Factors affect Chronic Kidney Disease in Gezira Region of Sudan

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Abstract

The goal of this study is to explore the factors that affect kidney disease patients in Sudan's Gezira region. A sample of 240 patients and control group members was drawn. Cox regression was used in Stata 16 to determine the factors that cause the time lag between diagnosis and first dialysis, as well as the factors that prolong the duration of patients' conditions. The majority of the factors in the first model are disease-related, such as symptoms, blood in the urine, infection in the urine, regular diagnosis, urethra, dialysis availability, as well as income, and moving to the hospital. Factors that prolong the duration of illness are more closely related to the patients' behavior, which is the age of the patient, the conduct of social work, how to reach the hospital, punctual taking of medications, adequate income, the cost, and availability of dialysis. The policy implications of the findings are how to strengthen the healthcare system and how to educate patients on the proper ways to deal with the disease.

Key Words: disease-related factors, patients' behavior, economic factors, time lag, duration

1. Introduction

The Center for Disease Control and Prevention defines chronic kidney disease (CKD) as a sickness in which the kidneys have been impaired and are unable to filter blood properly. As a result, blood waste and excess fluid stay in the body leading to other health issues such as heart disease and stroke. Kidneys are vital organs that aid in blood pressure control, red cell formation, chemical regulation in the blood, and keep bones healthy. (https://www.cdc.gov/kidneydisease/basics.html 2021). Kidney disease affects about 15% of the world's adult population causing insufficiency in red cells, frequent inflammation, low levels of calcium, high potassium, and phosphorus levels, as well as loss of appetite and a lower standard of living. However, the risk factors are diabetes, high blood pressure, heart disease, a family history of CKD, and obesity.

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The Gezira region is located in the heart of Sudan and contains one of the largest agricultural scheme in the Middle East, making it one of the county's most important areas. The region's capital, which is Sudan's second-largest city 409 above sea level on the west bank of the Blue Nile, 186 far from Khartoum the capital of Sudan. It has a kidney hospital for care and dialysis.

The launch of dialysis operations in Wad Madani dates back to the mid-1990s when the kidney section started work on dialysis for patients, which was then followed by the Madani Educational Hospital, and this section received funding from a range of medical institutions and charities from around the world, as well as local charities. Gezira Hospital for Kidney Diseases and Surgery first opened its doors to patients in 2003. The failure of some dialysis machines in Wad Madani Hospital for kidney Surgery results in increased suffering for patients undergoing blood dialysis, a terrible deterioration in in-hospital services, a deterioration in patient condition, and severe suffering caused by the lack of funds for dialysis surgery. Thirty dialysis machines have two dialysis sessions a week for 263 patients. As a result, patients are exposed to body fluids, lung inflammation, and shortness of breath, which may lead to death if dialysis is not performed, (https://www.alnilin.com/159431.htm). There is a growing number of CKD patients admitted to the hospital, accordingly, this phenomenon requires investigation. A questionnaire was designed with four parts, beginning with socioeconomic information, risk factor diagnosis, illness history, and elements that may hinder proper care and dialysis. A total of 300 questionnaires were distributed to the control group and patients, with 240 of them returning the questionnaires.

The growing prevalence of chronic renal disease in Sudan is the impetus for this research. Many medical studies have been conducted with a focus on the medical side; this study combines data on survival time based on socioeconomic factors and disease-related factors.

The study is divided into five sections: introduction, literature review, methodology, results and discussion, and conclusion.

