Online ISSN 3007-1941 Print ISSN 3007-1933

https://msra.online/index.php/Journal/about

Multidisciplinary Surgical Research Annals
https://msra.online/index.php/Journal/about
Volume 3, Issue 1 (2025)

A Predictive Model to Identify the Risk Factors for Stage Wise Chronic Kidney Disease in Faisalabad, Pakistan

Asma Mobeen[1], Mahwish Arshad[2], Muhammad Aftab[3], Dr. Saima Zia[4]

Article Details

Keywords: Chronic Kidney Disease, End Stage Renal Disease, Glomeruler Filtration Rate, Creatinine Test

Asma Mobeen
Government College Women University Faisalabad
Muhammad Aftab
Government College University, Faisalabad
Mahwish Arshad
Government College Women University, Faisalabad
Dr. Saima Zia
Researcher, Management Sciences Department, The University of Faisalabad

ABSTRACT

Chronic kidney disease (CKD) is often referred to as a "silent disease". CKD often has no symptoms in its early stages and can go undetected until it is very advanced. Chronic kidney disease also known as chronic renal disease. Glomerular filtration rate (GFR) is the best test to measure the level of kidney function and determine the stage of kidney disease. CKD classifies into five stages, with stage 1 to stage 4 being the mildest and usually causing few symptoms and stage 5 being a severe illness with poor life expectancy if untreated. Descriptive statistics; chi square measures of association and binary logistic regression were used to estimate odd ratios and 95% confidence intervals of 300 patients to evaluate the stage wise risk factors of CKD. The objective of this study was to determine the risk factor of CKD and produce a predictive model for stage wise CKD in Faisalabad, Pakistan. For this purpose, a well-structured questionnaire was employed to collect data. The patients having; elder age, unmarried, family history of CKD, anemia, less drinking water, blood in urine and excessive use of cold drinks were found significantly contributing as the risk factors of severe stage of CKD.

INTRODUCTION

Humans have five integral organs named brain, heart, kidneys, liver and lungs. Kidneys are related to urinary system, it helps to remove waste and excess substancesfrom the blood, which contains extra salt, water and excess ions.The Glomerular Filtration Rate (GFR) is a standard clinical measure used to evaluate renal function. This gives us an idea that how well kidneys perform blood filtration. In routine clinical practice, theestimated Glomerular Filtration Rate(eGFR) is calculatedbased on blood creatinine levels, by taking into consideration culture, gender and age (Cheung et al., 2023; Ammirati, 2020). CKD occurs when the kidneys are damaged or glomerular filtration rate (GFR) falls below 60ml/min/1.73m2 forthree months or more (Jafar, 2006; Bruck et al., 2016). GFR is considered to be the famous method to check the performance of kidney. CKD is divided into five stages. Stage Irepresents the mildest form of CKD, usually shows very few symptoms, while stage5, the most advanced stage, shows a serious illness with limited chances of recovery, often requires dialysis or kidney transplantation (Ammirati, 2020; Rizvi et al., 2010). Early signs of CKD are weakness, lack of appetite, vomiting, swelling, drowsiness, depression, shortness of breath (Kazmi, 2013; Rizvi et al., 2013). GFRhelps determine the stages of CKD based on the value of creatinine test.GFR is estimated in clinical practice using readily calculated equations that adjust serum creatinine values to age, sex, and ethnicity (Couser et al., 2011 andKovesdy et al., 2022).Serum creatinine test helps todetermine whether creatinine, a waste product that kidneys should filter out of body, is building up in blood(Kovesdy, 2022).

CLASSIFICATION OF CKD

Chronic kidney disease (CKD) is categorized into five stages based on the severity of kidney dysfunction, which is measured by the glomerular filtration rate (GFR)to assess how well the kidneys are filtering waste and excess fluid from the blood. A lower GFR indicates more severe kidney damage. Here's a more detailed explanation of each stage of CKD.

