Essentia:
Journal of Medical Practice and Research
Vol 2 No 1 June 2026, Hal 362-370
ISSN: 3123-4100 (Print) ISSN: 3123-4097 (Electronic)
Open Access: https://scriptaintelektual.com/essentia

Cardiovascular Disease Risk Score Correlates with Glomerular Filtration Rate in Hemodialysis Patients: A Cross-Sectional Pilot Study

Nabil Hajar[1*], Bintang Adhiyoso Wicaksono[2], Zulfachmi Wahab[3], Shofa Chasani[4], Galih Prakasa Adhyatma[5], Nabila Nuralya Joveazhari[6], Zeidan Ahmad Fahdalhaq[7]
[1-7] Universitas Muhammadiyah Semarang, Indonesia
email: nabilhajar@unimus.ac.id[1]

Article Info :
Received:
20-3-2026
Revised:
27-3-2026
Accepted:
04-4-2026

Abstract

Chronic kidney disease is closely linked to an elevated risk of cardiovascular morbidity and mortality, particularly among patients undergoing hemodialysis. This study aimed to examine the relationship between cardiovascular disease risk scores and renal function using an empirical cross-sectional design. A total of 72 eligible patients receiving hemodialysis were assessed using the World Health Organization Risk Prediction Chart for Southeast Asia Region B to estimate 10-year cardiovascular risk. Renal function was evaluated using the Cockcroft–Gault equation to determine glomerular filtration rate values. Descriptive analysis demonstrated a predominance of high cardiovascular risk categories alongside severely reduced renal function. Inferential analysis using the Spearman rank correlation test revealed a statistically significant inverse relationship between cardiovascular risk score and glomerular filtration rate ($r = -0.637$; $p = 0.000$). These findings indicate that higher cardiovascular risk is associated with more severe renal impairment. The results support the integration of cardiovascular risk assessment into routine clinical evaluation of patients with chronic kidney disease undergoing hemodialysis to improve early risk stratification and management strategies.

Keywords: *Chronic Kidney Disease, Cardiovascular Risk, Glomerular Filtration Rate, Hemodialysis, SEAR B Score.*

INTRODUCTION

The global burden of chronic kidney disease (CKD) and cardiovascular disease (CVD) has evolved into a converging public health crisis, characterized by shared pathophysiological pathways and mutually reinforcing risk trajectories, as evidenced by epidemiological frameworks highlighting cardiovascular complications as the leading cause of mortality among renal populations (World Health Organization (WHO), 2007; Ministry of Health of the Republic of Indonesia, 2018). Contemporary advances in nephrology and cardiovascular medicine increasingly recognize CKD not merely as an isolated renal impairment but as a systemic condition that accelerates vascular dysfunction, endothelial injury, and metabolic dysregulation, thereby amplifying cardiovascular risk beyond traditional determinants. This paradigm shift is further strengthened by the widespread use of risk stratification tools, such as WHO cardiovascular risk charts, which integrate demographic and metabolic parameters to estimate population-specific risk profiles, yet remain underutilized in high-risk subgroups such as hemodialysis patients. Within this evolving landscape, glomerular filtration rate (GFR) has emerged as a central biomarker reflecting renal functional decline, while simultaneously serving as an indirect indicator of systemic vascular health, suggesting a potentially quantifiable link between renal insufficiency and cardiovascular risk burden.

Empirical investigations have increasingly attempted to delineate the complex interplay between renal function decline and cardiovascular risk factors, though findings remain heterogeneous and context-dependent. Cross-sectional analyses have demonstrated that metabolic parameters, including serum uric acid and lipid profiles, exhibit significant associations with CKD prevalence and progression, implying that cardiovascular risk components may directly influence renal impairment trajectories (Cheng et al., 2022). Parallel research in diabetic populations has identified multifactorial determinants of estimated GFR, emphasizing the contribution of glycemic control, hypertension, and

