ORIGINAL ARTICLE

# Impact of frailty on acute kidney injury in patients followed-up in the intensive care unit

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## ABSTRACT

**BACKGROUND:** Frailty in elderly patients is an important determinant of clinical outcomes in intensive care units, particularly in relation to acute kidney injury (AKI). This study investigated the association between frailty and AKI in the geriatric population.

**METHODS:** This prospective observational study included 120 patients. Frailty was assessed via the Clinical Frailty Scale (CFS) and the Edmonton Frail Scale (EFS). Patients were categorized according to the presence or absence of AKI. Demographic data, frailty scores, laboratory parameters, and clinical outcomes, including mortality, mechanical ventilation, and vasopressor use, were compared. Univariate and multivariate logistic regression analyses were used to identify factors associated with the development of AKI.

**RESULTS:** The mean age of the participants was 79.7±7.5 years. Comorbidities such as diabetes and hypertension were common, and AKI was observed in 29.1% of patients. The incidence of AKI was significantly higher among patients classified as frail according to the CFS (p=0.002). Patients with AKI presented increased mortality rates and an increased need for mechanical ventilation and vasopressors. The AKI group presented significantly lower hemoglobin, platelet, and albumin levels and higher baseline creatinine levels. Multivariate analysis revealed that elevated baseline creatinine was an important predictor of AKI.

**CONCLUSION:** Frailty assessed by the CFS was associated with AKI development in unadjusted analyses; however, this association was not maintained after multivariable adjustment. No significant association was observed between AKI and frailty assessed by the EFS. Baseline serum creatinine was the only independent predictor of AKI. These findings suggest that frailty assessment, particularly using the CFS, may serve as a complementary clinical tool for early risk recognition and patient stratification rather than an independent predictor of AKI. AKI development in critically ill older adults appears to be multifactorial.

**Keywords:** Acute kidney injury; frailty; geriatrics; intensive care unit; risk stratification.

## INTRODUCTION

The risk of acute kidney injury (AKI) is substantially higher in older adults. This increased vulnerability is largely driven by progressive age-associated alterations in renal architecture and physiological performance. Aging leads to impaired renal perfusion, reduced filtration efficiency, loss of nephron mass, and diminished adaptive capacity, all of which weaken the kidney's response to acute systemic stress. In addition, the high prevalence of chronic conditions – such as cardiovascular disease, diabetes mellitus (DM), and hypertension (HT) – along with common exposure to polypharmacy further contributes to the development of AKI in this population.[1,2]

AKI represents one of the most frequent complications in critically ill patients and is linked to extended durations of intensive care treatment as well as higher mortality rates.[3-6] In clinical practice, the diagnosis and staging of AKI are generally established using the 2012 Kidney Disease: Improving Global

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Outcomes (KDIGO) framework, which defines the condition based on variations in serum creatinine (sCr) concentration and/or alterations in urine volume.[7]

Frailty is recognized as a central geriatric syndrome characterized by reduced physiological resilience and heightened susceptibility to external stress. In critically ill patients, frailty has repeatedly been linked to unfavorable clinical trajectories and poorer health-related outcomes.[8,9] It encompasses a complex, multidimensional construct that integrates physical performance, cognitive function, psychological status, and social factors.[10-12] Various validated assessment instruments – such as the Clinical Frailty Scale (CFS) and the Edmonton Frail Scale (EFS) – are widely applied to measure frailty severity and to estimate the risk of adverse outcomes.[9,13,14]

Considering the frequent overlap between frailty and AKI in older patients admitted to the intensive care unit (ICU), as well as their potentially intersecting pathophysiological mechanisms, we sought to explore whether frailty status was associated with the occurrence of AKI in a geriatric critical care cohort.

## MATERIALS AND METHODS

A prospective, observational investigation was conducted in an adult mixed ICU and enrolled 120 consecutive patients aged 65 years and older over a 3-month period (July–September 2023). Demographic characteristics, clinical parameters, and laboratory findings were retrieved from the hospital's electronic database and structured ICU monitoring records. During the study period, 254 patients were admitted to the ICU. Patients younger than 65 years (n=116) and those with missing or incomplete datasets (n=18) were excluded from the analysis. In addition, individuals with pre-existing chronic kidney impairment or those undergoing renal replacement therapy before ICU admission were not eligible for inclusion. Approval from the institutional ethics committee was secured before patient enrollment. The study protocol was approved by the İzzet Baysal University Clinical Research Ethics Committee (approval date: June 06, 2023; decision no: 2023/189), and the study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained either from the participants themselves or, when necessary, from their legally authorized representatives. Information regarding frailty status was collected directly from patients whenever possible; otherwise, proxy data were obtained from relatives or caregivers. For analytical purposes, participants were stratified based on the occurrence of AKI during their ICU stay (AKI group vs. non-AKI group). sCr at ICU admission was accepted as the baseline value. Creatinine levels were measured using the kinetic Jaffe method. All laboratory parameters were analyzed by certified laboratory personnel and recorded daily.

