e-ISSN 2795-3276
p-ISSN 2795-3270

INTERNATIONAL JOURNAL Research in Biological Science
www.gphjournal.org || editor@gphjournal.org

10.5281/zenodo.14899684 | Vol. 08 Issue 01 January - 2025 | Manuscript ID: #01763

Investigating the Prevalence, associated Risk Factors of Community-Acquired Acute Kidney Injury among hospitalized COVID-19 Patients at Almarj Teaching Hospital, Libya

Aimen M. Khalifa[1], Khalid G ALqathafy[2], Asmaa Faraj Salah[3], Salima Hawda[4]

[1] Department of Medicine, Faculty of Medicine- Almarj , University of Benghazi, Libya
[2,4]Biochemistry Department, Faculty of Medicine, Benghazi University
[3]Pedatric Department, Faculty of Medicine Almarj, Benghazi university, Libya

Abstract

With a variety of consequences resulting from the disease, the COVID-19 pandemic has had a substantial influence on global health. Among these, acute kidney damage (AKI) has become a serious issue, especially for patients who are admitted to hospitals. Acute kidney damage (AKI) affects about 10% of these patients.

Objective: Evaluating the prevalence of CA-AKI and determine risk factors and knowing how this illness affects COVID-19 mortality.

Methods: single-centered retrospective study which was conducted in 2024. It encompassed the medical records of hospitalized patients with severe Covid-19 infection patients who were admitted to isolation department of Elmarj Teaching Hospital in a specific period from August 21, 2020 to December 31 2021.

Results: Community acquired acute kidney injury (CA-AKI) was observed in 55 patients (31.3%).Among non-survivors, 78.2% experiencing AKI. In comparison, among survivors and only 21.8%. Predictors of CA-AKI in COVID-19 patients based on logistic regression. Age, Systolic blood pressure (SBP) and SO2. Conversely, oxygen saturation (SO2) was negatively correlated with AKI.

Conclusion: About one third of COVID-19 patients developed CA-AKI. These patients had higher mortality rate. CA-AKI were associated with aging, comorbidity and clinical aspect of patient. We recommend that healthcare providers closely observe kidney function and implement effective multimodal therapies when managing patients with COVID-19.

Keywords: Community-Acquired Acute Kidney Injury, COVID-19, Impact, Prevalence, Risk Factors.

How to cite: Khalifa, A., ALqathafy, K., & Salah, A. (2025). Investigating the Prevalence, associated Risk Factors of Community-Acquired Acute Kidney Injury among hospitalized COVID-19 Patients at Almarj Teaching Hospital, Libya. *GPH-International Journal of Biological & Medicine Science*, 8(01), 33-45. https://doi.org/10.5281/zenodo.14899684

Introduction

With a variety of consequences resulting from the disease, the COVID-19 pandemic has had a substantial influence on global health (1). Among these, acute kidney damage (AKI) has become a serious issue, especially for patients who are admitted to hospitals. Acute kidney damage (AKI) affects about 10% of these patients. The presence of comorbidities such diabetes mellitus and hypertension, which have been found to be important risk factors for the development of AKI in these individuals, as well as age, illness severity, and ethnicity may all have an impact on this rate (2,3).

Beyond immediate renal function, AKI has consequences such as higher mortality rates and longer hospital admissions. Research has indicated that individuals with COVID-19 who develop AKI are at a much higher risk of death and are more likely to need renal replacement therapy (RRT) than those who do not have renal impairment (4). While hospitalized patients with COVID-19 and other respiratory viral infections, such as influenza, have been found to have a similar incidence of acute kidney injury (AKI) (5), COVID-19 is associated with more severe cases of AKI (6), a higher incidence of chronic kidney disease (CKD), and higher mortality rates (7,8).

AKI in COVID-19 individuals has a complicated and multiple pathogenesis. Renal impairment is thought to be caused by direct viral infection of kidney cells as well as systemic effects such hemodynamic instability and inflammation (9). AKI and COVID-19 have been found to be more closely associated with the effects of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) on renal function than with the direct effects of experimental therapies (10). Acute kidney damage (AKI) is often associated with other markers of disease severity in hospitalized patients, such as sepsis (11) hypoxemic respiratory failure requiring mechanical ventilation (12), and hypotension requiring vasopressor support (13).

