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# FREQUENCY OF ACUTE KIDNEY INJURY IN PATIENTS WITH ACUTE CORONARY SYNDROME UNDERGOING PERCUTANEOUS CORONARY INTERVENTION

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## Abstract

***Objective:***
*The objective of this study was to determine the frequency of acute kidney injury (AKI) in patients with acute coronary syndrome (ACS) undergoing percutaneous coronary intervention (PCI).* ***Study Design:*** *This cross-sectional study was designed to assess the prevalence of AKI in ACS patients undergoing PCI. Data were collected, including baseline demographic details, clinical history, and serum creatinine levels. Ethical approval was obtained, and informed consent was secured from all participants.* ***Place and Duration of the Study:*** *The study was conducted at the Department of Cardiology, Liaquat University of Medical and Health Sciences, Hyderabad/Jamshoro, from November 1, 2023, to April 30, 2024.* ***Methodology:*** *A total of 260 patients meeting the inclusion criteria were included in this study. Baseline demographic and clinical data were gathered, and serum creatinine levels were measured pre- and post-PCI to assess the development of AKI based on the KDIGO guidelines. A six-month study period was implemented following ethical approval, and the study methodology included both clinical assessments and laboratory tests to evaluate renal function in patients undergoing PCI.* ***Results:*** *The overall prevalence of AKI was found to be 15.4%. Stratified analysis revealed higher AKI rates in patients aged 41–65 years (16.5%) compared to those aged 18–40 years (12.5%). AKI was also more prevalent in urban residents (20.6%) compared to rural residents (12.0%). Factors like hypertension (17.6% vs. 11.6%) and longer PCI duration (>1 hour, 17.0%) showed a non-significant trend towards higher AKI rates. Gender, diabetes, smoking, and family history did not significantly affect AKI outcomes.* ***Conclusion:*** *This study underscores the importance of monitoring renal function in ACS patients undergoing PCI. Findings highlight the need for early identification and management of at-risk patients to improve clinical outcomes and reduce AKI-related complications.*

## INTRODUCTION

Acute kidney injury (AKI) is a multifaceted condition characterized by a rapid decline in renal function over hours or days, with clinical manifestations ranging from a mild increase in serum creatinine to anuric renal failure requiring renal replacement therapy (1). Its most severe form is cardiorenal syndrome (CRS) type 1, defined as "an acute worsening of heart function leading to AKI or kidney dysfunction." This condition often complicates acute heart failure (AHF) or acute

coronary syndrome (ACS), significantly increasing the duration of hospital stays and mortality rates (2). Studies indicate that acute renal dysfunction affects approximately one in five ACS patients, making it a leading predictor of cardiovascular complications (3, 4). AKI is also a prevalent complication of percutaneous coronary interventions (PCI), contributing to elevated morbidity and mortality (5). Post-PCI AKI, often termed contrast-induced nephropathy, has been attributed primarily to the use of iodinated contrast media. While contrast media play a critical role in AKI development, additional mechanisms such as hemodynamic instability and cholesterol embolization may also contribute. Notably, angiography accounts for 80% of iatrogenic renal cholesterol embolization cases, with an estimated incidence of 0.06% to 1.8% among patients undergoing coronary angiography (6, 7). The development of acute kidney injury (AKI) in patients with acute coronary syndrome worsens the prognosis, so according to the ACTION- GTWG register the incidence of AKI in patients with STEMI was 16.1%, including 4% with severe AKI (creatinine >88.4 µmol/ L), and hospital mortality among patients with moderate (increased creatinine from 44.2to 8.4 µmol/L) and severe AKI was 14.2% and 31.8%, respectively, while in patients without AKI - 2.1%8. AKI is associated with an unfavorable short-term and long-term prognosis and directly correlates with the severity of renal dysfunction (8, 9). Study by Koiman et al. (10) reported the frequency of AKI in patient undergoing PCI was 2.6% (2,144/82,225). Another study reported the frequency of post PCI AKI was 8.51% (327 / 3842) (11). Study conducted in tertiary care hospital of Rawalpindi reported the frequency of AKI after PCI was 5.20% (12) Shinwari et al conducted study in tertiary care hospital of Peshawar reported the frequency of AKI after PCI was 30%. However, AKI was higher among patient whom PCI was done through femoral access as compared to radial access (20% vs 10%) (13). Study conducted in tertiary care hospital of Lahore reported the frequency of AKI in STEMI was 19.5% (14).

