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ACUTE KIDNEY INJURY IS ASSOCIATED WITH IN-HOSPITAL MORTALITY OF PATIENTS WITH COVID-19, BUT LESS COMMON AMONG VARIANT B.1.1.7 POSITIVE SARS-COV-2 INFECTION

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Abstract: The aim of this study is to compare the rates of acute kidney injury (AKI) occurence and mortality between hospitalized patients with SARS-CoV-2 infection variant B.1.1.7 positive and negative. 200 hospitalized patients with SARS-CoV-2 infection included in the study. The sociodemographic characteristics of the patients and the laboratory values were obtained retrospectively from the patient files and electronic records. 121 patients with variant B.1.1.7 positive SARS-CoV-2 (group I) and 79 patients with variant B.1.1.7 negative SARS-CoV-2 (group II) included in the study. Acute kidney injury developed at a higher rate in group II patients [15/79 (19%),] compared to group I patients [7/121 (5.8%)] (P=0.004). When 180 patients without chronic kidney disease included in the analysis, acute kidney injury developed in 7 (6.4%) of 110 variant-positive patients, while acute kidney injury developed in 13 (18.6%) of 70 variant-negative patients (P=0.011). It was shown that, AKI development was lower in variant positive patients compared to variant negative patients (OR: 0.32 and 95% CI: 0.12 – 0.88, P=0.027) and age was an independent risk factor for AKI (OR: 1.06 and 95% CI: 1.02 – 1.11, P=0.002). The development of AKI, presence of pre-dialysis chronic kidney disease and age were found to be independent risk factors for mortality [respectively (OR: 6.09 and 95% CI: 1.64 – 22.58, P=0.005), (OR: 5.37 and 95% CI: 1.38 – 20.93, P=0.016), (OR: 1.06 and 95% CI: 1.02 – 1.11, P=0.005)].

Keywords: Acute kidney injury, Mortality, SARS-CoV-2, Variant B.1.1.7

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1. Introduction

COVID-19 infection, defined as a pandemic by the World Health Organization (WHO) on 11th March 2020, is a deadly virus outbreak that seriously affects human life and the global economy. The International Committee on Taxonomy of Viruses named it as 'severe acute respiratory syndrome coronavirus-2' (SARS-CoV-2) because it has the same genome as the coronavirus infection that causes SARS (Gupta et al., 2020). The disease has spread tremendously around the world since its onset in December 2019, resulting in more than 329 million cases of COVID-19 with more than 5.5 million deaths so far (Chavda et al., 2022).

One of the first mutants for SARS-CoV-2 infection, B.1.1.7 (Alpha), was identified in southeast England in September 2020 and has quickly become the most common variant in the UK (Tao et al., 2021). Later, the B.1.351 variant (Beta) identified in South Africa, the P.1 variant (Gamma) identified in Brazil, and the Delta strain reported in India, spread rapidly all over the world (Gao et al., 2021). The variant detected in South Africa on 26th November 2021 was named Omicron (CDC, 2021). The Omicron variant has more than 50 mutations, and it is related to high transmissibility and mortality (Callaway, 2021). The Lambda variant was first identified in Peru in August 2020, and then the Mu variant was first identified in Colombia (Chavda et al., 2022). Zeta (P.2), Eta (B.1.525), Theta (P.3), Iota (B.1.526) and Kappa (B.1.617.1) variants are not considered to be of concern (Chavda et al., 2022). SARS-CoV-2 continually undergoes genomic mutations to adapt to the host, causing new challenges and limitations in current treatment options.