Knowing the local prevalence and risk factors for CA-AKI in COVID-19 patients is especially crucial in Libya, where medical resources may be scarce. During the epidemic, Elmarj Teaching Hospital is a vital healthcare facility.

Aim of the study:

Evaluating the prevalence of CA-AKI and determine risk factors and knowing how this illness affects COVID-19 mortality.

Patient and methods

The current study was carried out in 2024 and is a single-centered retrospective study. It included medical records for 176 hospitalized patients with severe Covid-19 infections, chosen from 513 patients admitted to Elmarj Teaching Hospital's isolation ward between August 21, 2020, and December 31, 2021.

On the other hand, the patients' demographic, clinical, and laboratory data were taken straight from the hospital records and entered into pre-designed data sheet that included their personal data, signs and symptoms, medical history, and results. The baseline investigation, which included a renal function test, was completed within two days of admissionPrior to administering any medication that might affect the test results .

Renal function assessment

Acute Kidney Injury (AKI) is defined and classified according to the KDIGO (Kidney Disease: Improving Global Outcomes) guidelines, when any of the following conditions are met: Serum Creatinine Increase at least 0.3 mg/dL (or 26.5 μmol/L) within a 48-hour period.An increase in serum creatinine to at least 1.5 times the baseline level, which should be known or assumed to have occurred within the previous 7 days. Or decrease in urine output of less than 0.5 mL/kg/hour for a minimum of 6 hours (14).

Staging of AKI was based on the following: an elevation of serum creatinine level 1.5–1.9 × baseline or ≥0.3 mg/dl elevation (stage 1); elevation of serum creatinine 2.0–2.9 × baseline (Stage 2); and 3.0 × baseline or increase in serum creatinine to ≥4.0 mg/dl or the initiation of renal replacement therapy (Stage 3)(14)

In instances where no baseline value is available within the last 7 to 365 days, it can be estimated using the back-calculation Modification of Diet in Renal Disease (MDRD) equation, assuming a glomerular filtration rate (GFR) of 75 mL/min/1.73 m^2.(15)

Inclusion and exclusion criteria

The study involved 176 patients diagnosed with severe COVID-19 infection, consistent with the severity criteria established by the WHO and CDC. This included individuals, individuals who have SpO2 <94% on room air at sea level, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2) <300 mm Hg, a respiratory rate >30 breaths/min, or lung infiltrates >50%..

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Patients with chronic kidney disease, mild ormoderate infections, alternative diagnoses, unver ified diagnoses, uncertain definitive outcomes, or incomplete medical records were excluded.

Statistical analysis.

Statistical analysis was performed with SPSS 23 to examine the demographic and clinical fea tures of the COVID-19 patient group and
to assess associations with acute kidney injury (AKI). Descriptive statistics were utilized to c haracterize categorical
variables revealed through counts and percentages. In contrast, continuous variables were dis played as mean and standard deviation. The Chi-
square test was utilized to evaluate the relationships between comorbidity and patient outcom

es regarding AKI, while logistic regressionwas carried out to determine the predictors of AKI in COVID19 patients. Pearson correlation coefficients were computed to evaluate the connec tions betweenserum creatinine and various continuous laboratory biomarkers. A significance threshold of $p<0.05$ was applied to assess statistical significance for all tests performed.

Results

The demographic and clinical characteristics of the COVID-19 patient showed in (Table 1) reveal a mean age of(66.24±15.45) years. The age range spans from 26 to 96 years, indicating a diverse population. Gender distribution shows a predominance of males, with 124 patients (70.5%) compared to 52 females (29.5%). Survival rates highlight a concerning trend, as 101 patients (57.4%) did not survive, while 75 patients (42.6%) were classified as survivors. Additionally, the data indicates that a significant majority, 124 patients (70.5%), required ICU admission.Vaccination status among patients demonstrates a high rate of non-vaccination, with 163 patients (92.6%) unvaccinated. Only 12 patients (6.8%) received one dose, and just one patient (0.6%) received two doses of the vaccine. The presence of comorbidities is notable; diabetes mellitus was reported in 99 patients (56.2%), while hypertension affected 89 patients (50.6%). Cardiovascular diseases were present in 60 patients (34.1%).