The purpose of this research is to ascertain the prevalence of acute kidney damage in patients having percutaneous coronary intervention who have acute coronary syndrome. Existing research indicates that the incidence of AKI with PCI varies greatly, ranging from 5.60 to 30%. This fluctuation in frequency could be the result of different AKI assessment definitions and guidelines. It is remarkable that AKI in patients with ACS who have undergone PCI has not received much attention in recent guidelines or in a number of cardiology textbooks. Research indicates that in patients with ACS, AKI worsens the prognosis and raises the chance of death. After leaving the hospital, the majority of ACS patients were not monitored. Therefore, the results of this study will assist the doctor in creating some plans for early detection of individuals who are at high risk of acute renal impairment.

## METHDOLOGY

The study was conducted after obtaining approval from the College of Physicians and Surgeons Pakistan (CPSP) and the ethical review committee of the institute. All patients presenting with acute coronary syndrome (ACS) in the emergency department and meeting the inclusion criteria were enrolled in the study. Prior to enrollment, informed consent was obtained from each patient after explaining the study details. At the time of enrollment, baseline demographic and clinical details were collected and recorded in a predesigned proforma. The diagnosis of ACS was made according to the criteria specified in the operational definition. After confirming the diagnosis, a 5cc blood sample was drawn by a trained phlebotomist using aseptic techniques to evaluate baseline serum creatinine levels. After laboratory investigations, all patients underwent percutaneous coronary intervention (PCI), which was performed by an interventional cardiologist with more than five years of post-fellowship experience. Serum creatinine levels were assessed 24 hours post-PCI and again at the time of discharge. All patients were followed until discharge to assess acute kidney injury (AKI) based on the criteria mentioned in the operational definition (attached as Annexure I).

Baseline patient details such as age, gender, residence, family monthly income, diabetes status (history of diabetes mellitus for at least six months), hypertension status (history of hypertension for at least six months), smoking history (defined as smoking five or more cigarettes per day for at least

one year), family history of kidney disease, culprit artery, number of vessels involved, duration of PCI, length of hospital stay, and presence of AKI were recorded in the predesigned proforma. Data were entered and analyzed using SPSS version 26. The Shapiro-Wilk test was applied to assess the normality of the data. For quantitative variables that were normally distributed, the mean and standard deviation (SD) were reported, while for non-normal variables (e.g., age, family monthly income, duration of PCI, and creatinine levels), the median and interquartile range (IQR) were presented. Qualitative variables such as gender, residence, diabetes, hypertension, smoking status, family history of kidney disease, culprit artery, number of vessels involved (single/double/triple), and AKI were reported as frequencies and percentages.

AKI was stratified by age, gender, residence, family monthly income, diabetes, hypertension, smoking status, family history of kidney disease, culprit artery, number of vessels involved, duration of PCI, and length of hospital stay. Post-stratification analyses were conducted using the chi-square test or Fisher's exact test, with a p-value of ≤0.05 considered statistically significant.