Coronaviruses bind to the angiotensin-converting enzyme 2 (ACE-2) receptor to enter the host (Zhou et al., 2022). It is known that ACE-2 protein is abundantly expressed in many cell types, such as intestinal epithelial

cells, renal tubular epithelial cells, cardiac and arterial smooth muscle cells (Zou et al., 2020). Therefore, COVID-19 infection may progress with dyspnea, diarrhea, acute heart damage and acute kidney failure as well as upper respiratory tract infection symptoms. AKI develops at a rate of 5–43% through various mechanisms such as acute tubular damage, poor renal perfusion, rhabdomyolysis, inadequate oral intake, increased insensible sweating, vomiting, sepsis, cytokine-mediated injury, and direct viral invasion and multi-organ failure in COVID-19 patients (Copur et al., 2022). A meta-analysis estimated that 28% of patients developed AKI and 9% needed dialysis. In addition, these rates were even higher in patients hospitalized in the intensive care unit (Copur et al., 2022). In these patients, AKI is associated with worse prognosis, longer hospitalization and increased mortality (Cheng et al., 2020; Chen et al., 2020; Kanbay et al., 2022).

Although hospitalized SARS-CoV-2 patients and the development of AKI have been studied many times, we could not find any study which investigates the effect of variant B.1.1.7 positivity on the development of AKI and mortality. Therefore, it was aimed to compare the rates of acute kidney injury (AKI) development and mortality between hospitalized patients with SARS-CoV-2 infection variant B.1.1.7 positive and negative.

2. Materials and Methods

This study was carried out retrospectively for the patients who were hospitalized for the treatment of COVID-19 at Samsun Training and Research Hospital between February 1, 2021 and March 31, 2021.

Patients, who underwent hemodialysis or peritoneal dialysis for chronic renal failure, or renal transplantation patients, patients with estimated glomerular filtration rates (eGFRs) less than 30 ml/min/1.73 m2, advanced chronic kidney disease, and patients younger than 18 years of age were excluded from the study. All included patients received the same treatment protocol. The treatment protocol was applied according to the 'COVID-19 Diagnosis and Treatment Guide' of the Ministry of Health (SBS, 2020).

A total of 200 hospitalized patients with positive polymerase chain reaction results for SARS-CoV-2 infection were included in the study. The patients were divided into two groups as variant B.1.1.7 positive (group I; n=121), and variant B.1.1.7 negative (group II; n=79). The sociodemographic characteristics of the patients and the laboratory results were obtained retrospectively from the files and electronic records. Comorbidities such as diabetes mellitus, hypertension, chronic obstructive pulmonary disease, congestive heart failure, coronary artery disease, malignancy and pre-dialysis chronic kidney disease of the patients were recorded. The length of hospitalization, the need for intensive care unit, the basal creatinine levels at hospitalization and the previously known creatinine levels of the patients were also recorded. Kidney Disease Improving Global Organization (KDIGO) criteria were used to determine whether there was renal dysfunction and whether acute kidney injury developed during hospitalization (Khwaja, 2012). According to these criteria; 1.5-1.9 times increase in serum creatinine level compared to basal value or creatinine value of 0.3 mg/dl increase was defines as stage 1, 2-2.9-fold increase from the baseline creatinine level was defined as stage 2, and at least 3-fold increase or serum creatinine level ≥ 4 mg/dl or the need for renal replacement therapy were considered as stage 3 (Khwaja, 2012). It was also recorded whether hemodialysis was taken, and the outcome of the treatment as exits, transfer to intensive care unit or discharged home. In-hospital mortality was evaluated according to the survival status.

Bio-Speedy, SARS COV-2 Double Gene RT-qPCR kit was used to diagnose COVID-19. This kit was studied with the BioRad CFX96 RT-PCR device. With the present kit, the diagnosis of COVID-19 was made with the SARS CoV-2 nucleoprotein and oligoprimers belonging to the ORF1ab conserved gene region. VOC-202012/01 is a variant of SARS-CoV-2 in the B.1.1.7 strain. “Bio-Speedy® SARS-CoV-2 + VOC202012/01 RT-qPCR/Türkiye” kit was used for COVID-19 variant detection.

