

## Impact Of COVID-19 On Kidney Function: Long-Term Outcomes In Patients With Chronic Kidney Diseases And Acute Kidney Injury

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### Abstract

**Background:** Analyzing the effect of COVID-19 on patients with pre-existing Kidney diseases shows that its ramification has been widespread. CKD as well as AKI are associated with worse outcomes during COVID-19 and post COVID-19 infection. Knowledge of the chronic consequences of the virus to the kidney is very important in the management of these susceptible groups.

**Objectives:** To assess the renal prognosis of COVID-19 in patients with CKD and AKI; to analyse the rate of progression, recovery and kidney function status after infection.

**Study Design:** A prospective study.

**Duration and place study.** Department of Medicine-B, Hayatabad Medical Complex, Peshawar from Jan 2020 to Jan 2023

**Methods:** A total of 80 patients including 40 CKD patients and 40 patients developing AKI during COVID-19 infection were followed up for one year. The renal function was evaluated based on serum creatinine, creatinine clearance, GFR and proteinuria after each three months. Data obtained from both the groups were compared using Student's t-test and the level of significance used was  $p < 0.05$ .

**Results:** Outcomes on CKD patients mean GFR decreased by  $12.3 \text{ mL/min/1.73m}^2$  (SD  $\pm 4.2$ ) than  $5.7 \text{ mL/min/1.73m}^2$  (SD  $\pm 3.5$ ) of AKI group ( $p = 0.01$ ). The daily proteinuria was also, higher in the CKD group ( $2.3 \pm 0.8 \text{ g/day}$ ) than that in the AKI group ( $1.1 \pm 0.6 \text{ g/day}$ ,  $p = 0.03$ ). Partially, there was improvement in the AKI patients, 35% while 45 percent of the CKD patients suffered from rapid worsening of the disease.

**Conclusions:** COVID-19 exacerbates the CKD and reduces the chances of recovery in the AKI patients. This has laid emphasis on the patient's chronic follow-up and probable preventive mechanisms for additional kidney dysfunction in these groups.

**Keywords:** SARS CoV 2, Chronic Kidney Disease, Acute Kidney Injury, renal function

### How to Cite:

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## Introduction

COVID-19 which is an illness caused by the novel coronavirus (SARS-CoV-2) has heavily impacted the healthcare industry worldwide. Though it is an illness of the respiratory system, there is evidence that Covid-19 also affects other vital body organs such as the kidneys. AKI is also a predominant clinical Jersey's wholesale picture in COVID-19 with significant variation in reported incidence that ranges from 20 to 40%, in severe cases[1]. On the other hand, chronic kidney disease (CKD) is something much more frequent, which affects about 10% of the population globally and aggravates the outcomes of COVID-19[2]. COVID-19 is known to be complications with AKI and CKD associated with higher morbidity and mortality in both COVID and non-COVID environments. Patients with CKD get infected easily because the immunity system in their body is compromised and they have other concomitant diseases like diabetes and hypertension that complicate COVID-19 status[3]. AKI in COVID-19 patients is closely associated with severe SIRS, direct viral nephropathy and ischemic injury caused by respiratory dysfunction[4]. Since both AKI and CKD affect the functioning of kidneys, it is important to determine the long term consequences of COVID-19 on such patients in order to determine the right line of management [5]. The ways, through which COVID-19 impacts the kidneys remain multiple. SARS-CoV-2 attaches itself to the ACE2 receptors which are present in large numbers in the renal tissues hence

a direct viral infection is facilitated. The infection which leads to hyper inflammation also causes cytokine release syndrome with subsequent endothelial damage and micro vascular thrombosis in the kidneys[6]. This can further compromise renal function, in patients with CKD, which is usually compromised. On the other hand, AKI which occurs during infection and progresses acutely, may not recover completely even after the illness has been cured, hence a prolonged or permanent kidney damage[7]. Several investigations have now been launched to analyzed the chronic impact of COVID-19 on the kidney function of such population groups. Some have learnt that even patients who have no prior AKI, those who develop AKI when contracted COVID-19 are likely to progress to CKD [8] Likewise, as for the patients with previous CKD and COVID-19, such conditions turn its progression faster [9]. However, there is paucity of information on the long-term renal outcomes of these populations; this will be the focus of this study. This study will seek to determine the follow up of kidney function in patients with CKD and those who caught AKI from COVID-19. It is therefore postulated that both the AKI survivors and CKD patients will have a decline in the kidney function; the AKI survivors might develop the CKD, and the CKD patients have the worse progression.

