

Clinical Characteristics, Predictors, and Outcomes of Pregnancy-Related Acute Kidney Injury in a Tertiary Hospital in Ghana: A Retrospective Study

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Abstract

Background

Pregnancy-related acute kidney injury (PRAKI) remains a major contributor to maternal morbidity and mortality in low- and middle-income countries despite global advances in obstetric and renal care. In Ghana, contemporary data are scarce, limiting the understanding of its clinical spectrum and outcomes. This study evaluated the demographic, clinical, biochemical, and obstetric predictors of maternal outcomes among women with PRAKI managed at the Komfo Anokye Teaching Hospital (KATH), Kumasi.

Methods

A hospital-based retrospective cross-sectional study was conducted among 108 women diagnosed with PRAKI between 2020 and 2024. Data on sociodemographic, clinical, obstetric, biochemical, and pharmacological parameters were extracted from medical records. Continuous variables are presented as medians (IQRs), and categorical variables are presented as frequencies and percentages. Bivariate analyses were performed via chi-square and Kruskal–Wallis tests, followed by multinomial logistic regression to identify independent predictors of death and progression to chronic kidney disease (CKD) or end-stage kidney disease (ESKD). A p value < 0.05 was considered to indicate statistical significance.

Results

The mean age of the participants was 32.1 ± 6.6 years, with the majority being aged 31–40 years (48.1%) and married (83.2%). Hypertensive disorders of pregnancy (35.9%) and sepsis (39.3%) were the predominant causes of PRAKI. At diagnosis, 47.7% were pregnant, and 52.3% were postpartum. Most patients (90.7%) were managed conservatively, whereas 10.3% required hemodialysis. The overall renal recovery rate was 51.4%, while 11.2% of the patients progressed to CKD/ESKD, and 37.4% died. Compared with antepartum diagnosis, postpartum presentation was associated with greater recovery ($p = 0.017$). Trimester status, preexisting CKD, malignant hypertension, and intensive care unit (ICU) admission were significantly associated with maternal outcomes ($p < 0.05$). Multinomial regression confirmed pregnancy status and ICU admission as independent predictors of mortality, and preexisting CKD was the strongest predictor of poor renal recovery.

Conclusion

PRAKI in KATH predominantly affects women in their reproductive prime and is largely driven by preventable hypertensive and septic complications. Despite advances in obstetric care, mortality and incomplete renal recovery remain high. Early identification of high-risk pregnancies, prompt management of hypertensive and infectious complications, and improved access to renal replacement therapy are

crucial to reducing the burden of PRAKI and its long-term sequelae in Ghana and similar resource-limited settings.

Introduction

Pregnancy-related acute kidney injury (PRAKI) represents a critical obstetric complication that significantly increases the risk of maternal and fetal morbidity and mortality [1, 2]. Once regarded as a reversible condition, PRAKI is now recognized as a potential precursor to chronic kidney disease (CKD), with up to one-third of affected women experiencing persistent renal impairment and approximately 2.4% progressing to end-stage kidney disease (ESKD) requiring dialysis [3, 4]. The global burden of PRAKI is disproportionately greater in low-resource settings, where limited access to healthcare and delayed diagnosis contribute to elevated maternal mortality and poor renal recovery [5].

In high-income countries, advances in antenatal surveillance, safer obstetric practices, and early nephrologic intervention have led to a marked decline in the incidence of PRAKI. Current cases in these settings primarily occur among women with preexisting comorbidities such as CKD, hypertension, or diabetes rather than from traditional obstetric causes [6]. In contrast, PRAKI remains a major contributor to maternal morbidity in low- and middle-income countries (LMICs), where preventable causes such as preeclampsia/eclampsia, sepsis, and obstetric hemorrhage predominate [7]. A systematic review in Africa reported maternal mortality rates as high as 34%, with frequent late presentation and incomplete renal recovery among survivors [8].

The etiologic profile of PRAKI has evolved. Septic abortion and hemorrhage were previously the leading causes; however, recent studies increasingly implicate hypertensive disorders of pregnancy, especially preeclampsia, eclampsia, and HELLP syndrome, as dominant contributors [9]. These disorders cause endothelial dysfunction, intravascular coagulation, and ischemic injury to the renal microvasculature, predisposing individuals to cortical necrosis and progression to CKD or ESKD [10]. These outcomes are further aggravated by delayed diagnosis, limited access to critical care resources, and financial barriers that postpone the initiation of dialysis.

In addition to its incidence and etiology, PRAKI imposes a considerable clinical burden, threatening both maternal and fetal survival. Maternal mortality has been reported to be between 2.5% and 34%, whereas perinatal and fetal mortality rates may reach 67.3% and 29.8%, respectively [11]. These alarming statistics highlight the persistent inequities in maternal healthcare delivery and underscore the urgency of improving early risk identification and management of renal complications during pregnancy.

Despite global progress, data on the PRAKI in Ghana remain scarce and largely outdated. The last major report from Korle-Bu Teaching Hospital, over three decades ago, identified septic abortion and postpartum hemorrhage as the main causes [12]. However, evolving demographics, better antenatal care, and modern obstetric practices may have altered disease patterns. Therefore, this study aimed to evaluate the clinical characteristics, laboratory findings, management strategies, and outcomes of women with PRAKI managed at Komfo Anokye Teaching Hospital (KATH). Identifying factors associated

with recovery, progression to CKD/ESKD, and mortality can provide evidence to guide early detection, optimize care, and inform national strategies to reduce kidney-related maternal deaths in Ghana and other LMICs.

Methods

Study design and site

This hospital-based retrospective cross-sectional study was conducted at the renal clinic of the Komfo Anokye Teaching Hospital (KATH) from 2020–2024. KATH is the second largest hospital in Ghana, with a bed capacity of approximately 1,200, and serves as the main referral center for the middle and northern zones of the country. The hospital has a busy obstetrics and gynecology department that manages a high volume of complicated pregnancies, including cases referred with preeclampsia, sepsis, and obstetric hemorrhage. Its renal unit is well established, providing dialysis and specialist renal care, and it is often involved in the management of women presenting with pregnancy-related acute kidney injury.

Eligibility criteria

Records of all female patients aged 14 years and above who were admitted to KATH during the study period with PRAKI were included. Patients were excluded if they already had end-stage kidney disease on chronic dialysis before pregnancy, if their kidney injury was clearly unrelated to pregnancy, or if their records lacked enough information to confirm the diagnosis or outcome. When a patient had more than one admission during the study period, only her first admission for PRAKI was included.

Participants/Data collection

The secondary data of 108 women with PRAKI were extracted from hospital medical records, admission/discharge registers, nephrology and obstetrics unit logs, laboratory databases, pharmacy records, and the dialysis register via a structured, pretested data extraction form. Sociodemographic information collected included age, marital status, ethnicity, educational level, and occupation. The metric variables included pregnancy status, trimester at presentation, gravidity, parity, gestational age, and mode of delivery. Clinical data included referral diagnosis, blood pressure grading, intensive care unit (ICU) admission, duration of admission, etiology, comorbidities, complications and whether hemodialysis was performed. The biochemical and laboratory data recorded at admission and discharge included serum creatinine and full blood count data. The pharmacological data included in-hospital medications such as antihypertensives, analgesics, antibiotics, and hematinics. Maternal outcomes were classified at discharge as recovery, progression to chronic kidney disease/end-stage kidney disease (CKD/ESKD), or in-hospital death. Fetal outcomes were also captured. Data abstraction was performed by trained research staff and medical doctors. The extracted dataset was reviewed for completeness; records that

lacked the core variables required to ascertain diagnosis or outcome were excluded per the eligibility criteria.

