

Factors Associated with Adverse Fetal Outcomes in Severe Preeclampsia Complicated by Acute Kidney Injury: An Observational Study at Bogodogo University Hospital, Burkina Faso

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Abstract

Introduction: Acute kidney injury (AKI) during severe preeclampsia represents a major public health problem. It is associated with high perinatal morbidity and mortality. Several factors, when present, may influence perinatal outcomes. The objective of this study was to describe the factors associated with adverse fetal outcomes in acute kidney injury during severe preeclampsia. **Methods:** The study was conducted in Burkina Faso at the University Hospital Center of Bogodogo. It was a descriptive-analytical study carried out from September 1, 2023, to August 31, 2024. Exhaustive sampling was used. Univariate analysis was performed using the Chi-square test, followed by multivariate logistic regression to identify factors associated with adverse fetal outcomes. A significance level of <5% was considered. **Results:** A total of 72 cases of AKI during severe preeclampsia were collected. The age group of 18 - 34 years was the most represented. Regarding adverse fetal outcomes, 27 perinatal deaths were recorded, representing 37.5%. Gestational age below 35 weeks significantly increased the risk of perinatal death by more than 19-fold (adjusted OR = 19.5; 95% CI: 3.81 - 40.12; P = 0.001). A systolic blood pressure between 160 and 180 mmHg reduced the risk

of perinatal death by 88% (adjusted OR = 0.12; 95% CI: 0.01 - 0.80). **Conclusion:** This study highlights the high frequency of adverse perinatal outcomes in preeclampsia complicated by acute kidney injury. Prematurity was significantly associated with perinatal death, whereas a systolic blood pressure between 160 and 180 mmHg appeared to be a protective factor.

Keywords

Fetal Outcome, Preeclampsia, Acute Kidney Injury

1. Introduction

Preeclampsia is a systemic disorder of pregnancy characterized by maternal vascular and placental dysfunction [1]. It represents a major public health concern, accounting for a significant proportion of maternal and perinatal deaths, particularly in low- and middle-income countries [2]. Its complications are frequent and, according to several authors, are predominantly acute kidney injury, eclampsia, HELLP syndrome (Hemolysis, Elevated Liver enzymes, and Low Platelets), and retroplacental hematoma (RPH) [1] [3]. Pregnancy-related complications are the second leading cause of acute kidney injury, with severe preeclampsia being the primary cause of pregnancy-associated kidney injury [4]-[6].

Pregnancy-related acute kidney injury is associated with significantly increased maternal mortality and a high risk of adverse fetal outcomes, including prematurity, intrauterine growth restriction, acute fetal distress, intrauterine fetal death, and early neonatal mortality [5] [7]. In Burkina Faso, several studies have shown that perinatal mortality remains high despite advances in obstetric and neonatal care [8]. A community-based cohort study in the Banfora health district reported a perinatal mortality rate of 79 per 1000 live births [8].

The pathophysiology underlying adverse fetal outcomes is complex and multifactorial, primarily involving placental insufficiency due to impaired uteroplacental perfusion [1]. This impaired circulation leads to chronic fetal hypoxia [1] [9]. The occurrence of renal involvement usually indicates a severe complication of preeclampsia, associated with marked placental dysfunction and poor perinatal prognosis. Several studies have shown that the severity of preeclampsia, the degree of proteinuria, early gestational age at diagnosis, and the presence of maternal complications are major determinants of fetal outcomes [7].

However, despite existing data on preeclampsia, studies specifically investigating factors associated with adverse fetal outcomes in severe preeclampsia complicated by acute kidney injury are scarce. In sub-Saharan Africa, maternal and perinatal morbidity and mortality related to severe preeclampsia and its complications are often exacerbated by delayed consultation, insufficient antenatal care, and limited access to specialized services [10] [11].

Given the lack of data on contributory factors for poor fetal outcomes in patients with acute kidney injury during preeclampsia, it is crucial to evaluate con-

text-specific factors to identify determinants of adverse fetal outcomes. Such findings could improve risk stratification, optimize maternal and fetal monitoring, and guide tailored obstetric and neonatal management strategies.

