

Determinants of Rapid Renal Function Decline in Elderly Patients with Stage 3-4 Chronic Kidney Disease: A retrospective study from Northeastern Thailand

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ABSTRACT

Background

Rapid kidney function decline in elderly patients with chronic kidney disease (CKD) often leads to end-stage renal disease (ESRD) and a higher healthcare burden. Evidence on its determinants in Thai populations, especially in Northeastern Thailand, is limited.

Objective

To examine factors associated with rapid estimated glomerular filtration rate (eGFR) decline in elderly patients with stage 3-4 chronic kidney disease.

Method

A retrospective study was conducted using electronic medical records of 232 patients aged 60–75 years with stage 3-4 chronic kidney disease who received care at four healthcare facilities between October 2022 and September 2023. Demographic, clinical, and laboratory data were collected. Rapid eGFR decline was defined as a reduction of ≥ 5 mL/min/1.73 m² per year. Determinants were assessed using multivariable logistic regression.

Result

Among 232 patients (66.4% female; mean age 67.8 ± 4.9 years; mean estimated glomerular filtration rate 43.4 mL/min/1.73 m²), 65.1% experienced rapid estimated glomerular filtration rate decline. Independent predictors included older age (adjusted odds ratio [aOR] 1.06, 95% CI 1.01–1.12, $p = 0.04$), income (aOR 0.99, 95% CI 0.99–1.00, $p = 0.03$), and higher systolic blood pressure (aOR 1.06, 95% CI 1.00–1.12, $p = 0.02$).

Conclusion

Rapid estimated glomerular filtration rate decline is common among elderly stage 3-4 chronic kidney disease patients in Northeastern Thailand. Advanced age, income, and high systolic blood pressure are key determinants of rapid kidney function decline. Early detection and strict blood pressure control, supported by multidisciplinary care, may slow chronic kidney disease progression and reduce end-stage renal disease risk.

KEY WORDS

Chronic kidney disease, Elderly patients, Rapid estimated glomerular filtration rate decline, Risk factors, Thailand

INTRODUCTION

Chronic kidney disease (CKD) is a major global public health challenge, with steadily increasing incidence and prevalence worldwide. According to the Kidney Disease: Improving Global Outcomes guideline, CKD is defined as a glomerular filtration rate (GFR) < 60 mL/min/1.73 m² persisting for at least 3 months and is associated with substantial morbidity and mortality.¹ Globally, more than 850 million people are affected by kidney-related disorders, including acute kidney injury, CKD, and end-stage renal disease (ESRD).²

In Thailand, CKD affects approximately 11.6 million people, accounting for 17.5% of the population with an estimated 8.6% in stages 3-5.³ Hypertension and diabetes mellitus are the leading causes, followed by CKD of unknown etiology, glomerulonephritis, nephrolithiasis, and nephrotoxic drug exposure.⁴ The Northeastern region has the highest CKD prevalence nationally (26.8%) with cases distributed across all disease stages.⁵

Without appropriate management, CKD progressively advance to ESRD, requiring renal replacement therapy such as continuous ambulatory peritoneal dialysis or hemodialysis. These interventions are costly, impose significant caregiver burdens, and markedly reduce patients' quality of life.⁶ Therefore, strategies aimed at slowing renal function decline and preventing complications are essential.

Patients with stage 3-4 CKD require close monitoring and proactive management to delay disease progression. However, evidence regarding factors associated with rapid decline in estimated glomerular filtration rate (eGFR) among elderly Thai patients, especially in Northeastern Thailand, remains limited. This study aimed to investigate determinants of rapid eGFR decline among elderly patients with stage 3-4 CKD in this high-risk region.

METHODS

This retrospective study was conducted among elderly patients with stage 3-4 CKD who received care in the Northeastern health service region of Thailand between October 1, 2022, and September 30, 2023. The study followed Kidney Disease: Improving Global Outcomes (KDIGO) definition for CKD, in which the disease is defined as an eGFR < 60 mL/min/1.73 m² persisting for ≥ 3 months.^{7,8}

This study was approved by the Human Research Ethics Committee of Ubon Ratchathani Rajabhat University (Approval No. HE681013). All procedures were conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants, and each participant signed a consent form before enrollment. To ensure confidentiality, all personal identifiers were removed and the data were anonymized before analysis.

Eligible participants were aged 60-75 years and had stage 3-4 CKD with an eGFR of 15.0-59.9 mL/min/1.73 m², calculated using the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) equation. Patients with missing eGFR data were excluded from the analysis.

Sample size was estimated using G*Power version 3.1.9.4, which indicated a minimum required sample size of 187 participants. A total of 232 medical met the eligibility criteria and were included in the final analysis.