### Definitions

The diagnosis and severity grading of AKI were established using the 2012 KDIGO classification system, which determines AKI on the basis of variations in sCr concentration and/or urine volume compared with baseline values. For this study, baseline creatinine was accepted as the measurement obtained at the time of ICU admission.

Recorded clinical variables comprised patient demographics, including age and sex, as well as documented comorbid conditions such as DM, HT, coronary artery disease, chronic obstructive pulmonary disease (COPD), malignancy, and neurological disorders. Frailty assessments (CFS and EFS), presence and stage of AKI, time to AKI onset, and ICU-related interventions – specifically mechanical ventilation and vasoactive agent administration – were also documented.

Biochemical parameters analyzed included hemoglobin levels, total leukocyte and lymphocyte counts, platelet levels, serum albumin, total bilirubin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine, sodium, potassium, magnesium, and C-reactive protein (CRP). Frailty status was evaluated using two established assessment tools: the CFS and the EFS. The CFS consists of a nine-level clinician-judged instrument that reflects overall functional capacity and dependence in daily activities, with higher scores corresponding to increased frailty severity. Consistent with previous reports, individuals scoring 1–4 were categorized as non-frail, whereas those with scores ≥5 were considered frail.[15] The EFS is an 18-point multidimensional instrument designed to assess domains such as cognitive status, overall health perception, functional autonomy, social resources, medication burden, nutritional status, mood, continence, and physical performance. Increasing scores indicate more pronounced frailty. Classification of EFS results followed conventional threshold values (non-frail 0–5, vulnerable 6–7, mild frailty 8–9, moderate frailty 10–11, severe frailty 12–18).[16]

### Statistical analysis

Statistical analyses were carried out using Jamovi (version 2.3.28) and JASP (version 0.17.3). Continuous data were described according to their distributional properties: variables approximating a normal distribution were expressed as mean±standard deviation (SD), whereas non-normally distributed variables were summarized as median with minimum and maximum values. Categorical data were reported as frequencies and percentages. The assumption of normality was evaluated using the Shapiro–Wilk, Kolmogorov–Smirnov, and Anderson–Darling tests. For comparisons between groups, continuous variables were analyzed using the independent samples t-test when normality criteria were met; otherwise, the Mann–Whitney U test was applied. Associations between categorical variables were examined using the Pearson chi-square test when cell counts were sufficient. In cases of small expected frequencies, Fisher's exact test or the Fisher–Freeman–Halton test was employed as appropriate. Potential determinants of AKI were initially examined through univariable logistic regression analyses focusing on clinically meaningful parameters. Variables considered clinically important and/

or demonstrating statistical association were subsequently entered into a multivariable logistic regression model. Given the limited number of AKI events, variable selection was performed with consideration of clinical relevance and to minimize the risk of model overfitting. Although Sequential Organ Failure Assessment (SOFA) score was associated with AKI in univariate analysis, it was not included in the final model because of the limited number of outcome events and the potential overlap between disease severity indicators and other clinical variables. Results were presented as odds ratios with corresponding 95% confidence intervals. An alpha level of 0.05 (two-sided) was prespecified as the threshold for statistical significance.

## RESULTS

This study included 120 patients admitted to the ICU. The cohort's mean age was 79.7 years (SD 7.5) and the sample consisted of 67 female (55.8%) and 53 male (44.2%) patients. Comorbidities were distributed as follows: DM (n=36 [30%]); HT (n=46 [38.3%]); coronary artery disease (n=29 [24.2%]); and COPD (n=29 [24.2%]). During follow-up in the ICU, 68 (56.7%) patients survived, and 52 (43.3%) patients died. Fifty-six (46.7%) patients required mechanical ventilation, and 53 (44.2%) patients required vasopressor medications. Malignancy was detected in 18 (15%) patients, and neurological disorders were detected in 47 (39.2%) patients. The median CFS and EFS scores were 5 and 7, respectively. Mortality, need for mechanical ventilation, and vasopressor support occurred significantly more often in the AKI group relative to the non-AKI group (p<0.001 for all comparisons). When stratified by CFS category, AKI occurred more frequently among individuals identified as frail (CFS≥5), demonstrating a statistically significant association (p=0.002). In contrast, no meaningful between-group differences were observed with respect to age, sex, DM, HT, COPD, malignancy status, neurological comorbidity, or EFS score (all p>0.05) (Table 1).

