

## Cross Sectional Analysis of Risk Factors for Advanced CKD in Hemodialysis at RSUD Dr. Hasri Ainun Habibie

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### ABSTRACT

Chronic Kidney Disease (CKD) is a major non-communicable disease associated with high morbidity, mortality, and healthcare costs worldwide. This study aimed to analyze factors associated with CKD stage among patients undergoing hemodialysis at RSUD Dr. Hasri Ainun Habibie, Gorontalo Province, Indonesia. A quantitative observational study with a cross-sectional design was conducted among 53 hemodialysis patients using a total sampling technique. Data were analyzed using univariate analysis, bivariate analysis with the Chi-square test, and multivariate analysis using multiple logistic regression. The results showed that the majority of patients were in the advanced stage of CKD (62.3%) and belonged to the young elderly age group (60–69 years). Bivariate analysis demonstrated that age ( $p < 0.001$ ), family history of CKD ( $p < 0.001$ ), history of urinary tract infection ( $p = 0.002$ ), heart disease ( $p = 0.013$ ), diabetes mellitus ( $p = 0.001$ ), hypertension ( $p < 0.001$ ), smoking habits ( $p = 0.032$ ), and energy drink consumption ( $p = 0.046$ ) were significantly associated with CKD stage. Multivariate logistic regression analysis identified age ( $p = 0.008$ ), family history of CKD ( $p = 0.039$ ), history of heart disease ( $p = 0.031$ ), and hypertension ( $p = 0.018$ ) as independent factors associated with advanced-stage CKD, with hypertension showing the strongest association. In conclusion, advanced-stage CKD among hemodialysis patients is associated with increasing age and chronic comorbid conditions, particularly hypertension and cardiovascular disease. Strengthening early screening programs and optimizing the management of hypertension and cardiovascular risk factors are essential to prevent CKD progression and reduce the burden of hemodialysis.



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### Keywords:

Chronic Kidney Disease (CKD); Risk Factors; Hemodialysis; Hypertension; Family History

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## **1. Introduction**

Chronic Kidney Disease (CKD) is a major public health problem that has received increasing global attention. CKD is defined as a progressive and irreversible decline in kidney function lasting for three months or more, leading to the kidneys' inability to maintain fluid, electrolyte, and metabolic waste balance in the body. According to the Global Burden of Disease study, CKD was ranked as the 10th leading cause of death worldwide and is projected to become the 5th leading cause by 2040 [1]. This trend highlights the growing clinical and public health significance of CKD, particularly in low- and middle-income countries where access to nephrology services and renal replacement therapy remains limited [2].

In Indonesia, the prevalence of CKD has continued to increase in recent years. Data from the Indonesian Renal Registry indicate that more than 150,000 patients were receiving routine hemodialysis, while BPJS Kesehatan reported 134,057 active hemodialysis patients nationwide in 2024. Notably, CKD is no longer confined to older adults but has increasingly affected individuals in the productive age group (25–44 years). This shift is closely associated with the rising prevalence of non-communicable diseases such as diabetes mellitus and hypertension, as well as unhealthy lifestyle behaviors including high salt and fat consumption, smoking, physical inactivity, and energy drink intake. These patterns suggest that lifestyle factors and comorbid conditions play a substantial role in the increasing burden of CKD in Indonesia [3].

A similar trend has been observed in Gorontalo Province. Provincial health data show that the number of CKD patients was 442 in 2019, decreased to 201 in 2020, and increased again to 241 in 2021. This upward trend continued, reaching an estimated 895 cases in 2024. At RSUD Dr. Hasri Ainun Habibie, the main referral hospital in the province, the number of patients undergoing hemodialysis increased from 44 in 2024 to 53 in 2025. Most patients presented at advanced stages of CKD with multiple comorbidities, including hypertension, diabetes mellitus, and heart disease, indicating delayed diagnosis and insufficient early detection at the primary healthcare level.

