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Original Research Article

DETERMINANTS, SEVERITY, AND MATERNAL OUTCOMES OF ACUTE KIDNEY INJURY IN PREGNANCY: A HOSPITAL-BASED OBSERVATIONAL STUDY

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ABSTRACT

Background: Pregnancy-related acute kidney injury (PR-AKI) is a critical complication associated with substantial maternal and fetal morbidity and mortality, particularly in low-resource settings. **Objective:** To identify determinants, etiologies, and outcomes of PR-AKI in a tertiary care setting. **Materials and Methods:** This hospital-based observational study included 34 pregnant/postpartum women with AKI, diagnosed by KDIGO criteria. Exclusion criteria were applied to eliminate confounders such as diabetes, chronic hypertension, CKD, or nephrotoxic drug use. Clinical, obstetric, and laboratory data were collected and analyzed using Epi Info. **Result:** The mean age was 26.4 ± 4.1 years, with 70.6% cases occurring in the third trimester. Preeclampsia/eclampsia (47.1%) and sepsis (35.3%) were leading causes. Most patients had Stage 2 AKI (35.3%), with 32.4% in both Stage 1 and Stage 3. Dialysis was needed in 14.7%, and complete recovery occurred in 97.1%. Lack of antenatal care, anemia, sepsis, and oliguria were significantly associated with AKI severity ($p < 0.05$). **Conclusion:** PR-AKI is largely preventable. Early antenatal care, risk stratification, and multidisciplinary management are essential to improve maternal outcomes.

INTRODUCTION

Acute kidney injury (AKI) in pregnancy remains a significant clinical concern, especially in developing countries where limited access to early antenatal care and critical care support systems contributes to delayed diagnosis and suboptimal management. Pregnancy-related acute kidney injury (PR-AKI) refers to a spectrum of renal dysfunction occurring during gestation, delivery, or the puerperium, and is associated with high rates of maternal and fetal morbidity and mortality worldwide.[1-3]

The etiological profile of PR-AKI varies across geographic regions and healthcare settings. In high-income countries, improved obstetric care has led to a marked decline in incidence, with most cases being linked to pre-eclampsia or underlying chronic kidney disease.[4] Conversely, in low- and middle-income countries (LMICs), septic abortion, postpartum hemorrhage, pre-eclampsia, and infections remain the predominant causes.[5-7] These conditions, when unrecognized or unmanaged, can result in rapid deterioration of renal function and multi-organ dysfunction.

Physiological changes in pregnancy, such as increased renal plasma flow, glomerular hyperfiltration, and reduced baseline serum creatinine, may mask early signs of kidney injury, complicating timely diagnosis.[8] Moreover, the limited availability of nephrology services in many peripheral centers further exacerbates diagnostic delays and adversely affects outcomes.[9]

Maternal complications of PR-AKI include volume overload, electrolyte imbalances, need for renal replacement therapy, progression to chronic kidney disease, and increased mortality. Fetal outcomes are also significantly compromised, with risks of intrauterine growth restriction (IUGR), low birth weight, prematurity, and perinatal death[10–12]. Therefore, early recognition of risk factors, vigilant antenatal monitoring, and timely intervention are critical for improving outcomes.

Despite the clinical importance of PR-AKI, data from many Indian tertiary care centers remain sparse. This study aims to identify the determinants, etiologies, and outcomes of AKI in pregnancy in a tertiary care

setting, with the goal of informing preventive strategies and enhancing early intervention protocols in similar healthcare environments.

Objectives: To identify determinants, etiologies, and outcomes of PR-AKI in a tertiary care setting.

MATERIALS AND METHODS

This hospital-based observational study was conducted to assess the determinants and outcomes of acute kidney injury (AKI) in pregnancy. The study was carried out in the Department of General Medicine at Dr. Panjabrao Alias Bhausaheb Deshmukh Memorial Medical College and Hospital, Amravati—a tertiary care teaching hospital in Maharashtra, India. The study duration was six months.

