ISSN 2466-488X (Online) doi: 10.5937/sjait2606155K

Originalni rad **Original article**

PHENOTYPIC PROFILE OF ECLAMPSIA AND SEVERE PREECLAMPSIA IN INTENSIVE CARE UNITS IN KINSHASA: A MULTICENTER CROSS-SECTIONAL STUDY

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Datum prijema rada: 20.12.2025. Prva ispravka rukopisa: 25.07.2026. Datum prihvatanja rada: 24.09.2026.

Background: *Eclampsia, a severe complication of preeclampsia, remains a major cause of maternal morbidity and mortality, particularly in low-resource settings. Understanding the phenotypic profiles of affected women in intensive care units (ICUs) can improve risk stratification and guide targeted management. This study aimed to describe the clinical, biological, and evolutionary characteristics of women with eclampsia admitted to ICUs in Kinshasa.* ***Methods:*** *We conducted a multicenter cross-sectional study across six tertiary and secondary ICUs in Kinshasa from January 2019 to December 2022. All women admitted with eclampsia were included. Data were retrospectively collected from medical records and ICU registers, covering sociodemographic characteristics, clinical presentation, organ dysfunctions, therapeutic interventions, and maternal outcomes. Descriptive statistics summarized patient characteristics, and bivariate analyses identified factors associated with ICU mortality.* ***Results:*** *A total of 212 women were included. The median age was 29 years, and 68.4% were referred from other healthcare facilities. Primiparity was common (41.5%). Neurological complications were frequent, with 42.9% experiencing seizures and 17.5% presenting with a Glasgow Coma Scale ≤ 8. Renal dysfunction (21.7%), HELLP syndrome (12.7%), and pulmonary edema (16.5%) were also observed. Magnesium sulfate and antihypertensive therapy were administered to the majority of patients. Overall maternal mortality was 14.2%, predominantly among women with neurological, renal, or multi-organ involvement. Phenotypic classification revealed four main profiles: neurological, renal/HELLP, cardiovascular/respiratory, and multi-organ involvement, with the last exhibiting the highest risk of death.* ***Conclusion:*** *Eclampsia in Kinshasa primarily presents with neurological, renal, and cardiovascular complications, which strongly influence ICU mortality. Phenotypic classification offers a practical framework for early identification of high-risk patients, optimizing ICU management, and informing health strategies in resource-limited settings.*

Keywords: *Critical Care; Eclampsia; Intensive Care Units; Phenotype; Preeclampsia*

Introduction

Eclampsia is a severe pregnancy-related hypertensive disorder, characterized by the onset of seizures in women with pre-existing preeclampsia, typically occurring after 20 weeks of gestation. It remains one of the leading causes of maternal morbidity and mortality worldwide, particularly in low-resource settings. Eclampsia and its precursor, severe preeclampsia, continue to present significant challenges in maternal health care, accounting for a substantial proportion of obstetric complications and maternal deaths, especially in sub-Saharan Africa, where access to specialized care is often limited[1].[1,2]

Pathophysiologically, eclampsia shares similar mechanisms with preeclampsia, including defective trophoblastic invasion of the uterine spiral arteries, leading to placental hypoperfusion, oxidative stress, and widespread endothelial

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dysfunction. This cascade of events contributes to the diverse clinical manifestations of the disease, which can range from mild hypertension to life-threatening conditions.[3,4] As the condition progresses, it can result in severe complications such as HELLP syndrome (Hemolysis, Elevated Liver Enzymes, Low Platelet Count), acute kidney injury (AKI), pulmonary edema, cerebrovascular accidents (strokes), and multi-organ failure.[5,6]

Admitting women with severe preeclampsia or eclampsia to intensive care units (ICUs) is common due to the high risk of these complications, which often require immediate and specialized medical intervention.[7] The emergence of phenotypic classifications of eclampsia, considering the predominant organ involvement (neurological, renal, cardiovascular, etc.), has opened up new avenues for better understanding the disease and improving clinical management. By identifying the predominant organ systems involved, clinicians can better predict the severity of the condition and optimize treatment strategies.[8,9]