Definition of outcomes

Acute kidney injury (AKI): was defined in accordance with the 2012 KDIGO criteria as any of the following: an increase in serum creatinine (SCr) by ≥ 0.3 mg/dL within 48 hours; a rise in SCr exceeding 50% relative to baseline within 7 days; or a reduction in urine output to less than 0.5 mL/kg/h sustained for at least 6 hours [13].

Pregnancy-related acute kidney injury (PR-AKI)

All etiologies of acute kidney dysfunction occur between early gestation and the third month following delivery [14].

Renal recovery

By day 7, serum creatinine either normalized to baseline levels, decreased to less than 1.5 times the baseline value, or fell within 50% above the original baseline concentration [15].

Chronic kidney disease (CKD) and end-stage kidney disease (ESKD)

CKD is defined as structural or functional abnormalities of the kidney accompanied by a glomerular filtration rate (GFR) of ≤ 60 mL/min/1.73 m² persisting for more than three months, whereas ESKD is defined as a GFR of less than 15 mL/min. [16].

Ethical considerations

Ethical approval

was obtained from the KATH Institutional Review Board (ethical clearance ID: KATH IRB/AP/053/25). Informed consent was waived due to the retrospective nature of the study and participants' data anonymised. Data collection adhered to the ethical principles outlined in the Declaration of Helsinki and complied with applicable local regulatory standards.

Statistical analysis

The data were entered into Microsoft Excel 2021 and analyzed via IBM SPSS Statistics version 27.0. Continuous variables were tested for normality via the Shapiro–Wilk test and are presented as the means $\pm$ standard deviations (SDs) or medians with interquartile ranges (IQRs). Categorical variables are summarized as frequencies and percentages. Maternal and childbirth outcomes are illustrated with bar charts. Between-group comparisons were performed via the independent samples t test or Mann–

Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate. Maternal outcomes were categorized as recovery, CKD/ESKD, or death. To identify independent predictors of these outcomes, multinomial logistic regression was performed, and the results are reported as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was defined as $p < 0.05$.

Results

Sociodemographic characteristics

A total of 108 women diagnosed with pregnancy-related acute kidney injury (PRAKI) were included in the study. The mean age of the participants was 32.1 ± 6.6 years, with most women aged 31–40 years. Most participants were married (83.2%), and the predominant ethnic group was Akan (85.9%). With respect to educational attainment, the majority had completed secondary education (68.9%), 17 (18.9%) had tertiary-level education, and 5 (5.6%) had no formal education. Occupationally, most participants were engaged in informal employment (65.6%), with 15 (16.1%) in formal employment and 14 (15.1%) unemployed.

At the time of PRAKI diagnosis, 47.7% were pregnant, and 52.3% were in the postpartum or ectopic period. Pregnancy status was significantly associated with maternal outcomes ($p = 0.017$), with postpartum presentations associated with higher recovery rates. The trimester of presentation was also significantly associated with maternal outcomes ($p = 0.012$). The majority of the women presenting in the first or second trimester developed CKD/ESKD or died, while most of them presenting in the third trimester recovered. The mode of delivery was Cesarean section in 65 (60.7%), vaginal delivery in 34 (31.8%), and salpingectomy in 2 (1.9%); 6 (5.6%) of the participants did not deliver. The treatment modality was primarily conservative management (90.7%), whereas 11 (10.3%) patients required hemodialysis. Blood pressure grading at admission revealed that 42.2% of the patients had normal values, 26.7% had mild-to-moderate hypertension, and 31.1% had severe hypertension. ICU admission was associated with outcomes ($p < 0.001$), with 71.1% of ICU patients dying during admission (Table 1).

Table 1
Sociodemography and clinical characteristics of participants stratified by maternal outcomes

Maternal Outcome					
Variables	Total	Recovery	CKD/ESKD	Death	P value
Age (years)	32.1 ± 6.6	33.1 ± 6.0	30.6 ± 7.5	30.9 ± 6.8	0.179
Age group (years)					0.412
≤ 20	4 (3.7)	1 (25.0)	0 (0.0)	3 (75.0)	
21–30	43 (39.8)	18 (41.9)	7 (16.3)	18 (41.9)	
31–40	52 (48.1)	26 (50.0)	6 (11.5)	20 (38.5)	
> 40	9 (8.3)	6 (66.7)	2 (22.2)	1 (11.1)	
Marital Status					0.869
Married	84 (83.2)	42 (50.0)	10 (11.9)	32 (38.1)	
Domestic Partner	2 (2.0)	1 (50.0)	0 (0.0)	1 (50.0)	
Single	15 (14.9)	6 (40.0)	3 (20.0)	6 (40.0)	
Ethnicity					0.424
Akan	79 (85.9)	39 (49.4)	12 (15.2)	28 (35.4)	
Ewe	2 (2.2)	0 (0.0)	0 (0.0)	2 (100.0)	
Mole-Dagbani	11 (12.0)	5 (45.5)	1 (9.1)	5 (45.5)	
Education					0.590
No formal education	5 (5.6)	2 (40.0)	0 (0.0)	3 (60.0)	
Primary	6 (6.7)	2 (33.3)	2 (33.3)	2 (33.3)	
Secondary	62 (68.9)	27 (43.5)	7 (11.3)	28 (45.2)	
Tertiary	17 (18.9)	9 (52.9)	3 (17.6)	5 (29.4)	
Occupation					0.878
Formal	15 (16.1)	6 (40.0)	2 (13.3)	7 (46.7)	
Informal	61 (65.6)	28 (45.9)	7 (11.5)	26 (42.6)	
Student	3 (3.2)	1 (33.3)	1 (33.3)	1 (33.3)	
Unemployed	14 (15.1)	8 (57.1)	2 (14.3)	4 (28.6)	
C/S: Cesarean section; BP: Blood pressure; ICU: Intensive care unit					