STAGE 1: GFRgreater than90 ml/min/1.73m^2

In stage I, kidney function is normal or slightly decreased, but there is evidence of kidney damage (e.g., presence of protein in urine or abnormal imaging findings).

STAGE 2: GFR = 60-89 ml/min/1.73m^2

This stage is defined by a mild decrease in kidney function, with potential for further deterioration if the underlying cause is not addressed.

STAGE 3: GFR = 30-59 ml/min/1.73m^2

Stage 3 characterized by a moderate decrease in kidney function. Symptoms such as fatigue, swelling, and changes in urination may develop at this stage.

STAGE4:GFR = 15-29ml/min/1.73m^2

This stage indicates a severe decrease in kidney function. Dialysis may be needed as the kidneys are functioning at a fraction of their capacity.

STAGE 5 (ESRD):GFR less than 15 ml/ min/1.73m^2

Stage 5 is known as end-stage renal disease (ESRD)or kidney failure. Dialysis or kidney transplantation is required to sustain life (Kovesdy, 2022; Bin Hamid et al., 2020).

End-Stage Renal Disease (ESRD) is the final stage in the progression of chronic kidney disease (CKD). Kidney disease is often referred as'silent disease' because it almost took 10 to 20 years before the end stage comes (Anand, 2014). When the kidney stops working or unable to filter waste and excess substancesfrom the blood then dialysis is required. Dialysis helps to maintain blood pressure and decrease salt, extra water and wastes. Dialysis is considered the last stageof kidney treatment,as kidneys have almost stopped functioning at this stage. On the

other hand, kidney transplant is a complex and costly surgical procedure, involves a healthy person willing to donateone of his or her kidney to the person inneed(Sathya, 2012; Anglade, 2023).CKD is a major global health problem in the 21st century and is increasing in prevalence(Kovesdy, 2022).Chronic kidney disease (CKD) is a universal public health issue that has devastating effects on about 750 million people worldwide with varying prevalence rate (Kareem et al.,2023). Chronic kidney disease (CKD) affects 37 million americans and is the ninth leading cause of death. People with CKD experience high rates of disability, morbidity, and mortality (Cheung et al., 2023).

In Asia, the prevalence of CKD stages 3-5 is 11.2% on average. When CKD stages 3-5 are broken down by geographic sub-region in Asia, the prevalence is 13.1% in western Asia, 8.6% in east Asia, 12.0% in south-east Asia, and 13.5% in south Asia. 9.8% of upper-middle-class countries, 13.8% of lower-middle-class countries, and 6.4% of one low-income country have CKD stages 3-5 prevalence.The mean CKD stage 3–5 prevalence is 12.1% in the India, 11.1% in Philippines, 7.0% in South Korea, 7.9% in Sri Lanka, 9.2% in China, 10.7% Iran, 7.8% in Mongolia, 12.2%Malaysia, 12.2% in Brunei, 10.0% in Thailand, 11.1% in Cambodia, 7.4% in Taiwan. On the other hand, the global mean CKD stages 3–5 prevalence was higher than the mean CKD prevalence in four countries: Singapore (34.3%), Pakistan (17.0%), Afghanistan (17.0%), and Bangladesh (16.4%) (Liyanage et al.,2022).

Chronic kidney disease (CKD) was identified as the 12th leading cause of death, resulting in 1.2 million fatalities in 2017. Projections indicate that this figure could rise to 4 million, positioning CKD as the 5th leading cause of death by 2040. Artificial Intelligence (AI) is a domain within computer science dedicated to the development of intelligent systems that can replicate human cognitive abilities such as learning, decision-making, and problem-solving. AI offers advantages such as accelerated processing, potentially more impartial decision-making, and the capacity to analyze extensive datasets that would be overwhelming for human analysis. Over the last ten years, various AI technologies, including machine learning (ML), deep learning (DL), natural language processing (NLP), and large language models (LLMs)have emerged, presenting promising strategies for enhancing CKD management. The integration of AI into the clinical care of CKD patients holds significant promise for facilitating early detection, forecasting, and improving patient outcomes. It is essential for healthcare providers, researchers, regulators, and industry stakeholders to collaborate in establishing comprehensive protocols that ensure adherence to legal requirements while minimizing risks and safeguarding patient safety (Sabanayagam et al.,2025).