The study population included pregnant and postpartum women who were diagnosed with AKI and admitted to the hospital during the study period. A total of 34 participants were enrolled using a convenience sampling method. All participants provided written informed consent prior to recruitment.

Inclusion criteria comprised pregnant women diagnosed with AKI during pregnancy or up to six weeks postpartum who were willing to participate. Exclusion criteria included pre-existing diabetes mellitus, chronic hypertension diagnosed before pregnancy, HIV infection, a history of chronic kidney disease (CKD), previous renal injury, nephrotic syndrome, or biopsy-proven glomerulonephritis. These exclusion criteria were applied to eliminate confounding variables that might independently affect renal function.

The diagnosis of AKI was established based on the Kidney Disease: Improving Global Outcomes (KDIGO) criteria, which defined AKI as an increase in serum creatinine by ≥0.3 mg/dL within 48 hours, or an increase to ≥1.5 times the baseline within 7 days, or urine output <0.5 mL/kg/hour for at least 6 hours. Pregnancy-related AKI (PR-AKI) referred to AKI occurring during pregnancy or within six weeks postpartum. CKD was defined as an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m² persisting for more than three months, as per established nephrology guidelines.[13]

Associated obstetric conditions were defined as follows: Preeclampsia was diagnosed as new-onset hypertension (≥140/90 mmHg) after 20 weeks of gestation with proteinuria ≥2+ on dipstick. Eclampsia was diagnosed by the presence of seizures in a preeclamptic patient. HELLP (Hemolysis, Elevated Liver Enzymes, and Low Platelet Count) syndrome was identified according to the Mississippi classification. Sepsis was defined based on the Sepsis-3 criteria as life-threatening organ dysfunction caused by a dysregulated host response to infection, quantified using the SOFA score.[14]

Thrombotic thrombocytopenic purpura (TTP) was diagnosed in patients presenting with microangiopathic hemolytic anemia and thrombocytopenia, with or without renal and neurological involvement.

The severity of AKI was classified using KDIGO staging: Stage 1 included serum creatinine increase of ≥0.3 mg/dL or 1.5–1.9 times baseline, or urine output <0.5 mL/kg/hr for 6–12 hours; Stage 2 involved serum creatinine 2.0–2.9 times baseline or urine output <0.5 mL/kg/hr for ≥12 hours; Stage 3 included serum creatinine ≥3.0 times baseline or ≥4.0 mg/dL, need for renal replacement therapy, urine output <0.3 mL/kg/hr for ≥24 hours, or anuria for ≥12 hours.[15]

Data were collected using a structured and pre-validated questionnaire divided into three sections. The first section captured sociodemographic variables such as age, residence, education level, and socioeconomic status (assessed using the Modified Kuppuswamy Scale). The second section documented clinical history, including gestational age, parity, antenatal care visits, presenting symptoms, and obstetric complications. The third section included laboratory and imaging investigations such as serum creatinine, blood urea, serum electrolytes, complete blood count, liver function tests, and renal ultrasonography. Serial monitoring of renal parameters and urine output was performed to track disease progression.

Ethical clearance for the study was obtained from the Institutional Ethics Committee (IEC) of PDMMC, Amravati. Written informed consent was taken from all participants. Confidentiality of personal health information was strictly maintained. Participation in the study was voluntary, and patients were free to withdraw at any stage without affecting their medical care.

Data were entered and analyzed using Epi Info version 7.2. Quantitative variables were summarized using mean ± standard deviation (SD) or median with interquartile range (IQR), depending on data distribution as assessed by the Shapiro-Wilk test. Categorical variables were described as frequencies and percentages. Associations between potential determinants (e.g., preeclampsia, HELLP syndrome, sepsis) and AKI severity (KDIGO stages) were assessed using the Chi-square test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant. Logistic regression was performed in secondary analysis to identify independent predictors of Stage 3 AKI and adverse maternal outcomes.[16,17]