Maternal Outcome					
Variables	Total	Recovery	CKD/ESKD	Death	P value
Pregnancy status					0.017
Pregnant	51 (47.7)	19 (37.3)	12 (23.5)	20 (39.2)	
Postpartum/Ectopic	56 (52.3)	32 (57.1)	2 (3.6)	22 (39.3)	
Trimester					0.012
1st	1 (1.3)	0 (0.0)	0 (0.0)	1 (100.0)	
2nd	19 (25.3)	9 (47.4)	8 (42.1)	2 (10.5)	
3rd	55 (73.3)	29 (52.7)	6 (10.9)	20 (36.4)	
Birth Type					0.127
Vaginal	34 (31.8)	11 (32.4)	9 (26.5)	14 (41.2)	
C/S	65 (60.7)	35 (53.8)	5 (7.7)	25 (38.5)	
Salpingectomy	2 (1.9)	1 (50.0)	0 (0.0)	1 (50.0)	
No delivery	6 (5.6)	4 (66.7)	0 (0.0)	2 (33.3)	
Treatment					0.909
Hemodialysis	11 (10.3)	5 (45.5)	2 (18.2)	4 (36.4)	
Conservative	97 (90.7)	46 (47.4)	13 (13.4)	38 (39.2)	
BP grade					0.666
Hypertension	24 (26.7)	11 (45.8)	5 (20.8)	8 (33.3)	
Severe hypertension	28 (31.1)	13 (46.4)	2 (7.1)	13 (46.4)	
No hypertension	38 (42.2)	17 (44.7)	5 (13.2)	16 (42.1)	
ICU admission	38 (41.3)	11 (28.9)	0 (0.0)	27 (71.1)	< 0.001
C/S: Cesarean section; BP: Blood pressure; ICU: Intensive care unit					

Laboratory and obstetric findings

The median admission creatinine level was lowest among women who recovered (272.0 $\mu\text{mol/L}$, IQR 208.0–371.0), intermediate among those who died (481.0 $\mu\text{mol/L}$, IQR 310.0–812.0), and highest among those in the CKD/ESKD group (633.5 $\mu\text{mol/L}$, IQR 421.0–725.0, $p = 0.036$). Discharge creatinine followed a similar pattern, remaining lowest in the recovery group (105.0 $\mu\text{mol/L}$, IQR 82.0–120.0) but markedly higher in the CKD/ESKD (320.0 $\mu\text{mol/L}$, IQR 259.0–457.5) and death (247.0 $\mu\text{mol/L}$, IQR 156.0–390.0) groups ($p = 0.007$).

WBC counts differed across groups. At admission, CKD/ESKD patients had lower counts ($8.0 \times 10^9/L$, IQR 6.0–10.0) than did patients who recovered ($13.7 \times 10^9/L$, IQR 10.3–17.8) or died ($13.7 \times 10^9/L$, IQR 10.2–18.4) ($p = 0.026$). At discharge, WBC counts were significantly greater in women who died ($16.2 \times 10^9/L$, IQR 11.5–21.3) than in those who recovered ($9.4 \times 10^9/L$, IQR 7.2–12.6, $p = 0.006$). The admission platelet count was greater in the CKD/ESKD group ($235 \times 10^9/L$, IQR 214–274) than in the recovery ($173 \times 10^9/L$, IQR 136–214) and death ($150 \times 10^9/L$, IQR 113–195, $p < 0.006$) groups. The gestational age at presentation was lower in the CKD/ESKD group (25.5 weeks, IQR 24.0–27.0) than in the recovery (34.0 weeks, IQR 30.0–36.0) and death (33.0 weeks, IQR 30.0–35.0, $p = 0.031$) groups. (Table 2)

Table 2
Median laboratory, clinical, and obstetric characteristics stratified by maternal outcomes

Maternal Outcome				
	Recovery	CKD/ESKD	Death	P value
Variables	Median (IQR)	Median (IQR)	Median (IQR)	
Admission Creatinine (μmol/l)	272.0 (151.0-570.4)	633.5 (218.5-988.0)	481.0 (327.0-763.0)	0.036
Discharge Creatinine (μmol/l)	169.0 (80.7-502.7)	447.0 (171.0-999.0)	475.0 (309.5-872.5)	0.007
Admission Hb (g/dl)	7.4 (6.4-9.4)	7.7 (6.7-10.5)	7.8 (5.4-7.8)	0.740
Discharge Hb (g/dl)	8.6 (7.6-9.8)	7.6 (5.6-8.5)	7.0 (6.4-9.6)	0.058
Admission WBC (x10 ⁹ /L)	13.7 (9.8-20.0)	8.0 (7.2-10.1)	13.7 (10.9-26.0)	0.026
Discharge WBC (x10 ⁹ /L)	11.7 (7.7-13.1)	9.2 (8.7-11.7)	18.2 (12.2-30.1)	0.006
Admission Platelet (x10 ⁹ /L)	115.0 (64.0-190.0)	235.0 (173.0-291.0)	93.0 (49.5-189.5)	0.006
Discharge Platelet (x10 ⁹ /L)	171.0 (130.5-219.3)	205.0 (143.0-267.0)	137.0 (53.0-176.0)	0.102
Duration of Admission (days)	11.0 (5.7-18.0)	8.0 (3.5-10.5)	7.0 (3.0-26.0)	0.354
SBP (mmHg)	150.0 (129.0-169.0)	147.0 (121.7-163.5)	139.0 (121.5-171.0)	0.718
DBP (mmHg)	90.0 (79.0-108.5)	94.0 (71.7-121.5)	84.0 (59.0-105.0)	0.148
Gravida	3.0 (2.0-4.5)	3.0 (2.0-5.0)	3.0 (2.0-4.0)	0.957
Parity	2.0 (1.0-3.0)	1.0 (0.0-4.0)	2.0 (1.0-3.0)	0.616
Gestational age (weeks)	34.0 (27.5-37.5)	25.5 (17.5-34.0)	33.0 (29.0-36.0)	0.031
SBP: systolic blood pressure; DBP: diastolic blood pressure				

Referral diagnosis and causes of PRAKI

The most common referral diagnosis was AKI (75.8%), followed by preeclampsia (15.4%), eclampsia (12.1%), and CKD (12.1%). CKD and malignant hypertension referrals were strongly associated with maternal outcomes ($p < 0.001$). All five women referred with malignant hypertension developed CKD/ESKD, while 18.2% of CKD referrals died and 9.1% recovered.

With respect to the causes of AKI, sepsis (39.3%) and preeclampsia/eclampsia (35.9%) were the predominant contributors. Intracranial necrosis, malignant hypertension, preexisting CKD and AKI were associated with maternal outcomes ($p < 0.05$). The majority of patients with intracranial necrosis died, and the majority with malignant hypertension progressed to CKD/ESKD. Preeclampsia/eclampsia as a cause was significantly related to maternal outcome, with most affected women achieving recovery ($p = 0.005$). (Table 3)