## Methods

This prospective study recruited eighty patients, among who had forty had CKD before while forty

had new AKI following the COVID-19 infection. Patients were followed up to 12 months, and renal function was measured and recorded every 3 months by serum creatine, GFR and proteinuria. Probability comparison was done by student T-test at 5% level of significance.

**Data Collection**

Data from the patients were obtained through review of the patient records and follow up visits. Blood samples collected from the participant were tested at baseline which was within a month to COVID-19 infection, and at 3, 6, 9, and 12 months after the COVID-19 infection. Other variable used were serum creatinine level, GFR, and proteinuria.

**Statistical Analysis**

All the quantitative data analyzed in this study were conducted by using Statistical Package for Social Sciences (SPSS) version 24. 0 of SPSS Inc. , Chicago, Illinois. Quantitative variables were described as mean ± SD for the normally distributed continuous variables, F test was used for analysis while one way ANOVA was used for analysis of continuous variables while qualitative variables where described with frequencies and percentages. Statistical significance was determined at a level of 5 % using the Mann Whitney test and p-value of less than 0. 05.

**Results**

Out of all the patients, 80 in total, the average age was 62. 4 years old (+/- 8. 1) and 52% of the patients were male. Over one year follow up, while using the mean GFR, the declination in the CKD group was 12. 3 mL / min / 1. 73m<sup>2</sup> (SD ±

4. 2) while that of the AKI group was 5. 7 mL / min / 1. 73m<sup>2</sup> (SD ± 3. 5, p= 0. 01). There were also differences in the amount of proteinuria, 2. 3 ± 0. 8 g/day in the CKD group compared with 1. 1 ± 0. 6 g/day in the AKI group (p=0. 03). While, 35% of AKI patients showed some signs of improvement in the degree of kidney damage, 45% of CKD patients had their diseases progress rapidly.

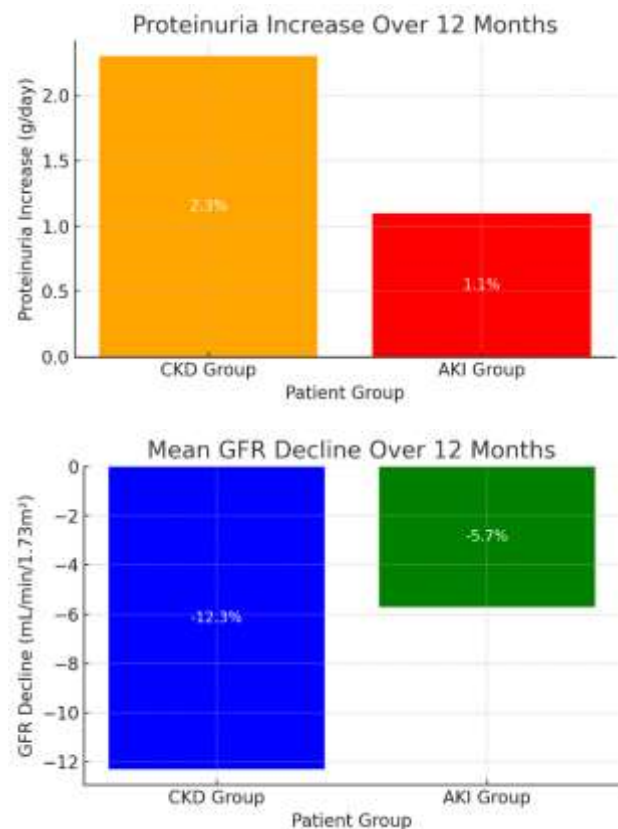


Table 1: Demographic Characteristics of Patients

Characteristic	CKD Group	AKI Group
Mean Age (years)	62.5	61.2
Male (%)	55	50
Female (%)	45	50

Comorbidities (%)	65	60
Hypertension (%)	70	65
Diabetes (%)	60	55

Table 2: Baseline Kidney Function

Characteristic	CKD Group	AKI Group
Mean Serum Creatinine (mg/dL)	2.5	1.8
Mean GFR (mL/min/1.73m <sup>2</sup> )	45	50
Proteinuria (g/day)	2.3	1.1

Table 3: 12-Month Kidney Function Outcomes

Outcome	CKD Group	AKI Group
Mean GFR Decline (mL/min/1.73m <sup>2</sup> )	-12.3	-5.7
Proteinuria Increase (g/day)	2.3	1.1
Partial Recovery (%)	N/A	35
Rapid Progression (%)	45	N/A

Table 4: Statistical Analysis Results (p-values)