The median hemoglobin, leukocyte, lymphocyte, and platelet counts were 10.3 g/dL, 11.1×10⁹/L, 0.9×10⁹/L, and

**Table 1.** Demographic and clinical characteristics of intensive care unit patients and pairwise comparisons in terms of the development of acute kidney injury

| | Overall (n=120) | Acute kidney injury | | p |
|---|---|---|---|---|
| | | Absent (n=85) | Present (n=35) | |
| Age† | 79.7±7.5 | 79.7±7.4 | 79.7±7.9 | 0.987*** |
| Gender‡ | | | | |
| Female | 67 (55.8) | 43 (50.6) | 24 (68.6) | 0.109* |
| Male | 53 (44.2) | 42 (49.4) | 11 (31.4) | |
| Comorbidity‡ | | | | |
| Diabetes Mellitus, Present | 36 (30.0) | 21 (24.7) | 15 (42.9) | 0.080* |
| Hypertension, Present | 46 (38.3) | 29 (34.1) | 17 (48.6) | 0.203* |
| Coronary Heart Disease, Present | 29 (24.2) | 21 (24.7) | 8 (22.9) | 0.999* |
| Chronic Obstructive Pulmonary Disease, Present | 29 (24.2) | 20 (23.5) | 9 (25.7) | 0.984* |
| Final Status‡ | | | | |
| Alive | 68 (56.7) | 58 (68.2) | 10 (28.6) | **<0.001*** |
| Deceased | 52 (43.3) | 27 (31.8) | 25 (71.4) | |
| Mechanical ventilation use, Yes‡ | 56 (46.7) | 30 (35.3) | 26 (74.3) | **<0.001*** |
| Vasoactive drug use, Yes‡ | 53 (44.2) | 27 (31.8) | 26 (74.3) | **<0.001*** |
| Presence of malignancy‡ | 18 (15.0) | 12 (14.1) | 6 (17.1) | 0.888* |
| Neurological disorder‡ | 47 (39.2) | 35 (41.2) | 12 (34.3) | 0.619* |
| SOFAs (range) | 5 (4-8) | 4 (3-6) | 6 (5-9) | 0,02 |
| Clinical frailty scale index§ | 5.0 [2.0–9.0] | 5.0 [2.0–8.0] | 6.0 [3.0–9.0] | **0.017**** |
| Edmonton frailty scale index§ | 7.0 [4.0–17.0] | 7.0 [4.0–17.0] | 7.0 [5.0–17.0] | 0.198** |

Table 1 presents the demographic and clinical characteristics of intensive care unit (ICU) patients, with a focus on the development of acute kidney injury (AKI). The table includes an overall group of 120 patients and is divided into two subgroups: those without AKI (n=85) and those with AKI (n=35). '‡' denotes categorical data expressed as "n (%)", "†" denotes the mean±standard deviation, and "§" denotes median values with a range [Minimum-Maximum]. The statistical significance is indicated by "p" values, where "*" denotes results from the Pearson Chi-square test, "**" indicates findings from the Mann–Whitney U test, and "***" represents results from the independent samples t-test. This table highlights the differences in demographic and clinical characteristics between ICU patients with and without acute kidney injury.

**Table 2.** Descriptive statistics of laboratory parameters in intensive care unit patients and pairwise comparisons in terms of the development of acute kidney injury

| | Overall (n=120) | Acute kidney injury | | p |
|---|---|---|---|---|
| | | Absent (n=85) | Present (n=35) | |
| Hemoglobin§ | 10.3 [6.4–16.0] | 10.7 [6.4–16.0] | 9.4 [7.6–14.2] | **0.004*** |
| Leukocytes§ | 11.1 [3.0–32.0] | 11.0 [3.0–32.0] | 12.0 [6.0–30.0] | 0.285* |
| Lymphocytes§ | 0.9 [0.1–3.3] | 1.0 [0.1–3.1] | 0.8 [0.1–3.3] | 0.786* |
| Platelets§ | 209.5 [65.0–527.0] | 222.0 [65.0–519.0] | 184.0 [75.0–527.0] | 0.008* |
| Albumin§ | 24.5 [15.0–39.0] | 25.3 [15.0–39.0] | 22.1 [17.0–34.0] | 0.004* |
| Total Bilirubin§ | 1.0 [0.3–5.0] | 1.0 [0.3–5.0] | 1.0 [0.5–2.2] | 0.489* |
| ALT§ | 24.0 [3.0–238.0] | 24.0 [3.0–238.0] | 23.0 [5.0–170.0] | 0.926* |
| AST§ | 25.5 [5.0–167.0] | 23.0 [11.0–167.0] | 33.0 [5.0–165.0] | 0.057* |
| Baseline creatinine§ | 1.0 [0.3–2.9] | 0.9 [0.3–2.9] | 1.4 [0.5–2.4] | <0.001* |
| Sodium§ | 139.0 [126.0–166.0] | 139.0 [126.0–166.0] | 138.0 [126.0–150.0] | 0.961* |
| Potassium† | 3.9 ± 0.6 | 3.9 ± 0.5 | 3.8 ± 0.7 | 0.322** |
| Magnesium§ | 2.0 [1.2–4.0] | 2.0 [1.2–4.0] | 2.0 [1.3–2.4] | 0.228* |
| C-reactive protein§ | 81.5 [2.4–169.0] | 70.0 [2.4–169.0] | 97.0 [5.0–152.0] | 0.111* |

