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The hidden burden of frailty in dialysis patients in Saudi Arabia

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Abstract
Background: Frailty is a multidimensional syndrome that is increasingly being recognized as a critical determinant of outcomes in patients with end-stage kidney disease undergoing dialysis.
Objectives: This study aimed to assess the prevalence of frailty among dialysis patients in Saudi Arabia using the Arabic version of the FRAIL scale (FRAIL-AR) and examine its association with clinical outcomes, including hospitalization rates, length of stay, intensive care unit admissions, emergency department visits, and relevant biochemical parameters.
Methods: This cross-sectional study was conducted in the outpatient dialysis unit of Johns Hopkins Aramco Healthcare Hospital (JHAH), Dhahran, Saudi Arabia. Eighty-five adult patients undergoing hemodialysis or peritoneal dialysis were included in this study. Descriptive and inferential statistical analyses were employed to evaluate the relationships between frailty status, demographic factors, and clinical outcomes.
Results: Of the 85 patients, 60 (70.6%) were classified as frail or partially frail, whereas 25 (29.4%) were classified as non-frail. Compared to non-frail patients, frail patients were significantly older (mean age: 71 years, compared to 57 years, p= 0.0034), experienced more frequent hospitalizations (p= 0.034), had longer hospital stays (12.2 days, compared to 5 days, p= 0.0080), and had a higher prevalence of diabetes (p= 0.0788) and heart failure (p= 0.0726). Lower albumin levels were significantly associated with frailty (p= 0.004). Multivariate analysis identified age, female sex, and albumin level as the predictors of frailty.
Conclusion: Frailty imposes a significant burden on dialysis patients, leading to increased hospitalization and treatment costs. Early identification of frailty through validated tools, such as the FRAIL-AR scale, and targeted interventions could enhance patient outcomes.

Keywords: Frailty, Dialysis, FRAIL-AR Scale, Hospitalization

Introduction

Frailty is a multidimensional syndrome that is increasingly being recognized as a critical determinant of outcomes in patients with end-stage kidney disease (ESKD) [1, 2]. It is characterized by a decline in physiological reserves and increased vulnerability to stressors, leading to adverse health outcomes, such as increased hospitalization rates, mortality, and reduced quality of life [3, 4]. Across all stages of kidney disease, frailty is consistently associated with various demographic, clinical, and biochemical factors including advanced age, female sex, diabetes, cardiovascular disease, and anemia. Biomarker studies have identified correlations between frailty and markers such as low vitamin D, low albumin, elevated C-reactive protein, and interleukin-6 [5, 6].

The prevalence of frailty in patients with end-stage kidney disease ranges from 30% to 80%, depending on the measurement tools employed [7, 8, 9]. In Saudi Arabia, demographic shifts characterized by an aging population and the increasing burden of non-communicable diseases, such as diabetes and hypertension, have heightened the clinical relevance of frailty [10, 11]. However, despite its significance, frailty remains underexplored in Saudi patients with ESKD, partly because of the lack of culturally adapted measurement tools. Recent validation of the Arabic version of the FRAIL scale (FRAIL-AR) has addressed this gap by providing a culturally appropriate tool for assessing frailty among older Saudi adults. This tool facilitates a more accurate identification of frailty and lays the foundation for research aimed at improving outcomes in this vulnerable population [12]. Compared to other frailty

assessment tools, such as the Fried Frailty Index (FFI), Clinical Frailty Scale (CFS), and Short Physical Performance Battery (SPPB) [13], the FRAIL-AR scale is simpler and quicker to administer, making it suitable for routine clinical use. Despite the utility of the FRAIL-AR scale, it has several limitations. Reliance on self-reported data can introduce bias, particularly in populations with cognitive impairment. Studies have consistently demonstrated that self-reported measures overestimate frailty in patients with chronic kidney disease [14]. Additionally, the FRAIL-AR scale lacks objective physical performance measures, which are included in other frailty scales such as the FFI and SPPB, potentially reducing its sensitivity in detecting early frailty. Nevertheless, the FRAIL-AR scale remains a valuable tool for rapid frailty screening.

The objective of our study was to assess the prevalence of frailty and analyze its impact on the outcomes of ESKD patients undergoing dialysis in Saudi Arabia using the FRAIL-AR scale. Specifically, we aimed to examine the association between frailty and key outcomes, including hospitalization rates, intensive care unit (ICU) admissions, emergency department (ED) visits, and biochemical parameters. By understanding these associations, we sought to identify potential interventional strategies to reduce frailty and improve the quality of care in this high-risk population.