The development of CKD is influenced by multifactorial and interrelated risk factors, encompassing biological characteristics (such as age and family history), comorbid conditions (including hypertension, diabetes mellitus, heart disease, and urinary tract infections), and behavioral or lifestyle factors (such as smoking and energy drink consumption). A study by Uswatun [4] reported significant associations between age, diabetes mellitus, hypertension, smoking, and alcohol consumption with CKD incidence among hemodialysis patients. Consistently, other studies have identified hypertension and diabetes mellitus as the most dominant comorbidities contributing to CKD progression [5]. These findings emphasize that CKD risk increases substantially when biological susceptibility is combined with chronic diseases and unhealthy behaviors.

Given the high cost of hemodialysis and the lifelong nature of CKD management, early identification of risk factors is essential to support preventive strategies and reduce progression to end-stage renal disease. Therefore, this study aims to analyze biological, comorbid, and behavioral risk factors associated with CKD among hemodialysis patients at RSUD Dr. Hasri Ainun Habibie, Gorontalo Province. The study seeks to identify factors contributing to late-stage CKD requiring hemodialysis, while also providing evidence to support early detection and prevention efforts at the primary care level to reduce disease progression and future treatment burden.

## 2. Methods

This study employed a quantitative observational design with a cross-sectional approach and was conducted at RSUD Dr. Hasri Ainun Habibie, Gorontalo Province, Indonesia, from January to March 2025. The study population consisted of all patients diagnosed with Chronic Kidney Disease (CKD) who were undergoing routine hemodialysis at the hospital during the study period. A total sampling technique was applied, whereby all eligible patients were recruited, resulting in a final sample of 53 hemodialysis patients. Inclusion criteria were patients aged 18 years or older, actively registered as hemodialysis patients, and willing to participate by providing informed consent. Patients with incomplete medical records, those in unstable clinical conditions at the time of data collection, or those who declined participation were excluded from the study.

Data were collected from both primary and secondary sources. Primary data were obtained through structured questionnaires and face-to-face interviews to collect sociodemographic and lifestyle-related information, while secondary data were extracted from medical records to confirm clinical diagnoses and comorbid conditions. The outcome variable in this study was late-stage CKD, defined as end-stage renal disease requiring maintenance hemodialysis, based on physician diagnosis and medical record documentation. Independent variables included biological factors (age, sex, and family history of CKD), comorbid diseases (hypertension, diabetes mellitus, heart disease, and history of urinary tract infection), and behavioral factors (smoking habits and energy drink consumption). Hypertension, diabetes mellitus, heart disease, and urinary tract infection were defined based on documented medical diagnoses, while smoking status and energy drink consumption were defined based on self-reported behaviors.

Data analysis was conducted in several stages. Univariate analysis was used to describe the characteristics of the respondents. Bivariate analysis using the Chi-square test was performed to examine the association between each independent variable and the outcome. Variables with a  $p$ -value  $<0.25$  in the bivariate analysis were included in the multivariate analysis. Multiple logistic regression was then applied to identify independent predictors of late-stage CKD after adjustment for potential confounders, with results presented as odds ratios (OR/Exp(B)) and 95% confidence intervals to emphasize effect sizes rather than  $p$ -values alone.

Ethical approval for this study was obtained from the Health Research Ethics Committee of RSUD Dr. Hasri Ainun Habibie, Gorontalo Province, as per the recommendation number 181/UN47.B7/KE/2025, valid from September 25, 2025, to September 25, 2026.

## 3. Results and Discussion

The bivariate analysis of factors associated with Chronic Kidney Disease (CKD) stages among 53 hemodialysis patients at RSUD Dr. Hasri Ainun Habibie is presented in **Table 1**. The majority of respondents were in the young elderly age group (60–69 years), and most were already at an advanced stage of CKD (62.3%). Bivariate analysis showed that age ( $p < 0.001$ ), family history of CKD ( $p < 0.001$ ), history of urinary tract infection ( $p = 0.002$ ), heart disease ( $p = 0.013$ ), diabetes mellitus ( $p = 0.001$ ), hypertension ( $p < 0.001$ ), active smoking ( $p = 0.032$ ), and energy drink consumption ( $p = 0.046$ ) were significantly associated with CKD stage. Gender was not significantly associated with CKD stage ( $p = 0.500$ ). Patients with a family history of CKD, hypertension, diabetes

mellitus, and urinary tract infection were predominantly found in advanced CKD stages, suggesting delayed diagnosis and prolonged exposure to multiple risk factors.