2.1. Statistical Analysis

SPSS 21.0.0.1 for Windows (SPSS; IBM) software was used for statistical analysis. Data distribution was determined using the Kolmogorov-Smirnov test. The homogeneity of the variables was determined using the one-way ANOVA test of homogeneity of variance. Continuous variables were reported as mean (±standard deviation) or as median (minimum-maximum) according to the data distribution. Categorical variables were reported as percentages. According to the data distribution student t-test or Mann Whitney U test were used to compare changes in laboratory values within the groups. Chi-square test or Fisher's Exact test were used to compare categorical variables between the two groups. Mortality data were presented as ratio (95% confidence interval). Logistic regression test was used in risk factor analysis. A p value of < 0.05 was considered significant statistically.

3. Results

Acute kidney injury developed in 22 of 200 patients included in the study (11%). While 7 of these 22 patients (5.8% of group I) were variant B.1.1.7 positive, 15 patients (19% of group II) were variant negative (P=0.004).

121 patients with variant B.1.1.7 positive (group I), and 79 patients with variant B.1.1.7 negative (groupII) included. The comparison of clinical and laboratory parameters of variant B.1.1.7 positive and variant B.1.1.7 negative patients included in the study is given in Table 1.

Table 1. The comparison of clinical and laboratory parameters of variant B.1.1.7 positive and variant B.1.1.7 negative patients in terms of mortality and the development of acute kidney injury.

	Variant positive (n = 121)(%)	Variant negative (n = 79)(%)	P
Age, mean ± SD	55.69 ± 15.77	60 ± 16.11	0.062
Gender (Male), n (%)	54 (44.6)	47 (59.5)	0.040
Comorbidity, n (%)	76 (62.8)	56 (70.9)	0.239
Diabetes Mellitus	31 (25.6)	14 (17.7)	0.191
Hypertension	54 (44.6)	41 (51.9)	0.314
COPD	12 (9.9)	17 (21.5)	0.023
Heart failure	12 (9.9)	12 (15.2)	0.262
Coronary artery disease	18 (14.9)	9 (11.4)	0.481
Malignancy	8 (6.6)	1 (1.3)	0.075
Chronic kidney disease	11 (9.1)	9 (11.4)	0.596
White Blood Count, per mm^3	6200 (1900 – 30000)	6000 (1800 – 19600)	0.331
Neutrophil	4100 (1000 – 27000)	4000 (1000 – 18300)	0.326
Lymphocyte	1200 (200 – 3400)	1200 (200 – 4200)	0.734
Hemoglobin*, gr / dL	12.8 ± 1.7	12.9 ± 1.7	0.884
Thrombocyte, per mm^3, x10	200 (18.7 – 544)	195 (46 – 664)	0.469
Baseline Creatinine	0.8 (0.4 – 2.8)	0.9 (0.5 – 3)	0.061
Creatinine at hospitalization	0.8 (0.4 – 8)	0.9 (0.5 – 13)	0.032
Urea	31.5 (12 – 206)	38 (11 – 201)	0.223
CRP	26.8 (0.6 – 378)	37.9 (0.47 – 306)	0.288
Ferritin	314 (4.7 – 1655)	185 (5.8 – 2000)	0.036
D-dimer	0.6 (0.2 – 15,2)	0.36 (0.02 – 14.9)	0.007
Acute kidney injury, n (%)	7 (5.8)	15 (19)	0.004
Hemodialysis	3 (2.5)	3(3.8)	0.699
Length of hospitalization, median (min – max)	7 (1 - 43)	7 (3 – 23)	0.900
Length od stay in ICU, n (%)	12 (9.9)	15 (19)	0.067
Exitus, n (%)	11 (9.1)	8 (10.1)	0.807

COPD= chronic obstructive pulmonary disease, ICU= intensive care unit

There was not any significant difference between the two groups in terms of age, comorbidities such as, diabetes mellitus, hypertension, congestive heart failure, coronary artery disease, malignancy and pre-dialysis chronic disease, and white blood cell, neutrophil, lymphocyte count, hemoglobin, platelet count, urea, CRP (C reactive protein), basal creatinine level before hospitalization, length of stay in the hospital or in the intensive care unit, the rate of hemodialysis need and mortality. However, male gender, chronic obstructive pulmonary disease history, and creatinine levels at admission, and the rate of acute kidney injury occurrence were higher in variant-negative patients, while ferritin and D-dimer levels were higher in variant-positive patients (Table 1).