2. Patients and Methods

2.1. Study Setting

The study was conducted in Burkina Faso, in the Department of Obstetrics and Gynecology and Reproductive Medicine at the University Hospital Center of Bobo-dougo.

2.2. Study Design and Period

This was a descriptive-analytical study conducted over a 12-month period, from September 1, 2023, to August 31, 2024.

2.3. Study Population

The study included all patients admitted to the Department of Obstetrics and Gynecology who presented with severe preeclampsia complicated by acute kidney injury during the study period.

2.4. Inclusion and Exclusion Criteria

All patients meeting the diagnostic criteria for severe preeclampsia complicated by acute kidney injury were included. Exclusion criteria were: history of chronic kidney disease and cases where serum creatinine levels or fetal outcomes were not documented.

2.5. Sampling

Exhaustive sampling was performed, including all patients with severe preeclampsia complicated by acute kidney injury.

2.6. Variables

The dependent variable was an adverse fetal outcome. Independent variables included sociodemographic characteristics, clinical, laboratory, and therapeutic data.

2.7. Data Collection Tools and Procedures

Data were collected from consultation registers and patient medical records using a standardized data collection form. The research team collected the data personally. Laboratory results at admission were considered, including serum creatinine and blood urea, as well as any follow-up results if available.

2.8. Operational Definitions

Adverse fetal outcome was defined as either intrauterine fetal death or early neonatal death. Early neonatal death was defined, according to the WHO, as the death

of a newborn occurring between birth and the seventh day of life [12]. Intrauterine fetal death was defined as the death of a fetus before complete expulsion or extraction of the fetus at a gestational age of ≥ 22 weeks of amenorrhea [13].

Acute kidney injury during pregnancy was defined according to the American College of Obstetricians and Gynecologists (ACOG) as any patient with severe preeclampsia presenting with a serum creatinine ≥ 97 $\mu\text{mol/L}$, without a history of pre-existing kidney disease, and in the absence of any other obvious cause of acute kidney injury [14] [15]. The absence of prior kidney disease was verified through patient interviews and prenatal records, including baseline creatinine levels. The stages of acute kidney injury were classified according to the Kidney Disease: Improving Global Outcomes (KDIGO) criteria [16].

Preeclampsia was defined as the combination of hypertension ($\geq 140/90$ mmHg) and proteinuria (≥ 300 mg/24h or $\geq 2+$ on dipstick) occurring after 20 weeks of gestation [2] [11]. Severe preeclampsia was defined as preeclampsia with systolic blood pressure ≥ 160 mmHg and/or diastolic blood pressure ≥ 110 mmHg, or preeclampsia associated with severe signs or complications [17].

2.9. Data Analysis

Data were entered using SPSS and exported to Stata for analysis. All analyses were performed with STATA 18. Continuous variables, such as age, were described using means and standard deviations and categorized into age groups. Categorical variables were presented as frequencies and proportions.

Univariate analysis was performed using the Chi-square test for categorical variables and the Student's t-test for continuous variables. Multivariate analysis was then conducted using logistic regression to calculate adjusted odds ratios (ORs) with 95% confidence intervals (CIs) to identify independent factors associated with adverse fetal outcomes, with a significance level of $P < 0.05$. Variables with p-values < 0.20 in univariate analysis were included in the multivariate model.

2.10. Ethical Considerations

Authorization for data collection was obtained from the authorities of the University Hospital Center of Bogodogo. The study was approved by the institutional ethics committee of the University Hospital Center of Bogodogo.

3. Results

3.1. General characteristics of the Study Population

3.1.1. Sociodemographic Characteristics

The sociodemographic characteristics of the study population are presented in **Table 1**.

The mean age of the study population was 26 years $\pm$ 7.13 years. Housewives accounted for 62.5% of the participants. Forty patients (55.56%) resided in rural areas.

Table 1. Sociodemographic characteristics of the study sample (n = 72).

