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Evaluation of the Effects of Glomerular Filtration Rate, Neutrophil-to-Lymphocyte Ratio, and Platelet-to-Lymphocyte Ratio on Mortality at the Initiation of Hemodialysis

can hüzmeli

chuzmeli@hotmail.com

Hatay Training and Research Hospital

Ayşe Şeker

Bursa City Hospital

Bestami Barış Çelik

Hatay Training and Research Hospital

Ali Borazan

Hatay Training and Research Hospital

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Abstract

Introduction:

In this study, we aimed to retrospectively examine the effects of neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and glomerular filtration rate (GFR) at the initiation of hemodialysis on mortality in hemodialysis patients.

Methods

The study was conducted retrospectively on patients who underwent hemodialysis in the province of Hatay between January 2010 and January 2025. Inclusion criteria were being on hemodialysis for at least 3 months and being older than 18 years. Exclusion criteria included home hemodialysis, peritoneal dialysis, age under 18 years, and undergoing hemodialysis for less than 3 months.

Results

A total of 1136 patients were included in the study. The mean age of the patients was 64.7 ± 13.42 years. The mean GFR at the initiation of hemodialysis was 8.48 ± 3.76 mL/min/1.73 m². No significant association was detected between NLR, PLR, and mortality. According to logistic regression analysis, the independent factors significantly associated with mortality were age, diabetes, and GFR category ($p < 0.05$). Each one-year increase in age increased the risk of death by 1.031 times ($p < 0.001$). The risk of death was approximately 1.76 times higher in diabetic patients compared with non-diabetics ($p < 0.001$). Patients with GFR < 7 mL/min/1.73 m² had 2.53 times higher mortality risk compared with those with GFR > 10 mL/min/1.73 m² ($p = 0.008$).

Conclusion

This study demonstrates that age, the presence of diabetes, and low initial GFR are significant determinants of mortality in hemodialysis patients. These findings highlight the importance of early intervention and management of comorbidities in this population.

INTRODUCTION

Under the KDIGO framework, chronic kidney disease (CKD) refers to abnormalities of renal structure or function that persist beyond three months. An estimated 850 million people were living with CKD worldwide in 2022 (1), corresponding to a reported global prevalence of roughly 9.1% (2), with a heavier burden observed in men. The condition accounted for 1.4 million deaths in 2019 and ranked as the eighth most frequent cause of death among non-communicable diseases (3).

KDOQI guidance advises referral for the assessment and creation of dialysis access once the glomerular filtration rate (GFR) declines to 15–20 mL/min/1.73 m² (4). Even so, and despite routine nephrology care, a substantial proportion of patients begin dialysis unexpectedly or under emergent conditions, with reported rates of unplanned initiation ranging from 40% to 60% (5).

Hemodialysis is generally considered when residual kidney function continues to fall below 15 mL/min/1.73 m² despite optimal conservative care, or when uremic symptoms, a decline in the capacity for daily activities, or worsening nutritional status can no longer be controlled by other means. In tolerant patients, initiation may be postponed while conservative treatment continues until GFR approaches < 8 mL/min/1.73 m²; nevertheless, to protect survival, dialysis should not be withheld beyond a GFR of 2 mL/min/1.73 m² even when the patient remains asymptomatic. In practice, treatment may begin as early as GFR > 15 mL/min/1.73 m² in patients with overt uremia, or be deferred to eGFR < 8 mL/min/1.73 m² in those without symptoms (6, 7).