The mean age and comorbidity of patients who developed acute kidney injury were higher than those who did not (P<0.001 and P=0.009, respectively). In addition, the development of AKI was lower in variant B.1.1.7 positive patients (P=0.004). The comparison of all patients with and without acute kidney injury is given in Table 2.

When age, male gender, positive variant status, presence of pre-dialysis chronic kidney disease and comorbidity status were modeled as independent variables in the risk factor analysis for the development of acute kidney injury was less in variant positive patients (OR: 0.32 and 95 %). CI: 0.12 – 0.88, P=0.027) and age (OR: 1.06 and 95 % CI: 1.02 – 1.11, P=0.002) were found to be independent risk factors for AKI. Gender (OR: 1.38 and 95 % CI: 0.51 – 3.77, P=0.526), CRF (OR: 0.39 and 95 % CI: 0.07 – 2.07, P=0.268), and the presence of comorbidity (OR: 2.45 and 95 % CI: 0.49 – 12.29, P=0.276) were not associated with the development of AKI.

180 of 200 patients did not have chronic kidney disease, while 20 patients had pre-dialysis chronic kidney disease. All these 20 patients had a level of stage 3 or less chronic kidney disease. Because patients with advanced chronic kidney disease are excluded at the beginning of the study. When 180 patients with chronic kidney disease were analyzed, AKI developed in 7 (6.4%) of 110 variant positive patients, while AKI developed in 13 (18.6%) of 70 variant negative patients. There was a higher rate of AKI development in variant-negative patients without renal failure (P=0.011). When only 20 patients with chronic kidney disease were analyzed, AKI did not develop in any of the 11 variant-positive patients, while AKI developed in 2 (22.2%) of the 9 variant-negative patients. Although the development of AKI was observed more frequently in variant negative patients

with pre-dialysis chronic kidney disease, this difference was not statistically significant (P=0.189). Among 180 patients without chronic kidney disease, the median length of hospital stay was 7.5 (1 – 43) days in variant positive patients (n=110) and 7 (3 – 23) days in variant negative patients (P=0.934). In 20 patients with chronic kidney disease, the median length of hospital stay was 4 (1 – 41) days in variant positive patients (n=11) and 7 (4 – 15) days in variant negative patients (P=0.340). There was no statistical difference between patients with and without chronic kidney disease in terms of length of service stay, regardless of whether the variant was positive or negative. Of the 200 patients, 19 died and 181 were discharged. Patients who died were older (P<0.001), had more chronic kidney disease not requiring dialysis (P=0.001), and had a higher incidence of newly developing acute kidney injury while hospitalized (P< 0.001). Comparison of all deceased and discharged patients is given in Table 3.

Table 2. Factors affecting the development of acute kidney injury (n=200)

	AKI developed (n: 22) (%)	AKI not developed (n: 178) (%)	P
Age, years, mean ± SD	70.6 ± 9.7	55.8 ± 15.9	< 0.001
Male gender, n (%)	13 (59.1)	88 (49.4)	0.393
Variant B.1.1.7 Positivity	7 (31.8)	114 (64)	0.004
Pre-dialysis chronic kidney disease	2 (9.1)	18 (10.1)	0.880
Comorbidity	20 (90.9)	112 (62.9)	0.009

Table 3. Factors affecting mortality (n=200)