Table 3
Referral diagnosis and causes of AKI stratified by maternal outcomes

Maternal Outcome					
Variable	Total	Recovery	CKD/ESKD	Death	P value
Referral Diagnosis					
AKI	69 (75.8)	34 (49.3)	6 (8.7)	29 (42.0)	0.064
CKD	11 (12.1)	1 (9.1)	8 (72.7)	2 (18.2)	< 0.001
ESKD	3 (3.3)	1 (33.3)	1 (33.3)	1 (33.3)	0.576
Malignant HPT	5 (5.5)	0 (0.0)	5 (100.0)	0 (0.0)	< 0.001
Sepsis	9 (9.9)	4 (44.4)	1 (11.1)	4 (44.4)	0.975
Preeclampsia	14 (15.4)	9 (64.3)	1 (7.1)	4 (28.6)	0.286
Eclampsia	11 (12.1)	4 (36.4)	1 (9.1)	6 (54.5)	0.651
Anemia	4 (4.4)	3 (75.0)	0 (0.0)	1 (25.0)	0.435
HELLP	14 (15.4)	8 (57.1)	0 (0.0)	6 (42.9)	0.256
DIC	4 (4.4)	1 (25.0)	0 (0.0)	3 (75.0)	0.362
Cerebral edema	1 (1.1)	1 (100.0)	0 (0.0)	0 (0.0)	0.540
Pneumonia	1 (1.1)	1 (100.0)	0 (0.0)	0 (0.0)	0.540
OHSS	1 (1.1)	1 (100.0)	0 (0.0)	0 (0.0)	0.540
Hemorrhage	4 (4.4)	0 (0.0)	0 (0.0)	4 (100.0)	0.054
Pulmonary embolism	1 (1.1)	0 (0.0)	0 (0.0)	1 (100.0)	0.494
CVA	1 (1.1)	0 (0.0)	0 (0.0)	1 (100.0)	0.494
Liver disease	2 (2.2)	1 (50.0)	0 (0.0)	1 (50.0)	0.855
APH	1 (1.1)	1 (100.0)	0 (0.0)	0 (0.0)	0.540
PPH	6 (6.6)	2 (33.3)	0 (0.0)	4 (66.7)	0.368
AKI: acute kidney injury; HPT: hypertension; HELLP: hemolysis, elevated liver enzymes, and low platelet; DIC: disseminated intravascular coagulation; OHSS: ovarian hyperstimulation syndrome; CVA: cardiovascular accident; APH: antepartum hemorrhage; PPH: postpartum hemorrhage; CGN: chronic glomerulonephritis; SCD: sickle cell disease					

Maternal Outcome					
Variable	Total	Recovery	CKD/ESKD	Death	P value
Referral Diagnosis					
CGN	1 (1.1)	1 (100.0)	0 (0.0)	0 (0.0)	0.540
AKI Causes					
Malignant HPT	3 (3.4)	0 (0.0)	2 (66.7)	1 (33.3)	0.012
Hypotension	4 (4.5)	1 (25.0)	0 (0.0)	3 (75.0)	0.359
Sepsis	35 (39.3)	15 (42.9)	3 (8.6)	17 (48.6)	0.477
Intracranial necrosis	8 (9.0)	1 (12.5)	0 (0.0)	7 (87.5)	0.012
Preeclampsia/Eclampsia	32 (35.9)	22 (68.8)	3 (9.4)	7 (21.9)	0.005
CKD	6 (6.7)	0 (0.0)	5 (83.3)	1 (16.7)	< 0.001
AKI	5 (5.6)	1 (20.0)	3 (60.0)	1 (20.0)	0.004
HELLP	13 (14.6)	6 (46.2)	0 (0.0)	7 (53.8)	0.296
DIC	3 (3.4)	1 (33.3)	0 (0.0)	2 (66.7)	0.618
Hemorrhage	13 (14.6)	6 (46.2)	0 (0.0)	7 (53.8)	0.296
HRS	2 (2.2)	1 (50.0)	0 (0.0)	1 (50.0)	0.863
Coagulopathy	1 (1.1)	0 (0.0)	0 (0.0)	1 (100.0)	0.491
OHSS	1 (1.1)	1 (100.0)	0 (0.0)	0 (0.0)	0.553
Malaria	1 (1.1)	0 (0.0)	0 (0.0)	1 (100.0)	0.491
Anemia	7 (7.9)	5 (71.4)	1 (14.3)	1 (14.3)	0.295
SCD	1 (1.1)	0 (0.0)	0 (0.0)	1 (100.0)	0.491
Pneumonia	2 (2.2)	1 (50.0)	1 (50.0)	0 (0.0)	0.202
AKI: acute kidney injury; HPT: hypertension; HELLP: hemolysis, elevated liver enzymes, and low platelet; DIC: disseminated intravascular coagulation; OHSS: ovarian hyperstimulation syndrome; CVA: cardiovascular accident; APH: antepartum hemorrhage; PPH: postpartum hemorrhage; CGN: chronic glomerulonephritis; SCD: sickle cell disease					

Comorbidities and complications

Hypertension was the most common comorbidity (50.5%) and was significantly associated with outcomes, with 56.0% of women recovering, 26.0% deaths, and 18.0% progressing to CKD/ESKD ($p = 0.036$). Both heart disease (3.0%) and kidney disease (9.1%) were uncommon but strongly associated with maternal outcome; most affected women progressed to CKD/ESKD ($p = 0.023$ and $p < 0.001$, respectively).

Among PRAKI complications, pulmonary edema was the most common (30.8%), followed by anemia (17.6%), seizures (15.7%), and electrolyte disturbances (14.3%). Respiratory disease, cardiac complications, CKD as a complication, and metabolic acidosis were significantly associated with outcomes ($p < 0.05$), and the majority of affected women died. The participant with pitting edema developed CKD/ESKD (Table 4).

Table 4
Participant comorbidities and PRAKI complications in relation to maternal outcomes

Maternal Outcome					
Variable	Total	Recovery	CKD/ESKD	Death	P value
Comorbidities					
Hypertension	50 (50.5)	28 (56.0)	9 (18.0)	13 (26.0)	0.036
Anemia	35 (35.4)	18 (51.4)	6 (17.1)	11 (31.5)	0.547
Sepsis	10 (10.1)	3 (30.0)	0 (0.0)	7 (70.0)	0.075
Respiratory disease	6 (6.1)	1 (16.7)	1 (16.7)	4 (66.6)	0.288
Heart disease	3 (3.0)	0 (0.0)	2 (66.7)	1 (33.3)	0.023
Kidney disease	9 (9.1)	1 (11.1)	7 (77.8)	1 (11.1)	< 0.001
MOF	1 (1.0)	0 (0.0)	0 (0.0)	1 (100)	0.444
Hyperkalemia	3 (3.0)	2 (66.7)	0(0.0)	1 (33.3)	0.705
Metabolic Acidosis	2 (2.0)	0 (0.0)	0 (0.0)	2 (100)	0.194
PPH	3 (3.0)	1 (33.3)	0 (0.0)	2 (66.7)	0.545
HIV	1 (1.0)	1 (100)	0 (0.0)	0 (0.0)	0.572
Brain injury	2 (2.0)	0 (0.0)	0 (0.0)	2 (100)	0.194
Complications					
Pulmonary Edema	28 (30.8)	15 (53.6)	3 (10.7)	10 (35.7)	0.551
Anemia	16 (17.6)	10 (62.5)	2 (12.5)	4 (25.0)	0.269
Sepsis	3 (3.3)	2 (66.7)	0 (0.0)	1 (33.3)	0.676
Liver disease	7 (7.7)	4 (57.1)	0 (0.0)	3 (42.9)	0.536
Respiratory disease	7 (7.7)	1 (14.3)	0 (0.0)	6 (85.7)	0.047
Electrolytes	13 (14.3)	6 (46.2)	0 (0.0)	7 (53.8)	0.282
Anuria/Oliguria	7 (7.7)	1 (14.3)	1 (14.3)	5 (71.4)	0.202
CKD	1 (1.1)	0 (0.0)	1 (100)	0 (0.0)	0.036
Seizure	17 (15.7)	10 (58.8)	3 (17.6)	4 (23.5)	0.486
DIC	5 (5.5)	2 (40.0)	0 (0.0)	3 (60.0)	0.563
HIV: Human immune virus; MOF: Multiorgan failure; DIC: Disseminated intravascular coagulation; CKD: Chronic kidney disease; HELLP: Hemolysis, elevated liver enzymes, and low platelet count					

