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Survival and Mortality Predictors Among Hemodialysis Patients in a Pakistani Tertiary Care Center: A Retrospective Cohort Study

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ABSTRACT

Background: End-stage renal disease (ESRD) is a growing public health burden in low- and middle-income countries, including Pakistan, where access to maintenance hemodialysis (MHD) is expanding, but long-term survival outcomes remain underreported. This study evaluated the survival duration and clinical predictors of mortality among patients undergoing MHD at a tertiary care hospital in Pakistan. **Methods:** A retrospective analysis of prospectively collected data was conducted on patients receiving MHD between 2012 and 2014 at Mayo Hospital, King Edward Medical University, Lahore. Patients on dialysis for ≥3 months were included. Demographic and clinical data were extracted from records. Survival was assessed using Kaplan-Meier analysis, and predictors of mortality were evaluated using Cox proportional hazards regression. **Results:** Of the 158 patients enrolled, 152 met inclusion criteria. Over a 122-week follow-up, 48 (31.5%) patients died and 104 survived. The overall mean survival was 108 ± 2 weeks. Multivariable Cox regression identified increasing age (HR = 1.04, p<0.001), body weight (HR = 1.03, p=0.015), and underweight status (HR = 1.93, p=0.034) as independent risk factors for mortality. Conversely, higher body mass index (BMI) (HR = 0.80, p<0.001) and serum albumin (HR = 0.52, p=0.036) were protective. **Conclusion:** Survival in hemodialysis patients is significantly influenced by age, nutritional status, and albumin levels. These findings support the implementation of routine nutritional assessments and targeted interventions to reduce mortality. Future studies should explore broader determinants in multicenter prospective cohorts to improve long-term outcomes for ESRD patients in resource-limited settings.

INTRODUCTION

Chronic kidney disease (CKD) is a significant global public health issue, with the progression to end-stage renal disease (ESRD) necessitating renal replacement therapies (RRT) such as hemodialysis, peritoneal dialysis, or kidney transplantation. Hemodialysis remains the most commonly utilized modality worldwide; however, it is both resource-intensive and associated with considerable morbidity and mortality. In 2010, approximately 2.6 million individuals received RRT globally, with projections estimating a rise to over 5 million by 2030 (Liyanage et al., 2015). In Pakistan, the burden of ESRD reflects global trends, compounded by socioeconomic disparities and challenges in healthcare access. The incidence of ESRD is estimated at 100–150 cases per million population annually, resulting in approximately 16,000 new patients requiring dialysis each year. The annual financial impact of the treatment of a dialysis patient is about Rs. 150,000 - 200,000 (US$ 2300) (Ali Jaffar Naqvi, 2000; Naqvi, 2009; Naseem et al., 2019). Because of the scarcity of resources, the main aim of treatment is the short-term survival of patients instead of focusing on improving the quality of life, which was found to be poor according to a local study (Anees et al., 2011; Kher, 2002). Despite technological advancements and improvements in dialysis care protocols, the survival rate of hemodialysis patients remains significantly lower than that of the general population. According to the United States Renal Data System (USRDS 2022), individuals aged 40–44 years undergoing dialysis have a projected life expectancy shorter than that of age-matched individuals without kidney disease (Collins et al., 2010; Johansen et al., 2023). In order to improve the long-term survival of patients, studies are needed to determine factors associated with survival, define standards, and optimize the practices of dialysis (Bukhari et al., 2023; Rao et al., 1998).

Factors contributing to this disparity include delayed presentation, inadequate dialysis frequency, malnutrition,

and comorbidities such as cardiovascular disease and hepatitis C infection (Robinson et al., 2016). Several international studies, particularly the Dialysis Outcomes and Practice Patterns Study (DOPPS), have identified consistent predictors of mortality in hemodialysis patients. These include older age, low haemoglobin, low body mass index (BMI), poor nutritional status, and fewer dialysis sessions per week (Bukhari et al., 2023; Robinson et al., 2016). However, there is limited robust evidence from South Asia, particularly Pakistan, where most existing research is cross-sectional and focuses on biochemical or quality-of-life parameters rather than survival outcomes. Given Pakistan's rising ESRD burden, the growing availability of dialysis services in cities, and persistent challenges in cost-effective care delivery, there is an urgent need to generate localized survival data (Bukhari et al., 2023). Identifying patient-specific mortality predictors can help inform individualized care planning, guide institutional dialysis protocols, and influence national nephrology policy.