systemic inflammation to renal deterioration (Al-Dwairi et al., 2025). In cardiovascular-focused studies, subclinical cardiac dysfunction—such as impaired left ventricular global longitudinal strain has been linked to CKD severity, reinforcing the bidirectional relationship between cardiac and renal pathologies (Truong et al., 2026). Pilot cross-sectional studies in related domains, including pharmacokinetics in heart failure and cognitive outcomes post-kidney donation, further illustrate the utility of cross-sectional designs in capturing complex, multi-system interactions within clinical populations (Lazarova et al., 2025; Mikuteit et al., 2022). Collectively, these studies underscore a growing recognition of interconnected risk systems, yet they stop short of establishing integrated predictive relationships between standardized cardiovascular risk scores and objective renal function metrics in dialysis cohorts.

Despite these advances, significant conceptual and empirical gaps persist in the literature, particularly regarding the direct correlation between composite cardiovascular risk scores and quantitative measures of renal function in patients undergoing hemodialysis. Many existing studies isolate either renal outcomes or cardiovascular endpoints without adequately integrating both dimensions into a unified analytical framework, thereby limiting the ability to capture their interdependence. Furthermore, variability in study populations, measurement approaches, and risk assessment tools has contributed to inconsistent findings, with some studies emphasizing metabolic predictors while others prioritize structural or functional cardiovascular markers. The reliance on surrogate markers rather than validated, population-specific risk scoring systems further constrains the generalizability of results, especially in regions with distinct epidemiological profiles such as Southeast Asia. This fragmentation highlights a critical need for studies that explicitly examine how standardized cardiovascular risk assessments relate to renal function decline within clinically relevant populations.

The unresolved nature of this relationship carries substantial scientific and practical implications, particularly in the context of hemodialysis patients who represent a high-risk group with disproportionately elevated morbidity and mortality rates. Understanding whether cardiovascular risk scores correlate with GFR could enhance early risk stratification, inform clinical decision-making, and support integrated management strategies targeting both renal and cardiovascular systems. In resource-limited settings, where advanced diagnostic modalities may be inaccessible, the ability to utilize simple, validated risk prediction tools to infer disease severity would represent a significant advancement in clinical practice. Moreover, given the rising prevalence of CKD and the documented role of cardiovascular complications as a primary cause of death, addressing this knowledge gap is essential for improving patient outcomes and optimizing healthcare resource allocation (World Health Organization (WHO), 2007; Ministry of Health of the Republic of Indonesia, 2018).

Positioned within this context, the present study seeks to contribute to the evolving discourse by explicitly examining the association between cardiovascular disease risk scores—derived from WHO SEAR B risk prediction charts—and glomerular filtration rate among patients undergoing hemodialysis. By integrating a standardized cardiovascular risk assessment framework with a clinically established measure of renal function, this research attempts to bridge the existing divide between cardiovascular and nephrological risk evaluation paradigms. The adoption of a cross-sectional analytical approach aligns with prior pilot investigations while extending their scope to address a more targeted and clinically relevant research question, thereby offering a nuanced perspective on the interplay between systemic risk factors and organ-specific outcomes.

This study aims to determine the correlation between cardiovascular disease risk scores and glomerular filtration rate in hemodialysis patients, with the expectation of elucidating a measurable relationship that reflects the severity of chronic kidney disease. The findings are anticipated to provide both theoretical contributions, by advancing the understanding of cardio-renal interactions, and methodological contributions, by demonstrating the applicability of integrated risk assessment models in clinical nephrology research.

RESEARCH METHODS

This study employed an empirical, analytical observational design with a cross-sectional approach to examine the relationship between cardiovascular disease risk scores and renal function among patients with chronic kidney disease undergoing hemodialysis. The study was conducted in November 2023 at the Hemodialysis Unit of Roemani Muhammadiyah Hospital, Semarang, Indonesia. A total of 88 participants were recruited using purposive sampling to ensure the inclusion of clinically relevant cases. Eligibility criteria comprised patients aged over 40 years, diagnosed with chronic kidney

disease, actively receiving hemodialysis treatment, possessing available serum creatinine data, and providing informed consent to participate. Participants were also required to be physically capable of undergoing clinical examination and structured interviews. Exclusion criteria were defined to minimize confounding factors and included patients with kidney dysfunction attributable to acute or secondary causes such as intoxication, glomerulonephritis, or urinary tract infections. Data collection procedures involved a combination of direct physical examinations and interviewer-administered questionnaires to obtain demographic and clinical variables relevant to cardiovascular risk assessment.