**RESULTS:**

**Table 1: Qualitative Data of Patients (n=260)**

The distribution of categorical variables among 260 patients. The majority (72.3%) were aged 41–65 years, while 27.7% were aged 18–40 years as shown below in Table 1. Females constituted 61.2% of the cohort, and 38.8% were males. A significant proportion (60.8%) of patients resided in rural areas, with 39.2% from urban areas. Most patients (57.3%) had a monthly family income exceeding 50,000, followed by 27.7% earning between 31,000 and 50,000, and 15% earning up to 30,000. Regarding comorbidities, 32.7% had diabetes mellitus, 63.5% had hypertension, and 29.2% were smokers. A small fraction (9.2%) had a family history of acute kidney injury (AKI). The most common culprit artery was the left anterior descending (LAD) artery in 49.6% of cases, followed by the right coronary artery (RCA) in 33.8% and the left circumflex artery (LCX) in 16.5%. A single vessel was involved in 58.1% of cases, while 32.3% and 9.6% had double- and triple-vessel involvement, respectively. The duration of percutaneous coronary intervention (PCI) exceeded one hour in 56.9% of cases, while 43.1% were completed within one hour. Slightly more than half (52.3%) of the patients had a hospital stay of 1–7 days, while 47.7% stayed for over seven days. AKI occurred in 15.4% of the patients, while 84.6% did not develop AKI.

**Table 1: Qualitative data of the patients(n=260)**

| Variables | | No. of patients | % |
|---|---|---|---|
| Age(years) | 18-40 | 72 | 27.7 |
| | 41-65 | 188 | 72.3 |
| Gender | Male | 101 | 38.8 |
| | Female | 159 | 61.2 |
| Residential status | Urban | 102 | 39.2 |
| | Rural | 158 | 60.8 |
| Family income (per month) | Upto 30,000 | 39 | 15 |
| | 31,000 to 50,000 | 72 | 27.7 |
| | >50,000 | 149 | 57.3 |
| Diabetes Mellitus | Yes | 85 | 32.7 |
| | No | 175 | 67.3 |
| Hypertension | Yes | 165 | 63.5 |
| | No | 95 | 36.5 |
| Smoking | Yes | 76 | 29.2 |
| | No | 184 | 70.8 |
| Family history of AKI | Yes | 24 | 9.2 |

| | | | |
|---|---|---|---|
| | No | 236 | 90.8 |
| Culprit artery | LAD | 129 | 49.6 |
| | LCX | 43 | 16.5 |
| | RCA | 88 | 33.8 |
| Vessel involved | Single | 151 | 58.1 |
| | Double | 84 | 32.3 |
| | Triple | 25 | 9.6 |
| Duration of PCI | Within 1 hour | 112 | 43.1 |
| | >1 hour | 148 | 56.9 |
| Duration of hospital stay(days) | 1-7 | 136 | 52.3 |
| | >7 | 124 | 47.7 |
| AKI | Yes | 40 | 15.4 |
| | No | 220 | 84.6 |

**Table 2: Quantitative Data of Patients (n=260)**

The means and standard deviations of continuous variables. The mean age of the patients was 46.53 ± 9.15 years as shown in Table 2.

**Table 2: Quantitative data of the patients(n=260)**

| Variables | Mean | Sd |
|---|---|---|
| Age(years) | 46.53 | 9.15 |
| Duration of PCI | 67.53 | 28.18 |
| Duration of hospital stay (days) | 7.27 | 4.14 |
| Baseline creatinine levels | 1.06 | 0.26 |
| After PCI creatinine levels | 1.33 | 0.36 |

The mean duration of PCI was 67.53 ± 28.18 minutes. Patients stayed in the hospital for an average of 7.27 ± 4.14 days. Baseline creatinine levels averaged 1.06 ± 0.26 mg/dL, which increased to 1.33 ± 0.36 mg/dL after PCI.

**Table 3: Frequency of Acute Kidney Injury in Patients with Acute Coronary Syndrome Undergoing PCI (n=260)**

Patients were divided into two age groups: 18–40 years and 41–65 years. Among patients aged 18–40 years (n=72), 12.5% (n=9) developed acute kidney injury (AKI), while 87.5% (n=63) did not. In the 41–65 years group (n=188), 16.5% (n=31) developed AKI, and 83.5% (n=157) did not as shown in Table 3. The difference in AKI occurrence between the age groups was not statistically significant (p = 0.425). Male patients (n=101) experienced an AKI rate of 14.9% (n=15), while 85.1% (n=86) did not develop AKI. Female patients (n=159) had a slightly higher AKI rate of 15.7% (n=25), with 84.3% (n=134) not developing AKI. The difference in AKI prevalence between genders was not significant (p = 0.849). Among urban residents (n=102), 20.6% (n=21) developed AKI, while 79.4% (n=81) did not. In rural residents (n=158), 12.0% (n=19) developed AKI, and 88.0% (n=139) did not. Although urban patients had a higher AKI rate, the difference was not statistically significant (p = 0.062). Patients with a monthly income up to 30,000 PKR (n=39) had an AKI rate of 10.3% (n=4), while 89.7% (n=35) did not develop AKI. In the income group of 31,000–50,000 PKR (n=72), 15.3% (n=11) developed AKI, and 84.7% (n=61) did not.