Variables	Number (n=72)	Percentage (%)
Age (Year)		
Mean Age ($\pm$ SD)	26 (7.13)	
<18	12	16.67
[18, 35[	45	62.5
≥ 35	15	20.83
Professional Activity		
Housewife	45	62.5
Civil Servant/Trader	18	25
Pupils/Students	9	12.5
Marital Status		
Married	59	81.94
Single	13	18.06
Residence		
Rural	40	55.56
Urban	32	44.44

SD: Standard deviation.

3.1.2. Clinical and Biological Aspects

Table 2 summarizes the clinical and laboratory characteristics of the study population.

Table 2. Clinical and biological aspects of the study sample (n = 72).

Variables	Number (n = 72)	Percentage (%)
Parity		
Nulliparous	36	50
Primiparous	8	11.11
Pauciparous (2 - 4)	17	23.61
Multiparous (>4)	11	15.28
History of Hypertension		
No	57	79.17
Yes	15	20.83
Number of Antenatal Care Visits		
<3	35	53.03
[3, 5[	26	39.39
> 5	5	7.58

Continued

Systolic Blood Pressure (SBP)		
<160	11	15.28
[160, 180[	31	43.06
≥180	30	41.66
Diastolic Blood Pressure (DBP)		
<110	4	5.56
[110, 120[	15	20.83
≥120	53	73.61
Gestational Age (Week of Amenorrhea (WA))		
<28 WA	9	12.5
[28, 35 WA[	32	44.44
≥35 WA	31	43.06
Urine Dipstick of Proteinuria (BU)		
≤3	36	50
>3	36	50
Hemoglobin Level Grammar /Deciliter (g/dL)		
<11 g/dL	51	70.83
≥11 g/dL	21	29.17
Serum Alanine Aminotransferase Level (ALAT)		
<46	37	51.39
≥46	35	48.61
Severity of Renal Injury		
Mild	45	62.5
Moderate	21	29.17
Severe	6	8.33

Regarding medical history, 20.83% of the patients had a prior history of hypertension. At admission, 30 patients (41.66%) had a systolic blood pressure ≥ 180 mmHg. Half of the patients had urine dipstick proteinuria of more than 3 crosses (≥3+). In terms of severity, 62.5% presented with acute kidney injury classified as mild. The clinical and biological characteristics are presented in **Table 2**.

3.1.3. Maternal Complications and Therapeutic Interventions

Maternal complications and therapeutic interventions are summarized in **Table 3**.

In our study, HELLP syndrome was identified in 19% of cases. Two patients (2.78%) developed eclampsia. Placental abruption occurred in eight cases, representing 11.8% of the study population. Regarding management, 66 patients received magnesium sulfate according to the standard protocol in combination with parenteral antihypertensive therapy. Four patients (5.56% of the study sample) required dialysis.

Table 3. Maternal complications and therapeutic interventions.

Complications and Therapeutics	Number (n = 72)	Percentage (%)
Associated HELLP Syndrome		
Yes	14	19.44
No	58	80.56
Associated Retroplacental Hematoma		
Yes	8	11.11
No	64	88.89
Associate Eclampsia		
Yes	2	2.78
No	70	97.22
Use of Injectable Antihypertensive Drugs		
Yes	66	91.67
No	6	8.33
Use of Magnesium Sulfate		
Yes	66	91.67
No	6	8.33
Fetal Extraction within 24 Hours		
Yes	35	48.61
No	37	51.39
Dialysis		
No	68	94.44
Yes	4	5.56

3.2. Adverse Fetal Outcomes

Table 4 shows the fetal outcomes among patients with severe preeclampsia complicated by acute kidney injury. Regarding fetal outcomes, a favorable outcome was observed in 45 newborns, representing 62.5% of the cases, characterized by survival up to the 7th day of life. Conversely, an unfavorable fetal outcome was recorded in 27 cases (37.5%). Among these unfavorable outcomes, 17 cases (23.61%) corresponded

to intrauterine fetal deaths, while 10 cases (13.89%) were early neonatal deaths occurring before the 7th day of life.

Table 4. Fetal outcomes among patients with severe preeclampsia complicated by acute kidney injury.