Cardiovascular disease risk was assessed using the World Health Organization (WHO) Risk Prediction Chart for the Southeast Asia Region B (SEAR B), which incorporates variables such as age, sex, smoking status, blood pressure, and comorbid conditions to estimate 10-year cardiovascular risk. Renal function was quantified using the Cockcroft–Gault equation to estimate glomerular filtration rate (GFR), based on age, body weight, and serum creatinine levels. Descriptive statistics were used to summarize participant characteristics, with data presented in proportions and percentages where appropriate. Inferential analysis was conducted using the Spearman rank correlation test to evaluate the relationship between cardiovascular risk scores and GFR, given the non-parametric nature of the data distribution. All statistical analyses were performed with a predefined significance threshold. Ethical approval for the study was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Muhammadiyah Semarang (KEPK FK Unimus), under reference number No. 084/EC/KEPK-FK/UNIMUS/2023, ensuring that all procedures adhered to established ethical standards for human subject research.

RESULTS AND DISCUSSION

Baseline Characteristics of Hemodialysis Patients and Clinical Risk Profiles

The study population consisted of 72 eligible patients undergoing hemodialysis, reflecting a clinically advanced cohort of chronic kidney disease cases characterized by multiple comorbidities and metabolic disturbances. The demographic distribution demonstrated a slightly higher proportion of female participants, accompanied by a predominance of elderly individuals, indicating age-related vulnerability to renal and cardiovascular deterioration. Such demographic patterns align with epidemiological observations that aging populations exhibit accelerated decline in renal function due to cumulative vascular and metabolic insults (Jiang et al., 2025). The interplay between aging and chronic disease burden reinforces the importance of stratifying risk profiles in hemodialysis populations.

The distribution of sex and age categories suggests a heterogeneous yet clinically representative cohort, in which both biological and behavioral determinants may influence disease progression. Female predominance in this sample may reflect differential healthcare access or survival patterns in CKD populations, although evidence remains inconclusive across settings (Khudhair, 2025). Age stratification indicates that more than half of participants fall within the elderly category, a finding consistent with the progressive nature of renal decline associated with aging physiology. This demographic structure underscores the necessity of integrating age-sensitive cardiovascular risk assessment tools in clinical evaluation.

A substantial proportion of participants presented with diabetes mellitus, highlighting its central role as a primary etiological factor in CKD progression and cardiovascular complications. The high prevalence of diabetes reflects its established contribution to endothelial dysfunction, oxidative stress, and microvascular damage, which collectively accelerate renal impairment (Al-Dwairi et al., 2025). This observation is further supported by studies demonstrating that glycemic dysregulation significantly influences estimated GFR trajectories in chronic disease populations. The coexistence of diabetes and CKD amplifies cardiovascular risk, reinforcing the need for integrated disease management strategies.

Serum creatinine levels among participants predominantly fell within the highest category, indicating severe renal impairment and advanced disease stage. Elevated creatinine serves as a surrogate marker for reduced filtration capacity and is widely utilized in clinical practice to estimate GFR (Stehlé et al., 2023). The predominance of high creatinine values in this cohort reflects the advanced clinical status of patients undergoing hemodialysis. Such findings emphasize the critical role of biochemical monitoring in assessing disease severity and guiding therapeutic interventions.

