Clareus Scientific Medical Sciences
Volume 3 Issue 1 January 2026
ISSN: 3064-8017

Cox Proportional Hazards Model Analysis of Kidney Failure Incidence among Dialysis Patients in Tabuk City

Citation: Elfarazdag MM Hussein., et al. "Cox Proportional Hazards Model Analysis of Kidney Failure Incidence among Dialysis Patients in Tabuk City". Clareus Scientific Medical Sciences 3.1 (2026): 08-20.

Article Type: Research Article

Received: February 19, 2025

Published: January 26, 2026

Elfarazdag MM Hussein*, Amin MA Haleeb, Atif Ali Yassin, Manahil Sid Ahmed Mustafa and Sara Mohamed Ahmed Elsheikh

University of Tabuk, Tabuk, Saudi Arabia

***Corresponding Author:** Elfarazdag MM Hussein, University of Tabuk, Tabuk, Saudi Arabia.

Abstract

Purpose: Renal failure is a significant and prevalent problem in global healthcare, and dialysis is the primary intervention for end-stage renal disease. This work examines the relationship between dialysis modality and gender on the risk of developing kidney failure in Tabuk City. It is handled using the Cox Proportional Hazards Model (CPHM) and is a part of the survival analysis in nephrology.

Methodology: This research assessed 100 patients suffering from kidney failure who receive dialysis at the King Khalid Hospital in Tabuk City. Other variables of interest were dialysis type, peritoneal or Hemodialysis and Gender. The CPHM assessed the survival results considering the censored data. We also calculated hazard ratios and survival probability.

Results: The present study evaluated the effect of Peritoneal Dialysis in preventing the risk of kidney failure compared to hemodialysis using a hazard ratio of 0.436, p = 0.002. Furthermore, the males were the weaker Sex in this study as they had a significantly lower hazard rate of kidney failure than the females (hazard rate = 0.471; p = 0.006) by 52.9%. Overall survival curves also supported the better results for peritoneal dialysis and females.

Conclusion: The implications of the study stress dialysis type and gender regarding survival results, which are consistent with previous research and include regional factors. Therefore, the study's findings suggest individualized treatment strategies and multi-factorial research studies to consider more variables for accurate risk evaluation.

Keywords: Kidney Failure; Dialysis; Survival Analysis; Proportional Hazards Models; Saudi Arabia

Introduction

The Cox Proportional Hazards Model (CPHM), explained by Sir David Cox in his 1972 paper, is perhaps one of the most valuable survival probability models and has been the primary conception of analysis in the survival analysis theory [1]. Survival analysis is still a pretty young discipline that has found its significant application in healthcare and clinical research, where it is essential to define the time of event, such as progression, recovery, or death [2]. The fact that this model does not assume some form of the baseline hazard function makes it preferable when dealing with a large dataset. The estimates derived from the survival outcomes and covariates make it easy for the researcher to evaluate the impact of factors such as treatment modalities, age, gender, and other medical histories on the risk of an event [3, 4].

Chronic kidney disease is a worldwide concern and is invaluable when using the CPHM for analysis. Being a progressive disease, kidney failure requires appropriate management intervention that will targeted towards specific patient groups [5]. Dialysis, the primary therapeutic modality, has two main types: Hemodialysis and Peritoneal Dialysis (PD). All have different meanings for the patient's prognosis [6, 7]. Another variable is gender; there is evidence for gender differences in clinical research, especially regarding illness course and therapy outcomes in males and females. Thus, follow-up strategies can be developed by improving statistics' sensitivity to detect patterns and evaluate risk factors of evolving kidney failure [8].

The usefulness of survival analysis in this regard is in comparing the occurrence of events at a particular time instead of just considering whether they occurred [9]. Depending on the type of disease, timing may be critical to treatment, which is especially important in chronic diseases that include kidney failure [10]. The CPHM stands out since it allowed it to include several covariates, exploring how patient characteristics and treatment options affect the outcome [11]. In addition, the model is capable of addressing censored data and thus optimizing the use of all obtainable data, providing more accurate and generalizable insights [12].

