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Risk Factors and Maternal Outcome of Preeclampsia at Shendi Teaching Hospital and Almak Nimir Teaching Hospital, Sudan

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Abstract

Background: Preeclampsia is a pregnancy-specific hypertensive disorder that typically develops after 20 weeks of gestation. It is a potentially progressive condition characterized by elevated blood pressure, often accompanied by proteinuria. If not detected and appropriately managed, it may progress to eclampsia, a severe complication associated with adverse maternal and fetal outcomes. ***Objective:*** This study aimed to determine the risk factors and maternal outcomes of preeclampsia at Shendi Teaching Hospital and Almak Nimir Teaching Hospital from May to November 2024. ***Methods:*** A hospital-based descriptive cross-sectional study was conducted from 1 May to 30 November 2024, involving 109 participants diagnosed with preeclampsia. Data were collected, processed, entered, and analyzed using the Statistical Package for the Social Sciences (SPSS), version 28.0. ***Results:*** All 109 (100.0%) study participants presented with headache, followed by vaginal bleeding, epigastric pain, and visual disturbances, reported by 37 (33.9%), 33 (30.3%), and 21 (19.3%) participants, respectively. Regarding obstetric history, 23 (21.1%) had a history of pregnancy-induced hypertension, 11 (10.1%) had a history of preeclampsia or eclampsia, 27 (24.8%) had a history of anemia during pregnancy, 15 (13.8%) had a history of miscarriage, 8 (7.3%) had a history of intrauterine growth restriction or intrauterine fetal death, and 5 (4.6%) had placental abnormalities. Regarding maternal management and outcomes, 15 (13.8%) participants received hydralazine, 36 (33.0%) received nifedipine, and 58 (53.2%) received methyldopa. Regarding mode of delivery, 54 (49.6%) participants delivered vaginally, 37 (33.9%) underwent emergency cesarean section, and 18 (16.5%) underwent elective cesarean section. Three (2.8%) participants required admission to the intensive care unit. Overall, 101 (92.7%) participants were discharged in good medical condition, 7 (6.4%) experienced complications, and 1 (0.9%) died. Advanced maternal age, obesity, and multiparity were identified as significant predictors of adverse maternal outcomes, with statistically significant associations. ***Conclusion and Recommendations:*** Early identification of risk factors, timely diagnosis, and appropriate management of preeclampsia are essential to improving maternal and fetal outcomes. Strengthening clinical assessment and implementing effective management strategies may help reduce associated complications and mortality. Furthermore, evaluating the feasibility and effectiveness of national public health initiatives focusing on preeclampsia prevention and awareness could have a substantial population-level impact. Further large-scale, multicenter studies are strongly recommended.

Keywords: Preeclampsia, eclampsia, hypertensive disorders of pregnancy, maternal outcomes, risk factors.

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INTRODUCTION

Preeclampsia (PE) is a pregnancy-specific hypertensive disorder that usually develops after 20 weeks of gestation. It is characterized by the new onset of hypertension in a previously normotensive woman, with systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure of ≥90 mmHg, accompanied by proteinuria or other signs of maternal organ dysfunction. Preeclampsia is a multisystem disorder of complex and incompletely understood etiology. It is associated with several adverse pregnancy outcomes, including preterm birth, intrauterine growth restriction, and increased maternal and neonatal morbidity and mortality [1]. Although its incidence varies among populations and study settings, preeclampsia affects approximately 2–