Maternal Outcome					
Variable	Total	Recovery	CKD/ESKD	Death	P value
Comorbidities					
Multi-Organ Failure	7 (7.7)	3 (42.9)	0 (0.0)	4 (57.1)	0.487
Thrombocytopaenia	2 (2.2)	0 (0.0)	0 (0.0)	2 (100)	0.240
HELLP	6 (6.6)	5 (83.3)	0 (0.0)	1 (16.7)	0.142
Fluid overload	1 (1.1)	0 (0.0)	0 (0.0)	1 (100)	0.494
Cardiac	11 (12.1)	1 (9.1)	1 (9.1)	9 (81.8)	0.014
Uremic gastritis	5 (5.5)	3 (60.0)	1 (20.0)	1 (20.0)	0.592
Neurological	10 (11.0)	3 (30.0)	3 (30.0)	4 (40.0)	0.225
Pitting edema	1 (1.1)	0 (0.0)	1 (100)	0 (0.0)	0.036
Metabolic Acidosis	5 (5.5)	0 (0.0)	0 (0.0)	5 (100)	0.025
Hypertension	3 (3.3)	3 (100)	0 (0.0)	0 (0.0)	0.151
HIV: Human immune virus; MOF: Multiorgan failure; DIC: Disseminated intravascular coagulation; CKD: Chronic kidney disease; HELLP: Hemolysis, elevated liver enzymes, and low platelet count					

Medication history

Nifedipine was the most frequently prescribed antihypertensive agent, with 75.4% of the administered patients recovering (57.4%, $p = 0.015$). Most of those administered morphine and ceftriaxone (65.2%) died. The majority (70.6%) of those administered amoxiclav also recovered. Nifedipine, morphine, amoxiclav and ceftriaxone use were significantly associated with outcomes ($p < 0.05$). Rarely used agents, such as fosfomycin and vancomycin, although prescribed to only one patient each, were also significantly associated with maternal outcome (both $p = 0.044$). (Table 5)

Table 5
Medication history of the study participants in relation to maternal outcomes

Maternal Outcome					
Drugs	Total	Recovery	CKD/ESKD	Death	P value
Antihypertensives					
Nifedipine	54 (77.1)	31 (57.4)	10 (18.5)	13 (24.1)	0.015
Hydralazine	28 (40.0)	13 (46.4)	5 (17.9)	10 (35.7)	0.787
Lebatolol	19 (27.1)	11 (57.9)	2 (10.5)	6 (31.6)	0.715
Amlodipine	5 (7.1)	1 (20.0)	1 (20.0)	3 (60.0)	0.316
Methyldopa	30 (42.8)	18 (60.0)	5 (16.7)	7 (23.3)	0.328
Carvediol	2 (2.8)	1 (50.0)	1 (50.0)	0 (0.0)	0.330
Furosemide	3 (4.3)	2 (66.7)	0 (0.0)	1 (33.3)	0.728
Spirinolactone	1 (1.4)	1 (100.0)	0 (0.0)	0 (0.0)	0.619
Analgesics					
Paracetamol	45 (70.3)	22 (48.9)	8 (17.8)	15 (33.3)	0.064
Morphine	34 (53.1)	15 (44.1)	0 (0.0)	19 (55.9)	0.001
Tramadol	12 (18.7)	7 (58.3)	3 (25.0)	2 (16.7)	0.114
Diclofenac	7 (10.9)	3 (42.9)	0 (0.0)	4 (57.1)	0.464
Ketamine	1 (1.6)	0 (0.0)	0 (0.0)	1 (100.0)	0.476
Profolol	1 (1.6)	0 (0.0)	0 (0.0)	1 (100.0)	0.476
Midazolam	3 (4.7)	0 (0.0)	0 (0.0)	3 (100.0)	0.100
Antibiotics					
Amoxiclav	17 (21.5)	12 (70.6)	2 (11.8)	3 (17.6)	0.039
Metronidazole	56 (70.9)	27 (48.2)	7 (12.5)	22 (39.3)	0.541
Ceftriaxone	23 (29.1)	8 (34.8)	0 (0.0)	15 (65.2)	0.009
Clindamycin	22 (27.8)	8 (36.4)	1 (4.5)	13 (59.1)	0.103
Cefuroxime	14 (17.7)	8 (57.1)	0 (0.0)	6 (42.9)	0.222
Azithromycin	11 (13.9)	5 (45.5)	1 (9.1)	5 (45.5)	0.878
Amoxicillin	3 (3.8)	1 (33.3)	0 (0.0)	2 (66.7)	0.612

Maternal Outcome					
Drugs	Total	Recovery	CKD/ESKD	Death	P value
Antihypertensives					
Amikacin	2 (2.5)	1 (50.0)	0 (0.0)	1 (50.0)	0.846
Ciprofloxacin	11 (13.9)	6 (54.5)	0 (0.0)	5 (45.5)	0.346
Cefotaxime	1 (1.2)	0 (0.0)	0 (0.0)	1 (100.0)	0.494
Levofloxacin	12 (15.2)	3 (25.0)	3 (25.0)	6 (50.0)	0.264
Fosfomycin	1 (1.2)	0 (0.0)	1 (100.0)	0 (0.0)	0.044
Cefepime	1 (1.2)	0 (0.0)	0 (0.0)	1 (100.0)	0.494
Vancomycin	1 (1.2)	0 (0.0)	1 (100.0)	0 (0.0)	0.044
Meropenem	4 (50.6)	1 (25.0)	1 (25.0)	2 (50.0)	0.672
Hematinics					
Folic acid	41 (78.9)	24 (58.5)	8 (19.5)	9 (22.0)	0.848
Tot'hema	23 (44.2)	14 (60.9)	4 (17.4)	5 (21.7)	0.837
Fersolate	20 (38.5)	12 (60.0)	5 (25.0)	3 (15.0)	0.657
Iron sucrose	1 (1.9)	0 (0.0)	1 (100.0)	0 (0.0)	0.150
Amino Pep	7 (13.5)	5 (71.4)	1 (14.3)	1 (14.3)	0.732
Erythropoietin	2 (3.8)	0 (0.0)	1 (50.0)	1 (50.0)	0.242
Vitamin B	1 (1.9)	1 (100.0)	0 (0.0)	0 (0.0)	0.688
Multivitamin	2 (3.8)	2 (100.0)	0 (0.0)	0 (0.0)	0.466

Maternal and childbirth outcomes

Approximately 47% of the participants recovered, with 12% and 1.9% progressing to CKD and ESKD, respectively. Approximately 39% of the participants died. (Fig. 1)

Figure 2 illustrates the distribution of childbirth outcomes among women with PRAKI. Preterm delivery was most common (39.1%), followed by term delivery (19.6%). Stillbirths accounted for 26.0% of the cases, whereas miscarriages (3.3%) and neonatal deaths (4.3%) were less common. The rare outcomes included ectopic pregnancy, intrauterine fetal death, and abortion, each reported in 1.1% of the participants (Fig. 2).

