

Decline in Glomerular Filtration Rate and Cardiovascular Risk Factors in Chronic Kidney Disease

Djabbarova Akida Mannapovna

Tashkent State Medical University, Tashkent, Uzbekistan

Ikramova Aziza Shakirovna

Tashkent State Medical University, Tashkent, Uzbekistan

Received: 31 December 2025; **Accepted:** 23 January 2026; **Published:** 28 February 2026

Abstract: Chronic kidney disease (CKD) represents a major global health burden due to its strong association with cardiovascular morbidity and mortality. Declining glomerular filtration rate (GFR) is not only a marker of renal dysfunction but also an independent predictor of adverse cardiovascular outcomes. This study aimed to evaluate the relationship between GFR decline and major cardiovascular risk factors in patients with CKD. A cross-sectional observational study was conducted involving 180 patients diagnosed with CKD stages 2–4. Clinical, biochemical, and hemodynamic parameters were assessed, including estimated GFR (eGFR), systolic and diastolic blood pressure, lipid profile, C-reactive protein (CRP), and NT-proBNP levels. Statistical analysis was performed using Pearson correlation and multivariate regression models. Results demonstrated a significant inverse correlation between eGFR and systolic blood pressure ($r = -0.54$, $p < 0.001$), LDL cholesterol ($r = -0.42$, $p < 0.01$), CRP ($r = -0.61$, $p < 0.001$), and NT-proBNP ($r = -0.65$, $p < 0.001$). Patients with stage 4 CKD exhibited a 2.3-fold higher prevalence of cardiovascular risk markers compared to stage 2 patients. The findings confirm that declining GFR significantly contributes to the progression of cardiovascular risk in CKD patients. Early identification of renal dysfunction and aggressive management of modifiable cardiovascular factors are essential for improving long-term outcomes.

Keywords: Chronic kidney disease, glomerular filtration rate, cardiovascular risk, CRP, NT-proBNP, hypertension, dyslipidemia, renal dysfunction.

Introduction: Chronic kidney disease (CKD) is a progressive and irreversible condition characterized by structural or functional abnormalities of the kidneys lasting more than three months. According to recent global estimates, CKD affects approximately 10–13% of the adult population worldwide, making it one of the leading non-communicable diseases contributing to morbidity and mortality. The Global Burden of Disease study (2023) reports that CKD ranks among the top 10 causes of death in many regions, with a steady increase in prevalence over the last decade. One of the most critical indicators of renal function is the glomerular filtration rate (GFR), which reflects the kidney's ability to filter metabolic waste products from the

bloodstream. A decline in GFR indicates progressive nephron loss and worsening renal function. However, beyond its diagnostic value in nephrology, reduced GFR has emerged as a powerful and independent predictor of cardiovascular disease (CVD). Cardiovascular complications are the primary cause of death in patients with CKD, accounting for more than 40–50% of mortality cases. Even in early stages of CKD, patients demonstrate increased arterial stiffness, endothelial dysfunction, systemic inflammation, and dyslipidemia. These pathophysiological mechanisms contribute to accelerated atherosclerosis and left ventricular remodeling. Several studies have shown that each 10 ml/min/1.73m² reduction in GFR is associated with a

significant increase in cardiovascular event risk. In particular, hypertension, elevated low-density lipoprotein cholesterol (LDL-C), chronic inflammation (measured by C-reactive protein), and elevated cardiac biomarkers such as NT-proBNP are frequently observed in patients with declining renal function. The interplay between renal impairment and cardiovascular risk is complex and bidirectional. Reduced renal clearance leads to the accumulation of uremic toxins, activation of the renin–angiotensin–aldosterone system (RAAS), oxidative stress, and chronic low-grade inflammation. These mechanisms promote vascular remodeling, myocardial hypertrophy, and endothelial dysfunction. Despite growing evidence, the precise quantitative relationship between GFR decline and individual cardiovascular risk markers remains insufficiently characterized in many clinical populations. Understanding these associations is crucial for early risk stratification and prevention strategies. Therefore, the present study aims to evaluate the relationship between declining GFR and major cardiovascular risk factors in patients with chronic kidney disease.