In many low- and middle-income countries, eclampsia continues to be a major contributor to maternal deaths due to delays in diagnosis, insufficient healthcare infrastructure, and challenges in the referral process. In the Democratic Republic of Congo, especially in Kinshasa, there isn't much data on the clinical profiles and outcomes of women with eclampsia who are admitted to ICUs. This makes it difficult to develop effective management strategies, despite the increasing burden of severe cases in urban settings where healthcare inequalities exacerbate the challenges.[10,11]

To address this gap, this study aims to describe the phenotypic profile of women with severe eclampsia admitted to intensive care units in Kinshasa. Through a multicenter cross-sectional study, we seek to better understand the clinical, biological, and evolutionary characteristics of these women and identify the main determinants of disease severity. By doing so, we aim to contribute to improved management strategies and, ultimately, a reduction in maternal mortality linked to eclampsia in Kinshasa.

Methods

Study Design

This was a multicenter, observational, cross-sectional study aimed at describing the phenotypic profile and factors associated with disease severity in women with eclampsia admitted to intensive care units (ICUs) in Kinshasa. The study included both tertiary and secondary hospitals to offer a comprehensive view of eclampsia management in the region.

Study Setting and Period

The study was conducted in the ICUs of six hospitals in Kinshasa, Democratic Republic of the Congo. These hospitals include the University Clinics of Kinshasa**,** Monkole Hospital Center**,** Desmet Hospital of Kinsuka**,** Ngaliema Clinic**,** Kinshasa General Referral Hospital, and Saint Joseph Hospital. Data was collected retrospectively over a four-year period from January 2019 to December 2022, covering patient admissions, management in the ICU, and assessment of maternal outcomes.

Study Population and Participants

Eligibility Criteria

Women who were admitted to the ICU during the study period with a diagnosis of eclampsia or severe preeclampsia were eligible for inclusion. Diagnosis of eclampsia was based on internationally accepted criteria, which include the presence of seizures in women with pre-existing preeclampsia, typically after 20 weeks of gestation. Severe preeclampsia was defined as hypertension with proteinuria and evidence of multiorgan dysfunction.

For the purpose of this study, eclampsia and severe preeclampsia were considered as part of a continuous spectrum of severe hypertensive disorders of pregnancy requiring ICU admission.

Patients were excluded if :

- Seizures were attributable to non-obstetric neurological conditions.
- Medical records were incomplete or non-exploitable.

Selection of Participants

An exhaustive sampling strategy was applied, where all eligible women who were admitted to the participating ICUs during the study period were included. No random sampling or matching was performed, ensuring that the study covered all

possible cases of eclampsia and severe preeclampsia in the given time frame.

Definitions and Study Variables

Outcome Variable

The primary outcome of interest was maternal health, which was categorized as either survival or death during hospitalization in the ICU.

Explanatory Variables

Collected variables included:

- **Sociodemographic variables**: age, referral status;
- **Clinical variables at admission**: Glasgow Coma Scale (GCS), blood pressure values, neurological manifestations;
- **Organ dysfunctions and complications**: acute kidney injury, acute pulmonary edema, HELLP syndrome, disseminated intravascular coagulation, sepsis, stroke;
- **Therapeutic variables** : use of magnesium sulfate or other anticonvulsants, antihypertensive therapy, mechanical ventilation.
- **Evolutionary variables** : length of ICU stay, occurrence of complications during ICU stay.

Phenotypic Classification

Clinical phenotypes were defined according to the predominant organ dysfunction at ICU admission. Each patient was assigned to a single phenotype using a structured hierarchical classification based on severity and life-threatening impact.

The neurological phenotype included patients with seizures associated with a Glasgow Coma Scale ≤ 12, persistent coma, or dominant neurological dysfunction requiring primary neurological stabilization.

The renal/HELLP phenotype included patients with acute kidney injury and/or HELLP syndrome in the absence of severe respiratory failure or major neurological impairment.

The cardiovascular/respiratory phenotype included patients presenting with pulmonary edema and/or respiratory failure requiring oxygen therapy or mechanical ventilation, without dominant neurological or renal failure.