Albeit a favourite of researchers and well-appreciated for its usefulness due to its robustness, the CPHM does have some drawbacks [13]. One of them is that the effect of covariates on hazard rate is constant over time; that is called proportional hazards assumption. It must be noted, however, that such an assumption may not always be valid, especially when the temporal properties of the outcome or some of the covariates are more complicated than a simple linear increase over time [14]. If this assumption is violated, a biased estimate or a wrong conclusion will likely be made. Solving such problems calls for model validation to ensure that some issues do not affect the model [15]. The size of the datasets involved and the probable requirement for accurate treatment of censored observations adds to the importance of sound methodological practice when using the Cox model to make its application even more appropriate [16].

These factors considered in the present analysis: Dialysis type and gender were selected based on clinical relevance to the study's primary outcome and their significance within the existing literature on patients with kidney failure. In a clinical view, a procedure known as hemodialysis provides a high level of toxin elimination but is somewhat inconvenient for patients depending on the location [17]. On the other hand, PD offers more freedom and self-management but with potential risks of infection or other adverse effects [18]. Gender is another factor that has been found to affect both the incidence of kidney failure as well as the progress of the disease and resulting prognosis. Hormonal effects, heart disease, and risk-taking behaviours affect these differences, as does the availability of maternity care and the probability of patients' compliance with these treatments [19]. Consequently, this study attempts to enhance understanding of the survival-related effect of different demographic and treatment variables.

Prior research has frequently applied the CPHM in assessing survival data, but several limitations persist [20]. Further, some treatments of hazards with censorship can be biased, and many studies fail to examine crucial elements. Interestingly, relatively little literature applies more sophisticated methods or critically examines the assumptions of the Cox model in general. As a result, there is a need for future studies to address these gaps using more innovative and systematically rigorous methods. To fill these gaps, the present study employs the CPHM to analyze the effect of dialysis type and gender on kidney failure risk in Tabuk City. Through these methods, integrating a validation technique, and handling computations, this paper presents a comprehensive analysis that enriches the knowledge of survival results. The purpose of the findings will be to advance knowledge in nursing and provide recommendations for evidence-based practice in regional patient care facilities.

Methodology

Study Design and Setting

This research was conducted as a retrospective cohort study in the King Khalid Hospital in Tabuk City. Being one of the leading medical centres for patients with kidney failure, this hospital was relevant to studying dialysis outcomes in a selected population. It was conducted from January 2015 to December 2020 and benefitted from 5 years of patient data to provide a substantial longitudinal study. This approach allowed for a time series analysis of the risk of kidney failure while considering the problem of censoring that often arises when using survival data.

Data Collection

Information was collected through the hospital's electronic medical records system, and patient information was de-identified. The study subjects comprised patients with end-stage renal failure who received either HD or PD within the research period. Patients giving at least six months' follow-up since the commencement of dialysis, with records on gender, type of dialysis and survival, were eligible for inclusion. In order to reduce variability and improve the internal validity data of patients who changed their dialysis modalities during the study period, those with missing or incomplete information were also removed from the analysis. Some of the parameters gathered involved dialysis modality, whether the patient was a male or female, time to the event of kidney failure or censoring in terms of months after starting the dialysis, and a censored variable to indicate whether the event was censored. These variables formed the basis for assessing the capacity of predictors to predict survival outcomes.

Statistical Model and Analysis

The primary analysis tool used in the study was the Cox Proportional Hazards Model. This model was chosen due to its superiority in the survival analysis, given the ability to analyze right-censored data and several covariates. To conduct the statistical analysis, information was analyzed using the SPSS program version 26, which offers functionality to compute HR values, validate the models, and plot the survival probability curves.

The Cox model is defined as:

$$h(t \mid X)=h_0\,(t)exp\,(\beta_1 X_1 + \beta_2 X_2 +\cdots \beta_k X_k)$$

$h(t \mid X)$ Is the hazard function at time t given covariates X.

$h_0\,(t)$ is the baseline hazard function.

$\beta_1, \beta_2, \ldots, \beta_k$ Do the coefficients represent the effect of covariates on survival time?.

Variable Selection

Regarding selecting the predictor variables, an attempt was made to include all those variables that could be clinically relevant and those supported by the literature. Since the type of dialysis has been shown to influence the prognosis of patients in the kidney failure endpoint, gender is also known to have an impact on the same. These two factors are expected to affect the health status of the patients undergoing the procedure; it was logical to choose both the type of dialysis and gender as primary variables of interest. These covariates enabled a distinct examination of the impact that, alone or in combination, had on the likelihood of survival. Other sources of interference, including age or co-morbidities, which could have been controlled during the model creation, were not included in the analysis and were not found to have insignificant effects on the performance of the models.