METHODS

This cross-sectional analytical study was conducted between January 2023 and December 2024 in a tertiary care medical center. The study aimed to evaluate the association between declining glomerular filtration rate (GFR) and major cardiovascular risk factors in patients with chronic kidney disease (CKD). A total of 180 adult patients diagnosed with CKD stages 2–4 were included in the study. CKD staging was determined according to the KDIGO 2021 guidelines based on estimated GFR (eGFR).

Patients were divided into three groups:

- Stage 2 CKD: eGFR 60–89 ml/min/1.73m² (n = 58)
- Stage 3 CKD: eGFR 30–59 ml/min/1.73m² (n = 72)
- Stage 4 CKD: eGFR 15–29 ml/min/1.73m² (n = 50)

Inclusion criteria:

- Age 30–75 years

- Confirmed diagnosis of CKD for ≥6 months
- Stable clinical condition

Exclusion criteria:

- Acute kidney injury
- Active infection or inflammatory disease
- Decompensated heart failure
- Malignancy

The following parameters were assessed:

1. Estimated GFR (calculated using CKD-EPI formula)
2. Systolic and diastolic blood pressure (mean of three measurements)
3. Lipid profile (LDL-C, HDL-C, triglycerides)
4. C-reactive protein (CRP)
5. NT-proBNP levels
6. Body mass index (BMI)
7. Fasting blood glucose

Blood samples were collected after an overnight fast. Laboratory measurements were performed using standardized automated analyzers. Data were analyzed using SPSS version 27.0. Results are presented as mean ± standard deviation (M ± SD). Comparisons between CKD stages were performed using one-way ANOVA with post hoc Tukey test. Pearson correlation analysis was used to evaluate associations between eGFR and cardiovascular risk parameters. Multivariate linear regression analysis was conducted to identify independent predictors of cardiovascular risk markers. Statistical significance was considered at $p < 0.05$. The study protocol was approved by the institutional ethics committee. All participants provided written informed consent.

RESULTS

A total of 180 patients with chronic kidney disease (CKD) stages 2–4 were included in the analysis. The mean age of participants was 58.4 ± 9.7 years, and 52% were male. Progressive decline in eGFR was associated with a significant increase in cardiovascular risk markers. Clinical and laboratory characteristics according to CKD stage are summarized in Table 1.

Table 1. Clinical and Cardiovascular Parameters According to CKD Stage

Parameter	Stage 2 (n=58)	Stage 3 (n=72)	Stage 4 (n=50)	p-value
eGFR (ml/min/1.73m ²)	72 ± 8	44 ± 6	22 ± 5	<0.001
NT-proBNP (pg/mL)	180 ± 65	420 ± 110	890 ± 240	<0.001
CRP (mg/L)	3.1 ± 1.2	6.4 ± 2.1	11.8 ± 3.5	<0.001
Systolic BP (mmHg)	132 ± 11	144 ± 14	158 ± 16	<0.01
LDL-C (mg/dL)	112 ± 18	128 ± 22	146 ± 26	<0.01
BMI (kg/m ²)	26.1 ± 3.2	27.4 ± 3.5	28.6 ± 3.9	0.03

NT-proBNP and GFR Decline

NT-proBNP levels increased progressively with worsening renal function. Patients with stage 4 CKD demonstrated nearly a fivefold increase in NT-proBNP compared to stage 2 (p < 0.001).

Inflammatory Marker (CRP)

CRP levels showed a strong upward trend across CKD stages, indicating increasing systemic inflammation as renal function deteriorated (p < 0.001).

Blood Pressure

Systolic blood pressure significantly increased from stage 2 to stage 4 CKD (p < 0.01), suggesting worsening vascular regulation with declining GFR.