2- literature Review

Lartey (2018) used a Cox Proportional Hazards Model to analyze data on when students dropped out of an introductory statistics course (STAT 216). The data showed that the number of prior math courses taken and/or MPLEX scores affected the time it took for students enrolled in STAT 216 to drop out. Milad (2018) demonstrated how Cox's regression is used to illustrate quantitative and descriptive variables of gender, body mass, and age groups via SPSS. Huwail (2018) used Kaplan-Mayer to extract 7 factors, and Cox regression to assess factors that influence patient survival. The data were obtained from records of patients with thalassemia at the ZiQar Health Department's Center for Hematological Hematology. Radiaan (2016) estimated survival functions using lognormal and Webeil, as well as Kaplan-Meyer, and checked equal survival functions using logarithm grades, before estimating Cox model parameters using the partial Likelihood method and evaluating variables using the Wald test. Bikair (2015) contrasted the logistic regression and Cox regression models to investigate the most significant determinants affecting women's marital status in Palestine. He discovered that the logistic regression model works best in evaluating the most important factors that have influenced women's marital status in Palestine, including refugee status, mother's survival, father's survival, educational status, and employment status. Mohamed, Ahmed, and Yusuf (2016) used Weibull, log average, exponential, and cox regression to examine factors that affect the survival time for breast cancer patients at Atom educational hospital / Khartoum / Sudan, from 2010 to 2014. A total of 384 samples were chosen. To investigate infant mortality in Palestine, Altelbani (2015) applied logistic regression and Cox regression to find the same variables that affect the phenomenon. The variables are sex, newborn whether single or twin, mother's education, and iron tablets are given to the mother during pregnancy. Apart from the age of the first and second marriage, Zaid (2014) looked at the causes of infant mortality in Palestinian territories using the 2010 Household Survey and found a decrease in the infant death rate. Hassan and Salih (2014) collected data from Baghdad's Shaikh Zaied emergency hospital for 165 patients infected with brain cancer between 2010 and 2012. They used the Cox – regression model. The Likelihood Ratio Test revealed that the model is far more suitable for the data of their study. Arabi and Elhassan (2013) discovered that pain in the kidneys, trembling, fever, headache, and pain between the shoulders are all symptoms of kidney failure treated at Hussein Abdalazeez Center for Renal Dialysis and Surgery in Duwaim, Sudan, this misery is exacerbated by socioeconomic factors such as mode of transportation, lack of socialization. Osman, Abboud, and Danielson (1987) conducted a comparative study of chronic renal failure causes in Sudan and Sweden (CRF). Chronic glomerulonephritis, obstructive nephropathy (stone disease), hypertension, and diabetes mellitus were discovered in that order in Sudan, and chronic glomerulonephritis, diabetes mellitus, and chronic pyelonephritis were discovered in that order in Sweden.

3. Methodology and Data

3.1 The Hazard Function

The hazard function h(t) is given by the following:

$$h(t) = P\{t < T < (t + \Delta)|T > t\} = \frac{f(t)}{(1 - F(t))} \quad (1)$$

The hazard function defines the concept of the risk of a result (e.g., death, failure, or time to get a job) in an interval after time t, assuming the subject survives to time t. It is the probability of an individual dying between t and $(t + \Delta\ )$, divided by the probability of the individual surviving beyond time t. Because it attempts to quantify the instantaneous risk that an event will occur at time t given that the subject survived to time t, the hazard function appears to be more intuitive to use in survival analysis than the probability density function (Smith, Smith, and Ryan (1999)

3.2 The Proportional Hazard

T and ANOVA tests require data normality, which does not apply to data of time elapsed to the event, and these data are right-skewed, so survival analysis is appropriate for such data. Survival time (time elapsed to event) data is distinguished by two characteristics: it is highly skewed and censored (incomplete), which precludes multiple regression analysis. So the most suitable type of analysis is proportional hazard regression (Hassan and Salih 2014). The real difference between a hazard and a rate is that a hazard happens right away, while a rate is calculated over time. The hazard ratio is the covariate hazard compared to an unspecified baseline (Koletsia and Pandis 2017). Proportional hazards models are a type of statistical model that relates the amount of time that elapses before an event to one or more covariates that may be associated with that amount of time. When comparing two groups, the hazard ratio is used. The hazard ratio, in particular, is the ratio of the total number of observed to expected events in two independent comparison groups.:

$$HR = \frac{\sum O_{Expopsed,t} / \sum E_{Exposed,t}}{\sum O_{Uexposed,t} / \sum E_{Unexposed,t}} = \frac{\sum O_{treated,t} / \sum E_{treated,t}}{\sum O_{control,t} / \sum E_{control,t}} \quad (2)$$

As the dependent variable in this study is time elapse between diagnosis and first dialysis session, and the duration of kidney disease, a hazard ratio of one value indicates that there is no systematic increase or decrease in the hazard of the dependent variable with changes in the predictor variable. A value of hazard ratio greater than one would reflect that as values in the predictor increase, there is an increasing hazard for the dependent variable. And a value less than one indicates that higher values in the predictor are associated with a lower hazard of the dependent variable. All Cox regression requires is the assumption that the ratio of hazards across groups remains constant over time. Stata package tests proportional hazard assumption.