	Deceased (n: 19) (%)	Discharged (n: 181) (%)	P
Age, years, mean ± SD	70.6 ± 13.8	56 ± 15.6	< 0.001
Male gender, n (%)	12 (63.2)	89 (49.2)	0.246
Positive variant	11 (57.9)	110 (60.8)	0.807
Pre-dialysis chronic kidney disease	6 (31.6)	14 (7.7)	0.001
Acute kidney injury	7 (36.8)	15 (8.3)	< 0.001
Comorbidity	15 (78.9)	117 (64.6)	0.210

In mortality risk factor analysis; when age, male gender, variant positivity, history of chronic kidney disease, AKI development status and comorbidity status were modeled as independent variables, development of AKI (OR: 6.09 and 95 % CI: 1.64 – 22.58, P=0.005), presence of predialysis chronic kidney disease (OR: 5.37 and 95 % CI: 1.38 - 20.93, P=0.016) and age (OR: 1.06 and 95 % CI: 1.02 - 1.11, P=0.005) were determined as independent risk factors for mortality. Positive variant (OR: 1.73 and 95 % CI: 0.54 – 5.52, P=0.355), gender (OR: 1.47 and 95 % CI: 0.49 – 4.48, P=0.493) and presence of comorbidity (OR: 0.41 and 95 % CI: 0.09 – 1.81, P=0.237) were not associated with the mortality.

4. Discussion

Acute kidney injury is common in hospitalized patients with SARS-CoV-2 infection and is associated with increased in-hospital mortality. Considering all the patients included in the study who were hospitalized due to SARS-CoV-2 infection in our study, a substantial rate of AKI developed in 11%. In addition, although AKI was lower in variant B.1.1.7 positive patients than in variant B.1.1.7 negative patients, advanced age and greater number of comorbid diseases increased AKI. Again, the development of AKI, the presence of pre-dialysis chronic kidney disease and advanced age were associated with increased mortality. Our study shows that in order to reduce mortality and prevent negative outcomes in patients hospitalized for SARS-CoV-2 infection, the development of AKI should be kept in mind and necessary precautions should be taken immediately.

SARS-CoV-2 infection starts with the entry of the virus through the mucous membrane of the mouth, nose or conjunctiva (Zhou et al., 2020). SARS-CoV-2 binds to the angiotensin-converting enzyme 2 (ACE2) receptor to enter the host cell (Gu et al., 2005). ACE2 is expressed in humans mainly in type II alveolar cells of the lung, but also in the small intestine, heart, liver, and kidney. In autopsy samples from previous SARS-CoV-2 infected patients, histochemical examination revealed virions, RNA, and antigens in the lung and other organs, including the kidney (Gu et al., 2005). In SARS-CoV-2 infection, acute kidney injury develops due to factors such as sepsis, drug toxicity, rhabdomyolysis, diarrhea-related pre-renal factors or decreased hydration (Ronco and Reis, 2020). In addition, direct renal cell infection is possible, especially with viral particles in the proximal tubules and podocytes (Couturier et al., 2020; Farkash et al., 2020; Su et al., 2020). In addition, in more severely affected patients, a cytokine storm may also cause kidney tissue damage, independent of the virus (D'Marco et al., 2020; Shi et al., 2020). It has been known for a long time that the inflammatory cytokines cause glomerulopathy as well as acute kidney injury (González-Cuadrado et al., 1997; Sanz et al., 2011). Even COVID-19-related acute kidney injury may also progress with damage to other organs such as the heart or with electrolyte abnormalities resulting from inappropriate ADH

syndrome development (Carriazo et al., 2020). Our study was similar to the study of Kanbay et al. in which 92 (11.9%) of 770 hospitalized patients developed acute kidney injury (Kanbay, 2022), and when all COVID-19 patients were taken into account, acute kidney injury was 11% in our study.