Community acquired acute kidney injury (CA-AKI) was observed in 55 patients (31.3%), with varying stages reported, including Stage I AKI in 29 patients (16.5%) ,Stage II AKI was seen in 14 patients (8.00%), Stage III AKI in 12 patients (6.80%) and 12 patients (6.80%) needed Renal Replacement Therapy (RRT).

Clinical symptoms at admission further illustrate the severity of the cases within this study. The mean duration of symptoms before admission was 7.31 days, with a range from 2 to 15 days, while the mean duration of hospitalization was recorded at 9.22 days, ranging from a minimum of 3 days to a maximum of 14 days. Gastrointestinal symptoms were present in 82 patients (46.6%), and fever was reported in a substantial majority, with 155 patients (88.1%) experiencing this symptom. General fatigue was also common, affecting 100 patients (56.8%).

Table 2 shows the relationship between various clinical variables and the occurrence of Acute Kidney Injury (CA-AKI) in COVID-19 patients .Diabetic patients showed a much higher incidence of CA-AKI, with a proportion of (40.4%). In contrast,only (19.5%) of non-diabetic patients had CA-AKI. This relationship was statistically significant, with a p-value of (0.03). Similarly, hypertension was associated with CA-AKI.In hypertensive patients a higher proportion of (38.2%) had AKI on admission , while(24.1%). of non-hypertensive patients had CA-AKI . The p-value was(0.044), indicating a significant relation between hypertension and the risk of developing CA-AKI. Surprisingly cardiovascular disease was not associated with increased risk of CA-AKI.

The impact of CA-AKI on patient prognosis also seen in Table 2 . Among non-survivors, 58 did not have CA-AKI while 43 did, resulting in a striking proportion of 78.2% experiencing AKI. In comparison, among survivors and only 12 had CA-AKI, leading to a much lower proportion of 21.8%. The p-value for this comparison is less than 0.001. However, ICU admission status did not demonstrate a significant relationship with the occurrence of AKI (p-value = 0.13),

Table 3reveals factors predictors of CA-AKI in COVID-19 patients based on logistic regression . Age emerged as a notable factor, with a coefficient of 0.032 (p = 0.021), indicating that for each additional year of age, the odds of developing CA-AKI increase by approximately 3.3% (Exp(B) = 1.033). Systolic blood pressure (SBP) also showed a significant association with CA-AKI, where an increase of 1 mmHg was linked to a 2.1% increase in the likelihood of developing CA-AKI (B = 0.021, p = 0.035). Conversely, oxygen saturation (SO2) was negatively correlated with AKI; each unit decrease in SO2 was associated with a 5.5% reduction in the odds of AKI (B = -0.055, p = 0.001), suggesting that lower oxygen saturation levels significantly increase the risk.

Other variables, such as diastolic blood pressure (DBP) , temperature (TEMP),and the Duration of Symptoms Before Admission did not show significant associations with CA-AKI development, with p-values of 0.199 ,0.724 and 0.957 , respectively. The constant term in the model was -2.285, indicating the baseline log-odds of AKI when all predictors are at zero, but it was not statistically significant either (p = 0.711).

The correlation analysis of various laboratory biomarkers with serum creatinin in COVID-19 patients shown in Table 4 reveals several significant positive correlations with several biomarkers, including ESR (r = 0.205, p = 0.006), sodium (Na) (r = 0.169, p = 0.025), and potassium (K) (r = 0.246, p = 0.001). Notably, the correlation between creatinine and potassium is particularly strong, suggesting that higher potassium levels may be associated with worsening kidney function in COVID-19 patients. Additionally, white blood cell count (WBC) shows a strong positive correlation with lactate dehydrogenase (LDH) (r = 0.604, p < 0.001), indicating that elevated WBC counts may reflect an inflammatory response linked to tissue damage.

