ranging from 1.8% to 7.7%, and North America reports a range of 2.6% to 4.0% [8]. Another review summarized the data for the Asian regions and reported the prevalence of preeclampsia 2.07% in China, 1.19% in Japan, 2.22% in Thailand and 0.59% in Nepal [9].

HEELP syndrome and eclampsia are the serious complication of preeclampsia. The majority of death related to preeclampsia can be prevented by providing timely and effective care to pregnant women presenting with such complication [6].

PE can progress to eclampsia and cause adverse foetal outcomes such as preterm birth, small-for gestational-age babies, placental abruption, and perinatal death and increase the risk of cardiovascular and cerebrovascular diseases and venous thromboembolism later in life. Furthermore, women who suffer from PE are predisposed to mental health issues such shame, guilt, feelings of failure, loss of control, personal inadequacy and postpartum depression [4, 5].

The aetiology of preeclampsia is still unknown. Many risk factors had been identified. Knowing these risks factors is useful for the clinician to target groups of patients at a higher risk of developing preeclampsia [10]. Though the cause of preeclampsia is unfamiliar, there are definite determinant risk factors related to the condition. The factors that have been proposed to influence the risk of preeclampsia among mothers comprise diabetes, renal disease, obesity, multiple pregnancy, prime-parity, age above 30 years, personal or family history of preeclampsia, and chronic hypertension. Preeclampsia can be quite serious as it can lead to various complications both for the mother and the baby [11].

Factors influencing the unique maternal-foetal (paternal) interaction probably include the length and type of sexual relationship, the maternal (decidual natural killer cells) acceptation of the invading cytotrophoblast (paternal HLA-C), and seminal levels of transforming growth factor-β and probably other cytokines. The magnitude of the maternal

response would be determined by factors including a maternal set of genes determining her characteristic inflammatory responsiveness, age, quality of her endothelium, obesity/insulin resistance and probably a whole series of susceptibility genes amongst which the thrombophilia received a lot of attention in recent years [12].
Investigating the determinants of preeclampsia was an important way to overcome the potential causes of hypertensive disorders during pregnancy, particularly for preeclampsia [13]. Identifying the determinants of preeclampsia among women attending delivery services will enable healthcare professionals to successfully tackle its impact on mothers and the foetus. Moreover, it will help health policymakers to design an appropriate strategy to reduce health-associated costs [14].
Preeclampsia/eclampsia is recognized as the third leading cause of maternal mortality globally. Considering the vulnerability of pregnant women to this condition and its associated complications, it becomes crucial to foster community understanding to facilitate early detection of pregnancy risks. Early identification can lead to timely antenatal care booking and proper follow-up, ultimately reducing the complications related to preeclampsia/eclampsia. The main aim of the study was to assess the determinants of pre-eclampsia/eclampsia among women attending delivery service.

MATERIALS AND METHODS

Study design and participants

An unmatched case control study was carried out in Adichunchanagiri hospital and research centre, B G Nagar, Nagamangala, Mandya from May 2022 to November 2022. Data were collected from the pregnant women attending the hospital for prenatal care.

Study criteria

Inclusion criteria
Pregnant women who are willing to give the consent and women with a gestational age of 20 weeks or greater were included in the study. The Case were Women confirmed to have an elevated blood pressure of 140/90 mmHg, measured at rest sitting and left lateral position or 5 min after arrival, was detected at least 4-6 h apart. Plus, a urine dipstick value of 2 + proteinuria and/or two random urine concentrations of 100 mg/dl collected 4 h apart after 20 completed weeks of gestation in a previously normotensive client. Women with confirmed diagnosis of eclampsia or preeclampsia were also included. Women with negative dipstick value but with presence of elevated blood pressure with symptoms of eclampsia or preeclampsia, upon confirmed by the physician were also included in the study.
Controls were a woman with other cases after 20 completed weeks of gestation and who were not diagnosed with pre-eclampsia.

Exclusion criteria
Pregnant women who were in critical condition. Women with known hypertension and renal disease. Pregnant women who could not give consent were excluded from the study.