15% of pregnancies. Low- and middle-income countries (LMICs) bear the greatest burden of the disease, accounting for a substantial proportion of the estimated 70,000–80,000 maternal deaths and 500,000 perinatal deaths associated with preeclampsia and its complications worldwide each year [2]. The condition is more common among women experiencing their first pregnancy and those with multiple gestations. Preeclampsia is one of the leading causes of maternal and neonatal morbidity and mortality worldwide. If not recognized and appropriately managed, it may progress to eclampsia, a life-threatening complication characterized by the occurrence of seizures. Preeclampsia is a pregnancy-dependent condition that requires the presence of placental tissue, even in the absence of a viable fetus, as in cases of hydatidiform mole. In most cases, the condition improves following delivery and removal of the placenta [3]. The pathophysiology of preeclampsia is primarily associated with abnormal placental development and inadequate remodeling of the maternal spiral arteries, resulting in reduced placental perfusion and ischemia. These abnormalities contribute to the release of antiangiogenic factors and other inflammatory mediators into the maternal circulation, leading to systemic endothelial dysfunction and microangiopathy. Consequently, widespread vascular damage occurs, affecting multiple maternal organs. In the kidneys, endothelial injury results in glomerular endotheliosis, characterized by swelling of glomerular endothelial cells and loss of endothelial fenestrations, which contribute to impaired renal function and proteinuria [4]. Preeclampsia is strongly associated with abnormal placentation, and delivery of the placenta is the definitive treatment for the condition. Several maternal and pregnancy-related factors increase the risk of developing preeclampsia. These include a previous history of preeclampsia, chronic hypertension, diabetes mellitus, obesity, renal disease, autoimmune disorders, a family history of preeclampsia, nulliparity, multiple pregnancy, advanced maternal age (particularly ≥40 years), and certain vascular and thrombotic disorders. Clinically, preeclampsia is characterized by newly developed hypertension after 20 weeks of gestation, accompanied by proteinuria or evidence of maternal organ dysfunction. Severe manifestations may include persistent headache, visual disturbances, epigastric or right upper quadrant pain, thrombocytopenia, liver dysfunction, renal impairment, pulmonary edema, and HELLP syndrome (hemolysis, elevated liver enzymes, and low platelet count) [5]. Preeclampsia remains one of the leading causes of maternal and neonatal morbidity and mortality globally. It contributes substantially to maternal and perinatal deaths, severe complications, and long-term health consequences for both mothers and their children. Preeclampsia and eclampsia are estimated to account for approximately 25% of maternal deaths in Latin America, while hypertensive disorders of pregnancy contribute to approximately 10% of maternal deaths in Africa and Asia. However, many deaths associated with preeclampsia and eclampsia are preventable through early detection, timely diagnosis, appropriate clinical management, and access to quality obstetric care. Therefore, strengthening healthcare services and implementing effective preventive and therapeutic strategies are essential to reducing maternal and neonatal morbidity and mortality [6]. In view of the significant maternal and neonatal complications associated with preeclampsia, identifying its risk factors and evaluating maternal outcomes are essential for improving pregnancy care and reducing preventable deaths. This study was therefore conducted at Shendi Teaching Hospital and Almak Nimir Teaching Hospital to investigate the risk factors associated with preeclampsia and assess maternal outcomes among affected women. The findings are expected to provide useful local evidence to support early risk identification, improve clinical management, and contribute to the development of effective strategies for preventing and reducing preeclampsia-related complications in the study area.

MATERIALS AND METHODS

A hospital-based descriptive cross-sectional study was conducted at Shendi Teaching Hospital and Almak Nimir Teaching Hospital, Sudan, during the period from 1 May to 30 November 2024. The study included 109 women diagnosed with preeclampsia who attended the two hospitals during the study period. Data were collected using a structured, well-designed questionnaire developed to address the study objectives. The principal investigator collected the data directly through interviews with the participants and by reviewing their medical records. Primary data were obtained directly from the participants, while secondary data were extracted from their medical files. Written informed consent was obtained from each participant after explaining the purpose of the study and assuring them of the privacy and confidentiality of their information. The questionnaire items were then explained to the participants, and the required information was collected and recorded by the principal investigator. The collected data were initially entered into Microsoft Excel and subsequently exported to the Statistical Package for the Social Sciences (SPSS), version 28.0, for statistical analysis. Descriptive statistics were used to summarize the study variables and present the findings as frequencies and percentages. Bivariate analysis was performed using cross-tabulations to examine the associations between maternal outcomes and relevant demographic, obstetric, and clinical risk factors. The Chi-square (χ^2) test was used to assess associations between categorical variables, and statistical significance was considered at a p-value of less than 0.05.

RESULTS

A hospital-based descriptive cross-sectional study was conducted involving 109 women diagnosed

with preeclampsia. Regarding maternal clinical characteristics and management, 32 (29.4%) participants had blood pressure readings ranging from 140/90 to 160/100 mmHg, while 77 (70.6%) had blood pressure readings above 160/100 mmHg. Regarding medical management, 15 (13.8%) participants received hydralazine, 36 (33.0%) received nifedipine, and 58 (53.2%) received methyldopa. Concerning the mode of delivery, 54 (49.6%) participants delivered vaginally, 37 (33.9%) underwent emergency cesarean section, and 18 (16.5%) underwent elective cesarean section. Regarding hospital stay, 98 (89.9%) participants stayed in the hospital for less than three days, while 11 (10.1%) stayed for 3–7 days. Furthermore, 3 (2.8%) participants required admission to the intensive care unit (ICU), as presented in Table 1. The findings also revealed statistically significant associations between adverse maternal outcomes and advanced maternal age, obesity, and multiparity ($p < 0.05$ for all associations), as detailed in Tables 1, 2,3, and 4, respectively.