Both the neutrophil-to-lymphocyte ratio (NLR) and the platelet-to-lymphocyte ratio (PLR) can be obtained directly from a routine complete blood count, making them inexpensive and widely available. They have been advanced as surrogate indicators of inflammation and endothelial dysfunction, and elevations in both have been documented across a broad range of inflammatory states (8). Within the immune response, neutrophils and lymphocytes serve complementary functions—the former underpinning innate defense and the latter driving adaptive immunity—and, as the body's initial barrier against invading pathogens, neutrophils rely on several distinct mechanisms to contain infection (9). Platelets preserve vascular integrity chiefly by aggregating and triggering the coagulation cascade, but they also take part in inflammatory processes, promoting leukocyte trafficking and secreting numerous cytokines and chemokines. By releasing pro-inflammatory mediators and adhering to the endothelium, they contribute to the development of atherosclerosis (8, 10).

Against this background, the present study aimed to investigate, in a large retrospective cohort, whether the glomerular filtration rate, neutrophil-to-lymphocyte ratio, and platelet-to-lymphocyte ratio measured at the initiation of hemodialysis are associated with mortality.

METHODS

We retrospectively reviewed adults who received hemodialysis in Hatay between January 2010 and January 2025. For each patient, GFR, complete blood count, biochemical values, and diagnoses at the time of hemodialysis onset were retrieved, together with the total time on hemodialysis and, where applicable, the date of death. Patients were eligible if they were at least 18 years old and had been on hemodialysis for a minimum of three months. Those receiving home hemodialysis or peritoneal dialysis, aged under 18 years, or dialyzed for less than three months were excluded.

The GFR level at which dialysis is commenced varies considerably between countries. Reported average thresholds are approximately 5 mL/min/1.73 m² in Taiwan, about 8.5 in the United Kingdom, and around

11 in the United States, with certain U.S. systems starting at mean eGFR values as high as 16–17 mL/min/1.73 m² (11).

In adults, the absolute neutrophil count is derived from the neutrophil percentage and usually lies between 2,500 and 7,000 cells/μL, while lymphocytes typically make up 20–40% of the white cell count (roughly 1,000–4,000 cells/μL); platelet counts, though laboratory-dependent, generally fall within 150,000–450,000/μL. Previously reported sex-specific 95% reference intervals were 0.43–2.75 (men) and 0.37–2.87 (women) for NLR, and 36.63–149.13 and 43.36–172.68 for PLR, respectively (12).

Statistical Analysis

All analyses were carried out in IBM SPSS Statistics 26.0. Normality of continuous variables was checked with the Kolmogorov–Smirnov test; those with a non-normal distribution were summarized as median (IQR) and compared across groups with the Mann–Whitney U test. Categorical data were expressed as n (%) and evaluated using the chi-square test, or Fisher's exact test where appropriate. Survival was examined with the Kaplan–Meier method. Factors related to mortality were identified through multivariable logistic regression using the Enter method, with the indicator (reference-category) contrast applied to categorical variables; GFR was divided into three categories (< 7, 7–10, and > 10 mL/min/1.73 m²), taking > 10 as the reference. Estimates were reported as odds ratios (Exp[B]) with 95% confidence intervals, and a two-sided $p < 0.05$ denoted statistical significance.

RESULTS

A total of 1136 patients were included in the study. The mean age of the patients was 64.7 ± 13.42 years (range: 19–94). Of the participants, 60.7% were male and 39.3% were female. The mean age of male patients was 63.8 ± 0.51 years, while that of female patients was 66.2 ± 0.61 years. The biochemical characteristics of the patients are presented in Table 1.

Table 1
Biochemical Characteristics of the Patients

Parameter	Mean ± SD
BUN (mg/dL)	82.8 ± 31.6
Creatinine (mg/dL)	7.14 ± 3.3
GFR (mL/min/1.73 m²)	8.48 ± 3.76
Sodium (mmol/L)	136.6 ± 5.4
Potassium (mmol/L)	5.07 ± 0.94
Albumin (g/dL)	3.53 ± 0.57
CRP (mg/L)	7.4 ± 16.35
Hb (g/dL)	9.32 ± 1.69
Hct (%)	28.67 ± 5.13
WBC (×10³/μL)	9.42 ± 3.95
Neutrophil (×10³/μL)	6.83 ± 3.53
Lymphocyte (×10³/μL)	1.52 ± 0.77
Platelet (×10³/μL)	252.2 ± 93.5
NLR	5.83 ± 5.12
PLR	210.4 ± 174.7
Hemodialysis duration (months)	49.0 ± 35.5