A multistage random sampling technique was employed to ensure representativeness. One health promotion hospital was randomly selected from each health service area, yielding four sites for patient recruitment across the Northeastern region.

Data were collected from electronic health records (EHRs) and patient medical charts using a structured data collection form developed for this study. The form consisted of three sections:

- 1) Demographic information: sex, age, income, education, primary caregiver, and the individual responsible for meal preparation.
- 2) Clinical information: BMI, comorbidities, and current medications, including both physician-prescribed drugs and non-prescribed products such as herbal medicines, dietary supplements, and vitamins.
- 3) Laboratory information: systolic and diastolic blood pressure, fasting plasma glucose (FPG), glycated hemoglobin (HbA1c), blood urea nitrogen (BUN), serum creatinine (Cr), eGFR, and serum electrolyte levels.

Definitions of CKD stage and eGFR calculation followed the CKD-EPI formula, consistent with established clinical practice and KDIGO guidelines.^{7,8} These variables were selected to allow a comprehensive evaluation of renal function and potential risk factors associated with eGFR decline.

The primary outcome measure was rapid eGFR decline, operationally defined in this study as an annual reduction in eGFR 5 mL/min/1.73 m² /year. eGFR values at baseline and follow-up were used to assess changes in renal function and classify patients into rapid decline and non-rapid decline groups.

All data were analyzed using standard statistical software. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize demographic and clinical characteristics. Bivariate analyses were initially performed to explore associations between potential risk factors and rapid decline in eGFR.

Multivariable logistic regression analysis was then applied to identify independent determinants of rapid eGFR decline, defined as an annual reduction ≥ 5 mL/min/1.73 m². Results are presented as odds ratios (ORs) and adjusted odds ratios (aORs) with 95% confidence intervals (CIs).

Statistical significance was set at a two-sided $p < 0.05$.

RESULTS

A total of 232 elderly patients with stage 3-4 CKD were included. Most were female (66.4%) with a mean age of 67.8 ± 4.9 years, and the average duration since CKD diagnosis was 4.4 ± 1.7 years. Most patients were farmers (56.0%), and (40.9%) prepared their own meals. Meanwhile, the primary caregivers were mainly children or grandchildren (65.9%). The most common comorbidities were diabetes mellitus (40.1%) and hypertension (37.9%). Regarding CKD stage, 45.7% of patients were classified as stage 3a, 46.5% as stage 3b, and 7.8% as stage 4. More than half (55.2%) reported a history of herbal medicine use but had discontinued it. Detailed demographic and clinical characteristics are presented in table 1.

Laboratory findings

As shown in table 2, the mean BMI was 24.1 ± 3.8 kg/m². The average systolic blood pressure was 147.1 ± 6.3 mmHg, and the mean diastolic pressure was 92.2 ± 5.6 mmHg. The mean eGFR was 43.4 ± 9.3 mL/min/1.73 m². Other laboratory results included a mean serum creatinine of 1.56 ± 0.54 mg/dL, BUN of 20.9 ± 4.9 mg/dL, FPG of 150.7 ± 36.0 mg/dL, HbA1c of $7.7 \pm 1.8\%$, hemoglobin of 13.0 ± 1.6 g/dL, and potassium of 4.3 ± 0.4 mmol/L. Overall, 65.1% of patients experienced a rapid decline in eGFR (≥ 5 mL/min/1.73 m² per year).

Factors associated with rapid eGFR decline

Multivariable logistic regression analysis identified three independent predictors of rapid eGFR decline (Table 3). These were: age 60-75 years (aOR: 1.06, 95% CI 1.01-1.12, $p = 0.04$); Income (aOR: 0.99, 95% CI 0.99-1.00, $p = 0.03$); and higher systolic blood pressure (aOR: 1.06, 95% CI 1.00-1.12, $p = 0.02$). Other variables, including sex, history of herbal medicine use, BMI, waist circumference, serum creatinine, BUN, fasting plasma glucose, HbA1c, hemoglobin, hematocrit, and potassium levels, were not significantly associated with rapid eGFR decline.

DISCUSSIONS

This study found that 65.1% of elderly patients with stage 3-4 CKD experienced rapid renal function decline, defined as an annual eGFR reduction of ≥ 5 mL/min/1.73 m². Three independent determinants such as older age, longer duration of CKD, and elevated systolic blood pressure were significantly associated with rapid eGFR decline. These findings emphasize the urgent need for strategies tailored to elderly CKD patients in Northeastern Thailand, where disease prevalence and burden are particularly high.