It is known that acute tubular necrosis (ATN) and endothelial damage caused by severe inflammation and hemodynamic imbalance in COVID-19 infection contribute to kidney damage (Su et al., 2020; Zahid et al., 2020), and AKI, proteinuria and hematuria may develop (Copur et al., 2022). AKI is usually observed in the context of systemic organ failure (Naicker et al., 2020). Among 701 COVID-19 patients admitted to a Wuhan hospital, 43.9% had proteinuria at presentation, 26.7% hematuria, 14.4% elevated serum creatinine, 13.1% high urea, and 13.1% estimated glomerular filtration rate reduction (eGFR) <60 mL/ min/1.73 m. In addition, 5.1% of these patients developed acute kidney injury, and it was found that the development of AKI during hospitalization was associated with in-hospital mortality (Cheng et al., 2020). However, in this study, there was no information about the basal creatinine levels of the patients before admission to the hospital. In our study, the baseline creatinine levels of the patients before admission to the hospital were also recorded retrospectively. The presence of chronic kidney disease significantly increased mortality, as in acute kidney disease, and the presence of chronic kidney disease was an independent risk factor for mortality in the risk factor analysis. To the best of our knowledge, this is the first study to show the association between the presence of pre-dialysis chronic kidney disease and poor outcome in COVID-19 patients. Therefore, evaluation of renal function during hospitalization of patients with chronic kidney disease and renal dysfunction that may change intermittently after hospitalization should be kept in mind. Adequate fluid support, stabilization of vital signs, oxygenation and avoidance of nephrotoxic drugs are of great importance. In this way, early detection and treatment of kidney abnormalities can help improve the prognosis of COVID-19.

Three waves of the SARS-COV-2 pandemic have hit the world hard so far, and more waves are likely to come. As new variants continue to emerge with new mutations, infectivity, contagiousness, virulence and antigenicity will continue to change and occupy the whole world. Although many reports about COVID-19 continue to come in recently, the nature of the virus and its ability to transform remain a mystery (El-Shabasy et al., 2022). A second wave of SARS-CoV-2 infections spread in the UK in 2020, in conjunction with the emergence of the more contagious B.1.1.7 variant (Snell et al., 2021). It is known that B.1.1.7 variant mutant virus remains in the respiratory tract for a longer time (Snell et al., 2021). In addition, hypoxemia was higher in those infected with the B.1.1.7 variant, which is known to be more contagious, supporting the evidence that the B.1.1.7 variant is associated with more severe disease (Snell et al., 2021). In a meta-analysis, it was stated that variant B.1.1.7 had a higher contagiousness, more severe disease and higher mortality rate compared to other variants (Liu et al, 2020), however, in our study, variant B.1.1.7 positivity had no effect on mortality.

Although there are studies on the development of AKI due to SARS-CoV-2 (Cheng et al., 2020; Naicker et al., 2020), there are not many studies comparing variant positive and negative patients (Öztürk and Yavuz, 2022). In this study, the rate of development of AKI was lower in patients with variant B.1.1.7 positive and variant negative patients hospitalized in the intensive care unit, as in the current study (Öztürk and Yavuz, 2022). In our study, 7 of 22 patients who developed AKI were variant positive (31.8%), while 15 of 22 patients who developed AKI were variant negative (68.2%). Again, in our study, risk factor analysis showed that variant B.1.1.7 positivity was protective for the development of AKI compared to variant B.1.1.7 negativity. Although this situation suggests that it may develop due to a passed mutation, more comprehensive studies with a higher number of cases are needed.

Smoking, advanced age, diabetes, hypertension and obesity for SARS-COV-2 infection are risk factors for mortality in SARS-CoV-2 infection (Garg et al., 2020; Peña et al., 2021). In our study, there was no difference in age between variant B.1.1.7 positive and negative patients, but patients with AKI were older, and advanced age was an independent risk factor for the development of AKI. The mean age of the patients who died was statistically significantly higher than the patients who were discharged (70.6±13.8, 56±15.6, respectively). In addition, the comorbidity rate was higher in patients with AKI than in patients without AKI (90.9%, 62.9%, respectively), which may be due to the higher mean age of patients with AKI.