The multi-organ involvement phenotype was defined by simultaneous dysfunction of at least two major organ systems (neurological, renal, or respiratory/cardiovascular) with no clearly dominant single system driving ICU admission.

In cases of overlapping dysfunction, classification was determined by the most immediately life-threatening condition requiring priority intervention at admission.

Data Sources and Measurements

Data were extracted retrospectively from patient medical records and ICU admission registers using a standardized data collection form. This ensured consistency across the six participating hospitals and made the data comparable. Clinical and laboratory measurements, including blood pressure, GCS, and lab tests, were recorded according to routine practices at each hospital.

Bias Control

To minimize selection bias, an exhaustive inclusion strategy was used, ensuring that no eligible patient was overlooked. Information bias was mitigated through the use of predefined data collection forms that standardized the abstraction process. However, the retrospective design of the study may still introduce residual information bias due to incomplete or inconsistent medical records.

In addition, variability in clinical documentation and differences in ICU management protocols across participating hospitals may have contributed to inter-center information bias.

Study Size

The study included all eligible patients admitted to the six participating ICUs during the study period, with no prior sample size calculation, as the study was descriptive and exhaustive in nature.

Handling of Quantitative Variables

Continuous variables were assessed for normality through visual inspection of distributions. Normally distributed variables were reported as means with standard deviations, while non-normally distributed variables were summarized as medians with interquartile ranges. For clinical relevance, certain continuous variables were categorized into

clinically meaningful thresholds, such as GCS ≤ 8, ICU length of stay > 7 days, and severe hypertension values (≥ 160/110 mmHg).

Statistical Analysis

Data were analyzed using SPSS software. Descriptive statistics were employed to summarize the sociodemographic, clinical, and management characteristics of the cohort. Categorical variables were presented as frequencies and percentages, while continuous variables were reported as described above.

Bivariate analysis was conducted to evaluate associations between potential explanatory variables and maternal mortality. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. For continuous variables, the Student's t-test or Mann-Whitney U test was used depending on the distribution of the data.

The relationship between potential prognostic factors (e.g., GCS ≤ 8, AKI, pulmonary edema, and HELLP syndrome) and mortality was assessed using odds ratios (ORs) with 95% confidence intervals (CIs). A p-value of less than 0.05 was considered statistically significant for all tests.

Due to the retrospective design and the limited number of outcome events, multivariable logistic regression analysis was not performed. Therefore, all associations should be interpreted as exploratory and not as independent predictors of mortality. Potential confounding between organ dysfunctions may exist.

Ethical Considerations

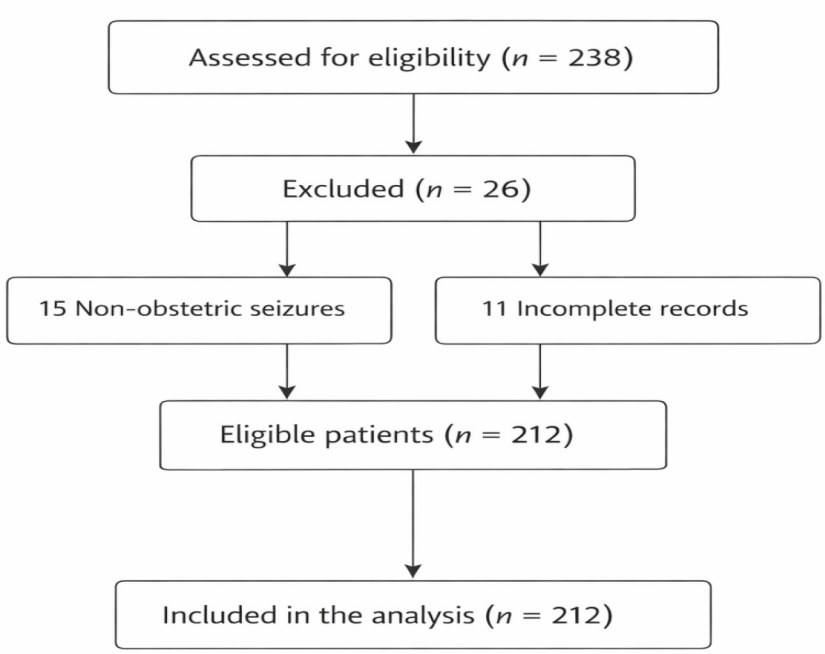
The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of the School of Public Health, University of Kinshasa (approval number : ESP/CE/196/2024). As the study was based on retrospective anonymized data, individual patient consent for publication was not required.