Table 1: Distribution of Study Participants According to Management and Maternal Outcome

Management and Maternal Outcome	Frequency	Percentage (%)
Blood pressure (mmHg)		
140/90–160/100 mmHg	32	29.4
>160/100 mmHg	77	70.6
Prescribed medical treatment		
Hydralazine	15	13.8
Nifedipine	36	33.0
Methyldopa	58	53.2
Mode of delivery		
Normal vaginal delivery	54	49.6
Emergency cesarean section	37	33.9
Elective cesarean section	18	16.5
Duration of hospital stay (days)		
< 3 days	98	89.9
3–7 days	11	10.1
Maternal admission to intensive care unit		
Yes	3	2.8
No	106	97.2
Total	**109**	**100.0**

Table 2: Association Between Age Groups (Years) and Overall Maternal Outcome Among Study Participants

Age group (years)	Discharged in good medical condition	Suffered from complications	Died	Total
18–25	14 (13.9%)	1 (14.3%)	0 (0.00%)	15 (13.8%)
26–35	40 (39.6%)	1 (14.3%)	0 (0.00%)	41 (37.6%)
36–45	45 (44.6%)	3 (42.8%)	0 (0.00%)	48 (44.0%)
>45	2 (1.9%)	2 (28.6%)	1 (100.0%)	5 (4.6%)
Total	**101 (100.0%)**	**7 (100.0%)**	**1 (100.0%)**	**109 (100.0%)**

Table 3: Association Between Body Mass Index and Overall Maternal Outcome Among Study Participants

Body mass index	Discharged in good medical condition	Suffered from complications	Died	Total
Normal body mass index	64 (63.4%)	1 (14.3%)	0 (0.00%)	65 (59.7%)
Overweight	33 (32.7%)	3 (42.8%)	0 (0.00%)	36 (33.0%)
Obese	4 (3.9%)	3 (42.8%)	1 (100.0%)	8 (7.3%)
Total	**101 (100.0%)**	**7 (100.0%)**	**1 (100.0%)**	**109 (100.0%)**

Table 4: Association Between Parity and Overall Maternal Outcome Among Study Participants

Parity	Discharged in good medical condition	Suffered from complications	Died	Total
Primiparous	37 (36.6%)	2 (28.6%)	0 (0.00%)	39 (35.8%)
Multiparous	52 (51.5%)	3 (42.8%)	1 (100.0%)	56 (51.4%)
Grand multiparous	12 (11.9%)	2 (28.6%)	0 (0.00%)	14 (12.8%)
Total	**101 (100.0%)**	**7 (100.0%)**	**1 (100.0%)**	**109 (100.0%)**

DISCUSSION

This study aimed to determine the risk factors and maternal outcomes of preeclampsia at Shendi Teaching Hospital and Almak Nimir Teaching Hospital between May and November 2024. A total of 109 women diagnosed with preeclampsia were enrolled in the study. The findings provide insight into the clinical management, mode of delivery, hospital stay, maternal complications, and factors associated with adverse maternal outcomes. Regarding maternal management, 15 (13.8%) participants received hydralazine, 36 (33.0%) received nifedipine, and 58 (53.2%) received