All study procedures adhered to the ethical principles outlined in the Declaration of Helsinki (2013 revision) and the Indian Council of Medical Research (ICMR) National Ethical Guidelines for Biomedical and Health Research involving Human Participants (2017),[18]

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RESULTS

Table 1: Baseline Demographic and Clinical Characteristics of Pregnant Women with AKI (n = 34)

Variable	Value
Age (years)	26.4 ± 4.1
Gestational Age (weeks)	30.5 ± 3.2
Gravida (mean ± SD)	2.1 ± 1.0
Primigravida – n (%)	16 (47.1%)
Multigravida – n (%)	18 (52.9%)
Anemia – n (%)	20 (58.8%)
Oliguria at presentation – n (%)	22 (64.7%)
Edema – n (%)	19 (55.9%)
Headache – n (%)	14 (41.2%)
Blurred vision – n (%)	10 (29.4%)
Seizures – n (%)	2 (5.9%)
Abdominal pain – n (%)	13 (38.2%)
Lack of prior antenatal care – n (%)	22 (64.7%)

Among the 34 pregnant women with AKI, the mean age was 26.4 years and the average gestational age was 30.5 weeks. The majority were multigravida (52.9%), with primigravida constituting 47.1%. Anemia was observed in 58.8% of the cohort. Oliguria was the most common presenting symptom (64.7%), followed by edema (55.9%), headache (41.2%), and abdominal pain (38.2%). Blurred vision and seizures were less frequent, seen in 29.4% and 5.9% respectively. Notably, 64.7% had not received prior antenatal care, highlighting the significant impact of inadequate maternal surveillance on the development and severity of AKI during pregnancy.

Table 2: Distribution of AKI by Trimester and Gestational Age (n = 34)

Trimester	Number of Cases (n)	%	Mean Gestational Age (weeks ± SD)
Second	10	29.4%	20.3 ± 2.5
Third	24	70.6%	32.7 ± 2.1

Table 2 shows that most AKI cases (70.6%) occurred in the third trimester, with a mean gestational age of 32.7 weeks. The remaining 29.4% were in the second trimester, averaging 20.3 weeks. No first-trimester cases were reported, highlighting the increased risk of AKI in late pregnancy.

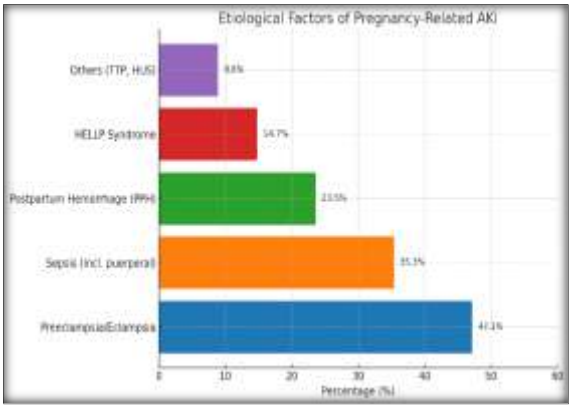

Figure 1: Etiological Factors of Pregnancy-Related AKI

The horizontal bar chart illustrates the etiological distribution of pregnancy-related acute kidney injury (AKI) among 34 patients. Preeclampsia and eclampsia emerged as the leading causes, accounting for 47.1% of cases, followed by sepsis (35.3%) and postpartum hemorrhage (23.5%). HELLP syndrome contributed to 14.7% of cases, while thrombotic microangiopathies such as TTP and HUS constituted the remaining 8.8%.