Fetal Outcomes	Description	n = 72	Percentage (%)
Favorable Fetal Outcome (n = 45)	Alive at day 7 after birth	45	62.5
Adverse Fetal Outcomes (n = 27)	Intrauterine fetal death (IUFD)	17	23.61
	Early neonatal death (before day 7 of life)	10	13.89
Total		72	100

3.3. Factors Associated with Adverse Fetal Outcomes

3.3.1. Univariate Analysis

- Sociodemographic Factors

Table 5 presents the sociodemographic factors associated with unfavorable fetal outcomes.

Table 5. Sociodemographic factors associated with perinatal mortality in acute kidney injury complicating severe preeclampsia: univariate analysis.

Variables	Perinatal Death (No)		Perinatal Death (Yes)		OR	P (Chi²)
	n = 45	%	n = 27	%		
Age						
Mean	25.84	(+/-) 7.25		26.94	(+/-) 7.04	T-test (0.30)
<18 Year	10	22.22	2	7.41	0.27	0.11
[18 - 35 Year[	26	57.78	19	70.37	REF	
≥35 Year	9	20	6	22.22	0.91	0.88
Profession Activity						
Housewife	29	64.44	16	59.26	REF	
Civil Servant/Trader	10	22.22	8	29.63	1.45	0.51
Pupils/Students	6	13.33	3	11.11	0.9	0.89
Marital Status						
Married	35	77.78	24	88.89	RFR	
Single	10	22.22	3	11.11	0.43	0.24
Residence						
Rural	25	55.56	15	55.56	REF	
Urban	20	44.44	12	44.44	1	

n: number.

In univariate analysis, maternal age was the only factor significantly associated with adverse fetal outcomes (see **Table 5**).

- **Clinical, Therapeutic, and Laboratory Factors**

Table 6 summarizes the clinical, therapeutic, and laboratory factors associated with adverse fetal outcomes.

Table 6. Clinical, therapeutic, and laboratory factors associated with adverse fetal outcomes.

Variables	Perinatal Death (No)		Perinatal Death (Yes)		OR	P (Chi ²)
	n = 45	%	n = 27	%		
Parity						
Pauciparous	10	22.22	7	25.93	RFR	
Nulliparous	27	60	9	33.33	0.4	0.26
Primiparous	3	6.67	5	18.52	2.3	0.3
Multiparous	5	11.11	6	22.22	1.7	0.4
Systolic Blood Pressure at Admission (mmHg)						
<160	4	8.89	7	25.93	RFR	
[160, 180[	21	46.67	10	37.04	0.27	0.07
≥180	20	44.44	10	37.04	0.28	0.08
Diastolic Blood Pressure at Admission (mmHg)						
<110	0	0	4	14.81	RFR	
[110, 120[	8	17.78	7	25.93	2	0.23
≥120	37	82.22	16	59.26		
Gestational Age (Week of Amenorrhea (WA))						
≥35 WA	28	62.22	3	11.11	REF	
<35 WA	17	37.78	24	88.89	13.17	0.001
Urine Dipstick of Proteinuria (BU)						
]–3]	22	48.89	14	51.85	RFR	
>3+	23	51.11	13	48.15	0.8	0.8
Hemoglobin Level Grammar/Deciliter (g/dL)						
≥11 G/DL	17	37.78	4	14.81	RFR	
<11 G/DL	28	62.22	23	85.19	3.49	0.04
Severity of Renal Injury						
Mild	29	64.44	16	59.26	RFR	
Moderate	16	35.56	5	18.52	0.5	0.34
Severe	0	0	6	22,22		

Continued

Use of Magnesium Sulfate						
Yes	23	65.71	12	34.29	REF	
No	22	59.46	15	40.54	1.3	0.58
Use of Injectable Antihypertensive Drugs						
Yes	41	62.12	25	37.88	REF	
No	4	66.67	2	33.33	0.82	0.82
Fetal Extraction within 24 Hours						
Yes	41	62.12	25	37.88	REF	
No	4	66.67	2	33.33	0.82	0.82

mmHg: millimeters of mercury; OR: odds ratio.