Results

1. Participants

From January 2019 to December 2022, a total of 238 women with suspected severe preeclampsia or eclampsia were initially screened across six ICUs in Kinshasa. After applying the eligibility criteria, 212 women were included in the final analysis. Twenty-six patients were excluded: 15 because their seizures were attributed to non-obstetric neurological conditions, and 11 due to incomplete or non-exploitable medical records. This exhaustive inclusion allows a comprehensive description of the severe preeclampsia population admitted to intensive care in this setting. (Figure 1)

Figure 1. Flow of participants through the study



2. Sociodemographic characteristics

The median age of the women included in the study was 29 years (interquartile range : 25–34 years). A large proportion of the participants (68.4%) were referred from other healthcare facilities, reflecting the severity of their conditions at ICU admission. Parity distribution showed that 41.5% of women were primiparous, 36.8% were multiparous, and 21.7% were grand multiparous (Table 1).

3. Clinical characteristics at ICU admission

At the time of ICU admission, a significant proportion of women had severe hypertension (89.2% with blood pressure ≥ 160/110 mmHg). Neurological symptoms were common, with 42.9% of women experiencing seizures and 17.5% presenting with a Glasgow Coma Scale (GCS) ≤ 8, indicating critical neurological impairment. Other frequent complaints included severe headache (35.8%) and visual disturbances (28.3%) (Table 2).

Table 1. Sociodemographic characteristics of participants (n = 212)

Variable	Number (n)	Percentage (%)
Age < 25 years	56	26.4
Age 25–34 years	104	49.1
Age ≥ 35 years	52	24.5
Referred from another facility	145	68.4
Direct admission	67	31.6
Primiparous	88	41.5
Multiparous	78	36.8
Grand multiparous	46	21.7

Legend: Sociodemographic profile of women admitted to ICUs, including age, referral status, and parity.

Table 2. Clinical characteristics at ICU admission (n = 212)

Clinical feature	Number (n)	Percentage (%)
Seizures	91	42.9
Severe headache	76	35.8
Visual disturbances	60	28.3
GCS ≤ 8	37	17.5
BP ≥ 160/110 mmHg	189	89.2
Peripheral edema	102	48.1

Legend: Key clinical signs observed at ICU admission, showing neurological and hypertensive severity.

4. Organ dysfunctions and complications

Acute kidney injury (AKI) was the most common organ complication, affecting 21.7% of women. Other significant complications included pulmonary edema (16.5%), HELLP syndrome (12.7%), and disseminated intravascular coagulation (DIC) (5.7%). Stroke (4.2%) and sepsis (3.8%) were less common but equally severe. Overall, multi-organ involvement was observed in 10.8% of the women (Table 3).

5. Therapeutic interventions

Magnesium sulfate was used for seizure prophylaxis in 91.5% of the patients, while 87.3% of women received antihypertensive therapy. Mechanical ventilation and renal replacement therapy were used in the most critically ill patients, with 8.5% requiring mechanical ventilation and 3.3% undergoing temporary dialysis (Table 4).

Table 3. Organ dysfunction and complications (n = 212)

Complication / organ affected	Number (n)	Percentage (%)
Acute kidney injury	46	21.7
Pulmonary edema	35	16.5
HELLP syndrome	27	12.7
DIC	12	5.7
Stroke	9	4.2
Sepsis	8	3.8
Multi-organ involvement	23	10.8

Legend: Frequency of organ dysfunctions and serious complications among ICU-admitted women.

Table 4. ICU therapeutic interventions (n = 212)

Intervention	n	%
Magnesium sulfate	194	91.5
Antihypertensive therapy	185	87.3
Mechanical ventilation	18	8.5
Blood transfusion	31	14.6
Temporary dialysis	7	3.3

Legend: Medical and supportive interventions administered in ICU.