Methods

Study design, setting, and patients

This cross-sectional study was conducted at Johns Hopkins Aramco Healthcare (JHAH) in Dhahran, Saudi Arabia, from June 30, 2024, to June 30, 2025. The primary objective of this study was to assess the prevalence of frailty in patients undergoing dialysis. This study aimed to explore the association between frailty and various clinical outcomes. The study population consisted of adult patients (age ≥18 years) who had been receiving maintenance hemodialysis or peritoneal dialysis for a minimum of three months and provided informed consent. Exclusion criteria included active malignancy or infection, cognitive impairment, and inability to communicate in Arabic. All participants provided informed consent in accordance with the Declaration of Helsinki. This study was approved by the JHAH Institutional Review Board (IRB# 24-32) on May 21, 2024.

Data collection

Frailty was evaluated using the FRAIL-AR scale, which classifies patients as frail, partially frail, or non-frail [12]. We collected data on variables including age, sex, dialysis modality and duration, and comorbidities such as diabetes and heart failure. Additionally, data on serum hemoglobin, albumin, and parathyroid hormone levels, along with healthcare utilization metrics (hospitalization, ICU admission, and ED visits), were gathered during the study period.

Statistical analysis

All data were analyzed using the IBM SPSS Statistics software (version 24.0) (SPSS Inc., Chicago, IL, USA). Descriptive statistics were computed for variables, such as age, dialysis vintage, hospitalization metrics, ICU admissions, comorbidities, and laboratory results. Pearson correlation coefficients were used to evaluate the relationships between frailty and these variables, focusing on correlations with age, sex, hospitalization metrics, albumin levels, and comorbid conditions, such as heart failure and diabetes mellitus. Chi-square tests were used for categorical variables, and ANOVA was applied to continuous variables to assess differences across frailty categories. All reported P-values were two-sided, and a *P* value less than 0.05 was considered statistically significant. A multivariate logistic regression analysis was conducted to explore the combined impact of various health factors on frailty.

Results

The demographic, clinical, and laboratory characteristics of the study cohort are presented in Tables 1 and 2. The participants had a mean age of 66 ± 15.6 years, with males constituting 48 (56%). Hemodialysis was the primary treatment modality, used by 67 (79%) of the patients. The median duration of dialysis was 4 ± 3.25 years. On average, 29 (34%) patients were hospitalized and 18 (21%) required ICU admission. The mean hospital stay was 7.5 ± 4.5 days. Regarding comorbidities, diabetes mellitus was prevalent, affecting 53 (62%) patients, whereas hypertension was the most common, affecting 76 (89%). Heart failure was diagnosed in 29 (34%) patients, and eight (9.4%) had a prior history of cancer. Laboratory assessments revealed an average hemoglobin level of 10.8 ± 3.5 g/dL. The mean parathyroid hormone level was 526 ± 326.33 pg/mL. Albumin averaged 3.8 ± 0.5 g/dL.

Table 1: Baseline Characteristics (n= 85)

Variable	n	%
Male	48	56.5%
Diabetes Mellitus	53	62.4%
Hypertension	76	89.4%
Heart Failure	29	34.1%
Prior Cancer	8	9.4%
Prior Transplant	6	7.1%
Hemodialysis	67	78.8%
Peritoneal Dialysis	18	21.2%

Table 2: Demographics and laboratory parameters

Variable	Mean±SD
Age (years)	66 ± 15.6
Dialysis Vintage (years)	4 ± 3.25
Hemoglobin (g/dL)	10.8 ± 3.5
Parathyroid Hormone (pg/mL)	525 ± 326.33
Albumin (g/dL)	3.80 ± 0.5

Among 85 patients, 30 (35.3%) were classified as frail, 30 (35.5%) as partially frail, and 25 (29.4%) as non-frail. Analysis of frailty and its association with various patient characteristics yielded several significant findings (Table 3). Frailty was significantly associated with older age, with frail patients averaging 71 years compared with 57 years in non-frail patients (p = 0.0034) (Figure 1A). Albumin levels were significantly lower in frail patients (3.57 g/dL) compared to non-frail patients (3.96 g/dL, p = 0.0041) (Figure 1B). There was a moderate correlation between frailty and comorbidities, particularly heart failure (r = 0.23) and diabetes mellitus (r = 0.21) (Figure 1C). However, this did not reach statistical significance for dialysis vintage or prior transplantation. Furthermore, there was a weak negative