The mean GFR at the initiation of hemodialysis was 8.48 ± 3.76 mL/min/1.73 m². No association was found between GFR and mortality. Similarly, no statistically significant difference in survival was observed among different GFR categories (Table 2). At the start of hemodialysis, the mean NLR was 5.83 ± 5.12 and the mean PLR was 210.4 ± 174.7. In hemodialysis patients, neither NLR nor PLR was associated with mortality.

Table 2
Survival Status According to GFR Categories

GFR (mL/min/1.73 m²)	Deceased n (%)	Survivors n (%)	p-value
< 7	275 (36.9%)	131 (33.6%)	0.489
7–10	276 (37.0%)	147 (37.7%)	
> 10	195 (26.1%)	112 (28.7%)	

In male patients, NLR was 5.68 ± 5.0, PLR was 199.2 ± 144.91, and GFR was 8.99 ± 4.0 mL/min/1.73 m², whereas in female patients, NLR was 6.0 ± 5.1, PLR was 227.7 ± 211.5, and GFR was 7.6 ± 3.1 mL/min/1.73 m². When NLR and PLR were categorized, no significant association with mortality was observed in either sex.

When examining the relationship between Hb levels and mortality, deceased patients had a mean Hb of 9.36 ± 1.66 g/dL, while survivors had a mean Hb of 9.24 ± 1.72 g/dL, with no statistically significant difference ($p = 0.244$). No association was found between Hb levels and mortality. Furthermore, when Hb values were categorized (< 9 g/dL, 9–10 g/dL, 10–12 g/dL, and > 12 g/dL), no significant differences in mortality were observed among the groups.

Comparing deceased and surviving patients, age was significantly higher in deceased patients (median 68 [IQR 18] vs 63 [16], $p < 0.001$). Among biochemical markers, creatinine (6.20 [2.91] vs 6.70 [3.60], $p = 0.003$) and phosphate medians were lower in deceased patients, whereas potassium (5.10 [1.20] vs 4.90 [1.20], $p = 0.002$) and ferritin (208.00 [209.75] vs 164.00 [182.75], $p = 0.031$) were higher. Phosphate and PTH were higher in survivors (phosphate 5.30 [1.90] vs 5.70 [2.00], $p = 0.024$; PTH 257.00 [247.00] vs 304.00 [213.00], $p = 0.006$). Albumin levels were higher in the survivor group (3.50 [0.80] vs 3.60 [0.70], $p < 0.001$). The baseline demographic, clinical, and laboratory characteristics of deceased and surviving patients are presented in Table 3.

Table 3
Comparison of Demographic, Clinical, and Laboratory Variables Between Deceased and Surviving Patients