Age and renal decline: Advanced age was a strong predictor of rapid eGFR decline. This result is consistent with earlier studies, which have shown that renal function

Table 1. Baseline characteristics of patients

Characteristics	Elderly patients (n = 232)
Age (years, mean $\pm$ SD)	67.83 $\pm$ 4.87
Income (THB/months, means $\pm$ SD)	1,098 $\pm$ 758.72
Time since CKD diagnosis (years, means $\pm$ SD)	4.38 $\pm$ 1.67
Gender, n (%)	
Male	78 (33.6)
Female	154 (66.4)
Occupation, n (%)	
Farmer	130 (56.0)
Unemployed	70 (30.2)
Employee	19 (8.2)
Trader	13 (5.6)
Person responsible for meal preparation, n (%)	
Self	95 (40.9)
Husband/wife	45 (19.4)
Children/Grandchildren	88 (37.9)
Caregiver	4 (1.7)
Caregiver, n (%)	
Parent	3 (1.3)
Husband/wife	68 (29.3)
Child/grandchild	153 (65.9)
Relative/sibling	8 (3.4)
Comorbidities, n (%)	
Heart disease	14 (6.00)
Hypertension	88 (37.9)
Diabetes	93 (40.1)
None	37 (15.9)
History of herbal medicine use in 6 months, n (%)	
Used now	52 (22.4)
Used but stopped	128 (55.2)
Frequency of use herbal in the 1 month (means $\pm$ SD)	12.8 $\pm$ 12.0
Baseline CKD stage, n (%)	
CKD stage 3a	106 (45.7)
CKD stage 3b	108 (46.6)
CKD stage 4	18 (7.8)
eGFR, n (%)	
eGFR < 5 mL/min/1.73 m ² /year	81 (34.9)
eGFR ≥ 5 mL/min/1.73 m ² /year	151 (65.1)

CKD; chronic kidney disease, eGFR; estimated glomerular filtration rate

naturally decreases by approximately 1 mL/min/1.73 m² per year in older individuals, with those around 70 years old experiencing cumulative losses exceeding 40 mL/min/1.73 m² over time.^{9,10} The biological processes of aging affect both renal structure and function, including reduced renal vasodilatory capacity, glomerulosclerosis, tubular atrophy, and interstitial fibrosis. Furthermore, the ability to concentrate and dilute urine, as well as regulate sodium and potassium balance, diminishes with age. These changes compromise homeostatic capacity and accelerate

Table 2. Baseline clinical and laboratory characteristics of patients (n = 232)

Parameters	Mean	SD	Minimum	Maximum
BMI (kg/m ²)	24.05	3.81	16.42	34.66
Systolic blood pressure (mm Hg)	147.14	6.33	139.00	165.00
Diastolic blood pressure (mm Hg)	92.17	5.56	70.00	110.00
Waist circumference (inches)	32.25	3.43	25.00	44.00
eGFR (mL/min/1.73 m ²)	43.40	9.34	16.00	59.00
Serum Creatinine Cr (mg/dL)	1.56	0.54	0.57	3.83
BUN (mg/dL)	20.92	4.95	10.00	44.00
FPG (mg/dL)	150.71	35.97	99.00	416.00
HbA1c (%)	7.74	1.76	4.30	15.10
Hemoglobin (g/dL)	12.97	1.61	9.00	20.51
Hematocrit (%)	38.76	5.15	25.60	46.90
Potassium (mmol/L)	4.31	0.44	3.30	5.00

BMI; Body Mass Index, eGFR; estimated glomerular filtration rate, Cr; Creatinine, BUN; Blood Urea Nitrogen, FPG; fasting plasma glucose, HbA1c; Hemoglobin A1c, SD; Standard deviation

CKD progression.¹¹ In populations where hypertension and diabetes are highly prevalent, the effect of aging on renal decline is likely compounded, leading to a higher risk of ESRD.

Duration of CKD: The length of time since CKD diagnosis showed a positive but non-significant association with rapid decline. Patients with longer disease duration showed greater reductions in eGFR, reflecting the cumulative burden of chronic kidney damage. The KDIGO Clinical Practice Guideline notes that patients in stages 3-4 are at particularly high risk of progression if they remain in these stages for extended periods.¹ Our findings support this view, suggesting that prolonged exposure to underlying risk factors such as hyperglycemia, hypertension, and oxidative stress contributes to structural renal damage and accelerated decline. In this study, the mean duration of CKD was 4.4 years. These findings underscore the importance of early identification and regular follow-up for patients with CKD, particularly older adults, to monitor disease progression and prevent further deterioration of kidney function.