This study aims to evaluate the survival of patients receiving maintenance hemodialysis at Mayo Hospital, King Edward Medical University (KEMU), Lahore. Using Kaplan-Meier survival analysis and Cox proportional hazards modeling, the study explores key demographic and clinical predictors of mortality in a real-world, resource-constrained tertiary care setting. The findings are expected to bridge an important knowledge gap in local nephrology practice and inform future interventions to improve patient outcomes.

METHODOLOGY

Study Design and Ethical Approval

This study was a retrospective analysis of prospectively collected clinical data from patients undergoing maintenance hemodialysis between 2012 and 2014 at Mayo Hospital, King Edward Medical University (KEMU), Lahore. Ethical approval for the analysis and publication of this data was granted by the Institutional Review Board of Bilqees Sarwar Hospital, Lahore, in January 2019. Given the retrospective nature of this analysis, a formal sample size calculation was not conducted.

Participant Recruitment and Data Collection

All patients diagnosed with end-stage renal disease (ESRD) who had been receiving maintenance hemodialysis (MHD) for more than three months at the time of enrollment were included in the study. Patients undergoing hemodialysis due to acute renal failure, or those who had transitioned to other renal replacement therapies—such as peritoneal dialysis or kidney transplantation—were excluded. Clinical and biochemical variables were retrospectively extracted from patient medical records and dialysis unit documentation using a structured abstraction format developed by the research team. Collected variables included demographic details, dialysis frequency, body mass index (BMI), serum albumin, hemoglobin, sodium, potassium, calcium, phosphate, uric acid, and viral markers (anti-HCV and HBsAg). These parameters were recorded at baseline and at either the time of death or the end of follow-up for survivors. All values were classified as normal or abnormal according to the Kidney Disease Outcomes Quality Initiative (KDOQI) reference ranges. Patients were followed for a duration of two and a half years. Follow-up was censored either at the end of the study period or at the time of death, whichever occurred first.

Statistical Analysis

Data were analyzed using Stata version 16. The Shapiro-Wilk test was applied to assess the normality of continuous variables. Descriptive statistics were reported as means and standard deviations for continuous variables and as frequencies and percentages for categorical variables. Cox proportional hazards regression analysis was employed to evaluate the association between clinical variables and survival. The duration of dialysis (in weeks) was used as the time-to-event variable, with death as the outcome. Variables with a p-value less than 0.250 in univariate analysis were entered into the multivariable model. Statistical significance in the final model was set at $p < 0.05$. Kaplan-Meier survival curves were constructed and stratified by age groups to illustrate survival probabilities over time.

RESULTS

A total of 158 patients were initially enrolled in the study. After excluding six patients who underwent renal transplantation, 152 participants were included in the final analysis. Of these, 104 patients survived the follow-up period, while 48 patients died during the study.

Table 1A

Sociodemographic characteristics of participants at baseline (N = 152)

Variable	Alive (n=104)	Dead (n=48)
Age (years)	45 ± 14	53 ± 15
Gender		
- Males	52 (34.2%)	29 (19.1%)
- Females	52 (34.2%)	19 (12.5%)
Education Level		
- Little or No Education	15 (10%)	6 (4%)
- Less than 10 Years	53 (35%)	19 (12.5%)
- 10 Years or Above	36 (23.5%)	23 (15%)
Occupation		
- Unemployed	64 (42%)	35 (23%)
- Housewives	23 (15%)	7 (5%)
- Employed	17 (11%)	6 (4%)
BMI Category		
- Underweight (BMI <20)	59 (38.8%)	29 (19.1%)
- Normal Weight (BMI 20–25)	45 (29.6%)	19 (12.5%)
Hepatitis C Status		
- Positive	73 (48%)	21 (13.8%)
- Negative	31 (20.4%)	27 (17.8%)
Frequency of Dialysis		
- Twice per week	36 (23.7%)	23 (16.4%)
- Thrice per week	68 (44.7%)	25 (19.1%)

