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Factors associated with kidney failure requiring hemodialysis: A case-control study

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Abstract

Background: Chronic kidney disease (CKD) may progress to kidney failure requiring hemodialysis. Hypertension, diabetes mellitus, obesity, and older age are commonly associated with CKD, but local evidence remains limited.
Purpose: To examine factors associated with kidney failure requiring hemodialysis among patients treated at a regional hospital in Central Java, Indonesia.
Method: This case-control study included 122 participants: 61 patients receiving maintenance hemodialysis as cases and 61 controls. Cases were selected using purposive sampling and controls using consecutive sampling. Age and histories of hypertension, diabetes mellitus, and obesity were assessed using a structured questionnaire. Associations were examined using chi-square tests with continuity correction and reported as odds ratios (ORs) with 95% confidence intervals (CIs).
Results: Age >60 years was not significantly associated with kidney failure requiring hemodialysis (p = 0.237; OR 0.58, 95% CI 0.26-1.26). Histories of hypertension (p = 0.016; OR 2.67, 95% CI 1.26-5.67), diabetes mellitus (p = 0.018; OR 2.84, 95% CI 1.26-6.39), and obesity (p = 0.033; OR 5.78, 95% CI 1.21-27.63) were significantly associated with the outcome.
Conclusion: Hypertension, diabetes mellitus, and obesity were associated with kidney failure requiring hemodialysis, whereas age >60 years was not. These estimates are unadjusted bivariate associations and should not be interpreted as causal effects.

Keywords: Age; Hypertension; Diabetes Mellitus; Obesity; Kidney Failure; Hemodialysis.

INTRODUCTION

Chronic kidney disease (CKD) is defined by persistent abnormalities of kidney structure or function, including reduced glomerular filtration rate or markers of kidney damage, for at least three months (Morton, Webster, Masson, & Nagler, 2017). CKD is classified according to cause, glomerular filtration rate, and albuminuria (Stevens, Ahmed, Carrero, Foster, Francis, Hall, & Levin, 2024). CKD may progress irreversibly to kidney failure, at which point impaired excretion of fluid, electrolytes, and metabolic waste can cause life-threatening complications (Chen, Knicely, & Grams, 2019).

CKD is a major global health burden. More than 10% of the world's population-over 800 million people-are estimated to be affected worldwide (Kovesdy, 2022).

A systematic review estimated the global prevalence of CKD at 11%-13% (Hill, Fatoba, Oke, Hirst, O'Callaghan, Lasserson, & Hobbs, 2016). The burden is substantial in low- and middle-income settings and contributes to premature mortality and health-system costs (Luyckx, Tonelli, & Stanifer, 2018). In Indonesia, the 2023 Indonesia Health Survey reported a diagnosed CKD prevalence of 0.18% (Health Development Policy Agency, 2024).

Kidney failure may require kidney replacement therapy through hemodialysis, peritoneal dialysis, or kidney transplantation. Hemodialysis removes metabolic waste and excess fluid and helps correct

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electrolyte and acid-base disturbances when kidney function is no longer sufficient (Stevens et al., 2024; Ministry of Health of the Republic of Indonesia, 2023).

Common causes of CKD include diabetes mellitus, hypertension, glomerular diseases, hereditary disorders, urinary tract obstruction, recurrent infection, and exposure to nephrotoxic agents. Factors associated with CKD development or progression include older age, hypertension, hyperglycemia, obesity, smoking, albuminuria, cardiovascular disease, and nephrotoxin exposure (Morton et al., 2017; Chen et al., 2019; Stevens et al., 2024). Diabetes and hypertension are leading causes of CKD and kidney failure worldwide (Kovesdy, 2022). Integrated management of glycemia, blood pressure, kidney risk, and cardiovascular risk is emphasized for people with diabetes and CKD (Rossing et al., 2022).

Age is associated with structural and functional changes in the kidney, including nephron loss, glomerulosclerosis, vascular changes, and a gradual decline in glomerular filtration rate (O'Sullivan, Hughes, & Ferenbach, 2017; Denic, Glassock, & Rule, 2016). However, age-related decline varies considerably among individuals and does not by itself establish CKD. An Indonesian hospital study reported that age >=60 years was associated with CKD stage V; differences in age distribution and cut-off definitions may therefore influence findings across studies (Yanti, Apriyeni, & Fridalni, 2023).