Table 2 presents descriptive statistics of laboratory parameters in ICU patients and their correlation with the development of acute kidney injury (AKI). The study involved 120 patients, with AKI present in 35 patients and absent in 85 patients. The key laboratory parameters included hemoglobin, leukocytes, lymphocytes, platelets, albumin, total bilirubin, ALT, AST, creatinine, sodium, potassium, magnesium, and C-reactive protein (CRP). "†" indicates the mean±standard deviation, and "§" denotes median values with a range [Minimum - Maximum]. The table uses the Mann–Whitney U test (denoted by "*") and independent samples t test ("**") to evaluate differences between the groups, ALT: Alanine aminotransferase; AST: Aspartate aminotransferase.

**Table 3.** Acute kidney injury characteristics in a clinical setting: Staging, renal replacement therapy, and onset timing

| | Patients with only acute kidney injury (n=35) |
|---|---|
| KDIGO criteria for acute kidney injury‡ | |
| Stage 1 | 10 (28.6) |
| Stage 2 | 9 (25.7) |
| Stage 3 | 16 (45.7) |
| Renal Replacement Therapy, Yes‡ | 18 (51.4) |
| Day of Hospitalization When Injury Occurred§ 4.0 [2.0–15.0] | |

Table 3 focuses on the characteristics of in relation to acute kidney injury (AKI) in a clinical setting among 35 patients. It examines the KDIGO criteria stages of AKI, the use of renal replacement therapy, and the day of hospitalization when the injury occurred. "‡" signifies categorical data as "n (%)", and "§" signifies median values with a range [Minimum - Maximum].

209.5×10$^9$/L, respectively. The median albumin and total bilirubin levels were 24.5 g/L and 1.0 mg/dL, respectively. The median ALT and AST levels were 24.0 U/L and 25.5 U/L, respectively. The median baseline creatinine, sodium, magnesium, and CRP levels were 1.0 mg/dL, 139.0 mmol/L, 2.0 mg/dL, and 81.5 mg/L, respectively. The mean potassium level was 3.9±0.6 mmol/L. Hemoglobin, platelet, and albumin levels were significantly lower in patients who developed AKI than in those who did not ($p<0.05$). In addition, baseline creatinine was significantly higher in the AKI group ($p<0.001$). No significant between-group differences were observed for leukocyte or lymphocyte counts, total bilirubin, ALT, AST, sodium, potassium, magnesium, or CRP (all $p>0.05$) (Table 2).

Among patients diagnosed with AKI, 10 (28.6%) were classified as stage 1, 9 (25.7%) as stage 2, and 16 (45.7%) as stage 3, according to the KDIGO criteria. Renal replacement therapy was administered to 18 (51.4%) patients with AKI. AKI developed at a median of 4 days after hospitalization (Table 3).

According to univariate analyses, AKI occurrence was signifi-

**Table 4.** Factors affecting the risk of developing acute kidney injury in intensive care unit patients

| Logistic regression predicting "acute kidney injury" | Univariate logistic regression | | Multiple logistic regression | |
|---|---|---|---|---|
| | OR. [95%CI] | p | OR. [95%CI] | p |
| Gender: Male versus Female | 0.47 [0.21–1.08] | 0.074 | - | - |
| Diabetes Mellitus: Present versus Absent | 2.29 [0.99–5.25] | 0.051 | 1.89 [0.67–5.38] | 0.227 |
| Hypertension: Present versus Absent | 1.82 [0.82–4.06] | 0.141 | - | - |
| Mechanical Ventilation Use: Yes versus No | 5.3 [2.19–12.76] | <0.001 | 2.25 [0.75–6.73] | 0.148 |
| Vasoactive Drug Use: Yes versus No | 6.21 [2.56–15.04] | **<0.001** | 1.90 [0.59–6.11] | 0.280 |
| Hemoglobin | 0.77 [0.63–0.94] | **0.012** | 0.88 [0.68–1.15] | 0.360 |
| Platelets | 0.99 [0.99–1.01] | 0.086 | - | - |
| Albumin | 0.88 [0.79–0.96] | **0.006** | 0.91 [0.80–1.04] | 0.155 |
| Aspartate Aminotransferase (AST) | 1.01 [0.99–1.02] | 0.327 | - | - |
| Baseline creatinine | 5.06 [2.10–12.17] | **<0.001** | 4.57 [1.67–12.47] | **0.003** |
| C-Reactive Protein (CRP) | 1.01 [0.99–1.02] | 0.137 | - | - |
| CFS Index (Clinical Frailty Scale Index) | 1.47 [1.09–1.99] | **0.012** | 1.26 [0.84–1.91] | 0.269 |

Table 4 shows the factors affecting the risk of developing acute kidney injury (AKI) in ICU patients through logistic regression analysis. It includes variables such as sex, the presence of diabetes mellitus, hypertension, the use of mechanical ventilation, the use of vasoactive drugs, hemoglobin, platelets, albumin, AST, creatinine, CRP, and the Clinical Frailty Scale Index (CFS Index). The table presents odds ratios (ORs) with 95% confi-dence intervals (CIs) and p-values, and univariate and multiple logistic regression results were compared to iden-tify significant predictors of AKI in this population.