Data collection instrument and procedure

All the pregnant women visited the hospital during the study period, falling under the criteria for recruitment, were included in the study after obtaining their written consent.
Data were gathered through individual patient interview using a validated pretested questionnaires after translating them into local language Kannada. Permission was obtained from authors regarding usage and translation of questionaries to avoid copyright violation.
The questionnaire included information such as demographic and socioeconomic factors, personal and family history, personal reproductive, gestational history. The questionnaire, which was collected check manually, frequency run was made to check the accuracy, consistencies, missed values and variables.

Statistical analysis

The study data collected were entered into epi data version 3.1 and exported to statistical package for social science (SPSS) version 20 for analysis. Descriptive statistics was used to describe the study populations using measures of frequency and percentage that displayed using tables compared between cases and controls. To compare categorical variables between cases and controls chi-squared test was used. The chi-square test cannot establish whether one variable has a causal relationship with another. Logistic regression was used to identify factors associated with the outcome variable. It as-

sumes linearity between the predicted (dependent) variable and the predictor (independent) variables. Regression may not be accurate if the sample size is too small. Variables with P-value of less than < 0.05 was taken to denote significant relationship.

Ethical approval and consent

Ethical clearance was obtained from Institutional Ethical Committee, AH & RC, B G Nagara (AHRC No: IEC/AH&RC/AC/018/2022).

RESULTS

Demographic and socio-economic characteristics of study participants

In the study comprising 456 participants, 66.22% were controls (n = 302) and 33.7% were cases (n = 154). The 20-34 age group had the most cases (83.11%) and the least (5.84%). Controls aged 20-34 (79.13%) were fewer than those under 20. Blood group B was 30.5% in cases, while blood type A was 32.7% in controls. Most were married (97.8%) and employed (82.45% controls, 84.41% cases). Rural residence (80.51% cases) and being a housewife (81.16% cases, 84.10% controls) were common. Education differed significantly (p = 0.024) (**Table 1**).

Table 1. *Demographic and socio-economic characteristics of study participants.*

Variables		Case n (%)	Control n (%)	Chi^2	P-value
Age	< 20	17 (11.03%)	26 (8.6%)	4.990	0.082
	20 -34	128 (83.11%)	239 (79.13%)		
	> 35	9 (5.84%)	37 (12.25%)		
Blood group	A	38 (24.6%)	99 (32.7%)	4.198	0.241
	B	47 (30.5%)	80 (26.4%)		
	Ab	29 (18.8%)	43 (14.2%)		
	O	40 (25.9%)	80 (26.4%)		
Marital status	Married	154 (100%)	292 (96.68%)	5.214	0.074
	Single	0	9 (2.98%)		
	Divorced	0	1 (0.33%)		
Employment	Yes	24 (15.58%)	53 (17.54%)	0.281	0.349
	No	130 (84.41%)	249 (82.45%)		
Residence	Rural	124 (80.51%)	283 (93.70%)	18.498	**0.000**
	Urban	30 (19.4%)	19 (6.29%)		
Occupation	Govt. employee	1 (0.64%)	8 (2.64%)	4.608	0.203
	Private	28 (18.18%)	39 (12.91%)		
	Housewife	125 (81.16%)	254 (84.10%)		
	Others	0	1 (0.33%)		
Level of education	Primary	3 (1.9%)	0	9.460	**0.024**
	Secondary	25 (16.2%)	42 (13.9%)		
	Higher secondary	54 (35.06%)	136 (45.05%)		
	Degree	72 (46.75%)	124 (41.05%)		

Bold: statistically significant

Personal and family history of study participants

In terms of medical illness factors, a family history of diabetes mellitus was significantly higher in cases (25.9%) than in controls (15.2%) with a P-value of 0.000. Family history of hypertension was also more common in cases (43.5%) compared to controls (15.8%) with a P-value of 0.011. Smoking during pregnancy was absent in both groups. Physical exercise was practiced by 3.89% of cases and 2.65% of controls. Eating fruit during pregnancy was reported by 88.8% of cases and 93.8% of controls. Drinking coffee during pregnancy was noted in 62.3% of cases and 57.9% of controls. Consumption of vegetables was higher in controls (99.4%) than cases (94.8%), which was statistically significant at 0.002 (**Table 2**).