6. ICU outcomes

The median ICU stay was 5 days, with 29.2% of patients staying longer than 7 days. Maternal mortality during ICU admission was 14.2%, with the highest observed in women with severe neurological or multi-organ involvement. In particular, women with GCS ≤ 8 (73.3% of deaths), AKI (60.0%), pulmonary edema (43.3%), and HELLP syndrome (36.7%) had disproportionately higher mortality (Table 5).

Table 5. ICU outcomes (n = 212)

Outcome / variable	n	%
ICU stay > 7 days	62	29.2
Maternal deaths	30	14.2
GCS ≤ 8 among deaths	22	73.3
AKI among deaths	18	60.0
Pulmonary edema among deaths	13	43.3
HELLP syndrome among deaths	11	36.7

Legend: Maternal outcomes, showing ICU length of stay and complications associated with mortality.

7. Clinical phenotypes

Four major phenotypic profiles were identified based on predominant organ dysfunction: neurological (17.5%), renal/HELLP (24.4%), cardiovascular/respiratory (21.7%), and multi-organ involvement (10.8%). The multi-organ involvement phenotype showed the highest risk of death. A subgroup of women who did not fit into the main categories (non-classifiable/moderate forms) accounted for 25.5% of the cohort (Table 6).

8. Bivariate associations with maternal mortality

In exploratory bivariate analyses, GCS ≤ 8, AKI, pulmonary edema, and HELLP syndrome were significantly associated with increased maternal mortality. These findings reinforce the importance

Table 6. Distribution of clinical phenotypes (n = 212)

Phenotype	n	%
Neurological	37	17.5
Renal / HELLP	52	24.4
Cardiovascular / respiratory	46	21.7
Multi-organ involvement	23	10.8
Non-classifiable / moderate forms	54	25.5

Legend: Clinical phenotypes identified based on predominant organ dysfunction.

Table 7. Associations with maternal mortality (bivariate analysis)

Variable	OR (95% CI)	p-value
GCS ≤ 8	8.3 (3.4 – 20.2)	<0.001
Acute kidney injury	5.1 (2.1 – 12.4)	0.002
Pulmonary edema	3.9 (1.5 – 10.2)	0.006
HELLP syndrome	3.2 (1.1 – 9.0)	0.03

Legend: Unadjusted odds ratios showing the association of key clinical variables with maternal mortality.

of early recognition and management of neurological, renal, and hematological complications as predictors of adverse outcomes (Table 7).

Discussion

Our multicenter cross-sectional study provides a comprehensive examination of the phenotypic profile of women with eclampsia admitted to ICUs in Kinshasa, highlighting the crucial role of neurological, renal, and cardiovascular complications in determining maternal mortality. The findings emphasize the severity of these complications in patients with eclampsia and underline their significant association with poor maternal outcomes.

The median age of the patients was 29 years, which reflects the typical age range of women affected by severe preeclampsia and eclampsia globally. This is in line with prior studies that report eclampsia as a major cause of maternal morbidity in young women.[1] Most of our patients (68.4%) were referred from other healthcare facilities, which demonstrates the importance of early detection and timely referral to specialized care for optimal management. The delayed referral to intensive care units remains a major concern in sub-Saharan Africa, where limited access to healthcare resources exacerbates the severity of eclampsia and increases the risk of maternal mortality.[2,3] Other studies from African settings also observed this delay.[4,5]

Our study found a high prevalence of primiparity, which has been consistently identified as a risk factor for the development of severe eclampsia and preeclampsia. Primiparous women are particularly vulnerable to hypertensive disorders of pregnancy, which may be more severe compared to multiparous women.[6,7] Similar research from other African countries supports these findings.[8]

Neurological complications were frequent, with 42.9% of women experiencing seizures and 17.5% presenting with a Glasgow Coma Scale (GCS) ≤ 8. These results are consistent with the recognized role of eclamptic seizures as a principal clinical manifestation in eclampsia and a significant factor in maternal mortality.[9] Eclampsia, characterized by convulsions, is one of the most perilous manifestations of hypertensive disorders in pregnancy, especially in low-resource environments where monitoring and prompt treatment may be hindered.[10,11] The association between low GCS and maternal death in our cohort further suggests the need for immediate ICU-level neurological stabilization and close monitoring from admission.[12,13]

Renal involvement, particularly acute kidney injury (AKI), was present in 21.7% of patients and was significantly linked to maternal mortality.