In one study, it is stated that men with COVID-19 face worse outcomes and death regardless of age (Jin et al., 2020). In our study, there was a significantly higher rate of males in variant B.1.1.7 negative patients compared to variant B.1.1.7 positive patients. The male gender ratio was higher in patients with AKI than in patients without AKI, but this difference between them was not statistically significant. Considering the patients who died and those who did not die, while the male gender was higher in the patients who died, this difference was not statistically significant. In addition, there was no correlation with the presence of male gender in the risk factor analysis of AKI development and mortality. There is a need for more comprehensive studies with a high number of cases in this regard.

COVID-19 has a more severe clinical course in patients with comorbidities such as diabetes, COPD, cardiovasculary diseases, hypertension and malignancy. Comorbidities are associated with significant morbidity and mortality (Ejaz et al., 2020). In our study, there was no difference in the frequency of comorbidity between

variant B.1.1.7 positive and negative patients. As expected, the comorbidity rate was significantly higher in 22 patients who developed AKI compared to patients who did not develop AKI, which may be associated with the older age of patients who developed AKI. Patients with chronic renal failure have a pro-inflammatory state with innate and adaptive immune defects (Betjes, 2013), and are known to have a higher risk for pneumonia (Sibbel et al., 2016). In our study, when the effect of the presence of pre-dialysis chronic kidney disease on the development of AKI was examined, the presence of CKD was interestingly not a risk factor for the development of AKI. There was no difference between the length of hospital stay of patients with and without pre-dialysis chronic kidney disease. It is thought that acute kidney injury in COVID-19 infection occurs independently of CKD due to many causes such as sepsis, cytokine storm, direct kidney involvement, glomerulonephritis, drug toxicity, rhabdomyolysis, diarrhea-decreased hydration.

It has been previously reported that kidney damage is associated with an increased risk of death in patients with influenza A virus subtype H1N1, SARS and COVID-19 (Chu et al., 2005; Jung et al., 2009; Cheng et al., 2020). Considering all COVID-19 patients in our study; In addition to the development of AKI, the presence of pre-dialysis chronic kidney disease increased mortality. In addition, these two factors were independent risk factors for mortality. For this reason, it seems very important to pay special attention to the history and retrospective data screening of the patients, from the moment they are admitted to the clinic. We think that early detection and treatment of kidney abnormalities from the first hospitalization of patients, including promptly taking preventive measures to reduce the risk of developing AKI, adequate hemodynamic support and avoidance of nephrotoxic drugs, may help improve the vital prognosis of COVID-19.

This study has some limitations: patients' clinical data were missing after discharge, so we were unable to evaluate the effects of COVID-19 on long-term outcomes. More extensive research is needed to determine the precise impact of previous COVID-19 on kidney structure and function and to determine the incidence of persistent chronic kidney disease in these patients.

5. Conclusion

In conclusion, acute kidney disease was high in COVID-19 patients at the time of hospital admission. Our study showed that the development of AKI is less in patients with B.1.1.7 mutation for the second time in the literature compared to patients without. Advanced age, pre-dialysis chronic kidney disease, and acute kidney injury at the time of hospitalization were associated with an increased risk of in-hospital death. We believe that raising awareness about existing kidney disease and early detection of acute kidney injury in patients hospitalized with the diagnosis of COVID-19 can help reduce deaths due to COVID-19 disease.

Author Contributions

The percentage of the author contributions is presented below. The author reviewed and approved the final version of the manuscript.

	DY	NK	DSKO	MB	MDD
C	35	10	10	35	10
D	100				
S	100				
DCP	25	25	25	25	
DAI	20	20	20	20	20
L	20	20	20	20	20
W	20	20	20	20	20
CR	25	25	25		25
SR	10	35	35	10	10
PM	20	20	20	20	20
FA	20	20	20	20	20

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Approval/Informed Consent

This study was approved by Samsun University ethics committee (approval date: May 05, 2020 and protocol code: SUKAEK/2022/5/9).

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