**Table 1.** Bivariate Analysis of Factors Associated with CKD Stage Among Hemodialysis Patients at Hasri Ainun Habibie Hospital

Variable	Chronic Kidney Disease Incident				Total		P-value
	Early-stages Phase	%	End-stages Phase	%	n	%	
<b>Age</b>							
Pre-elderly	16	30.2	1	1.9	17	32.1	< 0.001
Young Elderly	4	7.5	32	60.4	36	67.9	
Total	20	37.7	33	62.3	53	100	
<b>Family History</b>							
Has History	3	5.7	25	47.2	25	47.2	<0.001
No History	17	32.1	8	15.1	28	52.8	
Total	20	37.7	33	62.3	53	100	
<b>History of Urinary Tract Infection (UTI)</b>							
Has History	5	9.4	23	43.4	25	47.2	0.002
No History	15	28.3	10	18.9	28	52.8	
Total	20	37.7	33	62.3	53	100	
<b>History of Heart Disease</b>							
Has History	1	1.9	9	17.0	10	18.9	0.013
No History	19	35.8	24	45.3	43	81.1	
Total	20	37.7	33	62.3	53	100	
<b>History of Diabetes Mellitus</b>							
Has History	3	5.6	18	34.0	21	39.6	0.001
No History	17	32.1	15	28.3	32	60.4	
Total	20	37.7	33	62.3	53	100	
<b>History of Hypertension</b>							
Has History	5	9.4	29	54.7	34	64.2	<0.001
No History	15	28.2	4	7.5	19	35.8	
Total	20	37.7	33	62.3	53	100	
<b>Active Smoking Habit</b>							
Smoker	1	1.9	17	32.1	35	66.0	0.032
Non Smoker	19	35.8	16	30.2	18	34.0	
Total	20	37.7	33	62.3	53	100	
<b>Energy Drink Consumption Habit</b>							
Yes	2	3.7	18	34.0	20	37.7	0.046
No	18	34.0	15	28.3	33	62.3	
Total	20	37.7	33	62.3	53	100	

Notes: Chi-square test;  $p < 0.05$  considered statistically significant.

Sources: Primary Data, 2025

**Table 2** shows the results of multivariate analysis using multiple logistic regression. After adjustment for confounding variables, four factors remained significantly associated with advanced-stage CKD: age ( $p = 0.008$ ), family history of CKD ( $p = 0.039$ ), history of heart disease ( $p = 0.031$ ), and hypertension ( $p = 0.018$ ). These variables demonstrated independent effects on CKD progression.

Other variables, including diabetes mellitus, urinary tract infection, smoking habits, and energy drink consumption, were not statistically significant in the multivariate model ( $p > 0.05$ ), suggesting that their effects may be mediated through

other comorbid conditions or require longer exposure periods to influence CKD progression.

**Table 2.** Multivariate Logistic Regression Analysis of Factors Associated with Advanced Stage CKD

Variabel	Sig.
Age	0.008
Family History	0.039
History of Heart Disease	0.031
History of Hypertension	0.018

*Notes:* Multiple logistic regression analysis;  $p < 0.05$  considered statistically significant.

*Source:* SPSS Processing, 2025

This study demonstrated that increasing age was strongly associated with advanced-stage CKD. Most patients aged 60–69 years were already in the end-stage of the disease. Physiologically, glomerular filtration rate (GFR) declines by approximately 1 mL/min/year after the age of 40 due to nephron loss, interstitial fibrosis, and reduced renal perfusion. These findings are consistent with previous studies in Indonesia and global reports identifying age as a major predictor of CKD progression [1], [4]. Therefore, routine kidney function screening in individuals aged  $\geq 45$  years is crucial for early detection.