Hypertension is both a cause and a consequence of CKD. Chronic elevation of systemic and intraglomerular pressure promotes vascular injury, glomerulosclerosis, and progressive nephron loss (Ku, Lee, Wei, & Weir, 2019). Standardized blood-pressure assessment and evidence-based management are recommended in CKD (Cheung, Chang, Cushman, Furth, Hou, Ix, & Mann, 2021). An Indonesian case-control study found that hypertension was associated with chronic kidney failure (Gultom & Sudaryo, 2023).

Diabetes mellitus contributes to CKD through chronic hyperglycemia, altered intraglomerular hemodynamics, glomerular hypertrophy, inflammation, oxidative stress, and progressive fibrosis (Alicic, Rooney, & Tuttle, 2017; Samsu, 2021). Comprehensive diabetes management is central to preventing CKD progression and cardiovascular complications (Rossing et al., 2022).

Obesity is associated with CKD through glomerular hyperfiltration, neurohormonal activation, inflammation, insulin resistance, and its close relationships with hypertension and diabetes. A systematic review and meta-analysis found that obesity predicted incident low estimated glomerular filtration rate and albuminuria in the general population (Garofalo, Borrelli, Minutolo, Chiodini, De Nicola, & Conte, 2017). Higher body mass index was associated with CKD in initial analyses, but the association was attenuated after accounting for hypertension and fasting glucose, suggesting that these metabolic pathways may mediate much of the obesity-CKD relationship (Nguyen, Khafagy, Gao, Meerasa, Roshandel, Anvari, & Dash, 2023).

Records from the study hospital show that the number of patients with kidney failure requiring hemodialysis increased from 133 in 2024 to 164 in 2025. Given this rising trend, this study examined factors associated with kidney failure requiring hemodialysis among patients treated at the hospital.

RESEARCH METHOD

This analytic case-control study was conducted at Kraton Regional General Hospital, Pekalongan Regency, Central Java, Indonesia.

The source population for cases comprised all patients with kidney failure receiving maintenance hemodialysis at the study hospital (N = 133). A total of 122 participants were included: 61 cases receiving maintenance hemodialysis and 61 controls. Cases were selected using purposive sampling, and controls were selected using consecutive sampling.

Data on age and histories of hypertension, diabetes mellitus, and obesity were collected using a structured questionnaire.

Categorical variables were summarized as frequencies and percentages. Each independent variable was cross-tabulated with case-control status. Associations were assessed using the chi-square test with Yates' continuity correction for 2 x 2 tables. Effect sizes were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was set at $p < 0.05$.

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RESEARCH RESULTS

Table 1. Respondent characteristics and their associations with chronic kidney failure (N = 122)

Variable	Case (n = 61)	Control (n = 61)	p-value	OR (95% CI)
Age, Mean ± SD (range), years	49.5 ± 16.1 (18–79)	54.4 ± 16.2 (20–80)		
18–30 years	6/9.8	5/8.2		
31–40 years	11/18.0	8/13.1		
41–50 years	14/23.0	11/18.0		
51–60 years	15/24.6	15/24.6		
>60 years	15/24.6	22/36.1		
Age risk classification				
At risk (>60 years)*	15/24.6	22/36.1		
Not at risk (≤60 years)	46/75.4	39/63.9	0.237	0.58 (0.26–1.26)
History of hypertension				
At risk	44/72.1	30/49.2		
Not at risk	17/27.9	31/50.8	0.016	2.67 (1.26–5.67)
History of diabetes mellitus				
At risk	25/41.0	12/19.7		
Not at risk	36/59.0	49/80.3	0.018	2.84 (1.26–6.39)
History of obesity				
At risk	10/16.4	2/3.3		
Not at risk	51/83.6	59/96.7	0.033	5.78 (1.21–27.63)
Gender				
Male*	35/57.4	31/50.8		
Female	26/42.6	30/49.2	0.586	1.30 (0.64–2.66)
Smoking history				
Yes	28/45.9	17/27.9		
No	33/54.1	44/72.1	0.061	2.20 (1.03–4.66)