Table 1
Distribution of studied patients by socio demographic **Characteristics ,**
Almarj, 2024

Variable	Frequency	Percentage
Age		
Mean ± SD	**66.24 ± 15.45 years**	
Minimum	**26 years**	
Maximum	**96 years**	
Gender		
Male	**124**	**70.50%**
Female	**52**	**29.50%**
ICU Admission		
No	**52**	**29%**

Yes	**124**	**70.50%**
Vaccination Status		
Not vaccinated	**163**	**92.60%**
One dose	**12**	**6.80%**
Two doses	**1**	**0.60%**
Acute Kidney Injury (AKI)		
No	**121**	**68.70%**
Yes	**55**	**31.30%**
- Stage I	**29**	**16.50%**
- Stage II	**14**	**8%**
- Stage III	**12**	**6.80%**
- RRT	**12**	**6.80%**
Diabetes Mellitus		
No	**77**	**43.80%**
Yes	**99**	**56.20%**
Hypertension		
No	**87**	**49.40%**
Yes	**89**	**50.60%**
Cardiovascular Diseases		
No	**116**	**65.90%**
Yes	**60**	**34.10%**
Duration of Symptoms Before Admission		
Mean ± SD	**7.31 ± 3.2 days**	
Minimum	**2 days**	
Maximum	**15 days**	
Duration of Hospitalization		
Mean ± SD	**9.22 ± 7.85 days**	
Minimum	**3 days**	
Maximum	**14 days**	
Gastrointestinal Symptoms		
No	**94**	**53.40%**
Yes	**82**	**46.60%**
Fever		
No	**21**	**11.90%**
Yes	**155**	**88.10%**
General Fatigue		
No	**76**	**43.20%**
Yes	**100**	**56.80%**