The Cox proportional hazards regression model can be written as follows:

$$h(t) = h_0(t) exp\left(b_1 X_1 + b_2 X_2 \cdots + b_p X_p\right)(3)$$

Where $h(t)$ is the expected hazard at time t, $h_0(t)$ is the baseline hazard and represents the hazard when all of the predictors (or independent variables) X_1, X_2, X_p are equal to zero. The negative sign of income indicates individuals in the (zero) group have a lower hazard during the observed survival time than those in the (one) group. A hazard ratio greater than one implies that the covariate is higher in percentage than the dependent variable, whereas a hazard ratio less than one indicates that a one-unit rise in the predictor results in a one-unit decrease in the dependent variable by the number 1 minus the hazard ratio. (Koletsia and Pandis 2017). The relative risk indicates that a variable with a high label is likely to have the event than that with a low label, and the number of times is calculated by $e^{\hat{\beta}}$, as well as $R^2 = 1 - \exp\left(\frac{LR^2}{n}\right)$ (Smith et.al 1999)

3.2 Data

Primary data was collected using a questionnaire distributed to 300 patients and control group respondents admitted to Madani hospital for Kidney Treatment and Surgery in Sudan's Gezira region; 240 questionnaires were returned. There are primary patients' data, pre-infection by diseases, diagnosis, and patient's opinion about the cause of kidney disease. One of the study's weaknesses is that the censoring was not done properly due to the nature of data collection by a questionnaire taken instantly rather than following up with patients over a while. Censoring takes three forms: right censoring after recorded follow-up left censoring time before recorded follow-up, and internal censoring between two times (Stevenson, Mark (2007Half of the patients strongly agree that the high cost of dialysis contributes to the cession, while a quarter strongly agrees that dialysis availability is a problem. As a result, both variables are regarded as predictors. Respondents who did not have kidney disease at the time of data collection are censored to take the value (0). The chi-square associated with a likelihood relative to the normal alpha is used to determine the model's overall significant fit to the results. The chi-square associated with a probability relative to normal alpha is used to evaluate the cox assumption. The individual coefficients are interpreted as predicted change in log hazard so it is for every one-unit increase on the predictor variable.