Renal dysfunction in eclampsia is a recognized prognostic indicator for poor outcomes and has been demonstrated to exacerbate disease severity and elevate mortality risk.[14,15] These findings mirror those reported in other African studies where AKI is a common complication of severe preeclampsia.[16] Similarly, HELLP syndrome, present in 12.7% of our patients, was a significant predictor of maternal mortality. HELLP syndrome represents a severe form of preeclampsia and is associated with multi-organ failure, necessitating aggressive management to improve survival.[17,18]

Pulmonary edema, affecting 16.5% of our cohort, was another significant complication associated with high maternal mortality. Pulmonary edema in eclampsia is typically the result of severe hypertension and endothelial dysfunction, leading to increased capillary permeability and fluid leakage into the lungs.[19] Studies have indicated that the combination of hypertension and endothelial damage significantly contributes to the development of life-threatening cardiopulmonary events in eclamptic patients.[20,21]

Regarding management, magnesium sulfate and antihypertensive therapy were administered to nearly all patients, reflecting adherence to international treatment guidelines. Magnesium sulfate remains the first-line therapy for seizure control and prevention in eclampsia, and evidence supports its role in reducing maternal mortality.[22,23] Despite the administration of these evidence-based treatments, our study still reported a maternal mortality rate of 14.2%, highlighting the challenges faced in managing severe eclampsia, especially in resource-limited settings. The maternal mortality rate is often higher in settings where there are delays in referral and limited ICU capacity, both of which contribute to the poor outcomes observed in our cohort.[24]

The phenotypic classification revealed four major clinical phenotypes: neurological, renal/HELLP, cardiovascular/respiratory, and multi-organ involvement. Multi-organ involvement, which included simultaneous neurological, renal, and cardiovascular dysfunction, was associated with the highest mortality. These results suggest that phenotypic classification may be useful as an exploratory tool for early risk stratification in ICU settings, helping to identify patients at highest risk and potentially guide resource allocation.[25] However, its clinical utility remains preliminary and requires prospective validation before implementation in routine practice.

Study limitations include its retrospective design, inter-center variability in clinical documentation and ICU practices, and the absence of multivariable analysis, which limits the identification of independent predictors of mortality. In addition, missing or incomplete data may have introduced information bias, and differences in resource availability across hospitals may have influenced outcomes and limit generalizability.

CONCLUSION

Severe eclampsia in Kinshasa predominantly presents with neurological, renal, and cardiovascular complications, all of which are strongly associated with maternal mortality. Our study highlights the potential usefulness of a phenotypic classification approach to describe organ dysfunction patterns and identify high-risk patients in ICU settings. However, this classification should be considered exploratory and hypothesis-generating, and requires prospective validation before clinical application. Despite adherence to standard therapeutic protocols, including magnesium sulfate and antihypertensive therapy, maternal mortality remains high, underscoring the severity of disease presentation and systemic challenges in resource-limited settings. Efforts to improve early diagnosis, strengthen referral systems, and expand ICU capacity are essential to reduce maternal mortality associated with eclampsia in similar contexts.

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Statements

Funding:

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests:

The authors declare that they have no competing interests.

Author contributions:

JJK, AMB, KAM, and MF contributed to the conception and design of the study. WB, CI, RM,

RA, EA, MM, DT, PB, JC, DM, MD, RN, JM, MB, and BB contributed to data acquisition, analysis, and interpretation. JJK and AMB drafted the manuscript. All authors critically revised the manuscript and approved the final version.

Acknowledgements:

The authors wish to thank all healthcare personnel at the six participating ICUs in Kinshasa for their support in data collection and patient care. Special thanks to the medical records staff for facilitating access to patient files.

Consent for Publication:

This statement is not applicable; the study used retrospective anonymized data, and individual patient consent for publication was not required.

Availability of Data and Material:

The corresponding author can provide the datasets generated and analyzed during the current study upon reasonable request.

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