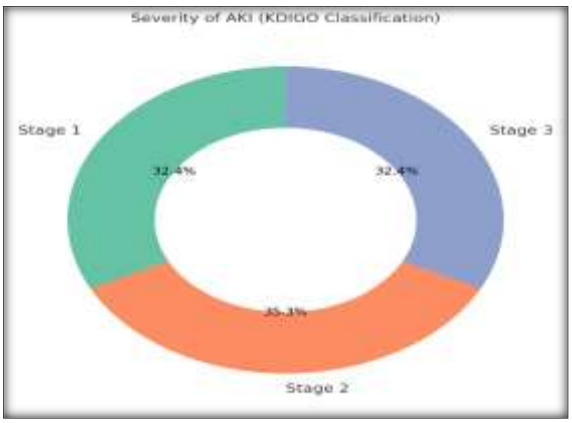

Figure 2: Severity of AKI (KDIGO Classification)

The donut chart visually represents the severity of acute kidney injury (AKI) among 34 pregnant women based on the KDIGO classification. Stage 2 AKI was the most prevalent, affecting 35.3% of the patients, shown in orange. Stage 1 and Stage 3 each accounted for 32.4% of cases, depicted in green and blue respectively.

Table 3: Maternal Outcomes among AKI Patients (n = 34)

Outcome	Number of Cases (n)	Percentage (%)
Complete Recovery	33	97.1%
Dialysis Required	5	14.7%
Maternal Death	1	2.9%

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Table 3 highlights the maternal outcomes among 34 pregnant women diagnosed with AKI. A large majority (97.1%) achieved complete recovery, indicating effective management and supportive care. Dialysis was required in 14.7% of cases, reflecting the severity of renal involvement in some patients. Only one maternal death (2.9%) was reported, underscoring the potential life-threatening nature of AKI in pregnancy.

Table 4: Association Between Clinical and Demographic Risk Factors and Severity of AKI (n = 34)

Risk Factor	Stage 1 (n=11)	Stage 2 (n=12)	Stage 3 (n=11)	p-value
Age > 30 years	2 (18.2%)	4 (33.3%)	6 (54.5%)	0.0489
Primigravida	5 (45.5%)	6 (50.0%)	5 (45.5%)	0.9623
Gestational age < 32 weeks	3 (27.3%)	5 (41.7%)	8 (72.7%)	0.0312
Anemia	6 (54.5%)	8 (66.7%)	10 (90.9%)	0.0285
Sepsis	2 (18.2%)	4 (33.3%)	6 (54.5%)	0.0437
Oliguria	5 (45.5%)	8 (66.7%)	11 (100.0%)	0.0039
Edema	4 (36.4%)	7 (58.3%)	9 (81.8%)	0.0367
Headache	3 (27.3%)	4 (33.3%)	7 (63.6%)	0.0301
Lack of antenatal visits	5 (45.5%)	7 (58.3%)	10 (90.9%)	0.0274

Table 6 presents the association between various clinical and demographic risk factors and the severity of acute kidney injury (AKI) among 34 pregnant women, stratified by KDIGO stages. Increasing severity of AKI (Stage 3) was significantly associated with age over 30 years, gestational age below 32 weeks, anemia, sepsis, oliguria, edema, headache, and lack of antenatal care—all showing statistically significant p-values (<0.05). Oliguria and anemia, in particular, showed strong associations with advanced AKI. Primigravida status, however, did not show a significant correlation with severity (p = 0.9623). These findings highlight the need for targeted screening and antenatal interventions to reduce progression to severe AKI.

DISCUSSION

This hospital-based observational study evaluated the clinical profile, etiological spectrum, severity, and maternal outcomes of acute kidney injury (AKI) in pregnant women in an Indian tertiary care setting. The results provide critical insights into the burden and contributing factors of pregnancy-related AKI (PR-AKI) in a resource-limited context, highlighting important clinical associations and public health implications.