methyldopa. These findings highlight the use of different antihypertensive medications in the management of preeclampsia. Similarly, Charity *et al.,* reported that most women with both early-onset preeclampsia (EO-PE) and late-onset preeclampsia (LO-PE) received antihypertensive treatment with oral alpha-methyldopa and nifedipine throughout pregnancy. Methyldopa is included in the World Health Organization's Model List of Essential Medicines for use during pregnancy. Furthermore, more than 90% of women who were prescribed and received nifedipine after delivery had previously received methyldopa during pregnancy and labour [7]. These findings demonstrate the importance of antihypertensive treatment in managing preeclampsia and controlling maternal blood pressure. Regarding the mode of delivery, 54 (49.6%) participants delivered vaginally, while 37 (33.9%) underwent emergency cesarean section and 18 (16.5%) underwent elective cesarean section. The relatively high proportion of cesarean deliveries may reflect the clinical severity of some cases and the need for timely delivery to prevent further maternal and fetal complications. In terms of hospital stay, 98 (89.9%) participants remained hospitalized for less than three days, whereas 11 (10.1%) stayed for 3–7 days. Additionally, 3 (2.8%) participants required admission to the intensive care unit (ICU). Regarding the overall maternal outcomes, 101 (92.7%) participants were discharged in good medical condition, 7 (6.4%) experienced complications, and 1 (0.9%) died. These findings indicate that most participants had favourable maternal outcomes, although a small proportion experienced serious complications, including maternal mortality. In comparison, Aya *et al.,* reported that preeclampsia with severe features was significantly associated with maternal complications ($p = 0.001$), with 40.5% of women with severe preeclampsia experiencing maternal complications [8]. Similarly, Bisma *et al.,* reported that 57 (63.4%) women underwent cesarean delivery, compared with 33 (36.7%) who delivered vaginally. Regarding maternal outcomes, 56 (62.2%) patients recovered without serious complications, while 17 (18.9%) developed low hemoglobin levels, 7 (7.8%) experienced kidney infections, and 6 (6.6%) developed pulmonary edema. Furthermore, 4 (4.4%) patients required admission to the critical care unit for close monitoring. No maternal deaths were recorded in their study [9]. Compared with these findings, the current study demonstrated a lower proportion of cesarean deliveries and ICU admissions, as well as a higher proportion of participants discharged in good medical condition. Differences in study populations, disease severity, clinical management, and healthcare settings may partly explain the variation in maternal outcomes between the studies. However, Hannah *et al.,* reported that 69.7% of deliveries among women with preeclampsia were performed by cesarean section, while 87.8% of women underwent iatrogenic induction of labour. Sixteen women (1.0%) died during hospitalization, four (0.3%) experienced an identifiable stroke, and 147 (9.5%) developed eclampsia. Notably, 10 of the 16 women who died also had eclampsia. The mortality rate was 7% among women with eclampsia compared with 0.4% among those without eclampsia (relative risk = 15.9; 95% CI: 5.9–43.1). Three of the four women who experienced stroke also developed eclampsia and subsequently died. Most women (86.9%) received magnesium sulfate. Furthermore, 17.6% of women with elevated creatinine levels experienced kidney injury, compared with 0.5% of women with normal creatinine levels. The mortality rate among women with kidney injury was 3% (relative risk = 6.2; 95% CI: 2.2–17.8). These findings emphasize the potentially life-threatening complications of severe preeclampsia, particularly eclampsia, stroke, and renal impairment. Although the maternal mortality rate in the current study was relatively low (0.9%), the occurrence of maternal death highlights the importance of early recognition, appropriate treatment, and continuous monitoring of women with preeclampsia. Furthermore, Charity *et al.,* reported that the mean gestational age at delivery was lower among women with early-onset preeclampsia than among those with late-onset preeclampsia. Women with early-onset preeclampsia were also more likely to experience antepartum hemorrhage and HELLP syndrome (hemolysis, elevated liver enzymes, and low platelet count) and had longer hospital stays due to complications. The proportion of women experiencing maternal complications was significantly higher in the early-onset preeclampsia group than in the late-onset group. Six maternal deaths were also reported in their study [7]. These findings further demonstrate the influence of the timing of disease onset on the severity and clinical outcomes of preeclampsia. In the current study, cross-tabulation analysis was performed to investigate the associations between maternal outcomes and selected demographic, obstetric, and clinical characteristics using the Chi-square test. The findings revealed statistically significant associations between adverse maternal outcomes and advanced maternal age, obesity, and multiparity ($p < 0.05$ for all associations). These findings suggest that maternal characteristics may play an important role in determining the clinical course and outcomes of preeclampsia. Regarding parity, Birhanu *et al.,* reported a pooled prevalence of preeclampsia of 13% in sub-Saharan Africa (95% CI: 0.12–0.14). Their findings also indicated that multigravida women had higher odds of developing preeclampsia than women who had never been pregnant (AOR = 1.89; 95% CI: 1.65–2.17). Furthermore, their trend analysis demonstrated an increase in the incidence of preeclampsia from 2.22% to 2.67% [10]. These findings support the importance of considering obstetric history when assessing women at risk of preeclampsia. However, it should be noted that their findings concerned the occurrence of preeclampsia rather than adverse maternal outcomes among women already diagnosed with the condition. In contrast, Hannah *et al.,* identified young maternal age as an important predictor of eclampsia, reporting an area under the receiver operating characteristic curve (AUC) of 0.76