Table 1B

Baseline clinical characteristics of participants (N = 152)

Variable	Alive (n=104)	Dead (n=48)
Height (cm)	163.1 ± 9.2	164.4 ± 11.1
Weight (kg)	63.4 ± 14.1	64.9 ± 16.7
BMI (kg/m^2)	25.2 ± 4.7	23.8 ± 4.6
Hemoglobin (mg/dl)	9.4 ± 1.8	9.8 ± 2.1
Albumin (mg/dl)	3.6 ± 0.5	3.5 ± 0.5
Sodium (mg/dl)	141.2 ± 5.7	138.8 ± 5.7

Potassium (U/L)	5.2 ± 0.9	5.2 ± 0.8
Phosphate (U/L)	6.0 ± 2.0	5.6 ± 1.9
Calcium PO_4 (U/L)	51.2 ± 19.6	49.0 ± 18.0
Uric Acid (mg/dl)	7.8 ± 2.0	7.3 ± 2.0
Length of Dialysis (weeks)	317	343

The sociodemographic characteristics of the participants are summarized in Table 1A. The mean age of survivors was 45 ± 14 years, compared to 53 ± 15 years among non-survivors. BMI was also lower among the deceased group (23.8 ± 4.6 kg/m^2) than survivors (25.2 ± 4.7 kg/m^2). Gender distribution was balanced across both groups, while educational status and occupational background revealed a higher frequency of low education and unemployment among patients who died. A larger proportion of patients classified as underweight (BMI <20) was observed among non-survivors (19.1%) compared to survivors (38.8%). Table 1B outlines baseline clinical parameters, showing slightly lower albumin levels in deceased patients, while other values such as hemoglobin, electrolytes, and uric acid were comparable.

In terms of survival outcomes, 48 patients experienced the event of interest (death), whereas 104 patients were censored by the end of the study at 122 weeks. The mean survival duration for the entire cohort was 108 ± 2 weeks (Figure 1). Stratification by age group revealed varying survival trends: patients aged <20 years had a mean survival duration of 97 ± 14 weeks, while those aged 20–40 years had the longest survival (117 ± 2 weeks). Patients aged 40–60 years had a mean survival of 105 ± 3 weeks, and the 60–80 years age group experienced the highest mortality rate (48.5%) with a mean survival of 100 ± 6 weeks. These age-based differences in survival distribution are depicted in the Kaplan-Meier curve (Figure 2).

Table 2

Multivariable Cox proportional hazards model (N = 152)

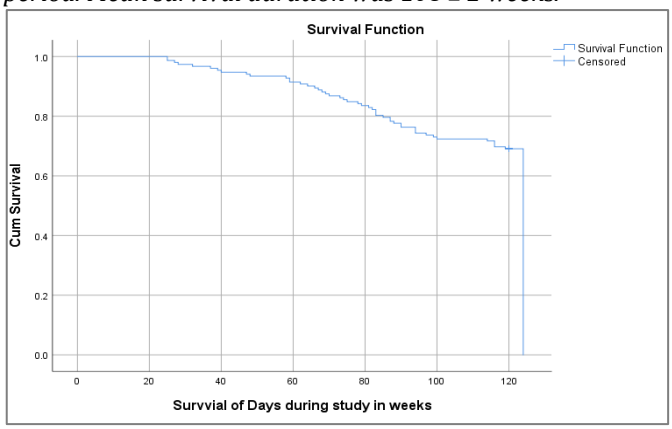
Variable	Hazard Ratio (HR)	95% CI	p-value
Age (in years)	1.04	1.02 – 1.07	<0.001**
Weight (in kg)	1.03	1.00 – 1.07	0.015**
BMI (kg/m^2)	0.80	0.72 – 0.90	<0.001**
Albumin (mg/dL)	0.52	0.29 – 0.96	0.036**
Underweight (BMI <20)*	1.93	1.05 – 3.55	0.034**

*Normal weight category kept as reference.
**Statistically significant.