Variable	Deceased Median (IQR) / n (%)	Survivors Median (IQR) / n (%)	p-value
Age (years)	68.00 (18.00)	63.00 (16.00)	< 0.001
Male sex	432 (57.9%)	257 (65.9%)	0.009
Diabetes mellitus (DM)	453 (60.8%)	176 (45.2%)	< 0.001
Hypertension (HT)	374 (50.2%)	163 (41.8%)	0.007
Coronary artery disease (CAD)	134 (18.1%)	62 (15.9%)	0.361
Hemodialysis duration (months)	33.00 (43.25)	52.00 (44.00)	< 0.001
Glucose (mg/dL)	123.00 (73.00)	119.00 (64.00)	0.277
BUN (mg/dL)	78.00 (38.75)	76.00 (36.00)	0.185
Creatinine (mg/dL)	6.20 (2.91)	6.70 (3.60)	0.003
Sodium (mmol/L)	137.00 (6.00)	138.00 (6.00)	0.270
Potassium (mmol/L)	5.10 (1.20)	4.90 (1.20)	0.002
Calcium (mg/dL)	8.30 (1.30)	8.30 (1.40)	0.998
Phosphate (mg/dL)	5.30 (1.90)	5.70 (2.00)	0.024
HCO_3 (mmol/L)	17.25 (7.45)	17.15 (7.47)	0.306
Uric acid (mg/dL)	7.60 (2.23)	7.70 (2.40)	0.902
Albumin (g/dL)	3.50 (0.80)	3.60 (0.70)	< 0.001
CRP (mg/L)	2.50 (5.45)	3.10 (8.15)	0.075
Hb (g/dL)	9.30 (2.00)	9.20 (2.23)	0.299
Hct (%)	28.50 (6.60)	28.30 (7.38)	0.516
WBC (×10³/μL)	8.50 (4.00)	8.90 (3.80)	0.246
Neutrophil (×10³/μL)	5.99 (3.61)	6.10 (3.10)	0.798
Lymphocyte (×10³/μL)	1.39 (0.97)	1.42 (0.88)	0.157
Platelet (×10³/μL)	236.50 (118.25)	247.00 (112.25)	0.401

Variable	Deceased Median (IQR) / n (%)	Survivors Median (IQR) / n (%)	p-value
NLR	4.27 (4.00)	4.12 (3.71)	0.261
PLR	170.90 (141.47)	165.69 (126.07)	0.496
GFR (mL/min/1.73 m²)	8.00 (4.20)	8.20 (4.45)	0.455
Ferritin (ng/mL)	208.00 (209.75)	164.00 (182.75)	0.031
PTH (pg/mL)	257.00 (247.00)	304.00 (213.00)	0.006

Regarding categorical variables, the proportion of males was higher among survivors (65.9% vs 57.9%, $p = 0.009$), whereas diabetes (60.8% vs 45.2%, $p < 0.001$) and hypertension (50.2% vs 41.8%, $p = 0.007$) were more frequent in deceased patients. No significant differences were observed between the groups for other continuous and categorical variables—including glucose, BUN, sodium, calcium, HCO_3, uric acid, CRP, hemoglobin, hematocrit, WBC, neutrophils, lymphocytes, platelets, NLR, PLR, GFR, and the presence of coronary artery disease (all $p \geq 0.05$).

According to the logistic regression analysis, the factors significantly affecting the dependent variable (mortality) were age, presence of diabetes, and GFR category ($p < 0.05$). Each additional year of age increased the odds of death by 1.031 ($p < 0.001$). Patients with diabetes had approximately 1.76 times higher risk of death compared to those without diabetes ($p < 0.001$). Among GFR categories, patients with GFR < 7 mL/min/1.73 m² had 2.53 times higher odds of death compared to the reference group with GFR > 10 mL/min/1.73 m² ($p = 0.008$).

Sex, hypertension, coronary artery disease, NLR, PLR, and continuous GFR were not statistically significant ($p > 0.05$). Overall, the model was significant, and age, presence of diabetes, and low GFR emerged as independent determinants of mortality (Table 4).

Table 4
Logistic Regression Analysis Results

Variable	B	S.E.	Wald	df	p-value	Exp(B)
Sex (Male)	-0.238	0.143	2.745	1	0.098	0.788
Age	0.031	0.005	35.676	1	< 0.001	1.031
NLR	0.012	0.017	0.449	1	0.503	1.012
PLR	0.000	0.001	0.067	1	0.796	1.000
GFR	0.051	0.037	1.869	1	0.172	1.053
DM (Yes)	0.567	0.147	14.817	1	< 0.001	1.762
HT (Yes)	0.107	0.143	0.560	1	0.454	1.113
CAD (Yes)	-0.206	0.185	1.241	1	0.265	0.814
GFR category	—	—	8.112	2	0.017	—
GFR category 1 (< 7)	0.929	0.351	6.983	1	0.008	2.531
GFR category 2 (7–10)	0.373	0.243	2.363	1	0.124	1.452
Constant	-1.580	0.632	6.256	1	0.012	0.206