In the univariate analysis, systolic blood pressure, gestational age at admission, and hemoglobin level at admission were significantly associated with perinatal death.

Delivery within 24 hours of admission, as well as the use of magnesium sulfate and antihypertensive therapy, were not significantly associated with perinatal mortality (see **Table 6**).

3.3.2. Multivariate Analysis

The factors associated with adverse fetal outcomes in multivariate analysis are presented in **Table 7**.

Table 7. Factors associated with perinatal mortality in acute kidney injury complicating severe preeclampsia: multivariate analysis.

Variables	Modality	Ora	P-Value	IC 95% Min	IC 95% Max
Age	<18 year	0.2	0.16	0.03	1.81
	≥35 year	1.04	0.66	0.30	6.38
Systolic Blood Pressure	[160 - 180 mmHg]	0.12	0.04	0.01	0.80
	≥180 mmHg	0.12	0.052	0.01	1.01
Gestational Age	<35 WA	19.5	0.00	3.81	40.12
Hemoglobin Level	<11 g/dL	3.0	0.13	0.72	12.50

ORa: adjusted odds ratio; IC 95%: confidence interval (95%); WA: week of amenorrhea; mmHg: millimeters of mercury.

In the table above, a systolic blood pressure between 160 and 180 mmHg was associated with an 88% reduction in perinatal deaths compared to a blood pres-

sure below 160 mmHg. The adjusted odds ratio was 0.12, with a 95% confidence interval (CI) of 0.01 - 0.80.

Prematurity was statistically associated with perinatal mortality. The earlier the gestational age, the higher the risk. Specifically, a gestational age at admission of less than 35 weeks increased the risk of adverse fetal outcomes by more than 19-fold, with an odds ratio of 19.5 (95% CI: 3.81 - 40.12, $P = 0.0001$).

Figure 1 illustrates the area under the curve (AUC) of the logistic regression model.

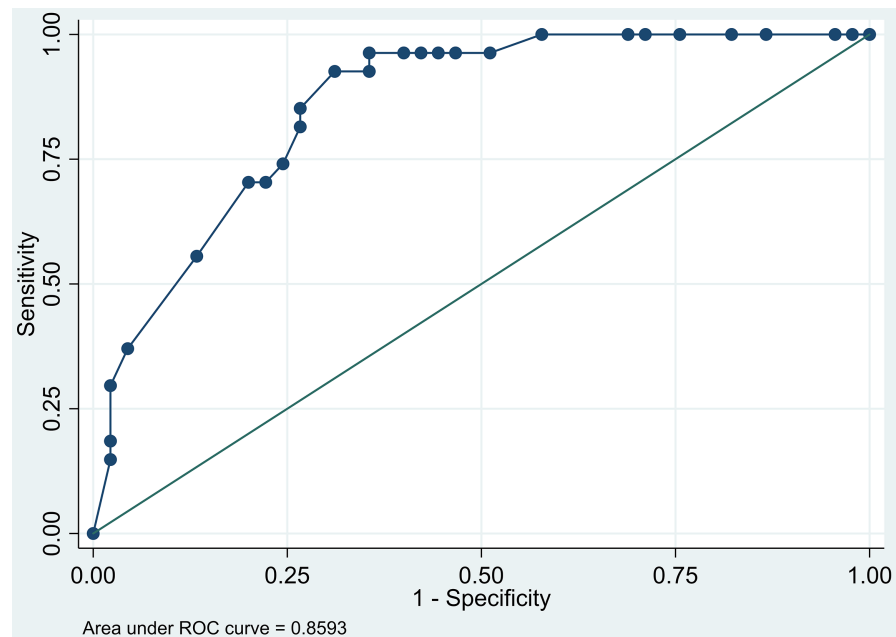


Figure 1. Area under the curve (AUC) of the logistic regression model for factors associated with perinatal mortality.