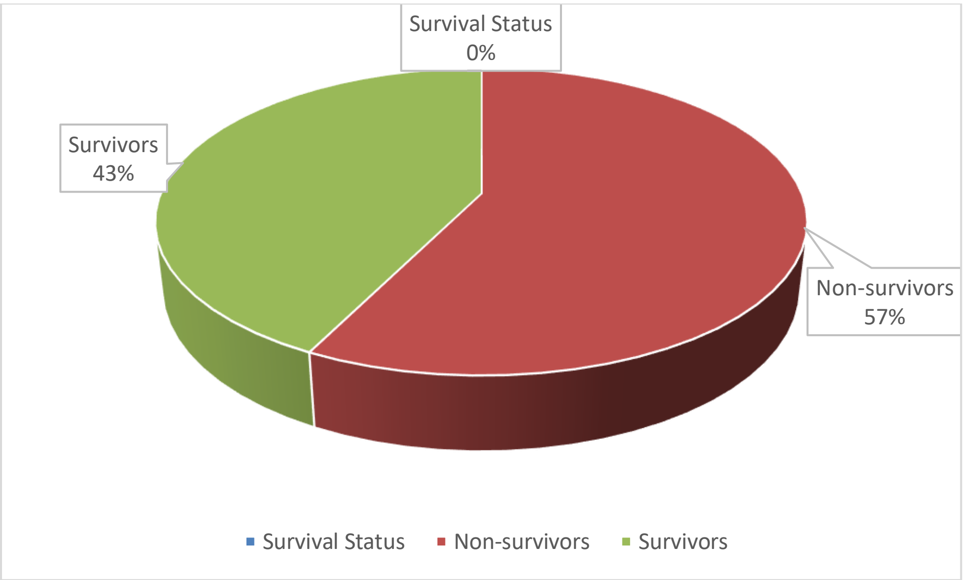

Fig (1): Distribution of studied patients by Survival Status, Almarj,2024

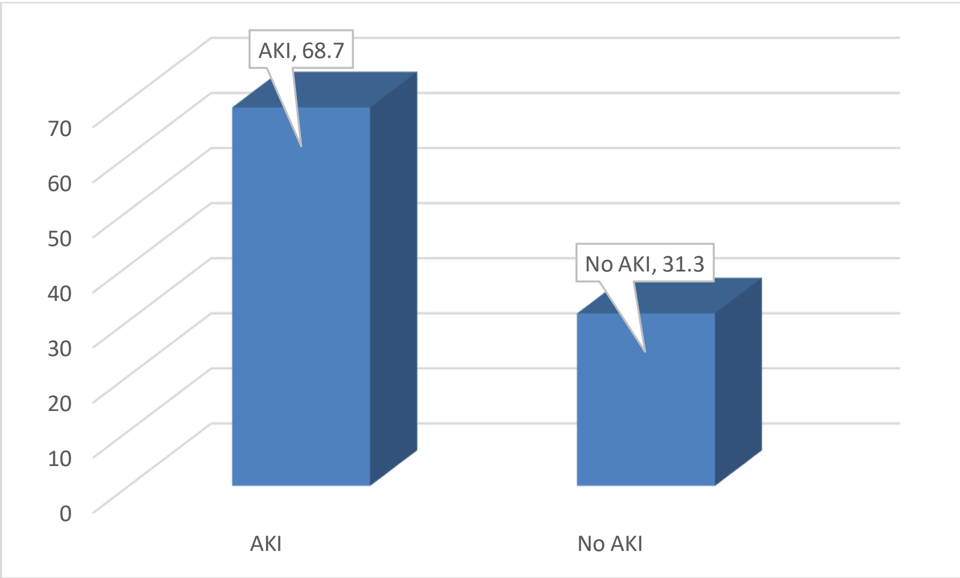

Fig (2): Distribution of studied patients by Acute Kidney Injury (AKI)**, Almarj,2024**

Table 2: Relation between AKI and patient characteristics, Almarj,2024.

Risk Factor	No AKI (n=121)	AKI (n=55)	P Value
Diabetes Mellitus			
Non-diabetic (77)	**62(80.5%)**	**15(19.5%)**	**0.03****
Diabetic (99)	**59(59.6%)**	**40(40.4%)**	

Hypertension			
No (87)	**66(75.9%)**	**21(24.1%)**	**0.044****
Yes(89)	**55(61.8%)**	**34(38.2%)**	
Cardiovascular Diseases			
No(116)	**84(72.4%)**	**32(27.6%)**	**0.145**
Yes(60)	**37(61.7%)**	**23(38.3%)**	
Survival Status			
Non-survivors(101)	**58 (57.4%)**	**43 (42.6%)**	**<0.001****
Survivors(75)	**63 (84%)**	**12 (16%)**	
ICU Admission			
No	**40 (33%)**	**12 (21.8%)**	**0.13**
Yes	**81 (67%)**	**43 (78.2%)**	

Table 3: Binary logistic regression analysis of factors affecting acute kidney injury (AKI), Almarj, 2024

Variable	B	S.E.	Wald	df	p. value	OR	95% (CI)
Age	0.032	0.014	5.369	1	0.021	1.033	(1.005, 1.062)
DBA	-0.003	0.057	0.003	1	0.957	0.997	(0.895, 1.112)
SBP	0.021	0.01	4.425	1	0.035	1.021	(1.002, 1.041)
DBP	-0.023	0.018	1.65	1	0.199	0.978	(0.943, 1.015)
SO2	-0.055	0.017	10.901	1	0.001	0.946	(0.916, 0.977)
Temp	0.054	0.154	0.125	1	0.724	1.056	(0.786, 1.419)
Constant	-2.285	6.172	0.137	1	0.711		

(NP: **acute kidney injury (AKI) as dependent variable with demographic and clinical criteria as explanatory variables**)

Table 4: Correlation between serum creatinine and other biochemical marker), Almarj, 2024.