**Table 3: Frequency of acute kidney injury in patients with acute coronary syndrome undergoing percutaneous coronary intervention (n=260)**

| Variables | | Acute Kidney Injury | | Total | P value |
|---|---|---|---|---|---|
| | | Yes | No | | |
| Age(years) | 18-40 | 9 | 63 | 72 | 0.425 |
| | | 12.5% | 87.5% | 100.0% | |
| | 41-65 | 31 | 157 | 188 | |
| | | 16.5% | 83.5% | 100.0% | |
| Gender | Male | 15 | 86 | 101 | 0.849 |
| | | 14.9% | 85.1% | 100.0% | |
| | Female | 25 | 134 | 159 | |
| | | 15.7% | 84.3% | 100.0% | |
| Residential status | Urban | 21 | 81 | 102 | 0.062 |
| | | 20.6% | 79.4% | 100.0% | |
| | Rural | 19 | 139 | 158 | |
| | | 12.0% | 88.0% | 100.0% | |
| Family income (per month) | Upto 30,000 | 4 | 35 | 39 | 0.603 |
| | | 10.3% | 89.7% | 100.0% | |
| | 31,000 to 50,000 | 11 | 61 | 72 | |
| | | 15.3% | 84.7% | 100.0% | |
| | >50,000 | 25 | 124 | 149 | |
| | | 16.8% | 83.2% | 100.0% | |
| Diabetes Mellitus | Yes | 12 | 73 | 85 | 0.693 |
| | | 14.1% | 85.9% | 100.0% | |
| | No | 28 | 147 | 175 | |
| | | 16.0% | 84.0% | 100.0% | |
| Hypertension | Yes | 29 | 136 | 165 | 0.197 |
| | | 17.6% | 82.4% | 100.0% | |
| | No | 11 | 84 | 95 | |
| | | 11.6% | 88.4% | 100.0% | |
| Smoking | Yes | 11 | 65 | 76 | 0.794 |
| | | 14.5% | 85.5% | 100.0% | |
| | No | 29 | 155 | 184 | |
| | | 15.8% | 84.2% | 100.0% | |
| Family history of AKI | Yes | 3 | 21 | 24 | 0.681 |
| | | 12.5% | 87.5% | 100.0% | |
| | No | 37 | 199 | 236 | |
| | | 15.7% | 84.3% | 100.0% | |
| Culprit artery | LAD | 17 | 112 | 129 | 0.468 |
| | | 13.2% | 86.8% | 100.0% | |
| | LCX | 9 | 34 | 43 | |
| | | 20.9% | 79.1% | 100.0% | |
| | RCA | 14 | 74 | 88 | |
| | | 15.9% | 84.1% | 100.0% | |
| Vessel involved | Single | 21 | 130 | 151 | 0.681 |
| | | 13.9% | 86.1% | 100.0% | |

| | | | | | |
|---|---|---|---|---|---|
| | Double | 14 | 70 | 84 | |
| | | 16.7% | 83.3% | 100.0% | |
| | Triple | 5 | 20 | 25 | |
| | | 20.0% | 80.0% | 100.0% | |
| Duration of PCI | Within 1 hour | 19 | 93 | 112 | 0.539 |
| | | 17.0% | 83.0% | 100.0% | |
| | >1 hour | 21 | 127 | 148 | |
| | | 14.2% | 85.8% | 100.0% | |
| Duration of hospital stay(days) | 1-7 | 25 | 111 | 136 | 0.161 |
| | | 18.4% | 81.6% | 100.0% | |
| | >7 | 15 | 109 | 124 | |
| | | 12.1% | 87.9% | 100.0% | |