DISCUSSION

To date, the single randomized trial contrasting earlier with later dialysis initiation detected no meaningful survival advantage for either strategy, and its authors suggested that treatment could reasonably be postponed until GFR reaches 7 mL/min/1.73 m² or symptoms emerge; for asymptomatic individuals, a starting range of 5–7 mL/min/1.73 m² has been proposed (13). In line with this, a meta-analysis found that an earlier start (estimated creatinine clearance 10–14 mL/min/1.73 m²) conferred no mortality benefit over a later one (5–7 mL/min/1.73 m²). These findings argue for anchoring the decision in the patient's symptoms and overall condition—supported by risk-prediction tools and individual characteristics—rather than in GFR alone, and reliance on a fixed numeric cutoff has accordingly given way to a more individualized approach (14).

A separate pooled analysis linked a higher GFR at the time of initiation to greater mortality. Across early and late starters, older age, diabetes, and a higher Charlson Comorbidity Index each predicted worse survival, and the odds of death rose by a factor of 1.03 for every additional 1 mL/min/1.73 m² of GFR and by 1.13 for every 5 mL/min/1.73 m². Relative to patients who began treatment at eGFR < 3 mL/min/1.73 m², those starting above 10 mL/min/1.73 m² carried a 33.04% higher mortality risk (15).

In an analysis restricted to asymptomatic patients, GFR was stratified into three bands (4–6, 6–8, and > 10 mL/min/1.73 m²); the 4–6 band carried the lowest hazard and the > 10 band the highest. One-year

mortality was likewise lower among patients initiating at GFR < 2 and 2–4 mL/min/1.73 m², whereas starting above 6 mL/min/1.73 m² was associated with a 1.5- to 2.8-fold higher mortality than the 4–6 band (16).

Applying a dynamic marginal structural model, investigators compared 15 initiation strategies spanning GFR values from 4 to 19 mL/min/1.73 m² in one-unit increments, and assessed five-year all-cause mortality and major adverse cardiovascular events. With 6–7 mL/min/1.73 m² as the reference, risk was minimized at 15–16 mL/min/1.73 m²: initiating in that higher range rather than at 6–7 lowered the absolute five-year mortality risk by 5.1% and cardiovascular events by 2.9%, whereas initiating at 4–5 mL/min/1.73 m² raised the absolute five-year risk by 0.8%. Among patients with heart failure, an earlier start reduced five-year mortality by 3.3% without changing the rate of major cardiovascular events (11).

Taken together, no firm consensus exists on the ideal moment to begin hemodialysis, and the choice should be tailored to the individual, weighing symptoms and patient-specific factors alongside GFR. The mean initiation GFR in our cohort, 8.4 mL/min/1.73 m², is in keeping with values reported from the United Kingdom, and our model indicated a higher mortality risk for patients starting below 7 mL/min/1.73 m² than for those above 10 mL/min/1.73 m².

In another cohort, baseline values at dialysis onset averaged hemoglobin 9.7 ± 1.6 g/dL, GFR 9.3 ± 5.8 mL/min/1.73 m², creatinine 6.8 ± 3.1 mg/dL, CRP 4.4 ± 2.6 mg/dL, and albumin 3.4 ± 0.7 g/dL, and mortality was greater among patients with lower creatinine and albumin together with higher CRP and a higher CRP-to-albumin ratio (17, 18).

Elsewhere, 26.6% of patients receiving pre-dialysis erythropoiesis-stimulating agent (ESA) therapy still had hemoglobin below 9.0 g/dL at initiation, whereas in a comparison group ESA treatment raised hemoglobin from 8.2 ± 0.8 to 10.9 ± 1.2 g/dL. Sustaining hemoglobin at ≥ 9.0 g/dL both before and after dialysis was associated with lower early all-cause and cardiovascular mortality than starting below 9.0 g/dL with subsequent ESA-driven correction (19, 20).