Multivariable Cox regression analysis identified several variables significantly associated with mortality. Increasing age was found to elevate the risk of death by 4% per additional year (HR = 1.04; 95% CI: 1.02–1.07; p<0.001), while each kilogram increase in weight corresponded to a 3% increased risk (HR = 1.03; 95% CI: 1.00–1.07; p=0.015). Conversely, higher BMI demonstrated a protective effect, with each one-unit increase reducing the risk of death by 20% (HR = 0.80; 95% CI: 0.72–0.90; p<0.001). Serum albumin levels were inversely associated with mortality (HR = 0.52; 95% CI: 0.29–0.96; p=0.036), and patients classified as underweight had nearly twice the mortality risk compared to those with normal BMI (HR = 1.93; 95% CI: 1.05–3.55; p=0.034).

Figure 1

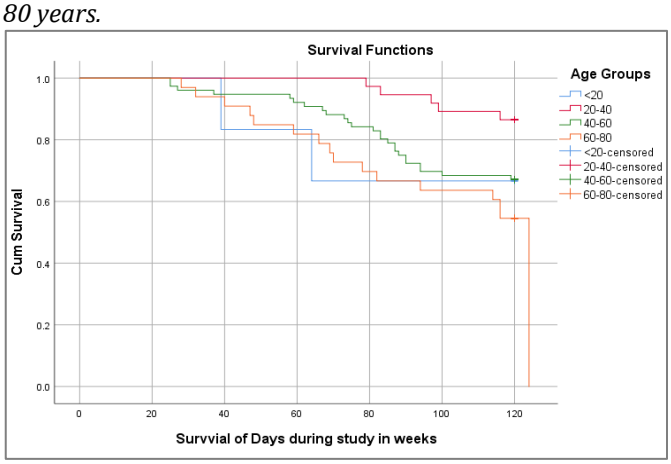
Kaplan-Meier survival curve depicting overall survival for all participants (N = 152) over the 122-week follow-up period. Mean survival duration was 108 ± 2 weeks.



(X-axis: Duration of dialysis in weeks; Y-axis: Cumulative survival probability).

Figure 2

Kaplan-Meier survival curves stratified by age groups for all participants (N = 152). The survival trend indicates reduced longevity with increasing age. The mean survival durations were 97 ± 14 weeks for patients aged <20 years, 117 ± 2 weeks for those aged 20–40 years, 105 ± 3 weeks for the 40–60 years group, and 100 ± 6 weeks for participants aged 60–80 years.



(X-axis: Duration of dialysis in weeks; Y-axis: Cumulative survival probability).

DISCUSSION

This study assessed survival outcomes and mortality predictors among patients receiving maintenance hemodialysis at a tertiary care hospital in Pakistan. Over a follow-up period of 122 weeks, the overall mean survival was 108 ± 2 weeks. Age, weight, BMI, serum albumin, and underweight status emerged as statistically significant predictors of mortality in the final multivariable Cox regression model. These findings underscore the importance of early risk identification and timely nutritional and clinical interventions to improve survival outcomes in resource-constrained dialysis settings.

Our study found that increasing age significantly raised the risk of mortality, with each additional year increasing the hazard by 4%. This aligns with global findings, including the Dialysis Outcomes and Practice Patterns Study (DOPPS), which identified age as a

consistent predictor of mortality across diverse populations (Robinson et al., 2016). Similarly, data from the United States Renal Data System (USRDS) confirm that older age is associated with significantly lower survival rates in hemodialysis patients (Johansen et al., 2023). Body mass index (BMI) and weight also demonstrated strong predictive value in our study. Notably, a higher BMI was protective, with each one-unit increase reducing mortality risk by 20%. This "obesity paradox" has been reported in several international studies, where underweight patients on dialysis fare worse than their overweight counterparts (Bae et al., 2022; Ouyang et al., 2016). Our findings support this paradox, showing that underweight individuals had nearly double the risk of mortality (HR = 1.93). In a study by (Leavey et al., 2001), BMI <20 was associated with the highest mortality among hemodialysis patients. A study from Korea by (Kim et al., 2023) also found BMI <18.5 to be significantly associated with increased all-cause mortality, reinforcing the idea that poor nutritional status may outweigh the traditional cardiovascular risks of obesity in ESRD patients.