Systolic blood pressure: Elevated systolic blood pressure (SBP) was identified as a significant determinant of rapid eGFR decline. This finding aligns with previous studies showing that uncontrolled SBP significantly accelerates CKD progression, particularly in patients with severely impaired renal function.¹² Hypertension contributes to glomerular hyperfiltration, endothelial dysfunction, renal fibrosis, and oxidative stress, all of which accelerate nephron loss and renal scarring. When combined with diabetes, the effect is even more pronounced, as hyperglycemia induces additional glomerular injury through advanced glycation end products and inflammatory pathways.^{13,14} Together,

Table 3. Factors associated with rapid decline in eGFR using logistic regression analysis

Variables	Rapid decline eGFR ≥ 5 mL/min/1.73 m ² /year			
	Univariable		Multivariable	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Gender (female vs male ref.)	1.21 (0.68-2.15)	0.51	0.86 (0.47-1.59)	0.64
Age	1.06 (1.00-1.12)	0.04*	1.06 (1.01-1.12)	0.04*
Income	1.00 (1.00-1.00)	0.73	0.99 (0.99-1.00)	0.03*
longer duration of CKD diagnosis (years)	1.20 (1.01-1.42)	0.03*	1.19 (0.99-1.42)	0.05
History of herbal medicine use				
Used now	1.56 (0.67-3.59)	0.29	1.37 (0.55-3.37)	0.49
Used but stopped	0.96 (0.49-1.87)	0.90	0.99 (0.48-2.03)	0.99
BMI (kg/m ²)	1.02 (0.95-1.10)	0.50	0.92 (0.80-1.06)	0.28
Systolic blood pressure (mm Hg)	1.05 (1.00-1.18)	0.05*	1.06 (1.00-1.12)	0.02*
Diastolic blood pressure (mm Hg)	0.96 (0.91-1.01)	0.15	0.92 (0.85-1.01)	0.06
Waist circumference (inches)	1.05 (0.97-1.14)	0.16	1.10 (0.94-1.29)	0.21
Serum creatinine (mg/dL)	0.98 (0.59-1.61)	0.93	1.10 (0.63-1.93)	0.72
BUN (mg/dL)	0.97 (0.92-1.03)	0.44	0.96 (0.90-1.02)	0.25
FPG (mg/dL)	1.00 (0.98-1.01)	0.74	1.00 (0.98-1.02)	0.62
HbA1c (%)	1.03 (0.88-1.21)	0.65	1.01 (0.84-1.22)	0.88
Hemoglobin (g/dL)	1.00 (0.85-1.19)	0.92	1.01 (0.84-1.22)	0.89
Hematocrit (%)	0.97 (0.92-1.02)	0.29	0.98 (0.92-1.04)	0.55
Potassium (mmol/L)	0.64 (0.35-1.18)	0.15	0.70 (0.36-1.35)	0.29

CKD; chronic kidney disease, BMI; Body mass index, BUN; Blood Urea Nitrogen, FPG; fasting plasma glucose, HbA1c; Hemoglobin A1c, OR; Odds ratios, aOR; adjusted odds ratios *p < 0.05

these mechanisms underscore the crucial importance of strict SBP control as part of CKD management, particularly in elderly patients with multiple comorbidities. Targeted antihypertensive therapy, lifestyle modification, and adherence to clinical guidelines could reduce the rate of progression and improve outcomes in this population.

Non-significant factors: Although factors such as herbal medicine use, waist circumference, fasting plasma glucose, HbA1c, and hemoglobin were not significantly associated with rapid eGFR decline in this study, they remain clinically relevant. Many patients reported having previously used herbal medicines. While no significant statistical association was found, some herbal preparations have been linked to nephrotoxicity, renal inflammation, or fibrosis, depending

on type, dosage, and duration of use.¹⁵⁻¹⁷ Likewise, central obesity and poor glycemic control are established contributors to renal decline through mechanisms such as insulin resistance, systemic inflammation, and glomerular hyperfiltration.¹⁸ The lack of significance in this study may be attributed to effective clinical management of these risk factors or to limitations in the dataset. Future studies should continue to investigate the long-term influence of these variables in larger and more diverse populations.

This study has notable strengths, including its focus on elderly CKD patients in Northeastern Thailand, the region with the country's highest prevalence, and the use of robust statistical methods to identify determinants of renal decline. However, the retrospective design relied on secondary data, limiting information on factors such as self-care behaviors, health literacy, and family support. The relatively small sample from selected hospitals may also limit generalizability. Despite these limitations, the findings highlight the importance of early screening, strict blood pressure control, and multidisciplinary care in delaying CKD progression and reducing the need for renal replacement therapy.

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CONCLUSION

This study showed that rapid renal function decline is common among elderly patients with stage 3-4 CKD in Northeastern Thailand, with older age, with older age, income, and elevated systolic blood pressure identified as key determinants. While other factors were not statistically significant, they remain clinically relevant. These findings underscore the importance of early screening, strict blood pressure management, lifestyle modification, and multidisciplinary care in slowing CKD progression, as well as public health strategies to expand screening and improve access to care in high-prevalence regions.

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