(95% CI: 0.71–0.80). Women younger than 20 years had a 30% probability of developing eclampsia, compared with 3.5% among women aged 30 years or older. The unadjusted odds ratio for eclampsia among women younger than 20 years, compared with those aged 20–29 years, was 4.52 (95% CI: 3.02–6.76). After adjustment for admission and maximum blood pressure, the odds ratio increased to 5.04 (95% CI: 3.34–7.51). Additionally, the study reported that women with a body mass index (BMI) below 18.5 kg/m² had a 40% probability of developing eclampsia, compared with 5.6% among women with a BMI above 35 kg/m² (AUC = 0.64; 95% CI: 0.59–0.69) [11]. Although these findings differ from the association between advanced maternal age and adverse maternal outcomes observed in the current study, the difference may be related to the outcomes investigated. Specifically, Hannah *et al.,* examined the prediction of eclampsia, whereas the present study assessed broader maternal outcomes. Therefore, the findings should be interpreted in relation to the different study populations and outcome measures. In a similar context, Maereg *et al.,* identified several factors associated with the development of preeclampsia through a meta-analysis. These included primiparity (OR = 2.52; 95% CI: 1.19–3.86), a previous history of preeclampsia or eclampsia (OR = 5.6; 95% CI: 1.82–9.28), a family history of preeclampsia or eclampsia (OR = 1.68; 95% CI: 1.26–2.11), high maternal BMI (OR = 1.69; 95% CI: 1.17–2.21), chronic hypertension (OR = 2.52; 95% CI: 1.29–3.74), anemia during pregnancy (OR = 3.22; 95% CI: 2.70–3.75), and inadequate antenatal care visits (OR = 2.71; 95% CI: 1.45–3.96) [12]. These findings highlight the importance of maternal health, nutritional status, obstetric history, and antenatal care in identifying women at increased risk of preeclampsia. The association between high maternal BMI and preeclampsia is particularly relevant to the current study, which also identified obesity as a factor significantly associated with adverse maternal outcomes. Furthermore, Mwashamba *et al.,* reported that, after adjustment for potential confounding factors, women aged 15–20 years were approximately four times more likely to develop severe preeclampsia than women aged 35 years and above (AOR = 3.84; 95% CI: 1.04–14.21). Rural residence was also associated with an increased likelihood of severe preeclampsia compared with urban residence (AOR = 2.65; 95% CI: 1.37–5.11). Additionally, women who were pregnant with a new partner had higher odds of developing severe preeclampsia (AOR = 7.56; 95% CI: 3.88–14.72). A family history of hypertension was also significantly associated with severe preeclampsia (AOR = 6.45; 95% CI: 3.22–12.92) [13]. These findings demonstrate that demographic, reproductive, and familial factors may contribute to the severity of preeclampsia. Nevertheless, differences in the age groups, study populations, and outcome definitions should be considered when comparing these findings with the results of the current study. Overall, the findings of the present study demonstrate that although most women with preeclampsia had favourable maternal outcomes, serious complications and maternal mortality remain important concerns. The significant associations observed between adverse maternal outcomes and advanced maternal age, obesity, and multiparity emphasize the importance of comprehensive maternal risk assessment, close clinical monitoring, and timely intervention. Early identification of high-risk women and appropriate management may help reduce complications and improve maternal outcomes.

CONCLUSION AND RECOMMENDATIONS

Preeclampsia remains a major contributor to maternal morbidity and mortality, requiring early detection, appropriate clinical management, and continuous monitoring throughout pregnancy and delivery. The findings of this study showed that most participants had favourable maternal outcomes; however, maternal complications and mortality were also observed. Advanced maternal age, obesity, and multiparity were significantly associated with adverse maternal outcomes. These findings highlight the importance of identifying maternal risk factors and providing timely and appropriate obstetric care to prevent disease progression and reduce associated complications. Strengthening antenatal care services, improving early risk assessment, ensuring timely diagnosis, and providing appropriate antihypertensive treatment are essential measures for improving maternal and fetal outcomes. Furthermore, public health initiatives focusing on preeclampsia awareness, maternal health education, and the early identification of high-risk pregnancies should be encouraged. Further large-scale, multicenter studies involving larger and more diverse populations are recommended to provide more comprehensive evidence regarding the risk factors, clinical characteristics, and maternal outcomes of preeclampsia.

Ethical Considerations

We obtained written informed consent from all participants before data collection. We clearly explained the study's purpose and objectives to each participant and informed them of their right to participate voluntarily and withdraw at any time without consequence. Confidentiality and privacy were strictly maintained throughout the study. All collected data were securely handled and used exclusively for research purposes. Participants' identities were kept anonymous, and no personally identifiable information was disclosed.

Consent: The patient’s written consent has been collected.

Competing Interests: Authors have declared that no competing interests exist.

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