MATERIALS AND METHODS

DATA SOURCE

Primary datawere collected from patients diagnosed with CKD at Allied Hospital, DHQ Hospital, National Hospital Faisalabad, for the year 2022 to 2023.

DATA COLLECTION

A structured questionnaire included 15 variables with different categories for CKD patients including ESRD patients. A convenience sample technique was used to collect the data of patients. This is across-sectional study consisted of data collected from 300 patient from different public and private hospitalsPakistan.The response variable is the stages of CKD patients from stage 1 to 5. We then compute two variables such as mild & severe stage. Mild stage consists of stage 1 to 4 while severe stage consist of stage 5.

Continuous variables include age and gender, marital status,living area, monthly income, education level, history of CKD, family history, kidney stone, anemia, blood in urine, smoking,

diabetes, hypertension, cold drinks were categorized using quartile analysis (Kazancioğlu, 2013; Aftab et al., 2019).The independent variables were first selecting using descriptive statistics and then variables associated with chronic kidney disease were further investigated using Logistic regression. Odds rations and 95% confidence intervals (C.Is) for different risk factors were computed. The data was analyzed using Statistical Package for Social Sciences (SPSS) version 21.

LOGISTIC REGRESSION ANALYSIS

Logistic regression analysis is commonly used in health-related study.Logistic regression may be used to predict whether a patient has a given disease (e.g., diabetes; coronary heart disease, chronic kidney disease), based on observed characteristics of the patient such as age, sex, body mass index, results of various blood tests, etc.

The binary logistic model is used to estimate the probability of a binary response based on one or more predictor (or independent) variables. It allows one to say that the presence of a risk factor increases the probability of a given outcome by a specific percentage.For binary response variable Y and an explanatory variable X, let $\pi(x) = P(Y = 1/X = x) = 1 - P(Y = 0/X = x)$.The logistic regression model is as follow

$$\pi(x) = \frac{exp(\alpha + \beta x)}{1 + exp(\alpha + \beta x)}$$

Equivalently, the log odds called the logit, has the linear relationship

$$[\pi(x)] = log \frac{\pi(x)}{1 - \pi(x)} = \alpha + \beta$$

This equates the logit link function to the linear predictor (Agresti, 2002).

RESULTS

The Table 2 shows descriptive Statistics of socio-demographic and socio-economic variables, A quartile analysis was used to construct intervals for the variables such as age, income status, education, and history of CKD. The results indicates that the most common age range for CKD incidence was 30 to 60years(149 patients) out of which 103 patients were in the acutestage and 46 patients were in the mild stage. The gender distribution of CKD patients also explains the different proportions of mild and severe stage patients and shows that more male patients (190) than female patients (110) have the disease and are also in the severe stage (123) compared to female patients (73) and the same is true for the mild stage. Our sample data on marital status of the patients reveals that more married patients (184) than single patients (116) had the disease.

TABLE 1: CATEGORIES OF RESPONSE VARIABLES WITH FREQUENCIES. STAGES OF CKD

Level	Frequency	Percent	Valid Percent	Cumulative Percent
Mild	104	34.7	34.7	34.7
Severe	196	65.3	65.3	100.0
Total	300	100.0	100.0	