Multinomial regression analysis

In the multivariable analysis, pregnancy status at diagnosis, trimester of presentation, intensive care unit (ICU) admission, and certain clinical and laboratory variables were identified as independent predictors of maternal renal outcomes. Postpartum presentation was protective against CKD/ESKD (OR 0.099, 95% CI 0.020–0.491, $p = 0.005$), whereas second-trimester diagnosis increased the odds of CKD/ESKD compared with third-trimester presentation (OR 4.296, 95% CI 1.176–15.702, $p = 0.027$). A lower gestational age at diagnosis independently predicted poor renal recovery (OR 0.896, 95% CI 0.823–0.974; $p = 0.010$). ICU admission was a strong predictor of mortality (OR 6.694, 95% CI 2.502–17.913, $p < 0.001$), as was intracranial necrosis (OR 9.333, 95% CI 1.089–79.973, $p = 0.042$). Preeclampsia/eclampsia as a cause of PRAKI reduced the odds of death (OR 0.202, 95% CI 0.072–0.562; $p = 0.002$).

With respect to medications, nifedipine (OR 0.210, 95% CI 0.060–0.735, $p = 0.015$) and amoxiclav (OR 0.192, 95% CI 0.048–0.759, $p = 0.019$) were protective against death. Biochemical predictors included higher admission creatinine for CKD/ESKD (OR 1.002, 95% CI 1.000–1.003, $p = 0.048$), higher discharge creatinine (OR 1.002, 95% CI 1.000–1.004, $p < 0.011$) and elevated discharge white blood cell count for mortality (OR 1.188, 95% CI 1.051–1.343, $p = 0.006$). Preexisting kidney disease was the strongest predictor of CKD/ESKD (OR 46.000, 95% CI 4.892–432.569, $p < 0.001$), whereas hypertension was protective against death (OR 0.353, 95% CI 0.145–0.858; $p = 0.021$). Additionally, cardiac complications independently predicted death (OR 12.414, 95% CI 1.489–103.479; $p = 0.020$) (Table 6).

Table 6
Multinomial regression of factors associated with adverse maternal outcomes

	CKD/ESKD		Death	
Variable	OR (95% CI)	P value	OR (95% CI)	P value
Pregnancy status				
Pregnant	Ref		Ref	
Postpartum/Ectopic	0.099 (0.020–0.491)	0.005	0.653 (0.285–1.498)	0.314
Trimester				
1st	1.781 (1.781–1.781)	-	-	-
2nd	4.296 (1.176–15.702)	0.027	0.322 (0.063–1.652)	0.174
3rd	Ref		Ref	
ICU admission				
Yes	-	-	6.694 (2.502–17.913)	< 0.001
No	Ref		Ref	
AKI causes				
Intracranial necrosis	-	-	9.333 (1.089–79.973)	0.042
Preeclampsia/Eclampsia	0.324 (0.075–1.397)	0.131	0.202 (0.072–0.562)	0.002
AKI	15.000 (1.378–163.226)	0.026	1.111 (0.067–18.421)	0.941
Drugs				
Nifedipine	1.613 (0.168–15.492)	0.679	0.210 (0.060–0.735)	0.015
Morphine	-	-	2.714 (0.882–8.351)	0.082
Amoxiclav	0.426 (0.079–2.294)	0.320	0.192 (0.048–0.759)	0.019
Ceftriaxone	-	-	2.813 (0.989–7.997)	0.052

	CKD/ESKD		Death	
Variable	OR (95% CI)	P value	OR (95% CI)	P value
Pregnancy status				
Lab findings				
Admission Creatinine (unit increase)	1.002 (1.000-1.003)	0.048	1.001 (1.000-1.003)	0.087
Discharge Creatine (unit increase)	1.002 (1.000-1.004)	0.075	1.002 (1.000-1.004)	0.011
Admission WBC (unit increase)	0.930 (0.833-1.039)	0.202	1.018 (0.977-1.059)	0.398
Discharge WBC (unit increase)	0.964 (0.742-1.252)	0.785	1.188 (1.051-1.343)	0.006
Admission Platelet (unit increase)	1.008 (1.002-1.015)	0.015	0.999 (0.994-1.005)	0.844
Gestational age (unit increase)	0.896 (0.823-0.974)	0.010	1.000 (0.924-1.083)	0.993
Comorbidities				
HTN	1.221 (0.354-4.216)	0.752	0.353 (0.145-0.858)	0.021
Kidney disease	46.000 (4.892-432.569)	< 0.001	1.243 (0.075-20.555)	0.879
Complications				
Respiratory	-	-	7.500 (0.859-65.519)	0.068
Cardiac	3.636 (0.210-62.927)	0.375	12.414 (1.489-103.479)	0.020

Discussion

This study assessed the clinical profile, management, and outcomes of PRAKI in women treated at a tertiary hospital in Ghana. Among the 108 participants, the mean age was 32.1 years, which is consistent with global data showing that PRAKI predominantly affects women in their peak reproductive years [17]. The clustering of cases in this age range reflects both biological and sociocultural factors predisposing patients to high-risk pregnancies. Similar to reports from India and Nigeria, most affected women in this study were married, had secondary-level education, and were engaged in informal employment, underscoring the intersection between socioeconomic vulnerability and delayed healthcare access [8,

18, 19]. These demographic patterns suggest that inadequate antenatal surveillance and limited financial autonomy may contribute to late presentation, emphasizing the need for maternal health literacy programs and financial protection for women in informal sectors.

Postpartum patients had a better recovery rate than antepartum patients did, indicating that the timing of diagnosis affects outcomes. Antepartum cases often mean delayed referral or worsening complications, whereas postpartum cases allow earlier treatment [20]. A study from Ethiopia revealed that timing was less important than factors such as preexisting kidney disease, vasopressor use, and high creatinine, which are more closely linked to poor outcomes [21]. PRAKI outcomes depend on severity, underlying health, cause, and access to care; timing helps, but it is not the only factor. Second-trimester PRAKI was strongly linked to CKD/ESKD or death, likely due to longer exposure to severe conditions such as preeclampsia, HELLP syndrome, and thrombotic microangiopathies [22]. These factors cause further damage, while late pregnancy complications are often shorter, and delivery can help with recovery. In contrast, South Asian studies reported higher death rates in third-trimester PRAKI, often due to hemorrhage and sepsis. A study in Pakistan revealed that these factors are common in late pregnancy and postpartum, with high rates of maternal and fetal death [23]. These differences reflect healthcare access and risk factors, highlighting the need for region-specific strategies. The high ICU death rate in our cohort reflects severe PRAKI seen at referral centers. ICU admission is a known sign of severity and poor outcome, often linked to late presentation with multiorgan failure [24–26]