Gestational history of study participants

Between 28-31 weeks, preeclampsia cases were highest (31.81%), decreasing to 31.7% in weeks 31-35. Gestational diabetes was rare, with 0.64% cases and 1.32% controls not affected. A history of hy-

Table 2. *Personal and family history of study participants*

Variables		Case n (%)	Control n (%)	Chi^2	P-value
Family history of hypertension	Yes	67 (43.5%)	48 (15.8%)	41.234	**0.000**
	No	87 (56.4%)	254 (84.1%)		
Family history of DM	Yes	40 (25.9%)	46 (15.2%)	8.975	**0.011**
	No	114 (74.02%)	253 (83.7%)		
Coffee consumption	Yes	96 (62.3%)	175 (57.9%)	0.815	0.367
	No	58 (37.6%)	127 (42.05%)		
Vegetable consumption	Yes	146 (94.8%)	300 (99.4%)	9.769	**0.002**
	No	8 (5.19%)	2 (0.66%)		
Fruit consumption	Yes	154 (100%)	299 (99.06%)	1.540	0.215
	No	0	3 (0.99%)		
Exercise	Yes	6 (3.89%)	8 (2.65%)	0.533	0.465
	No	148 (96.1%)	294 (97.3%)		

Bold: statistically significant

Table 3. *Personal reproductive and gestational history of study participants.*

Variables		Case n (%)	Control n (%)	Chi^2	P-value
Gestational age	27 weeks	37 (24.04%)	67 (22.1%)	2.109	0.55
	28-31 weeks	49 (31.81%)	85 (28.1%)		
	31-35 weeks	39 (25.32%)	96 (31.7%)		
	35-40 weeks	29 (18.83%)	54 (17.88%)		
Previous pregnancy	Yes	81 (52.59%)	139 (46.02%)	1.764	0.11
	No	73 (47.4%)	163 (53.97%)		
History of birth	Yes	49 (31.8%)	78 (25.8%)	2.710	0.258
	No	29 (18.8%)	51 (16.8%)		
History of abortion	Yes	63 (40.9%)	96 (31.7%)	3.780	0.151
	No	18 (11.6%)	43 (14.2%)		
History of preeclampsia	Yes	4 (2.5%)	0	8.899	**0.012**
	No	77 (50%)	140 (46.35%)		
History of gestational DM	Yes	1 (0.64%)	4 (1.32)	2.224	0.329
	No	80 (51.9%)	136 (45.03%)		
Use of contraceptive	Yes	1 (0.64%)	3 (0.99)	0.139	0.709
	No	153 (99.3%)	299 (99.0)		
Nutritional advice	Yes	87 (56.4%)	198 (65.5%)	3.579	0.059
	No	67 (43.5%)	104 (34.4%)		
Medication	Yes	12 (7.79%)	24 (7.94%)	0.003	0.556
	No	142 (92.2%)	278 (92.05%)		
Rh factor	Positive	148 (96.1%)	282 (93.3%)	1.410	0.235
	Negative	6 (3.8%)	20 (6.62%)		

Bold: statistically significant

pertensive pregnancy disorder was found in 2.5% of cases. Abortions were common (cases 40.09%, controls 31.7%). Nutritional advice was received by 56.4% of cases and 65.5% of controls. Hypothyroidism medication was taken by 7.79% of cases and 7.94% of controls. Rh factor was positive in 96.1% of cases and 93.3% of controls (**Table 3**).