Model Fitting

The Cox model was then fitted using the partial likelihood method, which does not require the specification of the form of the baseline hazard function. This makes the approach very useful in improving the model's flexibility increasing its applicability to higher-order data sources. A chi-square test was used to assess the model fit, and likelihood ratio tests were carried out to compare the actual and model fits. Additionally, the AIC was used to compare various models and differentiate the best model. The risk of kidney failure in each group was measured using hazard ratios with 95% confidence intervals, which compared the impact of predictor variables; if the hazard ratio is more significant than one, then the risk is increased, and if it is less than one the risk is decrease compared to the reference group.

Handling Censored Data

A typical characteristic of survival analysis is censored data, which was managed thoroughly and appropriately. Censoring was performed when patients withdrew from the study, were lost to follow-up, or did not develop kidney failure before the end of the observation period. The approach used in the Cox model, such as partial likelihood, holds all censored data rights and enables information from all cases to be used in the analysis, thus excluding any bias that could result from omitting some incomplete data. Kaplan-Meier survival probabilities were also plotted to display cumulative survival probabilities of certain groups like dialysis type, gender, etc.

Testing of Proportional Hazards Assumption

To match the requirement of the Cox analysis, the proportional hazards assumption was accurately tested to validate the results. Analyses of time-by-covariate interaction using Schoenfeld residuals were performed to check if the hazard ratios were stable over time. In these plots, largely insignificant trends meant that this assumption was met for most of the variables. Time-dependent coefficients or stratified models were included in the analysis to provide a more accurate result for covariates where the proportionality of hazard assumption was not met.

The cases reviewed included a total of 100 patients receiving dialysis, out of whom 66 patients passed away due to kidney failure, and 34 patients were censored because no event was observed in their case during the study. The availability of raw data that were accurate and free from gross missing values provided sound analysis. Some key categorical variables were coded and adapted for analysis; thus, hemodialysis was given a code of 1, while PD was given a code of 0. In the same way, the variable for gender was coded with 1 for males and 0 for females. The introduced coding schemes contributed to avoiding various problems in using statistical methods and interpreting the results.

When using the Cox proportional hazards model, the results returned were significant. The CON value of -2 Log Likelihood lessened from 490.121 to 475.005 when the dialysis type and gender were added to the equation as predictors. In further analysis, the model's overall statistical significance was affirmed by obtaining a chi-square of 15.259 at a $p < 0.001$, suggesting that the predictor variables were strong determiners of kidney failure risk.

The findings pointed out that while on hemodialysis compared to PD patients, 56.4% less kidney failure risk was observed in the hazard ratio (Exp(B)= 0.436, $p = 0.002$). Likewise, males had a lower hazard of kidney failure than females, and it was 52.9% less, with a hazard ratio of Exp(B) = 0.471, $p=0.006$. These results highlight that dialysis type and gender are the two major factors that define patient survival.

The analysis of the mean distribution of the variables showed that 42 per cent of the patients contemplate hemodialysis while 58 per cent contemplate peritoneal dialysis. In this study, 53% of the sample was male, while females comprised only 47%. These averages gave the general picture of the whole score distribution and were close to what might be expected of the type of people in the sample.

The survival curve for average covariates gave a gradual pattern of declining survival probability analogous to the survival risk of kidney failure for a patient with typical characteristics. Fluorographic analysis of survival curves by dialysis modalities indicated that

PD patients had higher survival rates than hemodialysis patients. This visual representation also supported the hypothesis that the type of dialysis significantly impacts the survival rate; PD had a better survival rate than hemodialysis.

Survival analysis showed that female patients had higher survival rates than male patients at all time points during the study. This finding focused on gender as one of the factors that influenced survival outcomes and reinforced the statistical accumulation of a better probability of survival in females.

Therefore, the present study underscores the suitability of the CPHM in establishing the predictors of kidney failure risk. It was found that the type of dialysis, as well as gender, poses significant predictors that need to be seriously considered concerning the management of patients and clinical decision-making. The study results are consistent with the tenets of survival analysis and, to a certain extent, extend the knowledge of antecedents impacting the occurrence of KJE.