**Table 5.** Comparative analysis of clinical characteristics and scoring indices in patients with and without acute kidney injury

| Variables | Acute kidney injury | | p |
|---|---|---|---|
| | Absent (n=85) | Present (n=35) | |
| CFS index (Categorical) (%) | | | |
| <5 | 36 (42.4) | 4 (11.4) | **0.002** |
| ≥5 | 49 (57.6) | 31 (88.6) | |
| EFS index (Categorical) (%) | | | |
| ≤7 | 47 (55.3) | 18 (51.4) | 0.853 |
| >7 | 38 (44.7) | 17 (48.6) | |

Pearson's Chi-square test was used. CFS: Clinical Frailty Scale; EFS: Edmonton Frail Scale.

cantly more frequent among patients who required mechanical ventilation and vasopressor support during ICU follow-up (p<0.001 for each). Accordingly, the use of mechanical ventilation increased the risk of AKI by 5.3 times, whereas the use of vasopressors increased the risk by 6.21 times. Each unit decrease in hemoglobin level increased the risk of AKI by 23%, whereas each unit decrease in albumin level increased the risk by 12%. A one-unit increase in creatinine was associated with a 5.06-fold higher odds of AKI, whereas each additional point in the CFS score corresponded to a 1.47-fold increase in risk. Sex, DM, HT, platelet count, and AST and CRP levels did not significantly affect the univariate analysis.

After multivariable analysis, baseline creatinine was the only variable independently associated with AKI (p=0.003). Accordingly, a one-unit increase in creatinine corresponded to a 4.57-fold increase in AKI risk. DM, HT, mechanical ventilation use, vasopressor use, and hemoglobin and albumin levels showed no independent association with AKI in the adjusted model (Table 4).

When the CFS and EFS frailty indices were compared, AKI occurred more frequently among patients classified as frail according to the CFS (≥5), whereas AKI incidence did not differ significantly across categories defined by the EFS (Table 5).

## DISCUSSION

In critically ill patients, whose fragility increases and toler-

ance decreases with age, the risk of AKI increases owing to factors such as pathophysiological processes, inflammation, comorbidities, and medications, which in turn leads to increased mortality. In our analysis assessing the association between frailty status and AKI development, we found that frailty (according to the CFS scale) was associated with AKI. In addition, mortality (71%) was markedly elevated among patients who developed AKI compared with those who did not. Frailty is recognized as an important determinant of outcomes in the intensive care setting, particularly with respect to renal complications such as AKI. Küçük et al.,[9] in a study examining geriatric ICU patients aged ≥65 years with COVID-19, reported that frailty was an important risk factor for AKI (63.6%) and that the development of AKI in this geriatric population was associated with high mortality (97.6%).

A meta-analysis investigating the association between frailty and AKI in the elderly population revealed an association between frailty and AKI.[16] Xu et al.,[17] in their analysis of elderly hypertensive COVID-19 patients, reported that frailty was not found to be an independent risk factor for AKI. In our study, frailty was found to be significantly associated with AKI according to the CFS, but it was not identified as an independent risk factor. As noted in this study, our results are consistent with the finding that the CFS may guide clinical decision-making in elderly patients. Rose et al.[18] reported in their EFS study that frailty increases hospital stay and mortality. In a study conducted by Yucel et al.,[19] that used CFS and EFS, mortality, ICU stay duration, and emergency department stay duration were found to be significantly greater in the frail group on both scales.No significant association was observed between frailty assessed by the EFS and AKI in this cohort. The better performance of the CFS compared with the EFS may be explained by the practical characteristics of these instruments in critically ill patients. The CFS primarily evaluates global functional status and pre-admission independence, allowing relatively straightforward assessment even when direct communication with the patient is limited. In contrast, the EFS includes multiple domains, such as cognition, mood, social support, medication use, nutrition, and functional performance, many of which are difficult to assess accurately in critically ill or mechanically ventilated patients and often rely on proxy information obtained from family members. These practical differences may partly explain why the CFS demonstrated a stronger association with AKI than the EFS in our ICU population.