In our series, the mean hemoglobin at initiation was 9.3 g/dL and showed no significant relationship with mortality. Patients who died were older and more frequently diabetic, and had lower albumin, creatinine, and phosphorus together with higher ferritin—a pattern consistent with greater inflammation and malnutrition.

As an inexpensive inflammatory index, NLR has been shown to predict all-cause mortality independently in CKD patients on maintenance HD. In one report an elevated NLR was present in 37.6% of patients and increased with longer time on dialysis; mortality reached 24.3% in the high-NLR group versus 8.6% in those with normal values, corresponding to a 2.6-fold increase in risk (21).

In a further study, mean eGFR fell from 7.7 ± 3.8 mL/min/1.73 m² six months before HD to 5.7 ± 2.5 at initiation, while NLR rose from 2.5 ± 1.0 to 4.9 ± 2.8. NLR moved in parallel with CRP and inversely with

albumin and was put forward as a marker for the timing of HD and for uremic symptoms, though it showed no significant link with GFR or hemoglobin (22).

Among patients aged 70 years or older undergoing a first arteriovenous fistula or graft procedure, preoperative NLR—alongside diabetes, chronic obstructive pulmonary disease, and peripheral artery disease—was an independent predictor of one-year mortality, pointing to a possible role for NLR in anticipating early death in elderly CKD patients preparing for HD access (23).

In our cohort, NLR and PLR were numerically higher in patients who died but did not reach statistical significance for mortality. In a published cohort, the median NLR and PLR were 3.42 and 142.38, and patients were stratified into four groups—A (NLR ≤ 3.42, PLR ≤ 142.38), B (NLR ≤ 3.42, PLR > 142.38), C (NLR > 3.42, PLR ≤ 142.38), and D (NLR > 3.42, PLR > 142.38); correlation analysis showed both ratios to be inversely related to albumin and hemoglobin. Across studies, a higher NLR has been tied to all-cause mortality and a higher PLR to cardiovascular mortality in HD patients (24–26), and both ratios have been suggested as reasonable indicators of erythropoietin resistance (27).

This study has several limitations. Its retrospective, registry-based design precludes causal inference and leaves it open to unmeasured confounding, including incomplete information on comorbidity burden, medication use, and dialysis-related parameters. NLR and PLR were measured only once, at initiation, so their behavior over time could not be evaluated. Because mortality was modeled as a binary outcome with logistic regression rather than with time-to-event methods, differences in follow-up duration were not fully accounted for. Finally, the single-region source of the cohort may limit the generalizability of the findings.

In summary, neither NLR nor PLR was significantly associated with mortality in our hemodialysis population. On multivariable analysis, older age, diabetes, and a GFR < 7 mL/min/1.73 m² at initiation were the independent determinants of death, with the low-GFR group carrying approximately 2.5 times the risk of the reference group. Hypertension, lower albumin, and higher ferritin distinguished the deceased patients on univariate comparison and probably reflect an underlying state of inflammation and malnutrition, but they did not remain independent predictors once adjusted for other variables. No definitive GFR threshold for HD initiation can yet be defined, and an individualized approach therefore remains advisable.

Declarations

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Conflicts of Interest

The authors declare that they have no competing interests.

Ethics Approval

This study was reviewed and approved by the Non-Interventional Clinical Research Ethics Committee of Hatay Mustafa Kemal University (Meeting Date: 18/06/2025; Meeting No: 08; Decision No: 38). The Ethics Committee determined that the research poses no ethical or scientific concerns regarding its conduct at the specified centers. All procedures were performed in accordance with institutional guidelines and the principles of the Declaration of Helsinki.

Consent to Participate

Informed consent was waived by the Ethics Committee because of the retrospective design of the study.