The discriminative performance of the multivariate logistic regression model was evaluated using an ROC curve. The area under the curve (AUC) was 0.85, indicating a good ability of the model to distinguish cases of perinatal death from favorable neonatal outcomes, with an approximate discrimination probability of 85%.

4. Discussion and Comments

4.1. Adverse Fetal Outcomes

From a fetal perspective, we observed 62.5% live births and 37.5% perinatal deaths. These findings are comparable to those reported by Conti-Ramsden *et al.* in South Africa, who documented an adverse fetal outcome rate of approximately 38% in a study on acute kidney injury associated with preeclampsia [18]. Our results are also consistent with those of Patel *et al.*, who reported in 2013 in India a perinatal mortality rate of 47.1% among patients with acute kidney injury during pregnancy [19].

However, our findings differ from those of Shalaby *et al.*, who, in a 2022 systematic review, reported a perinatal mortality rate as high as 60% among pregnant women with acute kidney injury [6]. This discrepancy may be explained by methodological differences, particularly the inclusion by these authors of all cases of acute kidney injury occurring during pregnancy, regardless of etiology.

4.2. Factors Associated with Adverse Fetal Outcomes

The study identified a significant obstetric maternal factor associated with perinatal mortality in patients with severe preeclampsia complicated by acute kidney injury. Multivariate analysis demonstrated that a gestational age of less than 35 weeks of amenorrhea was significantly associated with perinatal death. This finding may be explained by iatrogenic prematurity, often necessitated by the need for early delivery to preserve maternal life. The earlier the gestational age at delivery, the higher the risk of adverse outcomes. In our study, a gestational age of less than 35 weeks at admission increased the risk of perinatal death by more than 19-fold. Several authors have highlighted that prematurity and intra-uterine growth restriction are the leading causes of perinatal mortality in this context [4] [20]. Our findings are consistent with those of Ngwenya *et al.* in Zimbabwe (2017), who identified prematurity as the main determinant of perinatal mortality in severe preeclampsia [21]. Similarly, Paul Kiondo *et al.* in Uganda (2011) reported that pregnancies complicated by preeclampsia with a gestational age below 34 weeks were associated with high perinatal mortality. More broadly, Goldenberg *et al.* demonstrated that prematurity is the leading cause of neonatal mortality in low-resource settings, largely due to limited access to neonatal intensive care units [22].

Another factor identified in our study was systolic blood pressure. We found that a systolic blood pressure between 160 and 180 mmHg reduced the risk of perinatal death by 88% compared to blood pressure values < 160 mmHg or ≥180 mmHg.

This suggests a U-shaped relationship, where both excessively high blood pressure (>180 mmHg) and relatively lower levels (<160 mmHg) may be deleterious. This association likely reflects the severity of vascular and placental involvement. Severe hypertension may indicate advanced placental insufficiency, whereas an excessive or abrupt reduction in blood pressure may compromise uteroplacental perfusion, leading to fetal hypoxia and increased perinatal mortality.

In clinical practice, it is recommended to avoid rapid or excessive lowering of blood pressure in severe preeclampsia in order to prevent fetoplacental hypoperfusion [1] [23]. Our findings are consistent with those of other authors. Indeed, Magee *et al.* emphasized that blood pressure reduction in severe preeclampsia should be gradual to avoid a sudden decrease in placental blood flow [24].

4.3. Study Limitations

The retrospective nature of this study limits the accuracy and completeness of cer-

tain clinical data. Nevertheless, key parameters relevant to the study objectives were carefully considered in the analysis.

5. Conclusions

This study highlights the high frequency of unfavorable perinatal outcomes in preeclampsia complicated by acute kidney injury. Prematurity was identified as a significant risk factor for perinatal mortality. In contrast, a systolic blood pressure between 160 and 180 mmHg was associated with a reduced risk of perinatal death.

These findings underscore the importance of early detection, adequate antenatal care, and multidisciplinary management involving pediatricians, nephrologists, intensivists, and obstetricians in the care of patients with severe preeclampsia complicated by acute kidney injury. Optimized prevention and management of these complications are essential to reduce perinatal mortality and improve both maternal and fetal outcomes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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