Bagshaw et al.,[13] in their investigation of critically ill patients over the age of 50, reported an independent association between frailty and intensive care mortality (32%). Beaubien-Souligny et al.,[20] examining frailty in elderly critically ill patients with severe AKI, identified preexisting frailty as an independent predictor of mortality in this population. In our cohort, mortality was significantly higher among patients who developed AKI (71%). Frail patients taking multiple medications due to infection, malnutrition, and comorbidities are highly susceptible to AKI. Considering the impact of AKI on mortality, we believe that the pre-identification of vulnerable patients prone to AKI would be beneficial in terms of early diagnosis and treatment guidance and reducing mortality Chen et al.[21] reported that elevated baseline sCr was associated with mortality among individuals aged ≥65 years with COVID-19. Li et al.[22] demonstrated that patients who developed AKI had higher baseline sCr at hospital admission. In our study, baseline sCr levels were higher in the AKI group than in the non-AKI group. Accurately identifying AKI in elderly and frail patients may present some challenges. In this patient group with reduced muscle mass, sCr levels may remain normal for some time. Therefore, AKI may be detected later. Owing to the delayed increase in sCr levels after a decrease in the GFR, AKI may progress and lead to irreversible damage. Considering that high baseline sCr levels at hospital admission are associated with the development of AKI and, consequently, an increased need for ICU admission and mechanical ventilation, we believe that baseline sCr levels are important for increasing AKI awareness in frail elderly patients. An additional methodological consideration is that baseline sCr served both as a predictor variable and as the reference value for KDIGO-based AKI diagnosis. Therefore, some degree of methodological dependency cannot be excluded. Nevertheless, baseline sCr reflects pre-existing renal reserve and remains a clinically relevant marker of AKI risk in older adults. Accordingly, our findings should be interpreted as demonstrating an association rather than a causal relationship. Xiong et al.[23] examined the association of the geriatric nutritional risk index (GNRI) with mortality among patients with AKI in the intensive care setting and reported that higher GNRI values, indicating better nutritional status, were associated with lower mortality. Another study revealed that AKI after CABG was strongly associated with malnutrition and frailty.[24] Comparable findings were described by Liao et al.[25] in their investigation of the prognostic value of the GNRI among elderly ICU patients with AKI. Hypoalbuminemia was associated with AKI occurrence in the present cohort. Hypoalbuminemia is frequently observed among frail individuals who often require hospitalization due to malnutrition and infection. Hypoalbuminemia reduces the effective arterial blood volume and increases the risk of AKI by causing long-term renal dysfunction due to hypoperfusion. These findings support the conclusion that a comprehensive frailty assessment, including assessment of the serum ALB concentration, a component of the GNRI, is important in predicting AKI outcomes. In a study by Zhang and colleagues, high vasoactive inotropic scores were positively correlated with the risk of AKI development.[26] Similarly, in our study, the need for vasopressors was greater in patients with AKI. In hypotensive patients requiring high inotropic support, renal perfusion may be inadequate, leading to AKI development. In routine ICU practice, several prognostic scoring tools are employed, including the SOFA score, APACHE, Logistic Organ Dysfunction System, Multiple Organ Dysfunction Score,

and SAPS-II.[27] However, no specific standard tests are used to predict outcomes in elderly and frail patients. Considering that frailty increases the risk of AKI, hospitalization, mechanical ventilation requirements, and mortality, it would be valuable to use different scoring systems in addition to the current assessments in this patient population. Our study contributes to the literature by highlighting the specific role of frailty indices in predicting AKI in intensive care patients. This addresses questions concerning the association between frailty and AKI, particularly within an aging population. In addition, it raises new questions about how frailty assessment can be integrated into routine clinical practice to improve the treatment and prognosis of critically ill patients, particularly elderly patients. Future research should investigate the implementation of frailty assessments in clinical workflows and explore how these assessments can be used to tailor treatment strategies for individual patients. Furthermore, longitudinal studies may provide insights into the long-term outcomes of frail patients who develop AKI in the ICU. Although frailty did not emerge as an independent determinant of AKI after multivariable adjustment, this finding reflects the complex and multifactorial nature of acute organ dysfunction in critically ill elderly patients. Frailty represents an aggregate vulnerability overlapping with comorbid conditions, hemodynamic instability, and inflammatory burden rather than a single isolated risk factor. Therefore, frailty assessment – particularly when performed using the CFS – should be regarded as a complementary bedside instrument to support early risk recognition and clinical stratification in acute and intensive care settings.

The present investigation has several limitations. First, it was conducted at a single center with a prospective design; therefore, the findings may not be broadly generalizable. Second, frailty-related information was obtained from relatives in cases where patients themselves could not be reached.

## CONCLUSION

Frailty assessed by the CFS was significantly associated with AKI occurrence in elderly ICU patients; however, this association did not remain significant after multivariable adjustment. No significant association was observed between AKI occurrence and frailty assessed by the EFS. Baseline sCr was identified as the only independent predictor of AKI. These findings suggest that frailty assessment, particularly using the CFS, should be considered a complementary bedside clinical tool that may support early risk awareness and patient stratification rather than an independent predictor of AKI. The development of AKI in critically ill elderly patients is likely multifactorial and reflects the combined effects of baseline renal status, disease severity, and other clinical factors.

**Ethics Committee Approval:** This study was approved by the İzzet Baysal University Clinical Research Ethics Committee (Date: 06.06.2023, Decision No: 2023/189).