TABLE 2: DESCRIPTIVE STATISTICS OF SOCIO-DEMOGRAPHIC AND SOCIO-ECONOMIC VARIABLES

Variables		Stages of CKD					
		Mild (%)		Severe (%)		Total	
Age	<30	21	(39.6%)	32	(60.4%)	53	(100%)
	30-60	46	(30.9%)	103	(69.1%)	149	(100%)
	>60	37	(37.8%)	61	(62.2%)	98	(100%)
Gender	Male	67	(35.3%)	123	(64.7%)	190	(100%)
	Female	37	(33.6%)	73	(66.4%)	110	(100%)
Marital Status	Single*	37	(31.9%)	79	(68.1%)	116	(100%)
	Married	67	(36.4%)	117	(63.6%)	184	(100%)
Living area	Rural	57	(34.3%)	109	(65.7%)	166	(100%)
	Urban	47	(35.1%)	87	(64.9%)	134	(100%)
Monthly Income	< 40000	42	(31.6%)	91	(68.4%)	133	(100%)
	40000—70000	50	(36.5%)	87	(63.5%)	137	(100%)
	> 70000	12	(40.0%)	18	(60.0%)	30	(100%)
Education	Metric or less	76	(32.1%)	161	(67.9%)	237	(100%)
	Inter to	15	(57.7%)	11	(42.3%)	26	(100%)
	Graduation	8	(34.8%)	15	(65.2%)	23	(100%)
	Higher	5	(35.7%)	9	(64.3%)	14	(100%)

Source: Computed from primary data set collected through questionnaire

The next variable "living area" represents that 166 patients and 134 patients belonged to rural and urban area respectively and most of them were in the severe stage in both areas. The first two categories of low-income patients are more vulnerable to CKD disease compared to last category, with more patients being diagnosed with severe stage. The results for the education variable reveal that majority of CKD patients (237) had less than matric education and were in acute stage of the disease (161 patients). Overall results from descriptive statistics depict that CKD incidence is higher in patients aged 30 to 60 years, male patients, married patients, patients living in rural areas, patients with low income and low education.

TABLE 3: DESCRIPTIVE STATISTICS OF THE VARIABLE RELATED TO CHRONIC KIDNEY DISEASE.

Variables		Stages of CKD					
		Mild (%)		Severe (%)		Total	
History of CKD	≤ 2 years	93	(46.5%)	107	(53.5%)	200	(100%)
	> 2 years	11	(11.0%)	89	(89.0%)	100	(100%)
Family History	Yes	57	(37.7%)	94	(62.3%)	151	(100%)
	No	47	(31.5%)	102	(68.5%)	149	(100%)
Kidney Stone	Yes	54	(30.9%)	121	(69.1%)	175	(100%)
	No	50	(40.0%)	75	(60.0%)	125	(100%)
Anemia	Yes	60	(30.2%)	139	(69.8%)	199	(100%)
	No	44	(43.6%)	57	(56.4%)	101	(100%)
Blood in Urine	Yes	24	(45.3%)	29	(54.7%)	53	(100%)
	No	80	(32.4%)	167	(67.6%)	247	(100%)
Smoking	Yes	51	(39.2%)	79	(60.8%)	130	(100%)
	No	53	(31.2%)	117	(60.0%)	170	(100%)

Diabetes	Yes	51	(35.4%)	93	(64.6%)	144	(100%)
	No	53	(43.0%)	103	(56.4%)	156	(100%)
Hypertension	Yes	96	(35.7%)	173	(64.3%)	269	(100%)
	No	8	(25.8%)	23	(74.2%)	31	(100%)
Cold Drinks	Yes	81	(41.8%)	113	(58.2%)	194	(100%)
	No	23	(21.7%)	83	(78.3%)	106	(100%)

The table 3 presents the descriptive statistics of risk factors to CKD.Among the 300 CKD patients, the most frequent risk factor was hypertension with 269 patients having CKD, followed by the less than 2 years history of CKD (200), Anemia (199), use of heavy old drinks (194), kidney stone (175).The results further explains that history of CKD presents that most of the patients (200) had CKD for 2 or less years, 93 being in mild stage and 107 in severe stage. The distribution of the family history shows almost same proportions of patients in both categories such that 151 patients a family history of CKD like (father, mother, sister, brother), while number of patients without any family history of CKD were 149. Patients withkidney stone were175 patients, while 125 patients did nothave kidney stone and most of them were found in acute stage of the disease in both cases. The incidence of CKD was higher in anemic patients (199) than the patients without anemia (101) and higher number of anemic patients (139) suffered in severe stage of CKD compared to non-anemic patients (57). Majority of patients (247) had not problem of blood in urine. 130 patients were reported as smokers while 170 as non-smokers, most of whom were acute stagepatients.