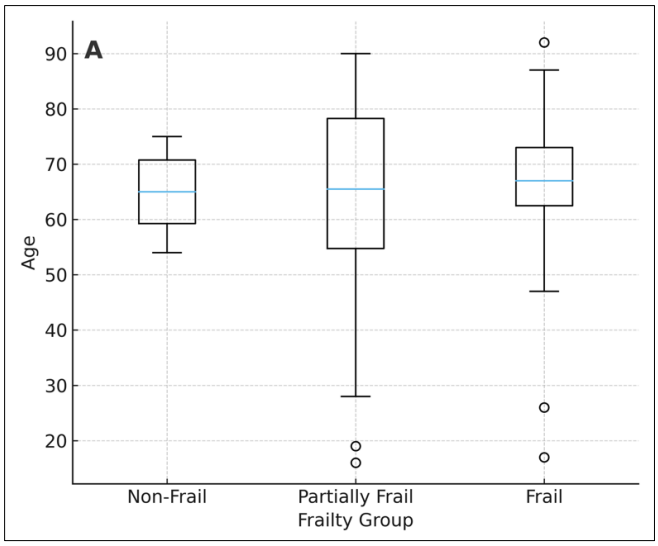
correlation between frailty and parathyroid hormone levels (r = -0.15), suggesting that lower parathyroid hormone levels might be associated with increased frailty, although this relationship was not as strong as the other correlations observed (Figure 1C).

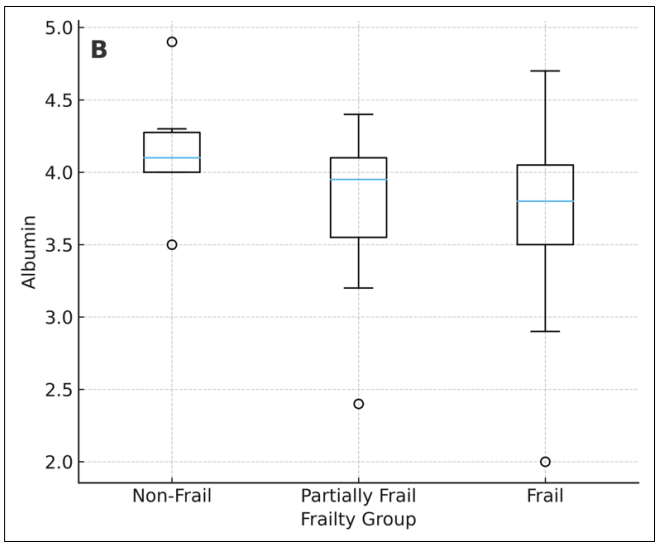
Table 3: Demographic, clinical, and laboratory characteristics across frailty categories (n=85)

Variable	Partially Frail(n=30)	Frail (n=30)	Non-Frail (n=25)	*P*-value
Age (years)*	66	71	57	0.0034
Male**	17 (20%)	11 (12.9%)	20 (23.5%)	0.0055
Diabetes Mellitus**	21(24.7%)	21(24.7%)	11(12.9%)	0.0788
Hypertension**	28 (32.9%)	27 (31.8%)	21(24.7%)	0.5295
Heart Failure**	8 (9.4%)	15 (17.6%)	6 (7.1%)	0.0726
Cancer **	3 (3.5%)	3 (3.5%)	2 (2.4%)	0.9594
Prior Transplant **	1(1.2%)	3 (3.5%)	2 (2.4%)	0.5874
Hemodialysis	26 (30.6%)	23 (27.1%)	18 (21.2%)	0.3894
Dialysis Vintage (years)*	4	3	3	0.7789
Emergency department visit (per patient month)	0.009	0.015	0.009	0.4630
Hospitalization (per patient month)	0.017	0.038	0.026	0.0340
ICU Admissions (per patient month)	0.006	0.005	0.008	0.630
Length of Hospital Stay (day)*	4.8	12.2	5	0.0080
Hgb (g/dL)*	10.77	10.48	11.06	0.5394
PTH (pg/mL)*	468.96	496.99	628.21	0.1655
Albumin (g/dL)*	3.91	3.57	3.96	0.0041