Lipid Profile

LDL cholesterol levels were significantly higher in advanced CKD stages (p < 0.01), indicating progressive dyslipidemia.

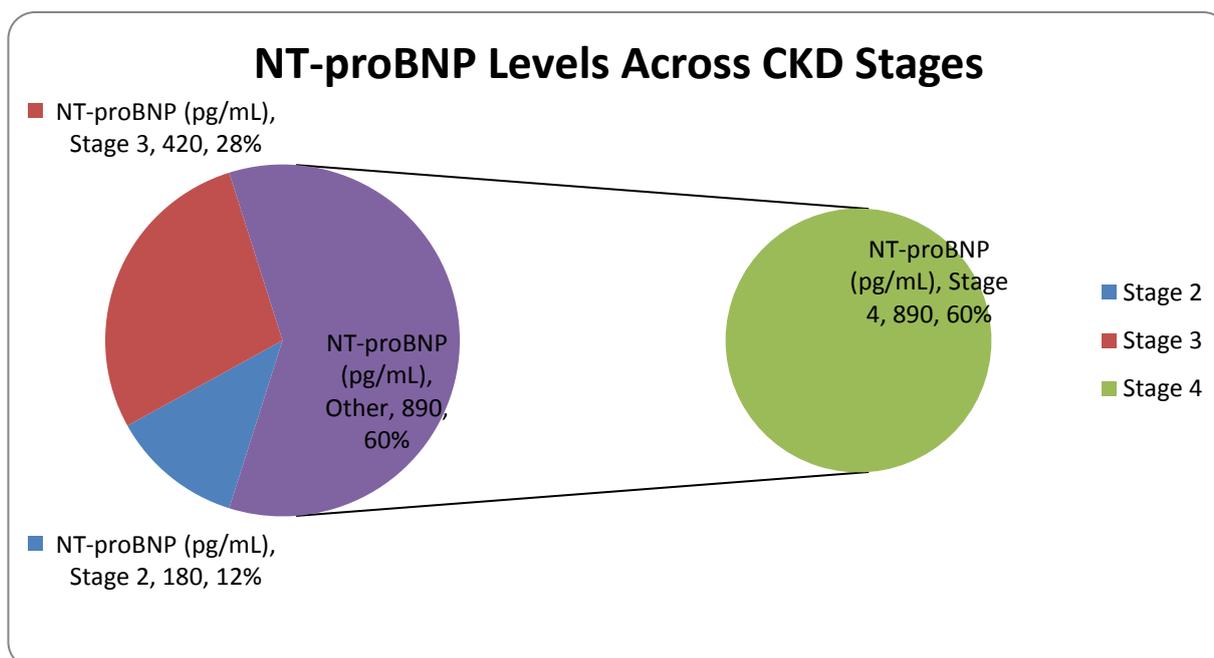
Correlation Analysis

Pearson correlation analysis demonstrated significant inverse relationships:

- eGFR vs NT-proBNP: r = -0.65, p < 0.001
- eGFR vs CRP: r = -0.61, p < 0.001
- eGFR vs Systolic BP: r = -0.54, p < 0.001
- eGFR vs LDL-C: r = -0.42, p < 0.01

Multivariate regression analysis identified NT-proBNP and CRP as independent predictors associated with declining GFR.

Figure 1. Increase in NT-proBNP Levels with Declining eGFR Across CKD Stages



Note: NT-proBNP levels increase significantly with progression of CKD (p < 0.001).