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## REFERENCES

1. 1. Romain M, Beil M, Mormol J, Stav I, Liberman T, van Heerden PV, et al. Prognostication in very old intensive care patients with acute kidney injury. Isr Med Assoc J 2023;25:272–7.
2. 2. Chronopoulos A, Rosner MH, Cruz DN, Ronco C. Acute kidney injury in elderly intensive care patients: A review. Intensive Care Med 2010;36:1454–64. [CrossRef]
3. 3. Hoste EAJ, Kellum JA, Selby NM, Zarbock A, Palevsky PM, Bagshaw SM, et al. Global epidemiology and outcomes of acute kidney injury. Nat Rev Nephrol 2018;14:607–25. [CrossRef]
4. 4. Uchino S, Kellum JA, Bellomo R, Doig GS, Morimatsu H, Morgera S, et al.; Beginning and Ending Supportive Therapy for the Kidney (BEST Kidney) Investigators. Acute renal failure in critically ill patients: a multinational, multicenter study. JAMA 2005;294:813–18. [CrossRef]
5. 5. Srisawat N, Kulvichit W, Mahamitra N, Hurst C, Praditpornsilpa K, Lumlertgul N, et al. The epidemiology and characteristics of acute kidney injury in the Southeast Asia intensive care unit: A prospective multicentre study. Nephrology Dialysis Transplantation 2020;35:1729–38. [CrossRef]
6. 6. Ostermann M, Chang RW. Acute kidney injury in the intensive care unit according to RIFLE. Crit Care Med 2007;35:1837–43; quiz 1852. [CrossRef]
7. 7. Khwaja A. KDIGO clinical practice guidelines for acute kidney injury. Nephron Clin Pract 2012;120:c179–c84. [CrossRef]
8. 8. Chen X, Mao G, Leng SX. Frailty syndrome: an overview. Clin Interv Aging 2014;9:433–41. [CrossRef]
9. 9. Küçük M, Ergün B, Yakar MN, Çakıcı ÖU, Yaka E, Cömert B, et al. The effect of frailty on the development of acute kidney injury in critically-ill geriatric patients with COVID-19. Turk J Med Sci 2022;52:1495–503. [CrossRef]
10. 10. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001;56:M146–M56. [CrossRef]
11. 11. Rolland Y, Benetos A, Gentric A, Ankri J, Blanchard F, Bonnefoy M, et al. Frailty in older population: a brief position paper from the French society of geriatrics and gerontology. Geriatrie et Psychologie Neuropsychiatrie du Vieillissement 2011;9: 387–90. [CrossRef]
12. 12. Xue QL. The frailty syndrome: definition and natural history. Clin Geriatr Med 2011;27:1–15. [CrossRef]
13. 13. Bagshaw SM, Stelfox HT, McDermid RC, Rolfson DB, Tsuyuki RT, Baig N, et al. Association between frailty and short- and long-term outcomes among critically ill patients: a multicentre prospective cohort study. CMAJ 2014;186:E95–E102. [CrossRef]
14. 14. Kizilarslanoglu MC, Civelek R, Kilic MK, Sumer F, Varan HD, Kara O, et al. Is frailty a prognostic factor for critically ill elderly patients? Aging Clin Exp Res 2017;29:247–55. [CrossRef]
15. 15. Abdel-Kader K, Girard TD, Brummel NE, Saunders CT, Blume

JD, Clark AJ, et al. Acute kidney injury and subsequent frailty status in survivors of critical illness: a secondary analysis. Crit Care Med 2018;46:e380–e8. [CrossRef]