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Frequent NSAID use				
Yes	21/34.4	10/16.4		
No	40/65.6	51/83.6	0.038	2.68 (1.13–6.32)
Family history of kidney disease				
Yes	14/23.0	6/9.8		
No	47/77.0	55/90.2	0.087	2.73 (0.97–7.67)

Table 1 shows that age category was not significantly associated with kidney failure requiring hemodialysis (p = 0.237). In contrast, histories of hypertension (p = 0.016; OR 2.67, 95% CI 1.26-5.67), diabetes mellitus (p = 0.018; OR 2.84, 95% CI 1.26-6.39), and obesity (p = 0.033; OR 5.78, 95% CI 1.21-27.63) were significantly associated with the outcome. Obesity produced the largest odds-ratio estimate, although its confidence interval was wide. The additional variables shown in the unchanged table require author verification before interpretation.

DISCUSSION

The main finding of this study was that histories of hypertension, diabetes mellitus, and obesity were associated with kidney failure requiring hemodialysis, whereas age >60 years was not. These results highlight potentially modifiable metabolic and cardiovascular factors rather than age alone. However, the associations were derived from separate bivariate analyses and should not be interpreted as independent causal effects.

The absence of a significant association with age differs from a previous report of an association between older age and CKD stage V (Yanti et al., 2023). Ageing remains biologically relevant because it is accompanied by nephron loss, vascular and glomerular changes, and gradual decline in glomerular filtration (O'Sullivan et al., 2017; Denic et al., 2016). The different result in the present study may reflect the age distribution, sample size, or cut-off used to define the older-age category. The estimate should therefore be interpreted as a null finding in this sample, not as evidence that older age is protective.

The association with hypertension is consistent with an Indonesian case-control study (Gultom & Sudaryo, 2023). Sustained elevation of systemic and intraglomerular pressure can damage renal vessels, promote glomerulosclerosis, and accelerate nephron loss. Because hypertension may remain asymptomatic, regular blood-pressure assessment and effective long-term control are important components of kidney-disease prevention (Ku et al., 2019; Cheung et al., 2021).

Diabetes mellitus was also associated with kidney failure requiring hemodialysis. Chronic hyperglycemia can alter intraglomerular hemodynamics and promote glomerular hypertrophy, inflammation, oxidative stress, and fibrosis (Alicic et al., 2017; Samsu, 2021). This finding supports integrated management of glycemia, blood pressure, and cardiovascular risk in people with diabetes (Rossing et al., 2022).

Obesity produced the largest odds-ratio estimate among the examined variables, but the confidence interval was wide, indicating limited precision. Broader evidence links obesity with incident CKD through glomerular hyperfiltration, inflammation, insulin resistance, hypertension, and dysglycemia (Garofalo et al., 2017; Nguyen et al., 2023). The present obesity estimate should therefore be interpreted cautiously and confirmed in larger studies with multivariable adjustment.

This study has several limitations. Its case-control design cannot establish temporal direction or causality. Purposive selection of cases, recruitment from a single hospital, and questionnaire-based histories may introduce selection, recall, or reporting bias. In addition, only bivariate chi-square analyses were performed, so confounding and the independent contribution of hypertension, diabetes mellitus, and obesity could not be assessed. The control-group recruitment process, eligibility criteria, exposure

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definitions, and data-collection period require sufficiently detailed reporting to support replication.

CONCLUSION

Histories of hypertension, diabetes mellitus, and obesity were associated with kidney failure requiring hemodialysis, whereas age >60 years was not. Obesity showed the largest association, although the estimate was imprecise. Because the analysis was bivariate and the study was conducted at a single hospital, the findings should be interpreted as unadjusted associations rather than causal effects.

SUGGESTION

Kraton Regional General Hospital should strengthen integrated screening and counseling for patients with hypertension, diabetes mellitus, and obesity, with emphasis on blood-pressure control, glycemic management, healthy body weight, and timely assessment of kidney function. Future studies should use larger multicenter samples, objective exposure measurements, clearly defined control groups, and multivariable models to estimate the independent association of each factor with kidney failure requiring hemodialysis.

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