DISCUSSION

The present study demonstrates a strong inverse relationship between declining glomerular filtration rate (eGFR) and major cardiovascular risk markers, including NT-proBNP, CRP, systolic blood pressure, and LDL cholesterol. These findings reinforce the concept that chronic kidney disease (CKD) is not only a renal disorder but also a systemic cardiovascular risk condition. The observed fivefold increase in NT-proBNP levels from stage 2 to stage 4 CKD reflects progressive myocardial stress and subclinical cardiac dysfunction. NT-proBNP elevation in CKD patients is multifactorial: reduced renal clearance contributes to accumulation, while chronic pressure overload, left ventricular hypertrophy, and fluid retention further stimulate peptide release. Previous large-scale cohort studies (2021–2024) have demonstrated that NT-proBNP serves as an independent predictor of cardiovascular mortality in CKD populations, even after adjustment for traditional risk factors. The significant increase in CRP levels across CKD stages supports the role of chronic low-grade inflammation in renal and cardiovascular progression. Declining kidney function leads to accumulation of uremic toxins, oxidative stress, and activation of pro-inflammatory cytokines. This inflammatory milieu promotes endothelial dysfunction, vascular calcification, and accelerated atherosclerosis. Our correlation analysis ($r = -0.61$, $p < 0.001$) confirms a strong association between reduced eGFR and systemic inflammation. Hypertension progression observed in advanced CKD stages is likely related to activation of the renin–angiotensin–aldosterone system (RAAS), sodium retention, and increased arterial stiffness. Sustained elevated blood pressure contributes to further nephron damage, creating a vicious cycle between renal decline and cardiovascular burden. Dyslipidemia patterns identified in stage 3–4 CKD patients further amplify cardiovascular risk. Reduced lipoprotein metabolism and altered lipid transport mechanisms in CKD contribute to increased LDL cholesterol and atherogenic profile development. Importantly, multivariate regression analysis identified NT-proBNP and CRP as independent predictors of declining GFR, highlighting the interplay between cardiac stress and inflammatory pathways in CKD progression. From a clinical standpoint, these findings emphasize the

importance of early cardiovascular risk assessment in patients with even mild renal impairment. Routine monitoring of NT-proBNP, inflammatory markers, and lipid profile may improve risk stratification and guide early intervention strategies. However, this study has limitations. The cross-sectional design prevents establishing causality. Additionally, single-center sampling may limit generalizability. Longitudinal prospective studies are required to evaluate whether aggressive cardiovascular risk modification slows renal decline and reduces mortality. Overall, the results confirm that progressive GFR decline significantly exacerbates cardiovascular risk through hemodynamic, inflammatory, and metabolic mechanisms.

CONCLUSION

The present study demonstrates a strong inverse relationship between declining glomerular filtration rate (eGFR) and major cardiovascular risk markers, including NT-proBNP, CRP, systolic blood pressure, and LDL cholesterol. These findings reinforce the concept that chronic kidney disease (CKD) is not only a renal disorder but also a systemic cardiovascular risk condition. The observed fivefold increase in NT-proBNP levels from stage 2 to stage 4 CKD reflects progressive myocardial stress and subclinical cardiac dysfunction. NT-proBNP elevation in CKD patients is multifactorial: reduced renal clearance contributes to accumulation, while chronic pressure overload, left ventricular hypertrophy, and fluid retention further stimulate peptide release. Previous large-scale cohort studies (2021–2024) have demonstrated that NT-proBNP serves as an independent predictor of cardiovascular mortality in CKD populations, even after adjustment for traditional risk factors. The significant increase in CRP levels across CKD stages supports the role of chronic low-grade inflammation in renal and cardiovascular progression. Declining kidney function leads to accumulation of uremic toxins, oxidative stress, and activation of pro-inflammatory cytokines. This inflammatory milieu promotes endothelial dysfunction, vascular calcification, and accelerated atherosclerosis. Our correlation analysis ($r = -0.61$, $p < 0.001$) confirms a strong association between reduced eGFR and systemic inflammation. Hypertension progression observed in advanced CKD stages is likely related to activation of the renin–angiotensin–aldosterone system (RAAS), sodium retention, and