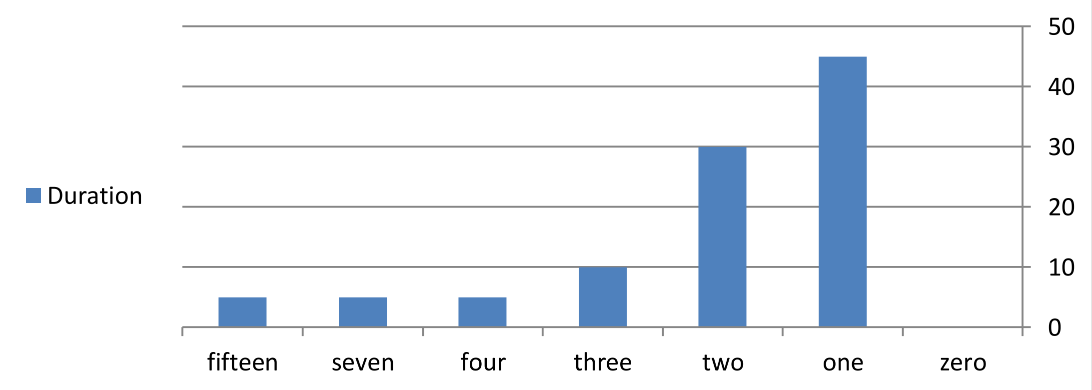
4. Results and Discussion

4.1 Descriptive Statistics

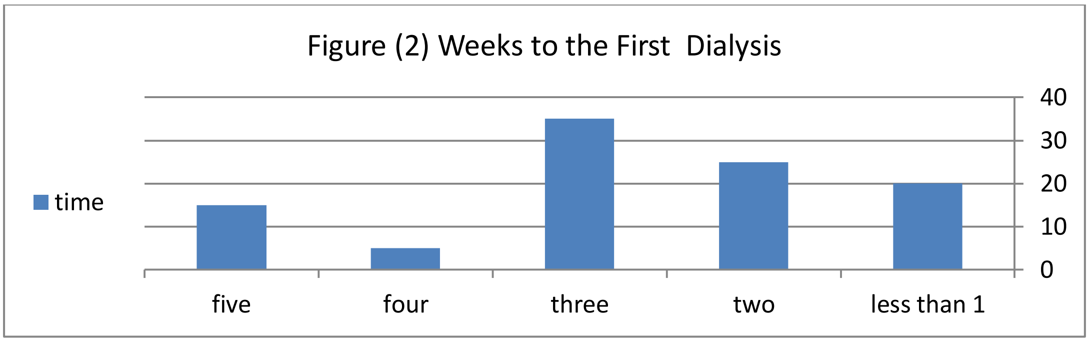
Households account for 35% of kidney patients, 45% are between the ages of 40 and 59, 40% and 25% of total kidney patients, respectively, stopped dialysis due to a lack of dialysis and high costs, only 25% started dialysis right after diagnosis, 47.5% regularly making a diagnosis, and 42.5% punctually taking medication. Kidney disease is caused by hypertension and cystitis in 40% and 30% of cases, respectively. Kidney infection, diabetes, and urinary obstruction each contribute 10% to kidney disease.

To see if the time of sickness and the time between the onset of sickness and the first dialyses are both not normally distributed, descriptive statistics indicate that both are not normally distributed with Jarque-Bera statistic 29.3 and 3391.9, respectively, with 0.000 probability. The average length of illness is 4.35 years, with a 1.33-week gap between diagnosis and first dialysis. Time of sickness (-0.54) is skewed to the left, and time to the first dialysis is skewed to the right (3.87). These findings support the use of the Cox proportional hazards regression model.

Figure (1) Duration of Kidney Disease in Years



Forty-five percent of patients have kidney disease for one year, and thirty percent have it for two years.



More than half of the patients postponed their first dialysis for two to three weeks. Only 15% deferred dialysis for five weeks. Eighty percent of those who postponed dialysis do so because of a lack of funds.

4.2 Estimation Results

Two models were estimated, the first of which has time as a dependent variable, which represents the number of weeks between the onset of the illness and the first dialyses appears in discrete values. The second is the length of time that kidney disease has been present whereas the variable is divided into five categories: less than one year, two years, three years, and four years or more.

The first model in Table (1) was designed to assess the amount of time that elapsed between the diagnosis of kidney disease and the first dialysis session. The model was tested for the proportional hazard assumption, yielding a chi-square of 11.56 with a probability of 0.24, confirming the acceptance of the hazard assumption. The likelihood ratio test (LR), which generated a chi-square of 367.52 with probability (000), confirmed the model fit. All of the estimates in the table above are statistically significant (***) and have the predicted sign. The results show that both models have common variables some with hazard ratio greater than 1 and the same signs i.e. blood in the urine, and expensive dialysis. Income as a common variable produces a contradicting, positive effect on the time to dialysis, with a hazard ratio greater than 1, and a negative effect on the duration of infection with hazard ratio less than one, therefore the effects of income time to dialysis is greater than on duration. On the contrary, the regular diagnosis has a negative effect, and a hazard ratio of less than one, while its effect on duration is positive with a hazard ratio greater than1, the effect on duration is more than time to dialysis. Income, urethra, availability of dialysis, regular diagnosis, and means to reach the hospital. Five variables have shown negative signs and hazard ratios less than one, which means that a one-unit increase in each of them is associated with a lower level of the dependent variable time to the first dialysis. A one-point improvement in stating that there is no infection in urine, for example, cuts the time to the first dialysis session by 0.4. The absence of an infection shortened the time required for the first dialysis. Similarly, the availability of dialysis, no link between kidney failure and economic factors, and regular diagnosis reduce the time to dialysis. The opposite is true for whether there is insufficient income, blood in the urine, and expensive treatment are associated with an increase in the time to dialysis, their hazard ratios were greater than one and associated with an increase in the time to dialysis. The absence of symptoms before learning of the infection resulted in a positive and hazard ratio greater than one, which lengthens the time to dialysis. The same is true for the discontinuation of dialyses due to affordably high costs.