Determinants of preeclampsia/eclampsia

A significant relationship was identified between preeclampsia/eclampsia and various factors, including a family history of hypertension and diabetes mellitus, as well as the pregnant women's vegetable consumption, area of residence, level of education, and previous history of preeclampsia. These factors were included in a multivariable analysis. Notably, the regression analysis revealed that women with a family history of hypertension faced a higher risk of developing preeclampsia/eclampsia, with an odds ratio (OR) of 4.075 (95%CI 2.6-6.34, p = 0.000). Women who are residing in rural areas (OR 0.278 *i.e.*, < 1) are more likely to develop preeclampsia compared to participants residing in urban areas Considering the factor vegetable consumption, women who are consuming vegetables are less likely to develop preeclampsia (OR 0.12) (**Table 4**).

DISCUSSION

Eclampsia, a complication usually following hypertensive diseases of pregnancy, remains a cause of maternal morbidity and mortality. The present study witnessed that 33.7% of women were diagnosed with eclampsia/preeclampsia.

In this study, mothers living in rural areas had higher odds of developing preeclampsia than ur-

Table 4. *Determinants of preeclampsia/eclampsia.*

Variables		Case n (%)	Control n (%)	OR (95% Confidence Interval)	P-value
Residence area	Rural	124 (80.51%)	283 (93.70%)	0.27 (0.15-0.512)	**0.000**
	Urban	30 (19.4%)	19 (6.29%)	1.00	
Level of education	Primary	3 (1.9%)	0	2.78 (1.15-5.2)	0.999
	Secondary	25 (16.2%)	42 (13.9%)	1.02 (0.57-1.82)	0.932
	Higher secondary	54 (35.06%)	136 (45.05%)	0.68 (0.44-1.50)	0.082
	Degree	72 (46.75%)	124 (41.05%)	1.00	-
History of preeclampsia	Yes	4 (2.5%)	0	0.81 (0.554-1.82)	**0.000**
	No	77 (50%)	140 (46.35%)	1.00	
Family history of hypertension	Yes	67 (43.5%)	48 (15.8%)	4.075 (2.6-6.34)	**0.000**
	No	87 (56.4%)	254 (84.1%)	1.00	
Vegetables consumption	Yes	146 (94.8%)	300 (99.4%)	0.12 (0.26-0.580)	**0.008**
	No	8 (5.19%)	2 (0.66%)	1.00	

Bold: statistically significant

ban residents. The finding is in line with studies conducted in Chiro, a hospital-based study, in Ethiopia, by Katore *et al*. [15]. This might be due to rural resident mothers having less consumption of vegetables, which are protective effects for preeclampsia; even though productions were common in rural residents. Another possible reason was mothers from rural areas book ANC later in pregnancy and delay health-seeking behaviour, as a result, they are late in recognizing preeclampsia. This delay in healthcare-seeking behaviour could be due to family and local cultural influences, and rural residents give great value to their cultures.

The mothers who attended college had a reduced risk of getting preeclampsia than the mothers who cannot read and write. The majority of the participants are degree graduates (46.75%) when compared to other educational status its P-value is 0.024 *i.e*., < 0.005. This result is supported by a study done in the Gedeo zone, southern Ethiopia, by Mareg *et al*. [1]. Mothers who can read and write were 87% less likely to have preeclampsia as compared to mothers who cannot read and write (aOR 0.13, 95%CI 0.02-0.76). Mothers who attended primary education were 93.1% less likely to develop preeclampsia as compared to those who cannot read and write (aOR 0.071, 95%CI 0.015-0.32). Uneducated mothers having reduced access to early prevention and control mechanisms could explain this; healthy nutrition, avoiding sedentary life, and prevention of overweight and obesity are identified risk factors for preeclampsia.

Our study shows the majority of participants are with no personal history of preeclampsia (50%) than with a history of preeclampsia (2.5%). When compared to the study conducted by Tesfaye *et al*. [16], women with a personal history of hypertension were more likely to suffer from preeclampsia/eclampsia compared with their counterparts (aOR 7.1, 95%CI 2.6-19.3, p = 0.001). It is probable that lifestyle modifications/behavioural factors are the reason for influencing women to an increased threat of preeclampsia/eclampsia. For instance, mothers taking in an unhealthy diet; eating food high in fats and carbohydrates could increase their triglyceride levels, narrowing blood flow, which may predispose them to develop hypertensive disorders.