The results also show that 144 patients were diabetic while 156 were non-diabeticpatients with93 and 103in severe stage respectively. In the case of hypertension, a significantly different proportion of patients was observed with269 patients having hypertension and 31 non-hypertensive patients.Out of which96 hypertensive patients were in mild and 173 were in severe stage. Heavy cold drinks beverage usage was also among most frequent risk factors and reported by 194 patients, including 113 in severe stage, against 106 patients who were not heavy cold drinks beverage user.

TABLE 4: ESTIMATION OF MODEL USING LOGISTIC REGRESSION

Variables		β	S.E.	Wald test statistic	P-value	O.R	95% C.I for O.R	
							Lower	Upper
Age	<30					1.00		
	30-45	0.696	0.552	1.593	0.207	2.006	0.680	5.912
	> 60	1.005	0.45	4.99	0.025	2.731	1.131	6.592
History of CKD	Under or equal 2 years	0.943	0.499	3.578	0.049	1.00 2.568	1.966	6.824
	Above 2 years							
Diabetes	Yes	2.432	0.429	32.124	0.000	11.385	4.910	26.401
	No					1.00		
Anemia	Yes	1.473	0.432	11.649	0.001	4.362	1.872	10.162
	No					1.00		

Hypertension	Yes No	−1.090	0.348	9.807	0.002	3.336 1.00	0.170	0.665
Blood in urine	Yes No	0.693	0.406	2.906	0.008	2.00 1.00	1.902	4.435
Cold Drinks	Yes No	1.366	0.367	13.871	0.000	3.919 1.00	1.910	8.043

Note. SE-Standard Error, OR- Odds Ratio, 95% confidence interval

The results from logistic regression are presented in table 4, where the values of coefficient estimates, standard errors, p-values, and odds ratios with 95% confidence intervals are given. It is observed that people who are above 60 years of age have a higher risk of CKD than those below 30 years of age (OR = 2.731, p=0.025), results for the patients between 30 to 45 are not statistically significant.

DISCUSSION

Following factors were found to be significant risk factors in previous and current study.This confirmed the recommendation of Levey *et al.* 2003 regarding increased CKD risks of persons older than 60 years of age. The patients who survived more than two years with the disease aresignificantly more likely to have CKD thanpatients withless than or equal to 2 years (OR = 2.568, p=0.049). CKD risk increased indiabetic and hypertensive patientswith OR = 11.385, p=0.000 and OR = 3.336, p = 0.002, respectively, compared to non-diabetic and non-hypertensive patients. Our results confirmed the findings ofRizvi and Manzoor2002; Rizvi et al.,2013; Anand et al., 2014;Yacoub et al., 2016 and Matsushita et al., 2022, whoidentified hypertension and diabetes as key risk factors for the development of CKD. Haroun *et al.*, 2003 found stage 1 hypertension and cigarette smoking as major risk factors of CKD. Anemia is a frequent complication and can cause problems in CKD patients (McMurray et al., 2012; Ammirati 2020). Our findings regarding anemia also suggest that compared to non-anemiapatients, risk of CKD significantly increased in anemic patients with OR = 4.362, p = 0.001.The patients with problem of blood in urine have significantly higher risk of CKD than the patients without it (OR = 2.00, p = 0.088). Consumption of heavy cold drinks has also been foundto be a significant contributing factor to the likelihood of having CKD (OR = 3.919, p = 0.000). The findings of the studysuggest that factors such as excess use of cold drinks, anemia, diabetes, hypertension, being older than 60 years of age, problem of blood in urinesignificantly increase the chances of havingCKD.