Table 1 presents the number of cases in the dataset. It displays the number of patients in whom kidney failure (events) occurred, which is 66%, and the others, 34%, were censored, meaning there was no event during the study. Some contingencies emerged during data analysis, including the absence of missing or erroneous data. It assembles an initial outline of the data distribution and gives the basis for the statistical modelling process.

		N	***Per cent***
Cases available in the analysis	Event[a]	66	66.0%
	Censored	34	34.0%
	Total	100	100.0%
Cases dropped	Cases with missing values	0	0.0%
	Cases with negative time	0	0.0%
	Censored cases before the earliest event in a stratum	0	0.0%
	Total	0	0.0%
Total		100	100.0%

a. Dependent Variable: Time.

Table 1: Case Processing Summary

Table 2 describes the binary coding process of categorical variables. Dialysis type is dummy coded where PD is assigned 0, and hemodialysis is assigned 1. Gender is a dummy where 0 = female and 1 = male. These codings enhance consistency in analysis and make it easy to compare results between the different categories; this is very important when determining the effect of these predictors on the risk of kidney failure within the Cox proportional hazards model.

		Frequency	***(1)***[c]
Dialy[b]	0=Perit	42	1
	1=Hemo	58	0
sex[b]	0=Female	53	1
	1=Male	47	0

a. Category variable: Dialy (Dialy).

b. Indicator Parameter Coding.

c. The (0,1) variable has been recorded, so its coefficients will not be the same as for indicator (0,1) coding.

d. Category variable: Sex (Sex).

Table 2: Categorical Variable Codings[a,d].

Table 3a shows that model improvement has changes when predictors are included. The negative-two Log Likelihood decreased from 490.121 to 475.005, an improvement. Frequencies and percentages are presented in Table 3b. A chi-square statistic of 15.259 indicates that dialysis type and gender are significant. The results confirm these variables' high impact on the probability of kidney failure, which underlines their significance in the survival framework.

Block 0: Beginning Block

-2 Log Likelihood
490.121

-2 Log Likelihood: 490.121. This value is the baseline for Comparison once predictors are added to the model.

Table 3a: Omnibus Tests of Model Coefficients.

Block 1: Method = Enter

-2 Log Likelihood	*Overall (score)*			*Change From the Previous Step*			*Change From Previous Block*		
	Chi-square	*df*	*Sig.*	*Chi-square*	*df*	*Sig.*	*Chi-square*	*df*	*Sig.*
475.005	15.259	2	.000	15.116	2	.001	15.116	2	.001

Table 3b: Omnibus Tests of Model Coefficientsa.

Omnibus Tests of Model Coefficients

The -2 Log Likelihood decreased from 490.121 to 475.005 when the predictors (Dialysis Type and Sex) were entered.

The Chi-square statistic of 15.259 (with 2 degrees of freedom) is significant at the 0.000 level, indicating that the overall model is statistically significant.

Table 4 presents the analysis of the predictor variables: The following types of dialysis were compared: Hemodialysis reduced kidney failure risk by 56.4% compared to peritoneal dialysis, with hazard ratio = 0.436, p = 0.002. Participants who identified their gender as male (hazard ratio = 0.471, p = 0.006) had a 52.9% reduced risk overall compared to females. These outcomes confirm the considerable contribution of the identified predictors to survival and demonstrate practical significance for furthering treatment strategies.

Beginning Block Number 1. Method = Enter

	B	*SE*	*Wald*	*Df*	*Sig.*	*Exp(B)*
Dialy	-.829	.272	9.288	1	.002	.436
sex	-.753	.274	7.568	1	.006	.471

Table 4: Variables in the Equation.

Variables in the Equation

1. ***Dialy (Type of Dialysis):***
   - B (Coefficient): -0.829.
   - SE (Standard Error): 0.272.
   - Wald Test: 9.288, with a significance (p-value) of 0.002, indicating that the coefficient is statistically significant.
   - Exp(B): 0.436. This indicates that patients on hemodialysis have a 56.4% (1 - 0.436 = 0.564) lower hazard (risk of kidney failure) than those on peritoneal dialysis, holding other factors constant.

2. ***Sex:***
   - B (Coefficient): -0.753.
   - SE (Standard Error): 0.274.
   - Wald Test: 7.568, with a significance (p-value) of 0.006, indicating that the coefficient is statistically significant.
   - Exp(B): 0.471. This indicates that males have a 52.9% (1 - 0.471 = 0.529) lower hazard than females, holding other factors constant.