A significant association was observed between family history and CKD stage. Patients with a positive family history were more likely to present with advanced CKD, indicating genetic susceptibility. Studies in Ethiopia and Nigeria reported that individuals with a family history of kidney disease have a four- to eight-fold higher risk of developing CKD [6], [7]. Genetic variants such as APOL1 and UMOD may contribute to increased vulnerability to renal damage [9]. These findings emphasize the importance of targeted screening among first-degree relatives of CKD patients.

Bivariate analysis revealed a significant association between a history of urinary tract infection (UTI) and CKD stage. Recurrent UTIs may cause chronic pyelonephritis and permanent renal scarring, leading to progressive kidney damage. However, UTI history was not significant in the multivariate model, suggesting that its effect may be indirect or mediated by other clinical factors such as hypertension and diabetes.

Heart disease remained a significant independent predictor of CKD progression. This finding supports the concept of cardiorenal syndrome, in which cardiac dysfunction contributes to renal hypoperfusion, neurohormonal activation, and inflammatory processes that accelerate nephron damage. Effective cardiovascular disease management is therefore essential to slow CKD progression [12], [13].

Diabetes mellitus showed a significant association with CKD stage in bivariate analysis but lost significance in the multivariate model. Chronic hyperglycemia causes structural renal changes leading to diabetic nephropathy, the most common cause of CKD globally [14], [15]. The loss of significance after adjustment may indicate overlap with hypertension and age, which often coexist with diabetes in advanced CKD patients.

Hypertension was one of the most dominant independent risk factors for advanced CKD. Persistent elevated blood pressure causes arteriosclerosis, increased intraglomerular pressure, and progressive glomerulosclerosis, resulting in declining GFR. Previous studies have shown that effective blood pressure control ( $< 130/80$  mmHg) can significantly slow CKD progression [17], [18].

Active smoking and energy drink consumption were significantly associated with CKD in bivariate analysis but were not independent predictors after adjustment. Smoking induces oxidative stress, endothelial dysfunction, and inflammation, while excessive energy drink consumption may increase blood pressure and renal workload. These behaviors may act as contributory rather than primary risk factors, particularly when chronic comorbidities are present.

This study has several limitations. First, the cross-sectional design limits causal inference between risk factors and CKD progression. Second, the relatively small sample size from a single referral hospital may limit the generalizability of the findings. Third, behavioral variables such as smoking and energy drink consumption were self-reported and may be subject to recall bias. Finally, early-stage CKD patients not yet receiving hemodialysis were not included, which may underestimate the role of certain risk factors in early disease development. Future longitudinal studies with larger samples and broader populations are recommended.

#### **4. Conclusion**

This study concludes that advanced-stage Chronic Kidney Disease (CKD) among hemodialysis patients at RSUD Dr. Hasri Ainun Habibie is significantly associated with increasing age, family history of CKD, hypertension, and heart disease. Among these factors, hypertension demonstrated the strongest independent association with advanced CKD. Although several behavioral and clinical factors such as diabetes mellitus, urinary tract infection, smoking habits, and energy drink consumption were significantly associated with CKD stage in bivariate analysis, their effects were not independently significant after adjustment for confounding variables. This indicates that CKD progression is influenced by the interaction of multiple risk factors, particularly chronic comorbid conditions. Given the cross-sectional design of this study, causal relationships cannot be established. However, the findings highlight the importance of early detection strategies, especially among older individuals and those with a family history of CKD, as well as the need for optimal control of hypertension and cardiovascular disease to slow CKD progression and reduce the burden of hemodialysis. Future longitudinal studies with larger and more diverse populations are recommended to further clarify causal pathways and evaluate preventive interventions.

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#### **Conflicts of Interest:**

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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