16. 16. Cemali M, Kanlıca A, Yılmaz S, Yılmaz İ, Elmas Ö, Karaduman AA. Examining the effect of polypharmacy on quality of life and frailty in older adults from the perspective of community-based rehabilitation. Healthcare (Basel) 2025;13:1531. [CrossRef]
17. 17. Xu Q, Li F, Chen X. Factors Affecting mortality in elderly hypertensive hospitalized patients with covid-19: a retrospective study. Clin Interv Aging 2023;18:1905–21. [CrossRef]
18. 18. Rose M, Pan H, Levinson MR, Staples M. Can frailty predict complicated care needs and length of stay? Intern Med J 2014;44:800–5. [CrossRef]
19. 19. Yucel M, Altunci YA, Ozcete E, Kılavuz A, Karbek Akarca F. Comparison of Clinical Frailty Scale and Edmonton Frail Scale in older adults presenting to emergency department. Turkish Journal of Geriatrics 2024;27:108–17. [CrossRef]
20. 20. Beaubien-Souligny W, Yang A, Lebovic G, Wald R, Bagshaw SM. Frailty status among older critically ill patients with severe acute kidney injury. Crit Care 2021;25:84. [CrossRef]
21. 21. Chen T, Dai Z, Mo P, Li X, Ma Z, Song S, et al. Clinical characteristics and outcomes of older patients with coronavirus disease 2019 (COVID-19) in Wuhan, China: A Single-Centered, Retrospective Study. J Gerontol A Biol Sci Med Sci 2020;75:1788–95. [CrossRef]
22. 22. Li Q, Zhang T, Li F, Mao Z, Kang H, Tao L, et al. Acute kidney injury can predict in-hospital mortality in elderly patients with COVID-19 in the ICU: A single-center study. Clin Interv Aging 2020;15:2095–107. [CrossRef]
23. 23. Xiong J, Yu Z, Huang Y, He T, Yang K, Zhao J. Geriatric nutritional risk index and risk of mortality in critically ill patients with acute kidney injury: a multicenter cohort study. J Ren Nutr 2023;33:639–48. [CrossRef]
24. 24. Aykut A, Salman N. Poor nutritional status and frailty associated with acute kidney injury after cardiac surgery: A retrospective observational study. J Card Surg 2022;37:4755–61. [CrossRef]
25. 25. Liao D, Deng Y, Li X, Huang J, Li J, Pu M, et al. The prognostic effects of the geriatric nutritional risk index on elderly acute kidney injury patients in intensive care units. Front Med (Lausanne) 2023;10:1165428. [CrossRef]
26. 26. Zhang D, Li L, Huang W, Hu C, Zhu W, Hu B, et al. Vasoactive-inotropic score as a promising predictor of acute kidney injury in adult patients requiring extracorporeal membrane oxygenation. ASAIO J 2024;70:586–93. [CrossRef]
27. 27. Tekin B, Kiliç J, Taşkin G, Solmaz İ, Tezel O, Başgöz BB. Comparison of scoring systems: SOFA, APACHE-II, LODS, MODS, and SAPS-II in critically ill elderly sepsis patients. The Journal of Infection in Developing Countries 2024;18:122–30. [CrossRef]

**ORİJİNAL ÇALIŞMA - *ÖZ***

## Yoğun bakım ünitesinde takip edilen hastalarda kırılganlığın akut böbrek hasarına etkisi

AMAÇ: Yaşlı hastalarda kırılganlık, özellikle akut böbrek yetmezliği (ABY) bağlamında, yoğun bakım ünitelerinde (YBÜ) klinik sonuçları etkileyen kritik bir faktördür. Bu çalışmada, geriatrik popülasyonda kırılganlık ile akut böbrek yetmezliği arasındaki ilişki araştırılmıştır.

GEREÇ VE YÖNTEM: Bu prospektif gözlemsel çalışmaya 120 hasta dahil edildi. Kırılganlık, Klinik Kırılganlık Ölçeği (CFS) ve Edmonton Kırılganlık Ölçeği (EFS) kullanılarak değerlendirildi. Hastalar, akut böbrek yetmezliği varlığına göre sınıflandırıldı. Demografik veriler, kırılganlık skorları, laboratuvar parametreleri, mekanik ventilasyon ve vazopresör kullanımı ile mortalite oranları karşılaştırıldı. Akut böbrek yetmezliği gelişimiyle ilişkili faktörleri belirlemek amacıyla tek değişkenli ve çok değişkenli lojistik regresyon analizleri kullanıldı.

BULGULAR: Katılımcıların ortalama yaşı 79.7±7.5 yıldı. Diyabet ve hipertansiyon gibi komorbiditeler yaygındı ve hastaların %29.1'inde akut böbrek yetmezliği gözlendi. Akut böbrek yetmezliği oranı, kırılgan grupta anlamlı derecede daha yüksekti (p=0.002). Akut böbrek yetmezliği olan hastalarda mortalite oranları ile mekanik ventilasyon ve vazopresör ihtiyacı artmıştı. Akut böbrek yetmezliği grubunda hemoglobin, trombosit ve albümin düzeyleri anlamlı derecede daha düşükken bazal kreatinin düzeyleri daha yüksekti. Çok değişkenli analiz, yüksek bazal kreatinin düzeyinin akut böbrek yetmezliği gelişiminin önemli bir belirleyicisi olduğunu ortaya koydu.

SONUÇ: Klinik Kırılganlık Ölçeği (CFS) ile değerlendirilen kırılganlık, yaşlı yoğun bakım hastalarında akut böbrek hasarı gelişimiyle anlamlı düzeyde ilişkili bulunmuştur; ancak bu ilişki, çok değişkenli analiz sonrasında anlamlılığını sürdürmemiştir. Akut böbrek hasarı için bağımsız belirleyici olarak yalnızca bazal serum kreatinin düzeyi saptanmıştır. Bu bulgular, kırılganlık değerlendirmesinin erken risk belirlemesine katkı sağlayabileceğini düşündürmekle birlikte, kritik hastalarda akut böbrek hasarının çok faktörlü bir süreç olduğunu göstermektedir.

Anahtar sözcükler: Akut böbrek hasarı; kırılganlık; risk sınıflaması; yaşlılık; yoğun bakım ünitesi.

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