Biochemical markers revealed important links to PRAKI outcomes. Patients who developed CKD/ESKD had lower admission WBC counts ($8.0 \times 10^9/L$) and higher discharge WBC counts ($9.2 \times 10^9/L$), suggesting persistent inflammation in those with chronic damage. An elevated WBC count is a known sign of poor recovery and is tied to systemic inflammation and endothelial injury [27, 28]. The platelet count also varied ($p = 0.006$), being highest in the CKD/ESKD group. Although low platelet counts are often linked to poor outcomes in preeclampsia-related AKI, high platelet counts here may suggest rebound or inflammation-driven changes, as observed in post-preeclamptic AKI [22, 29]. Discharge creatinine was much higher in CKD/ESKD ($447 \mu\text{mol/L}$) and fatal patients ($475 \mu\text{mol/L}$) than in recovered patients ($169 \mu\text{mol/L}$), with strong significance ($p = 0.007$), echoing global evidence that high discharge creatinine is linked to long-term kidney damage [30, 31]. These findings indicate incomplete recovery in some patients and highlight the need for post-discharge follow-up, which is often lacking in African settings. Hypertension (50.5%) and anemia (35.4%) were the most common comorbidities, with matching patterns in Nigeria and Kenya [32–34]. Hypertension was associated with poor outcomes ($p = 0.036$), demonstrating its role in kidney injury. Heart disease (3.0%) and kidney disease (9.1%) were less common but strongly linked to CKD/ESKD and death ($p = 0.023$ and $p < 0.001$), indicating how comorbidities affect renal outcomes.

Several complications, including respiratory disease, cardiac dysfunction, CKD, pitting edema, and metabolic acidosis, are significantly linked to mortality, reflecting the multiorgan failure typical of severe PRAKI and commonly reported in African cohorts [35]. Respiratory issues may result from pulmonary edema due to volume overload or heart failure, both of which are difficult to manage in low-resource

ICUs. Metabolic acidosis indicates advanced renal failure and is often associated with late presentation and delayed dialysis. Treatment patterns highlight the complexity of PRAKI care. Nifedipine (77.1%) was linked to better outcomes ($p = 0.015$), supporting its safer profile in pregnancy-related hypertension [36, 37]. Morphine use (53.1%) was linked to mortality ($p < 0.001$), likely indicating severe illness rather than drug toxicity. Broad-spectrum antibiotics such as amoxiclav ($p = 0.039$) and ceftriaxone ($p = 0.009$) were linked to outcomes, likely due to their use in serious infections. Similar antibiotic use is common in African obstetric care, where broad coverage is often needed without laboratory confirmation [38].

The regression model (Table 6) revealed that pregnancy status at diagnosis and ICU admission were key predictors of poor outcomes in PRAKI patients. Women diagnosed during pregnancy had higher risks of CKD/ESKD or death than those diagnosed postpartum. Malignant hypertension and preeclampsia/eclampsia are strongly linked to kidney damage, supporting evidence that these conditions cause lasting injury through endothelial dysfunction and clotting issues [39]. Preexisting CKD also increases the risk of nonrecovery, confirming that prior kidney damage worsens outcomes [40, 41]. Collectively, PRAKI outcomes are multifactorial and reflect an intersection of obstetric, renal, and systemic determinants. Early antenatal detection of hypertensive disorders, aggressive hemodynamic stabilization, and timely nephrology involvement, particularly before ICU transfer, could substantially reduce irreversible renal injury and maternal mortality.

Limitations of the study

This study is limited by its retrospective design, which inherently limits causal inference, as data were extracted from clinical records that may be incomplete or inconsistently documented. Additionally, the single-center nature of the study limits generalizability, as the findings reflect the patient population and health system practices of a tertiary referral facility and may not be representative of community or primary-level settings. Furthermore, the relatively small sample size, particularly in subgroups such as those requiring dialysis or those with rare complications, reduced the statistical power.

Conclusions

This study highlights the significant burden of PRAKI in a tertiary hospital setting in Ghana, with adverse maternal renal outcomes strongly associated with second-trimester presentation, postpartum status, ICU admission, preexisting kidney disease, hypertensive disorders, and selected complications. The high rates of progression to CKD or ESKD underscore PRAKI as not only an acute obstetric complication but also a contributor to the long-term burden of kidney disease in low-resource settings. These findings suggest an urgent need for strengthened antenatal surveillance, particularly for women with hypertensive disorders during pregnancy, and early recognition of kidney injury at peripheral facilities to prevent delays in referral. Expanding access to diagnostic tools, renal replacement therapy, and critical care in resource-limited settings is essential to reduce preventable maternal morbidity and mortality.

Abbreviations

PRAKI
Pregnancy–related acute kidney injury
KATH
Komfo Anokye Teaching Hospital
IQR
Interquartile range
CKD
Chronic kidney disease
ESKD
End–stage kidney disease
LMICs
Low–and middle–income countries
ICU
Intensive Care Unit
AKI
Acute kidney injury
GFR
Glomerular filtration rate
BP
Blood pressure
SBP
Systolic blood pressure
DBP
Diastolic blood pressure
C/S
Cesarean section
HPT
Hypertension
HELLP
hemolysis, elevated liver enzymes, and low platelet count
DIC
Disseminated intravascular coagulation
OHSS
Ovarian hyperstimulation syndrome
CVA
Cardiovascular accident
APH
Antepartum hemorrhage
PPH
Postpartum hemorrhage

CGN
Chronic glomerulonephritis
SCD
Sickle cell disease
HIV
Human immune virus
MOF
Multiorgan failure

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the KATH Institutional Review Board (ethical clearance ID: KATH IRB/AP/053/25). Informed consent was waived due to the retrospective nature of the study and participants' data anonymised. Data collection adhered to the ethical principles outlined in the Declaration of Helsinki and complied with applicable local regulatory standards.

Consent for publication

Consent for publication was sought from the Komfo Anokye Teaching Hospital.

Competing interests

The authors declare that there are no competing interests.

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Author Contribution

PO: Conception and design of the study, data collection and analysis, drafting of the manuscript; IO: Conception and design of the study, data collection and analysis, drafting of the manuscript; SAO: Data collection and analysis, drafting of the manuscript; MTL: Data collection and analysis, drafting of the manuscript; PK: Data collection and analysis; PA: Data analysis, drafting of the manuscript; AOB: Data collection and drafting of the manuscript; KAS: Data collection and drafting of the manuscript; RKDE: Conception and design of the study, data collection and analysis, drafting of the manuscript. All the authors reviewed and approved the manuscript.

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Data Availability

The datasets used in the current study are available from the corresponding author upon reasonable request.