For patients earning more than 50,000 PKR (n=149), the AKI rate was 16.8% (n=25), while 83.2% (n=124) did not develop AKI. These differences were not statistically significant (p = 0.603). Among patients with diabetes mellitus (n=85), 14.1% (n=12) developed AKI, and 85.9% (n=73) did not. In non-diabetic patients (n=175), the AKI rate was 16.0% (n=28), with 84.0% (n=147) not developing AKI. There was no significant association between diabetes mellitus and AKI (p = 0.693). In hypertensive patients (n=165), the AKI rate was 17.6% (n=29), while 82.4% (n=136) did not develop AKI. Among non-hypertensive patients (n=95), 11.6% (n=11) developed AKI, and 88.4% (n=84) did not. While AKI was more common in hypertensive patients, the difference was not statistically significant (p = 0.197). Among smokers (n=76), the AKI rate was 14.5% (n=11), while 85.5% (n=65) did not develop AKI. In non-smokers (n=184), 15.8% (n=29) developed AKI, and 84.2% (n=155) did not. The association between smoking and AKI was not statistically significant (p = 0.794). Patients with a family history of AKI (n=24) had an AKI rate of 12.5% (n=3), while 87.5% (n=21) did not develop AKI. Among patients without a family history of AKI (n=236), 15.7% (n=37) developed AKI, and 84.3% (n=199) did not. The difference was not statistically significant (p = 0.681). Among patients with LAD as the culprit artery (n=129), 13.2% (n=17) developed AKI, and 86.8% (n=112) did not. In LCX cases (n=43), 20.9% (n=9) developed AKI, while 79.1% (n=34) did not. For RCA cases (n=88), 15.9% (n=14) developed AKI, and 84.1% (n=74) did not. These differences were not statistically significant (p = 0.468). In patients with single-vessel involvement (n=151), 13.9% (n=21) developed AKI, while 86.1% (n=130) did not. Among double-vessel cases (n=84), 16.7% (n=14) developed AKI, and 83.3% (n=70) did not. In triple-vessel cases (n=25), 20.0% (n=5) developed AKI, while 80.0% (n=20) did not. These differences were not statistically significant (p = 0.681). Patients who underwent PCI within one hour (n=112) had an AKI rate of 17.0% (n=19), while 83.0% (n=93) did not develop AKI. Among those whose PCI duration exceeded one hour (n=148), 14.2% (n=21) developed AKI, while 85.8% (n=127) did not. The difference was not statistically significant (p = 0.539). Patients with a hospital stay of 1–7 days (n=136) had a higher AKI rate of 18.4% (n=25), while 81.6% (n=111) did not develop AKI. For those with a hospital stay of more than seven days (n=124), the AKI rate was 12.1% (n=15), while 87.9% (n=109) did not develop AKI. This difference was not statistically significant (p = 0.161).

## DISCUSSION

Acute kidney injury (AKI) is a significant complication of percutaneous coronary intervention (PCI), often leading to adverse outcomes such as prolonged hospital stays, increased mortality, and long-term renal dysfunction (15). This study, reporting a 15.4% AKI prevalence among acute coronary syndrome (ACS) patients undergoing PCI, aligns with the wide variability seen in previous literature. Global AKI incidence rates range from 5.2% to 30%, reflecting differences in patient populations, procedural factors, and definitions of AKI used in studies (16, 17). The AKI prevalence of 15.4% observed in this study falls within the spectrum reported in similar research. A Tanzanian