Concerning the second model the Likelihood ratio (LR) is 71.02 with a probability of 0.00 indicating that the model fits the data extremely well. The test of proportional-hazards assumption is 9.9 with a probability of 0.45, indicating that the ratio of the hazards for any two individuals is constant over time. The absence of dialysis lengthens the disease's duration, as shown by the sign and magnitude of the calculated hazard ratio. Likewise, lack of adequate income prolongs the time of infection as the negative sign and the magnitude of less than one of the estimated hazard ratios by income. Similarly, the irregular diagnosis exhibits a positive sign and estimated hazard greater than one, indicating the augmentation of the time of the renal disease. In the same way, the high cost of dialysis causes patients to discontinue dialysis, a result reached by a positive sign and a magnitude of hazard ratio greater than one. Taking medications on time, not having a urethra, and doing social work, on the other hand, all have negative signs and have a lower hazard score, indicating that they are associated with a shorter disease period. Finally, as respondents get older, the difficulty of getting to the hospital and the presence of blood in the urine produce positive, greater than one danger ratios, indicating a connection with a longer duration of kidney disease. Thus, the expected signs were obtained for all the variables except for the effect of diagnosis on the duration of the disease.

Table (1) Cox Proportional Hazards Regression Model

Predicators	Time to the first dialyses		Duration: length of infection	
	Coefficient	Hazard Ratio	Coefficient	Hazard Ratio
Infection	-0.40***	0.67***		
Income	2.23***	9.92***	-1.08***	0.34***
Symptoms	0.36***	1.43***	-0.31***	0.73***
Urethra	-2.06***	0.13***	-3.09***	0.05***
Blood	1.37***	3.93***	1.74***	5.70***
Available	-0.55***	0.57***	-0.93***	-0.40***
Diagnosis	-0.58***	0.56***	0.41***	1.25***
Expensive	0.37***	1.45***	0.22***	1.24***
Reach	-0.50***	0.60***	1.27***	4.00***
Social			-1.08***	0.39***
Age1			1.14***	2.08***
Economic			0.24***	1.28***
Punctual			0.34***	0.78***
Chi Square	Test 367.52***	Fit 11.56 (0.24)	Fit 71.02***	Test 9.9 (0.45)

Source research's calculation by Stata 16

4.3 Discussion

On the one hand, patient behavior, except routine diagnosis, has a major effect on the time between diagnosis and first dialysis, as well as the duration of illness. They generate a negative hazard ratio sign, meaning that the patient's conduct reduces the time to dialysis and the length of the illness. Individuals with a higher socioeconomic rating had less risk of survival time than those with a lower level, according to socioeconomic factors. One-point progress in economic, diagnosis, infection, and availability cuts the time to the first dialysis session by 15%, 12%, 26%, and 22% respectively. Similarly, increasing the availability of dialysis, taking medications daily, and participating in social events decreases the duration of disease by 63 percent, 23 percent, 11 percent, and 68 percent, respectively. It's worth noting that the questionnaire responses were graded on a scale where the strong agreement was assigned a value of (1) and the strong disagreement was assigned a value of (5). Two aspects must be addressed: how patients get to the hospital and social work. It is well known that health problems associated with kidney dialysis include pain in the kidneys, trembling, fever, headache, and pain between the shoulders; however, because most patients reach the hospital by foot, their misery is multiplied. It is well understood in social work that people prefer to be alone, which contributes to their misery; however, doing social work reduces this suffering by putting their time to good use (Arabi and ElHassan 2013). Sufficient income, the absence of symptoms, the and availability of dialysis all reduce the chance of the condition lasting longer than it should. On the other side, blood in the urine, a lack of regular checkups, costly treatment, difficulties getting to the hospital, and advanced age all increase the likelihood of the condition lasting longer. As a result, human behavior, in combination with economic circumstances, has a substantial influence in extending the duration of renal disease.