CONCLUSION

Chronic kidney disease is often considered as silent disease. CKD classifies into five stages, with stage 1 to stage 4 being the mildest and stage 5 being a severe illness with poor life expectancy if untreated. Descriptive statistics; chi square measures of association and binary logistic regression were used to estimate odd ratios and 95% confidence intervals of 300 patients to evaluate the stage wise risk factors of CKD. The findings of this study indicates that significant variables were age, history of CKD, anemia, hypertension, diabetes, blood in urine, uses of cold drinks. Blood in the urine, which was a new variable we introduced, also had a significant effect on CKD.Only Blood in urine was significant variable for the prediction of

CKD. The study indicates that CKD can be detected at early stage if you have blood in urine. It will help to prevent the disease from turning into an acute stage. According to our results, patients aged 46-60 years are morelikely to have CKD in the severe stage. We also assessed the facilities for patients in both hospitals and examined that the bedding facilities of dialysis wards are not sufficientto increasing number of patients in Faisalabad. To eliminate this problem, the government should review it every year. It is also suggested that more extensive studies should be carried out, using large sample size to analyze the risk factors of CKD in Pakistan.

REFERENCES

1. Aftab, M., Ramzan, A., Bhatti, S. H., Ahmad, T., Raza, M. A., Shah, S. M. A., & Akram, M. (2019). Correlates of diabetic retinopathy: A case study. *Pak J Pharm Sci*, *32*(4), 1909-1912.
2. Agresti, A., (2002). Categorical data analysis, Second Edition, Wiley Series in Probability and Statistics, America, 653 p.
3. Ammirati, A. L. (2020). Chronic kidney disease. *Revista da Associação Médica Brasileira*, *66*, s03-s09.
4. Anand, S., Khanam, M. A., & Finkelstein, F. O. (2014). Global perspective of kidney disease. *Nutrition in kidney disease*, 11-23.
5. Anglade-McCormick, M. J. (2023). *Hepatitis C Infection and Kidney Transplant Waiting Time Among End-Stage Renal Disease Patients* (Doctoral dissertation, Walden University).
6. Bin Hamid, R., & Khan, M. T. (2020). Renal Transplant Unit, National Institute of Solid Organ and Tissue Transplantation, Dow University of Health Sciences, Karachi, Pakistan: On a Road to Minimize ESRD Burden. *Journal of Islamabad Medical & Dental College*, *9*(3), 155-157.
7. Bruck, K., Stel, V. S., Gambaro, G., Hallan, S., Völzke, H., Ärnlöv, J., ... & European CKD Burden Consortium. (2016). CKD prevalence varies across the European general population. *Journal of the American Society of Nephrology*, *27*(7), 2135-2147.
8. Cheung, K. L., Crews, D. C., Cushman, M., Yuan, Y., Wilkinson, K., Long, D. L., ... & Gutiérrez, O. M. (2023). Risk factors for incident CKD in Black and White Americans: the REGARDS study. *American Journal of Kidney Diseases*, *82*(1), 11-21.
9. Couser, W. G., Remuzzi, G., Mendis, S., & Tonelli, M. (2011). The contribution of chronic kidney disease to the global burden of major noncommunicable diseases. *Kidney international*, *80*(12), 1258-1270.
10. Geylis, M., Coreanu, T., Novack, V., & Landau, D. (2023). Risk factors for childhood chronic kidney disease: A population-based study. *Pediatric Nephrology*, *38*(5), 1569-1576.
11. Haroun, M. K., Jaar, B. G., Hoffman, S. C., Comstock, G. W., Klag, M. J., & Coresh, J. (2003). Risk factors for chronic kidney disease: a prospective study of 23,534 men and women in Washington County, Maryland. *Journal of the American Society of Nephrology*, *14*(11), 2934-2941.
12. Jafar, T. H., Schmid, C. H., & Levey, A. S. (2005). Serum creatinine as marker of kidney function in South Asians: a study of reduced GFR in adults in Pakistan. *Journal of the American Society of Nephrology*, *16*(5), 1413-1419.
13. Jafar, T. H. (2006). The growing burden of chronic kidney disease in Pakistan. *The New England journal of medicine*, *354*(10), 995.
14. Kareem, S., Jamali, A., Ali, S., Arbab, M. Y., Salman, B., & Imtiaz, S. Epidemiology and risk factors of chronic kidney disease in rural areas (Badin) of Sindh, Pakistan. *vectors*, *6*, 7.
15. Kazancioğlu, R. (2013). Risk factors for chronic kidney disease: an update. *Kidney international supplements*, *3*(4), 368-371.