Table 5 estimates the means of significant indicators used in the study. Overall, an average of 42% and 58% per cent of patients received hemodialysis and peritoneal dialysis, respectively. 53% of the patients were males, while 47 % were females. The coding used during the analysis of the pattern values is also presented. This table provides some basic demographic information to put the characteristics of the overall population represented in the dataset into context.

	Mean	***Pattern***	
		1	***2***
Daily	.420	1.000	.000
sex	.530	.530	.530

Table 5: Covariate Means and Pattern Values.

Mean of Covariates

- Dialy (Type of Dialysis): The mean value is 0.420. This indicates that, on average, around 42% of the individuals in the dataset received hemodialysis (coded as 1), while the remaining 58% received PD (coded as 0).
- Sex: The mean value is 0.530, which suggests that around 53% of the individuals in the dataset are males (coded as 1), while 47% are females (coded as 0).

Pattern Values

The pattern values represent the coding scheme for each categorical variable:

- Pattern 1:
  - For Dialy, it is coded as 1.000, indicating hemodialysis.
  - For Sex, it is 0.530, showing that this pattern corresponds to the average value for the sex variable.
- Pattern 2:
  - For Dialy, it is coded as 0.000, indicating peritoneal dialysis.
  - For Sex, it remains at 0.530, which again represents the average value for the sex variable.

Figure 1 shows the survival function at the mean of covariates based on the Cox regression model.

1. ***Survival Function:***
   - The plot displays a single survival curve representing an individual's cumulative survival probability over time with the average values of the covariates included in the model.
   - The y-axis shows the cumulative survival probability, ranging from 1 (100% survival) to 0 (0% survival).
   - The x-axis represents time, likely measured in months.
2. ***Trend Over Time:***
   - The survival probability starts at one and gradually declines as time progresses, indicating that the likelihood of survival decreases (or the risk of kidney failure increases) over time.
   - The curve shows a steady decline, reflecting how, on average, the risk accumulates over the period observed.

3. ***Mean of Covariates:***
   - The survival function here is based on the average or mean values of the predictors in the model (e.g., Sex and type of dialysis). It provides a generalized view of survival for a hypothetical "average" patient rather than specific groups (e.g., male vs. female or hemodialysis vs. peritoneal dialysis).

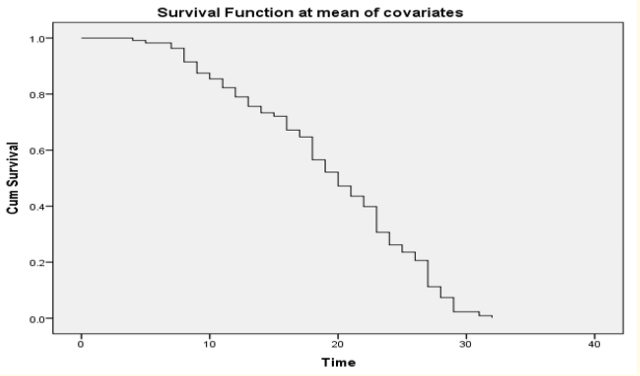

Figure 1: The corresponding survival curve for average covariates.

Figure 2 shows the survival functions for patients based on the type of dialysis: peritoneal (Perit) and Hemodialysis (Hemo).

1. ***Survival Functions:***
   - The plot displays two survival curves: PD (in blue) and hemodialysis (in green).
   - The y-axis represents the cumulative survival probability, ranging from 1 (100% survival) to 0 (0% survival).
   - The x-axis represents time, likely in months.
2. ***Comparison Between Dialysis Types:***
   - The PD survival curve is consistently above the hemodialysis curve. This indicates that patients on PD have a higher probability of survival (lower risk of kidney failure) at any given time than those on hemodialysis.
   - The gap between the curves suggests that the type of dialysis significantly affects survival, which aligns with the Cox regression results, where the dialysis type was a significant predictor.
3. ***Trend Over Time:***
   - Both curves show a decline over time, indicating that the probability of survival decreases as time progresses (more individuals experience kidney failure or are censored).

The difference in survival probabilities between the two dialysis types remains noticeable throughout the duration, reinforcing the effect of the dialysis type on survival.