One of the challenges in researching kidney patients is the Ministry of Health's and its affiliates' lack of historical patient records, which necessitated the use of primary data through a questionnaire. Aside from a shortage of medical researchers, doctors in Sudan devote their time to clinical work rather than study because there is no such occupation or career. Sudanese medical personnel do not work full-time in medical research and are often drawn to the clinical phase, which can preclude them from conducting outstanding research. This situation resulted in the presence of only a few researches on the internet, and those that are available date from the 1980s. The majority of Sudanese medical journals are not universal and do not appear in global medical search engines, rendering them unrecognized in the international community.

5. Conclusion

Cox proportional hazard has been applied to the primary data due to the existence of survival data and its deviation from normality expectations as well as its skewing to the right. Nine variables were used to analyze the factors that affect the time to first dialysis and their effect on the condition of kidney failure patients. The variables produced a negative sign and had a hazard ratio of less than one. The most important are socioeconomic and disease-related factors. However, ten variables were used to investigate the duration of the illness, four of which displayed negative symptoms and had less than one danger ratio. Patients struggle to get to the hospital because two-thirds of them do so on foot, and they are often faced with dialysis being inaccessible, in addition to its high cost, even though 95 percent of them have an insufficient income. The policy consequence is that the state and federal governments are responsible for a significant portion of the cost of rehabilitating the kidney hospital, as well as increasing the number of dialysis machines, improving the working environment, and building new facilities, as well as coping with the causes of kidney failure. Another crucial aspect is notifying patients and others who might be exposed to kidney disease about proper actions and avoiding activities that may aggravate or worsen their condition. Since insufficient funds play a role in delaying dialysis and thereby lengthening the time of disease, poverty must be irradiated. In terms of the disease's duration, there are 12 variables found, five of which lower risk and the other seven of which raise it.

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Appendixes

Appendix (1) You stopped dialyses because it was unavailable * Income

		Income		Total
		Adequate	Not Adequate	
You stopped dialyses because it was unavailable	I completely agree	6	90	96
	I don't agree	0	6	6
	I completely don't agree	0	18	18
	6	0	1	1
	NA	24	95	119
Total		30	210	240

Appendix (2) How long have you been sick * Regular diagnosis

		Regular diagnosis			Total
		I completely agree	I completely don't agree	NA	
How long have you been sick	Less than a year	18	6	0	24
	Two years	30	0	0	30
	Three years	42	0	0	42
	Four years	6	0	0	6
	Five years or more	18	0	0	18
	Not applicable	0	0	120	120
Total		114	6	120	240

Annex (3) Proportional hazard Assumption of Model (1)

	rho	chi2	df	Prob>chi2
income	-0.01	0.02	1	0.88
infection	-0.10	1.19	1	0.27
symptoms	0.12	1.77	1	0.18
urethra	0.00	0	1	1.00
blood	0.00	0	1	0.97
diagnosis	0.14	1.73	1	0.19
available	0.01	0.01	1	0.91
expensive	0.05	0.29	1	0.59
reach	0.10	1.18	1	0.28
global test		11.56	9	0.24

Annex (4) Proportional hazard Assumption of Model (2)

	rho	chi2	df	Prob>chi2
income	0.02322	0.09	1	0.7686
symptoms	0.01333	0.02	1	0.8826
urethra	0.05247	0.25	1	0.6145
blood	-0.02455	0.08	1	0.7727
diagnosis	-0.02988	0.16	1	0.6892
available	-0.02135	0.07	1	0.7965
economic	0.04178	0.27	1	0.6065

punctual	0.03525	0.15	1	0.6941
reach	-0.09516	1.18	1	0.2781
age1	0.02738	0.11	1	0.7434
global test		9.9	10	0.4491