*Mean ** Number & Percentage

P value < .05 (frail vs non-frail), ICU; intensive care unit, Hgb: Hemoglobin, PTH: Parathyroid Hormone





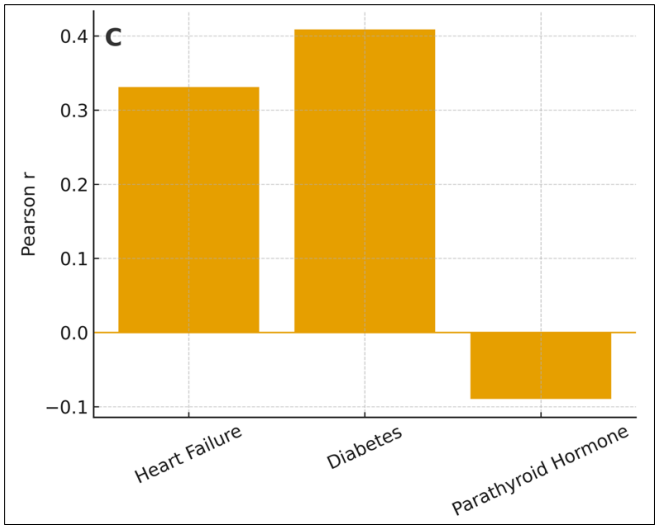


Fig 1: Distribution of age and albumin by frailty category and correlations between frailty and key clinical variables. A) Age by frailty category; Frail patients are older than partially frail and non-frail. B) Serum albumin by frailty category; Frail patients show lower albumin levels compared with Partially Frail and Non-Frail patients. C) Correlation of comorbidities with frailty, showing a positive correlation for heart failure and diabetes, and a weak negative correlation for parathyroid hormone levels.

Hospitalizations were more frequent among frail patients, who had an average hospitalization rate of 0.038 per patient month, compared to 0.026 in non-frail patients (p = 0.034). ICU admissions were numerically higher among frail patients; however, the difference was not statistically significant. A significant difference in the length of hospital stay was observed, with frail patients staying on average 12.2 days compared to 5 days in the non-frail group (p = 0.0080) (Figure 2). Multivariate analysis identified key predictors of frailty, including age, sex, and albumin levels. Older age was marginally associated with increased frailty, whereas lower albumin levels were significantly associated with frailty. Gender also emerged as a significant predictor, with females being more likely to be frail than males.