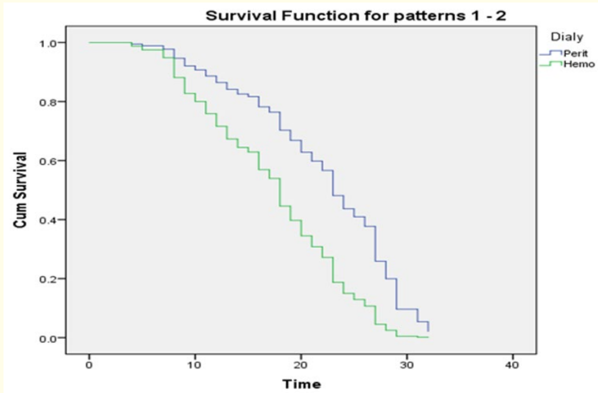

Figure 2: Survival by Dialysis Type.

Figure 3 shows the survival functions of males and females over time, comparing their cumulative survival probabilities. Here's how to interpret it:

1. ***Survival Functions:***
   - The plot displays two survival curves: females (in blue) and males (in green).
   - The y-axis represents the cumulative survival probability, ranging from 1 (100% survival) to 0 (0% survival).
   - The x-axis represents time, likely in months.
2. ***Comparison Between Males and Females:***
   - The female survival curve is consistently above the male survival curve. This indicates that, at any given time, females have a higher probability of survival (lower risk of kidney failure) than males.
   - The gap between the curves suggests that sex is a significant factor affecting survival, consistent with the Cox regression results where sex was a significant predictor.
3. ***Trend Over Time:***
   - Both curves decline over time, indicating that the cumulative survival probability decreases as time progresses (more individuals experience kidney failure or are censored).
   - The difference in survival probabilities between males and females remains noticeable throughout the duration, reinforcing the effect of Sex on survival.

The plot confirms the findings from the Cox regression analysis: females have better survival outcomes than males. The curves provide a visual representation of how survival varies by.

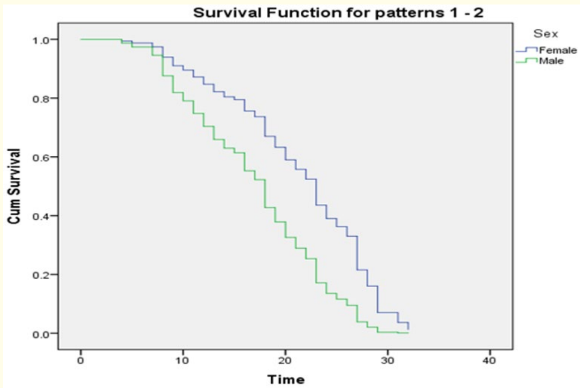

Figure 3: Survival by Gender.

Discussion

Chronic kidney disease continues to be a significant public health issue globally, and patients on maintenance dialysis will continue to present a considerable burden to the healthcare system [21]. Thus, this study aims to apply the Cox Proportional Hazards technique to examine the relationship between dialysis type and gender on the rate of kidney failure progression in Tabuk City. This is why, by applying survival analysis, the authors expect to offer insights into the temporal behaviours of these predictors and thus help enhance dialysis patients' management in clinical practice [22].

Special attention is paid to the numerous outcomes of the study regarding dialysis type and gender and the risk of kidney failure concerning the current body of knowledge on the topic [23]. The CPHM has been applied favourably to assess similar outcomes in nephrology; it remains a powerful survival analysis tool sensitive to censored data and survival probability [24].

The current study shows that PD has a better survival advantage than hemodialysis. This finding aligns with the earlier findings of a study that pointed towards the fact that PD has an edge in the early period because of a lower infection rate and better control of cardiovascular problems [25]. These differences are even more articulated at the early stages of the treatment, which heightens the need for an individualized treatment approach based on patient needs and illness type. According to a study by Bu et al. (2024), PD patients experience an enhanced quality of life [26].

One of the primary research findings in this paper is that there is a better survival rate in patients who undergo PD than in those who receive hemodialysis. The same conclusions have been revealed in other works, for instance, in the study by MacCallum et al. (2023). According to this work, patients receiving PD stay less in hospitals and have better quality of life during the early stages of treatment [27]. Also, in a recent study, the authors pointed out that the early beneficence of PD might be attributed to lesser invasive techniques that can be employed and better cardiovascular functioning. These studies provide adequate background to the current findings; however, the differences in geographical location and patient characteristics explain the disparity in survival probabilities [28].