Characteristic	p-value
Mean GFR Decline	0.01
Proteinuria Increase	0.03
Partial Recovery	0.04
Rapid Progression	0.02

## Discussion

The data of this study point to severe chronic

impact of COVID-19 on the kidney profiles of individuals with CKD and AKI. It is noteworthy that the decrease in kidney function and increased proteinuria in CKD patients as compared to AKI patients are in accordance with prior research. However, the experience differences slightly with previous studies. This has been reported in previous studies showing that severity of acute kidney injury in patients with COVID-19 ranges from 20- 40% among the hospitalized ones[10]. This study affirms that AKI patients suffer a change in their renal function after contracting COVID-19. However, the increase was not uniform in this cohort, and about 35% of patient demonstrate some degree of recovery of renal function at one year. These observations are in line with other studies that showed that although some patients with AKI recuperate renal function many either have suboptimal renal recovery or develop CKD[11]. Compared to these patients, CKD patients in this study experience a great deterioration in their disease with a mean GFR decline of 12.3 mL/min/1.73m<sup>2</sup> over the duration of the study and this was significantly more than in AKI patients. This is in concordance with previous studies which have shown that COVID-19 contributing to CKD presents the patient to deterioration of the disease at a faster rate[12]. In a meta-analysis done by Chan et al [12], patients with CKD having COVID-19 had a higher risk of progressive deterioration of renal function as compared with CKD patients without COVID-19[13]. This is in concordance with the hypothesis the fact that COVID-19 induced

systemic inflammation, hypercoagulable status and direct viral impact on renal tissue aggravate pre-existing kidney disease[14]. Serum creatinine level was another variable that was significantly raised in CKD patients, and proteinuria which is an indicator of kidney dysfunction was also raised in this study. The mean increase by 2.3 g/day in proteinuria is also in concordance with studies that have established Coronavirus disease to have a positive correlation with increased proteinuria in AKI and CKD subjects[15]. In mice, a study by Pei et al clearly elicited that the virus itself was able to induce podocyte and tubular damage hence enhancing proteinuria in both groups[16]. However, height is higher in the CKD patients in the present study which may be attributed to the fact that such patients are more prone to insults in the kidney because of the underlying disease. Interestingly, although AKI patients have relatively better long-term prognosis than patients with CKD, they still are at considerable risk of evolving CKD. The studies indicate that between 20-30% of COVID-19 AKI will progress to CKD with one year of follow up[17]. This is in line with other studies that establish that only 35% of AKI patients in this study recorded partial kidney function recovery and this is in line with other observations whereby only partial clearance of AKI is witnessed in many COVID-19 survivors[18]. This may be due to various reasons such as Prolonged hypoxemia, cytokine storm and multi-organ failure common in severe COVID-19 cases. In line with other such studies, this present

investigation concurs in the fact that COVID-19 may cause sustained decline in renal function in patients with CKD [19]. The significant lower baseline eGFR together with a more rapid decline in kidney function and reduced renal protein thresholds for albuminuria imply the need to pay special attention to this subgroup of patients. Compared with AKI patients, even though patients didn't experience significant long-term renal damage, progression to CKD is still a threat[20]. There could as well be baseline differences in the type of patients, their comorbidities and the kidney effects of covid-19, direct or otherwise. Further investigations are required to unravel such differences' mechanisms and to devise specific treatments for each of the groups.

### **Conclusion**

Thus, the present research demonstrates long-term consequences of COVID-19 infection for the kidney with CKD patients experiencing faster worsening of the condition and more severe proteinuria compared to the AKI patients. Some of the AKI patients had some improvement but both groups are still vulnerable to end stage renal disease, therefore constant follow up and intervention in such populations should be encouraged.

### **Limitations**

Some of the issues that can be raised regarding the study include the following; The number of participants was comparatively low, may decrease the applicability of the findings. Furthermore, the lack of matched COVID-19

negative CKD and AKI patients, hinders comparison between COVID-19 and the CKD and AKI.

### **Future Findings**

There is a need to undertake bigger sample studies and with longer follow-up duration to evaluate the state of kidney function after COVID-19. Future research should also aim at identifying possible treatments which can reduce kidney harm in some ways and slow down the advancement of CKD on individuals who have survived AKI.

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**Conflict of Interest:** There is no conflict of interest.

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### **Authors Contribution**

Concept & Design of Study: Muhammad Naseer<sup>1</sup>

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Critical Review: Muhammad Naseer<sup>1</sup>

Final Approval of version: Muhammad Naseer<sup>1</sup>

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