Consent for Publication

No identifiable personal information is included in this manuscript.

Availability of Data and Material

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code Availability

No custom code or software was developed for this study. Statistical analyses were performed using IBM SPSS Statistics.

Authors' Contributions

Concept and design: Can Hüzmeli, Ayşe Şeker. Data collection: Can Hüzmeli, Bestami Barış Çelik. Data analysis and interpretation: Can Hüzmeli, Ayşe Şeker. Statistical analysis: Can Hüzmeli. Literature review: Can Hüzmeli, Ayşe Şeker. Manuscript drafting: Can Hüzmeli. Critical revision of the manuscript: Ayşe Şeker, Ali Borazan. Supervision: Ali Borazan. Approval of the final version: All authors.

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Figures

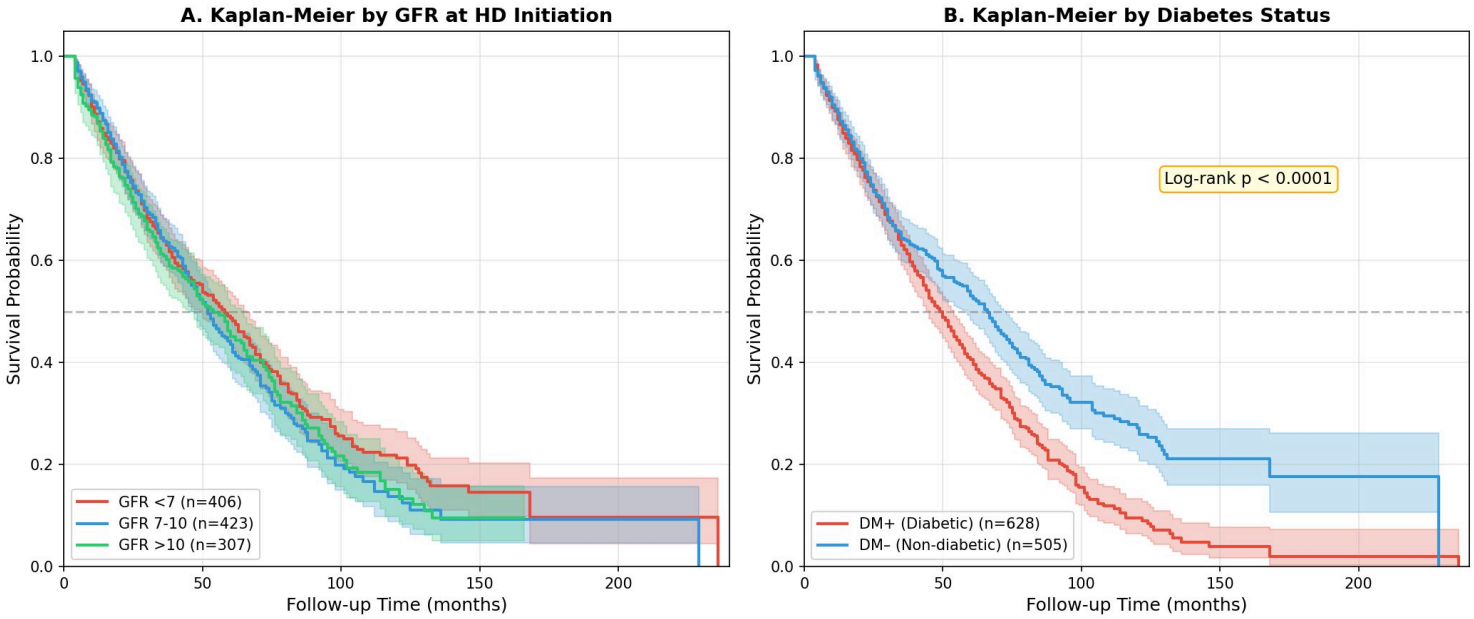


Figure 1

Legend not included with this version