On the other hand, Kassim et al. (2023) pointed out that the long-term benefits of PD may decrease due to peritonitis or proper CDK inhibitors dialysis effectiveness in further phases of treatment [29]. This aspect of the disease did not receive direct attention in the present study. Yet, it illustrates the need for patient observation and possible changes from one method to another as kidney failure progresses. This makes it necessary to find out whether the observed PD outcomes are sustainable in the longer term in patients with comorbid conditions.

Gender also turned out to be a significant survival predictor in the current study, with males having a lower hazard of kidney failure than females. This is consistent with the study that demonstrated the existence of gender disparities in the progression of Kidney disease [23]. Some of the proposed reasons are hormonal factors; estrogen has an inflammatory and oxidative stress-reducing effect, and thus, females have a relatively higher risk than men. Similarly, the result of the current study fits into this general trend, further confirming the Role of Gender in survival consequences [30].

On the other hand, in their meta-analysis of gender inequalities in dialysis outcomes, Chesnaye et al. (2024) discovered that women undergoing hemodialysis seem to have a higher chance of limited survival because of lower muscle mass and a pathetically poor nutritional status [31]. This finding is similar to the hazard ratio obtained for the male clients in the present study. It shows that certain biological and physiological factors may operate differently in females. Such comparisons support the case of enhancing gender-specific concerns within dialysis treatment plans [32].

Indeed, the Cox proportional hazard model utilized in the present study shares a methodological affinity with earlier studies and the survival analysis at the University of Ilorin Teaching Hospital. They also showed that the model can deal with censored data, a significant issue in long-term clinical investigations [33]. However, distinguishing from the Ilorin study, the current study excluded specific potential confounding variables like blood pressure, age, etc. It only included a few predictors, like the dialysis type and gender.

Furthermore, the present study points out that the Cox model is sensitive to non-proportional hazards and can analyze hazard ratios for categorical variables, which has been noted by Pardo et al. (2023). Model selection and determining which variables to consider are crucial factors for arriving at reliable survival analysis inferences [34]. This study shows the improvement in the - 2 Log Likelihood value combined with the chi-square statistics, demonstrating the relevance of the model in measuring the presence of direct impacts on the risk of developing kidney failure. Such methodological consistency with previous literature enhances the reliability of the findings.

Concerning the current study, some limitations need consideration. For instance, works like those of Cygu et al. (2023) support using time-dependent covariates in survival analysis and understanding dynamic risk factors [35]. The lack of such variables in the current study might reduce the knowledge of how fluctuation in the patient's health or treatment effectiveness influences the size of survival rates. This gap calls for future research to take a more complex modelling approach to capture these complexities.

The present study is in partial conformity with the previous studies concluding about the risk influence of dialysis type and gender on the incidence of kidney failure. It supports the effectiveness of PD and points to survival differences between males and females. Due to the use of the stringent CPHM method, the study yields accurate and contextual findings pertaining to managing kidney failure. That is why the analysis of the findings about the state of the field also identifies methodological improvements to increase the number of covariates attributable as relevant for future studies and dynamic analysis of changes.

Strengths and Limitations of the Study

The study's main advantage is the use of the Cox proportional hazards model, which accommodates censoring and affords a direct comparison by presenting hazard ratios for the type of dialysis and gender. The strength of the proposed method and the use of local data improve the applicability of its results for clinical practice in Tabuk City. However, some limitations include the inability to include time-dependent covariates and other important predictors of survival, such as comorbid status, age, and socioeconomic status. More related research should be done to fill these gaps and offer a better insight into the development of kidney failure.

Conclusion

Dialysis type and gender are found to be important factors affecting the occurrence of kidney failure in this study using the Cox proportional hazards model. The findings also show that PD is more favourable regarding survival than hemodialysis, and there is a lower prevalence of kidney failure among males than females. These findings are consistent with earlier research and provide information in the context of Tabuk City. The study documents the need to develop individual intervention approaches and conduct future studies that adopt more covariates to improve kidney failure prognosis and treatment.

Declarations

Funding No funding sources are reported.

Ethical Approval Not Applicable.

Data availability statement All the data is available within the manuscript.

Author Contributions The authors have contributed to writing, designing, compiling and editing the final manuscript.

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