Serum albumin, a surrogate marker for nutritional and inflammatory status, also showed a strong inverse relationship with mortality. Patients with lower albumin levels had significantly higher risk of death, consistent with previous findings in developed countries (Kalantar-Zadeh et al., 2003; Kikuchi et al., 2017). The USRDS and DOPPS cohorts have consistently identified hypoalbuminemia as a powerful predictor of mortality, with thresholds below 3.5 g/dL indicating poor prognosis. In our cohort, deceased patients had mean albumin levels of 3.5 ± 0.5 mg/dL, marginally lower than survivors, supporting the hypothesis that nutritional and inflammatory status are crucial determinants of outcomes. Interestingly, gender and hemoglobin levels were not significantly associated with survival in our model, although international literature provides mixed findings. While some studies have suggested a protective role of higher hemoglobin within optimal ranges (Bukhari et al., 2023; Locatelli et al., 2004; Locatelli et al., 2013), others argue for individualized targets based on comorbidities and erythropoietin responsiveness ("Meta-analysis: Erythropoiesis-Stimulating Agents in Patients With Chronic Kidney Disease," 2010). The lack of association in our study could be due to uniformly low hemoglobin levels and limited variation across the cohort. Kaplan-Meier curves in our study demonstrated declining survival with increasing age. Patients aged 20–40 had the highest mean survival (117 ± 2 weeks), while those >60 years had the highest mortality (48.5%) and lowest survival duration (100 ± 6 weeks). This trend is consistent with published survival curves from the UK Renal Registry and other DOPPS cohorts, further validating our methodology and findings (Rao et al., 2016).

Although HCV status was collected, it did not emerge as a significant mortality predictor in our model. However, multiple studies from Pakistan and other low- and middle-income countries have reported associations between chronic viral infections and mortality, possibly due to hepatic complications and systemic inflammation (Jha et al., 2012; Khan et al., 2020). This may reflect improvements in dialysis availability in Pakistan's urban centers, increased physician awareness, and adherence to minimum adequacy standards, although affordability continues to limit broader impact.

CONCLUSION

This study provides valuable insight into the survival patterns and mortality predictors among patients undergoing maintenance hemodialysis in a tertiary care hospital in Pakistan. Over a 122-week follow-up period, the overall mean survival was 108 weeks, with age, body mass index (BMI), weight, serum albumin levels, and underweight status emerging as significant predictors of mortality. The findings reinforce well-established global evidence regarding the impact of malnutrition, advanced age, and low albumin on patient outcomes in end-stage renal disease (ESRD). These results underscore the importance of routine nutritional assessments, individualized treatment strategies, and timely interventions to enhance survival outcomes in this vulnerable population. Given the growing ESRD burden in Pakistan and similar low- and middle-income countries, our results highlight the need for proactive healthcare planning, particularly in resource-constrained dialysis environments.

Limitations and Future Directions

This study, while informative, has several limitations that merit consideration. First, its single-center design may limit the generalizability of the findings to other regions or dialysis centers with differing patient demographics, clinical practices, or resource availability. Second, although the data were prospectively collected, the retrospective nature of the analysis may have introduced residual confounding, particularly for variables not routinely documented in patient records. Key clinical parameters, such as dialysis adequacy (Kt/V, a standardised measure of urea clearance), inflammatory biomarkers (e.g., C-reactive protein, interleukins), cardiovascular comorbidities, and socioeconomic status, were not assessed, potentially influencing observed survival outcomes. Furthermore, data on patient adherence to dialysis schedules and medications, including erythropoiesis-stimulating agents, were unavailable. These factors could have provided a more comprehensive understanding of mortality risks. In addition, survival bias may have occurred, as patients who died early during the course of treatment or prior to meeting the inclusion criteria were not captured. Lastly, ethical approval was obtained retrospectively, several years after data collection, which is permissible under current ethical guidelines for retrospective studies. Future research should adopt a multicenter, prospective approach incorporating more comprehensive clinical, biochemical, and psychosocial data to validate these findings and guide interventions that improve survival in hemodialysis patients in Pakistan and similar resource-limited settings.

Conflict of Interest

The authors declare that they have no financial, commercial, personal, or academic conflicts of interest that could have influenced the conduct, analysis, or reporting of this study. If any potential conflicts arise post-submission, the corresponding author will promptly inform the journal.

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