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Figures

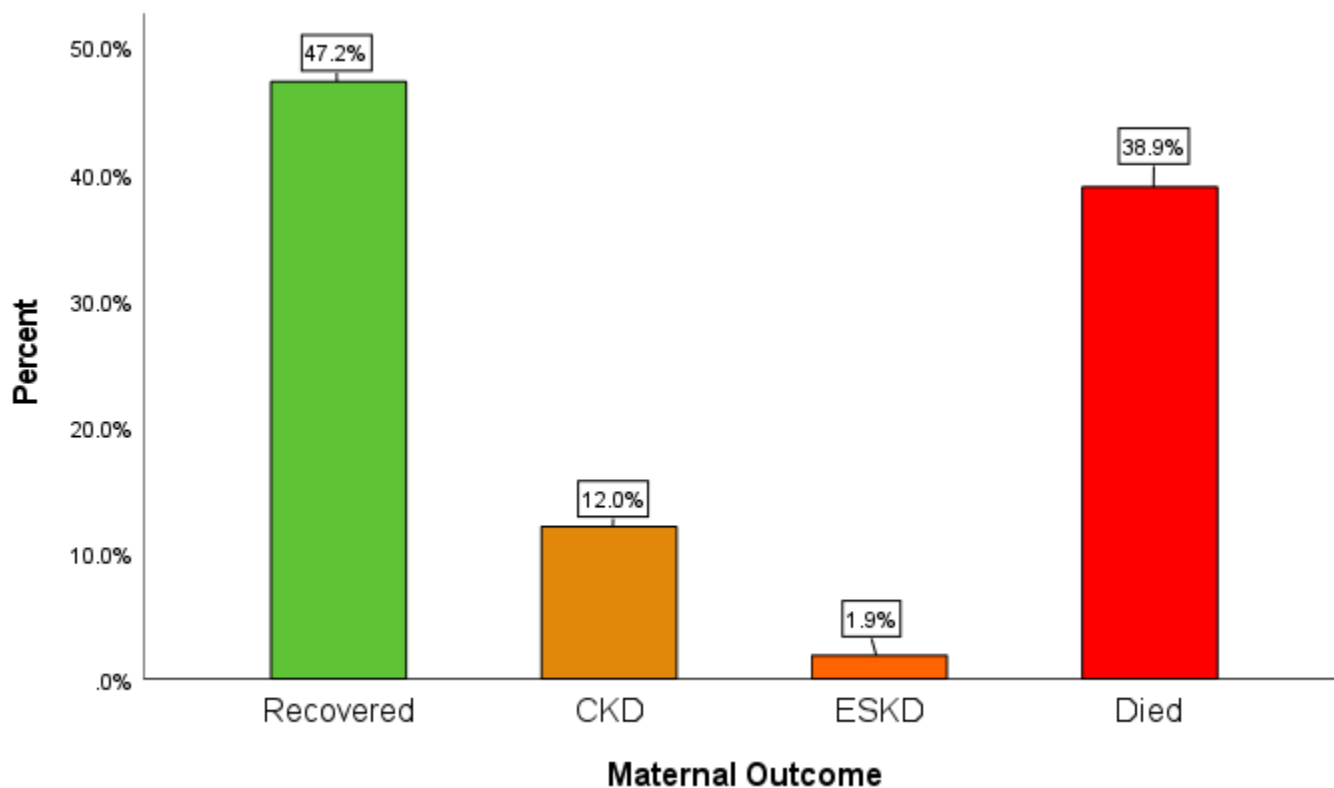


Figure 1

Maternal outcomes among study participants

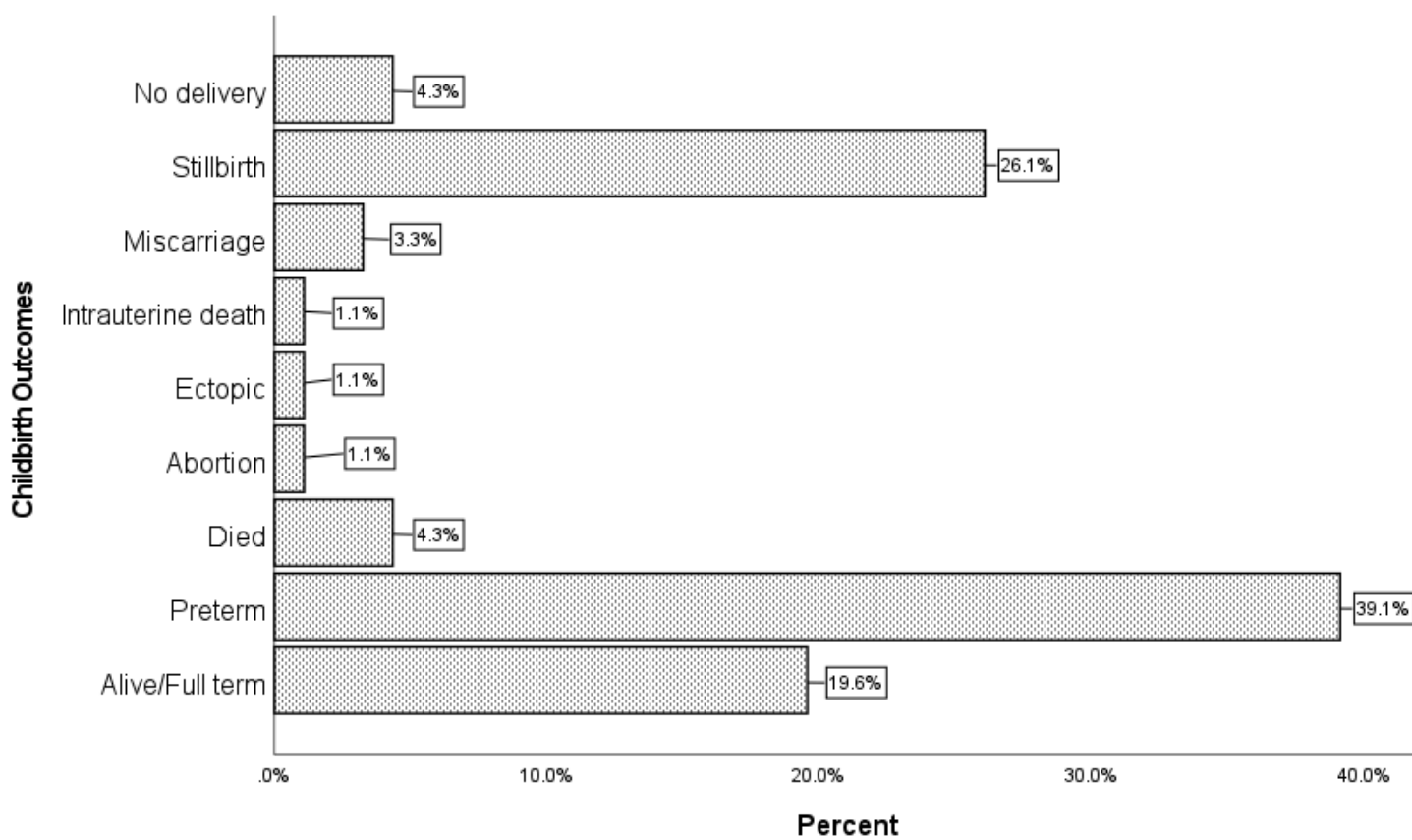


Figure 2

Childbirth outcomes among study participants