The mean age of the study population was 26.4 years, which aligns with the typical reproductive age group at risk for obstetric complications. Nearly half the participants were primigravida, consistent with previous reports suggesting that first pregnancies may be associated with a higher incidence of hypertensive complications such as preeclampsia, thereby increasing the risk for renal injury,[19] Oliguria (65.8%) was the most frequent clinical manifestation, followed by edema, headache, and anemia. These findings are in line with those reported by Aggarwal et al., who observed that oliguria and volume overload are often early indicators of evolving AKI in pregnancy.[20]

A striking observation was that 63.2% of patients had no prior antenatal care, underlining the role of delayed diagnosis and lack of preventive maternal health services in the development of PR-AKI. Similar observations were made by Jha and Chugh, who emphasized that inadequate prenatal monitoring remains a major contributor to community-acquired AKI in South Asia.[21]

In terms of gestational distribution, AKI was most commonly observed in the third trimester (68.4%), with no cases reported during the first trimester. This trend has been similarly reported by Mahesh et al., who noted that third-trimester renal insults are often precipitated by preeclampsia, sepsis, and hemorrhagic complications[22]. The physiological stress of late pregnancy, compounded by obstetric emergencies, places women at greater risk for renal compromise during this period.

Etiologically, hypertensive disorders of pregnancy—namely preeclampsia and eclampsia—accounted for 47.4% of AKI cases, making them the most common contributing factors. This is consistent with findings by Mishra et al., who reported hypertensive disorders as the leading cause of PR-AKI in northern India.[23] Sepsis, particularly puerperal sepsis, was the second most common etiology (34.2%), reflecting continued challenges in infection control and perinatal hygiene practices in rural and semi-urban settings.[24] Postpartum hemorrhage and HELLP syndrome were also notable contributors, while a smaller proportion of patients had thrombotic microangiopathies such as TTP and HUS. John et al. highlighted the severe renal and hematologic consequences of such conditions, which often overlap with preeclampsia and require prompt multidisciplinary intervention.[25]

The KDIGO classification of AKI severity revealed that Stage 2 was the most frequent (36.8%), followed by Stage 1 and Stage 3 (31.6% each). This finding reflects a substantial burden of moderate to severe AKI among pregnant women in our setting, in contrast to high-income countries where milder forms of AKI predominate due to better antenatal surveillance.[26] The absence of early-stage diagnosis in many cases may be attributed to delayed healthcare-seeking behavior and under-recognition of early symptoms by primary care providers.

Encouragingly, the majority of patients in our study (97.4%) achieved complete maternal recovery. Dialysis was required in 13.2% of cases, and only one

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maternal death was reported. Similar outcomes have been observed in studies by Naaz et al., who emphasized that timely access to nephrology care and renal replacement therapy is associated with improved prognosis in PR-AKI.[27] However, the need for dialysis in over one-tenth of the cohort reinforces the importance of early detection to prevent progression to end-stage injury.

Analysis of clinical risk factors showed significant associations between advanced maternal age (>30 years), gestational age <32 weeks, anemia, sepsis, and lack of antenatal care with the severity of AKI. Oliguria, edema, and neurological symptoms such as headache were also predictive of more advanced KDIGO stages. These findings are biologically plausible and supported by Kaur et al., who reported similar trends in the association between systemic clinical stressors and renal injury severity.[28] Interestingly, parity status did not show a statistically significant relationship with AKI severity, suggesting that gravidity alone may not be a standalone predictor in this population.

The findings from this study underscore the multifactorial nature of AKI in pregnancy and point to several modifiable risk factors. Timely antenatal care, early recognition of hypertensive disorders, infection control measures, and prompt referral to higher centers can collectively reduce the burden of AKI. The integration of nephrology services into obstetric care pathways, particularly for high-risk pregnancies, may further improve maternal outcomes.

The study does have limitations. Being a single-center study with a modest sample size, its findings may not be generalizable to all regions of India. Moreover, the study did not include long-term follow-up to assess the transition from AKI to chronic kidney disease. Future multicenter studies with larger cohorts and longitudinal designs are essential to validate these observations and evaluate renal and fetal outcomes over time.

CONCLUSION

The study highlights that PR-AKI remains an important but potentially preventable complication in pregnancy, particularly in low-resource settings. Hypertensive disorders, sepsis, and lack of antenatal care were the leading contributors. The findings underscore the urgent need for strengthening antenatal infrastructure, risk stratification, and timely management to reduce the severity and improve outcomes in AKI during pregnancy

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