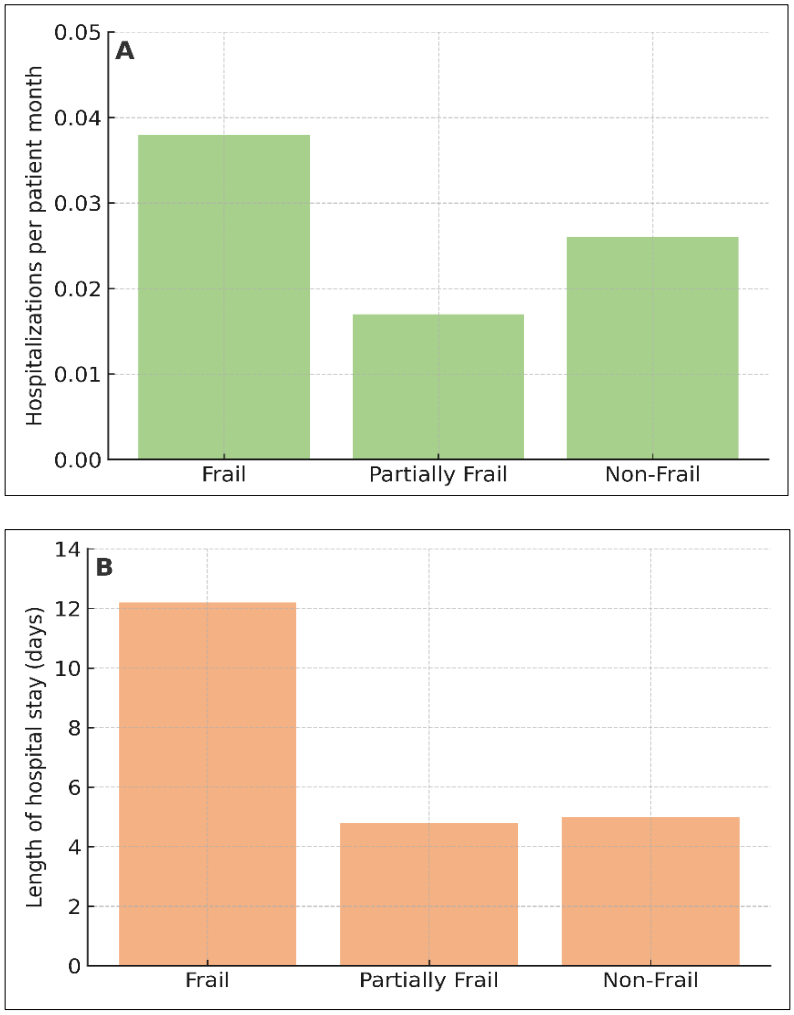


Figure 2: A) Hospitalizations per patient month. B) length of hospital stay among different Frailty Categories

Discussion

This study demonstrated the prevalence of frailty among dialysis patients in Saudi Arabia and its association with adverse clinical outcomes. Consistent with previous research, our findings indicate that frail patients experience more frequent hospitalizations and extended hospital stays [15]. Additionally, there is a noted trend towards increased emergency department visits and ICU admissions, a pattern observed in other studies [16, 17, 18]. The small sample size may have contributed to failure to reach statistical significance.

Kidney disease contributes to frailty through metabolic disturbances including mitochondrial dysfunction, uremia, acidosis, and anorexia. Hormonal imbalances, inflammation, and the accumulation of advanced glycation end-products further promote sarcopenia and increase vulnerability [19, 20, 21]. The correlation between frailty and other comorbidities, particularly age, sex, diabetes mellitus, and heart failure underscores the complex interplay between chronic conditions and frailty. The moderate correlation observed in this study is supported by similar findings from global research, where comorbidities have been shown to accelerate the progression of frailty in dialysis patients [22, 23]. Another significant finding was the association between frailty and low albumin level. Lower albumin levels indicate a poor nutritional status, which is known to exacerbate frailty. This aligns with previous studies that have identified nutritional deficiencies as key contributors to frailty in patients on dialysis [24, 25]. This underscores the importance of integrated care models that address the physical, nutritional, and metabolic challenges posed by these conditions in the context of frailty.

Although this study, potentially limited by its small sample size, did not identify a significant association between dialysis modality and frailty, it remains crucial to investigate the role of dialysis modalities in future research. Studies by Kurella *et al*. have indicated that dialysis modality may influence frailty outcomes over time, with peritoneal dialysis potentially offering certain benefits [26, 27]. Given the limited physiological reserves and higher burden of comorbidities in the dialysis population, addressing frailty will necessitate the implementation of targeted interventions, such as home-based care, physical rehabilitation, and early nutritional support to enhance overall patient outcomes. Evidence on interventions for frailty in kidney disease remains limited, with no large-scale trials conducted to date. Two pilot studies examined exercise-based approaches in patients undergoing hemodialysis and peritoneal dialysis patients [28, 29]. Frailty, as measured by the physical frailty phenotype, was reduced in all the participants with high adherence and acceptability. The association between exercise and improved health outcomes in patients undergoing dialysis has been previously documented. A 22% reduction in mortality among ESKD patients on hemodialysis who engaged in 10 min/day of physical activity has been reported [30].

The strengths of this study include the use of the FRAIL-AR scale, which is a validated and culturally appropriate tool for assessing frailty in the Arabic-speaking population. Additionally, the study's comprehensive approach, assessing both clinical outcomes and laboratory parameters, provides a robust understanding of the impact of frailty in dialysis patients. Our study had several limitations. The relatively small sample size may limit the generalizability of our findings to broader dialysis populations. Furthermore, the observational nature of the study precludes the assessment of causality between frailty and observed outcomes. Larger studies should adopt longitudinal designs to explore the temporal relationships between frailty, comorbidities, and healthcare utilization.

In conclusion, this study highlights the significant impact of frailty on healthcare outcomes among dialysis patients, demonstrating its correlation with increased hospitalization rates, prolonged inpatient stays, and heightened overall healthcare utilization. These findings emphasize the critical importance of recognizing frailty as a key clinical syndrome that influences prognosis and quality of life in this vulnerable population. The early identification of frailty through validated assessment tools can facilitate timely and targeted interventions aimed at reversing or stabilizing its progression.

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Author's Contribution
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Conflict of Interest
Not available

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