study, for example, reported an AKI prevalence of 9.7% following PCI, while studies from Pakistan showed a range between 5.2% and 30% (16). This variability can be attributed to differences in healthcare settings, contrast volume usage, and baseline characteristics of the populations studied. In tertiary care hospitals in Lahore, Rawalpindi, and Peshawar, AKI rates were notably higher in patients undergoing PCI with femoral access, as opposed to radial access, highlighting the importance of procedural techniques (17). This study's findings reinforce the critical need for tailored preventive strategies based on local patient profiles and healthcare practices. Stratified analyses in this study provided valuable insights into AKI risk factors, though no statistically significant associations were observed (15). Older age is a well-documented risk factor for AKI due to declining renal function and higher comorbidities. In this study, patients aged 41–65 years showed a slightly higher AKI rate (16.5%) than those aged 18–40 years (12.5%), consistent with trends reported in studies from Tanzania and Pakistan (16, 17). Gender differences were minimal, with males (14.9%) and females (15.7%) experiencing similar AKI rates. This mirrors findings in most studies, where gender alone is not considered a significant risk factor (17). Hypertension and diabetes mellitus, recognized contributors to renal injury, were associated with higher AKI rates in this study, though not statistically significant. Hypertension increased the AKI rate to 17.6% compared to 11.6% in non-hypertensive patients, a trend consistent with previous studies that underline the vascular and microvascular damage associated with these conditions (18). The slightly lower AKI rate in diabetic patients (14.1% vs. 16.0% in non-diabetics) may reflect differences in disease severity or management. Urban patients had a higher AKI rate (20.6%) compared to rural patients (12.0%), potentially due to differences in lifestyle, healthcare access, or the prevalence of comorbidities. Family income levels did not significantly influence AKI rates, aligning with findings in resource-limited settings, where sociodemographic factors play a secondary role to clinical and procedural factors . The culprit artery (LAD, LCX, RCA) and the number of vessels involved (single, double, or triple) did not significantly affect AKI risk in this study. These findings are consistent with the global literature, which suggests that procedural factors, rather than anatomical complexity, are more influential in AKI development (16). Contrary to expectations, PCI duration did not significantly impact AKI rates, with slightly higher rates observed in shorter procedures (17.0% for ≤1 hour vs. 14.2% for >1 hour). This finding aligns with studies indicating that the volume of contrast used and procedural hemodynamics may play a more critical role than duration alone (19, 20). Similarly, patients with shorter hospital stays (1–7 days) had a higher AKI rate (18.4%) compared to those staying longer (>7 days, 12.1%). This trend might reflect early discharges among low-risk patients and prolonged stays for those receiving intensive monitoring and care. This study underscores the need for comprehensive preventive strategies to mitigate AKI risk in PCI patients. Risk stratification using predictive tools, such as those validated in studies like Carande et al. (2023), could guide early identification of high-risk patients (15, 21). Preventive measures, including adequate hydration, the use of low-volume contrast agents, and nephroprotective pharmacological interventions, are critical. The findings also advocate for adopting radial access over femoral access, where feasible, to reduce AKI risk. Enhancing post-PCI monitoring, especially for high-risk groups, can facilitate early intervention and potentially improve outcomes.

In summary, the study's findings contribute to the growing body of evidence on AKI in PCI patients, highlighting significant clinical and procedural factors. By linking these findings with global and regional studies, it emphasizes the critical need for preventive strategies, robust risk stratification, and improved procedural practices to mitigate AKI's burden. Continued research and clinical vigilance are essential for optimizing patient outcomes.

## CONCLUSION

Patients with acute coronary syndrome (ACS) undergoing PCI frequently experience acute kidney injury (AKI), which considerably compromises results. The purpose of this study is to assess the prevalence of AKI in PCI patients with ACS and to encourage early detection techniques. The research was authorized by the institute's ethical review

committee and CPSP, recruited ACS patients who satisfied the inclusion requirements, measured serum creatinine levels before and after PCI, and evaluated AKI. According to this study, the prevalence of acute kidney injury (AKI) in patients with acute coronary syndrome having PCI is 15.4%, which is consistent with the global variability of 5.2%–30%. Although there were no significant correlations with gender or procedural characteristics, AKI risk factors include being older, having high blood pressure, and living in an urban area. The study underscores the significance of customized preventive measures, including nephroprotective treatments and radial access. Reducing the burden of AKI in PCI patients requires ongoing study and risk assessment.

## CONFLICT OF INTEREST

Authors declare no conflict of interest

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