Biomarker	Pearson Correlation with Creatinin	P- value
WBS	0.103	0.173
LDH	0.122	0.107
D-Dimer	0.128	0.09
Procalcitonin	0.017	0.821
ESR	0.205**	0.006**
CRP	0.013	0.863
Ferritin	0.001	0.994
Sodium (Na)	0.169*	0.025*
Potassium (K)	0.246**	0.001**
Chloride (Cl)	0.017	0.827

Discussion

The findings from the research on community-acquired acute kidney injury (CA-AKI) among hospitalized COVID-19 patients at Elmarj Teaching Hospital offer important insights into the occurrence, risk factors, and prognostic consequences of AKI. Schaubroeck et al. validated that AKI is a common complication of COVID-19 among critically ill patients (16). The analysis shows that 31.3% of patients encountered CA-AKI, emphasizing an important health issue. This discovery aligns with a study conducted at the medical ICU of the university hospital in Clermont-Ferrand, France, which reported a 31% prevalence of AKI in critically ill COVID-19 patients (17).

This was similar to findings from a large prospective cohort study carried out at a tertiary teaching hospital with three branches in Wuhan, China, where we noted a notable prevalence of kidney disease in hospitalized COVID-19 patients. Over 40% of these individuals showed renal disease signs (18). The research revealed that diabetic individuals experienced a significantly greater occurrence of CA-AKI, which is consistent with current studies that recognize diabetes as a key risk factor for AKI among different patient groups, especially those affected by COVID-19.

Diabetes is recognized to worsen kidney dysfunction because of associated complications and altered hemodynamics, which may be further intensified by the inflammatory reaction caused by SARS-CoV-2 infection (19).

Hypertension was markedly linked to CA-AKI. This discovery highlights the significance of tracking blood pressure in COVID-19 patients, since hypertension may result in elevated vascular resistance and impaired renal perfusion, which can exacerbate kidney damage. The absence of a link between cardiovascular disease and CA-AKI in this study is significant and indicates that different factors might be more important in determining renal outcomes in COVID-19 patients (20).

The influence of CA-AKI on patient outcomes was clearly demonstrated by survival rates, as a p-value of under 0.001 revealed a strong link between AKI and the risk of death. This result aligns with earlier research indicating that AKI is linked to higher mortality rates in hospitalized individuals, especially in those with severe COVID-19. The elevated mortality rate in patients with CA-AKI underscores the necessity for prompt identification and intervention to reduce kidney damage and enhance overall results (18,21).

Logistic regression analysis revealed that age, systolic blood pressure, and decreased oxygen saturation levels are important predictors of CA-AKI development. These results support the idea that older individuals and those with high blood pressure face an increased risk of kidney complications during COVID-19 infection, indicating that ensuring sufficient oxygen levels might help prevent kidney damage.

Anastasia et al., 2023 displayed that the main risk factors for kidney injury among hospitalized patients with COVID-19 were male sex, cardiovascular diseases, and chronic kidney disease. High serum angiopoietin-1 levels and a decrease in blood lymphocyte count and fibrinogen level also increased the risk of AKI (22).

Muriel et al., 2021 revealed that predictors of AKI were age, diabetes mellitus, and hypertension. On the other hand, inflammatory (interleukin-6, C-reactive protein, and ferritin) or thrombotic (D-dimer and fibrinogen) markers were not associated with AKI (23).

Filipe et al., 2021 documented that hypertension, lower hemoglobin, and lower CRP were independent risk factors for the development of AKD. Older age, higher serum ferritin, and development of AKD were independent predictors of in-hospital mortality in COVID-19-AKI patients (24).

Correlation analysis demonstrated notable positive associations between serum creatinine levels and several biomarkers, including potassium, sodium, and inflammatory indicators like ESR and WBC count, indicative of an inflammatory response linked to tissue injury.

In summary, these results underscore the complex factors contributing to CA-AKI in hospitalized COVID-19 patients and pinpoint essential areas for clinical intervention. Monitoring diabetes and hypertension is crucial for managing at-risk groups, while focusing on laboratory biomarkers can assist in the early identification and treatment of AKI.

Conclusion and recommendation:

We concluded that approximately one-third of COVID-19 patients experienced CA-AKI. These patients experienced a higher mortality rate. CA-AKI was linked to aging, comorbidity, and the clinical features of the patient. Consequently, careful monitoring of acute kidney injury (AKI) is crucial from the initial phases of treatment. We suggest that healthcare professionals carefully monitor kidney function and apply effective multimodal treatments when managing patients with COVID-19.

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