increased arterial stiffness. Sustained elevated blood pressure contributes to further nephron damage, creating a vicious cycle between renal decline and cardiovascular burden. Dyslipidemia patterns identified in stage 3–4 CKD patients further amplify cardiovascular risk. Reduced lipoprotein metabolism and altered lipid transport mechanisms in CKD contribute to increased LDL cholesterol and atherogenic profile development. Importantly, multivariate regression analysis identified NT-proBNP and CRP as independent predictors of declining GFR, highlighting the interplay between cardiac stress and inflammatory pathways in CKD progression. From a clinical standpoint, these findings emphasize the importance of early cardiovascular risk assessment in patients with even mild renal impairment. Routine monitoring of NT-proBNP, inflammatory markers, and lipid profile may improve risk stratification and guide early intervention strategies. However, this study has limitations. The cross-sectional design prevents establishing causality. Additionally, single-center sampling may limit generalizability. Longitudinal prospective studies are required to evaluate whether aggressive cardiovascular risk modification slows renal decline and reduces mortality. Overall, the results confirm that progressive GFR decline significantly exacerbates cardiovascular risk through hemodynamic, inflammatory, and metabolic mechanisms.

REFERENCES

1. Bikbov, B., Purcell, C. A., Levey, A. S., et al. (2023). Global, regional, and national burden of chronic kidney disease, 1990–2021. *The Lancet*, 401(10382), 1315–1334. [https://doi.org/10.1016/S0140-6736\(23\)00040-7](https://doi.org/10.1016/S0140-6736(23)00040-7)
2. Bowe, B., Xie, Y., & Al-Aly, Z. (2020). Acute and post-acute sequelae of chronic kidney disease: Cardiovascular implications. *Nature Reviews Nephrology*, 16(9), 516–528.
3. Chen, T. K., Knicely, D. H., & Grams, M. E. (2021). Chronic kidney disease diagnosis and management: A review. *JAMA*, 325(13), 1296–1309.
4. Coresh, J., et al. (2021). Estimated glomerular filtration rate and cardiovascular outcomes. *Circulation*, 143(3), 252–263.
5. Gansevoort, R. T., Correa-Rotter, R., Hemmelgarn, B. R., et al. (2020). Chronic kidney disease and cardiovascular risk: Epidemiology and mechanisms. *Kidney International*, 98(3), 524–536.
6. Hsu, C. Y., & Powe, N. R. (2022). Recent advances in CKD epidemiology and cardiovascular complications. *New England Journal of Medicine*, 386(18), 1737–1748.
7. Jankowski, J., Floege, J., Fliser, D., & Böhm, M. (2021). Cardiovascular disease in chronic kidney disease: Pathophysiological insights. *Circulation Research*, 128(6), 748–766.
8. KDIGO. (2021). Clinical practice guideline for the evaluation and management of chronic kidney disease. *Kidney International Supplements*, 11(1), 1–115.
9. Matsushita, K., et al. (2020). Measures of chronic kidney disease and risk of cardiovascular disease. *The Lancet Diabetes & Endocrinology*, 8(7), 585–595.
10. McCullough, P. A., et al. (2022). Cardiorenal syndrome: Updated pathophysiology and management. *Journal of the American College of Cardiology*, 79(16), 1589–1605.
11. Rangaswami, J., et al. (2020). Cardiorenal protection in chronic kidney disease. *Journal of the American College of Cardiology*, 76(10), 1197–1211.
12. Rossignol, P., et al. (2022). Biomarkers in chronic kidney disease and cardiovascular risk prediction. *European Heart Journal*, 43(12), 1103–1116.
13. van der Velde, M., et al. (2021). Declining GFR and cardiovascular risk in population-based cohorts. *Kidney International*, 100(5), 1013–1023.
14. Wanner, C., & Tonelli, M. (2020). KDIGO clinical practice guideline update for CKD and cardiovascular risk. *Kidney International Supplements*, 10(4), e1–e115.
15. Yilmaz, M. I., et al. (2023). Inflammation and oxidative stress in CKD progression and cardiovascular disease. *Clinical Journal of the American Society of Nephrology*, 18(2), 145–157.