Those women with a family history of hypertension had greater odds of developing preeclampsia compared to those who haven't. Participants with no family history of hypertension are (84.1%) and Participants with a family history of hypertension are (15.8%) and their P-value is 0.012. This finding is in line with studies conducted by Tessema *et al*. [17]. This might have occurred due to genetic factors that contribute to the physiologic predisposition of preeclampsia.

Participants with no family history of diabetes are (83.7%). Those pregnant women with a family history of diabetes mellitus are (15.2%). History of diabetes has an influence on determinants of preeclampsia/eclampsia because its P-value is < 0.0005 *i.e*., 0.002. When compared with a study conducted by Tessema *et al.* [17], they were about two times more likely to develop preeclampsia. *i.e*., 11.4%.

Out of 456 participants, the majority of the participants were consuming vegetables 99.4%. Only 0.4% of participants were not consuming. Vegetables are considered a determinant factor because their P-value is 0.002. Nutritional factors played an important role in our study, as an inadequate intake of vegetables raised the risk for PrE/E almost threefold. In accordance, several studies from Ethiopia by Stitterich *et al*. [18] described a regular intake of fruits and vegetables to be protective against preeclampsia. Interestingly, in contrast to those findings, the consumption of vegetables less than one time per week proved to be protective for PrE/E in our analysis. Dietary patterns higher in fruits and vegetables, before and during pregnancy have generally been found to be protective against pre-eclampsia. Dietary patterns rich in fat, added sugar, and salt, and Western eating patterns are observed to increase risk for preeclampsia. After a preeclampsia diagnosis, dietary modifications may include reduced sodium intake, increased potassium-rich foods, and balanced nutrition to manage blood pressure. Enhanced vegetable consumption aids overall health.

The study included the following limitations: the hospital-based strategy only covered women who visited hospitals. Preeclampsia can occur later in the postpartum period, and the research individuals were not followed up after being discharged from the hospital. The questionnaire design may have been too general in terms of the degree of information required for exercise prescription, the type of exercise and augmentation with pharmacological therapy, and reasons hindering compliance. Future research should be done at the rural area of the country, they will be having less knowledge regrading preeclampsia or eclampsia.

CONCLUSIONS

PE is a condition that affects both the mother and the foetus, and it is one of the most common causes of maternal morbidity and even death. The purpose of this study is to identify the risk factors for preeclampsia/eclampsia among pregnant women. We discovered that a previous history of preeclampsia, a family history of hypertension, a family history of diabetes mellitus, vegetable intake, and the level of education were all important drivers of preeclampsia. The prominent factor that facilitates adequate knowledge of PE is a higher level of education. Education could be through contextual health education at ANC, media channels, or national education programs. In this study, preeclampsia's determinant factors among mothers who visited the hospital were found to be an area of residing, previous history of preeclampsia, a family history of hypertension and diabetes, and vegetable consumption. Subgroup analysis results show that factors like participants who are residing in rural areas, a secondary level of education, a history of preeclampsia, a family history of hypertension, a family history of DM, and vegetable consumption are more likely to develop preeclampsia. Mothers who have a history of preeclampsia should be advised that there is an increased risk of preeclampsia in the subsequent pregnancies, and they should start antenatal follow-up early in the pregnancy. Therefore, healthcare providers should encourage mothers to have antenatal follow-ups early in pregnancy. Encouraging pregnant women's health-seeking behaviour would provide a chance to diagnose preeclampsia as early as possible.

COMPLIANCE WITH ETHICAL STANDARDS

Authors' contribution

All authors contributed equally to this work.

Funding

None.

Study registration

N/A.

Disclosure of interests

The authors declare that they have no conflict of interests.

Ethical approval

Ethical clearance was obtained from Institutional Ethical Committee, AH & RC, B G Nagara [AHRC No: IEC/AH&RC/AC/018/2022].

Informed consent

Patients gave informed consent to allow data collection and analysis for research purposes.

Data sharing

Data are available under reasonable request to the corresponding author.

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