16. Kazmi, W. H., & Danial, K. (2012). Chronic Kidney Disease Update. *Topics in Renal Biopsy and Pathology*, 197-258.
17. Kovesdy, C. P. (2022). Epidemiology of chronic kidney disease: an update 2022. *Kidney International Supplements*, *12*(1), 7-11.
18. Liyanage, T., Toyama, T., Hockham, C., Ninomiya, T., Perkovic, V., Woodward, M., ... & Jun, M. (2022). Prevalence of chronic kidney disease in Asia: a systematic review and analysis. *BMJ global health*, *7*(1), e007525.
19. Matsushita, K., Ballew, S. H., Wang, A. Y. M., Kalyesubula, R., Schaeffner, E., & Agarwal, R. (2022). Epidemiology and risk of cardiovascular disease in populations with chronic kidney disease. *Nature Reviews Nephrology*, *18*(11), 696-707.
20. McMurray, J., Parfrey, P., Adamson, J. W., Aljama, P., Berns, J. S., Bohlius, J., ... & Weiss, G. (2012). Kidney disease: Improving global outcomes (KDIGO) anemia work group. KDIGO clinical practice guideline for anemia in chronic kidney disease. *Kidney International Supplements*, 279-335.
21. Naqvi, S. J. (2009). Renal diseases in Pakistan-'time to act.'. *J Nephrol Renal Transplant*, *2*(1), 133-35.
22. NHS –Kidney Disease, chronic – Causes: http://www.nhs.uk/Conditions/Kidney-disease-chronic/Pages/Causes.aspx
23. Rehman, I. U., & Khan, T. M. (2020). Epidemiology of chronic kidney diseases (CKD) in Malaysia and Pakistan, pathophysiology of CKD-associated pruritus and other CKD-associated dermatological disorders. *Progress In Microbes & Molecular Biology*, *3*(1).
24. Rizvi, S. A. H., & Manzoor, K. (2002). Causes of chronic renal failure in Pakistan: a single large center experience. *Saudi journal of kidney diseases and transplantation*, *13*(3), 376-379
25. Rizvi, S. A. H., Naqvi, S. A. A., Zafar, M. N., & Akhtar, S. F. (2013). A kidney transplantation model in a low-resource country: an experience from Pakistan. *Kidney international supplements*, *3*(2), 236-240.
26. Rizvi, S. A., Naqvi, S. A., Zafar, M. N., Hussain, Z., Hashmi, A., Hussain, M., ... & Ahmed, E. (2010). Living related renal transplants with lifelong follow-up. A model for the developing world. *Clinical nephrology*, *74*, S142-9.
27. Sathya, G. R. (2012). Prevalence of Risk Factors for Chronic Kidney Disease in a Coastal Area of Tamil Nadu, South India. *IOSR Journal of Dental and Medical Sciences*, *2*, 29-33.
28. Sabanayagam, C., Banu, R., Lim, C., Tham, Y. C., Cheng, C. Y., Tan, G., ... & Wong, T. Y. (2025). Artificial intelligence in chronic kidney disease management: a scoping review. *Theranostics*, *15*(10), 4566.
29. World Kidney Day: Chronic Kidney Disease. 2015; http://www.worldkidneyday.org/faqs/chronic-kidney-disease/
30. Yacoub, R., Habib, H., Lahdo, A., Al Ali, R., Varjabedian, L., Atalla, G., ... & Albitar, S. (2010). Association between smoking and chronic kidney disease: a case control study. *BMC public health*, *10*(1), 1-6.