Smoking behavior was also assessed as a relevant cardiovascular risk factor, with a notable proportion of participants identified as active smokers. Smoking has been consistently linked to vascular inflammation, oxidative stress, and accelerated atherosclerosis, all of which contribute to both CKD

progression and cardiovascular morbidity (Etaee et al., 2022). The presence of this modifiable risk factor within the cohort suggests opportunities for targeted behavioral interventions. Addressing lifestyle factors remains essential in reducing overall disease burden in hemodialysis patients.

The integration of multiple risk factors within this cohort reflects a complex clinical phenotype characterized by overlapping metabolic, vascular, and behavioral determinants. This multidimensional risk profile aligns with emerging frameworks that conceptualize CKD as a systemic disorder rather than an isolated renal condition (Wang et al., 2026). The convergence of these factors necessitates comprehensive risk assessment models capable of capturing both renal and cardiovascular dimensions. Such an approach is critical for improving prognostic accuracy and patient outcomes.

Table 1. Characteristics of the Subjects

Characteristics	Frequency	Percentage (%)
Sex (Male)	33	45.8
Sex (Female)	39	54.2
Age 45–59 years	34	47.2
Age >60 years	38	52.8
Diabetes Mellitus	50	69.4
Non-Diabetes	22	30.6
Creatinine >3.8	64	88.9
Smokers	27	37.5

Source: Primary data, 2023.

The data presented in Table 1 highlight the clustering of major cardiovascular and renal risk factors within the study population, reinforcing the concept of shared pathophysiological pathways. High prevalence of diabetes and elevated creatinine levels collectively indicate advanced metabolic and renal dysfunction. Such clustering has been associated with increased cardiovascular morbidity in CKD populations, particularly in those undergoing dialysis (Bhagat et al., 2022). The coexistence of these variables underscores the importance of integrated clinical evaluation.

From a pathophysiological perspective, the interaction between diabetes, hypertension, and renal impairment contributes to progressive vascular damage and reduced organ perfusion. Chronic exposure to hyperglycemia and elevated blood pressure leads to endothelial dysfunction, which subsequently impairs renal microcirculation (Shan et al., 2023). This mechanism explains the observed association between metabolic disorders and declining kidney function. The findings further support the hypothesis that systemic vascular health plays a central role in CKD progression.

Comparative evidence from previous studies indicates that similar demographic and clinical profiles are commonly observed in hemodialysis populations across diverse geographic settings. The consistency of these patterns suggests that the observed characteristics are not context-specific but rather reflect universal disease mechanisms (Miura et al., 2025). This reinforces the external validity of the current findings and their relevance to broader clinical populations. Such consistency strengthens the rationale for standardized risk assessment approaches.

The presence of multiple overlapping risk factors within the cohort highlights the need for multidimensional clinical frameworks that integrate demographic, metabolic, and behavioral variables. Traditional single-factor approaches may fail to capture the complexity of disease progression in CKD patients. Emerging models emphasize the importance of composite risk scoring systems to improve predictive accuracy (Kvasnička et al., 2025). These approaches align with the broader shift toward personalized medicine in nephrology and cardiovascular care.

Distribution of Cardiovascular Risk Scores and Renal Function Categories

The distribution of cardiovascular risk scores based on the WHO SEAR B chart revealed a predominance of moderate-to-high risk categories among patients undergoing hemodialysis. The largest proportion of participants was classified within the 30%–<40% risk category, indicating a substantial predicted probability of cardiovascular events within a ten-year horizon. This pattern reflects the cumulative burden of risk factors such as hypertension, diabetes, and age, which are embedded within the SEAR B scoring algorithm (World Health Organization, 2007). The observed distribution supports

the notion that hemodialysis patients represent a clinically vulnerable population requiring comprehensive cardiovascular surveillance.

The stratification of cardiovascular risk highlights the heterogeneity of risk profiles within the cohort despite uniformly advanced renal disease. Lower risk categories were still represented, suggesting variability in individual exposure to modifiable and non-modifiable risk determinants. Such variability aligns with emerging evidence that cardiovascular risk in CKD populations is influenced by complex interactions between metabolic, genetic, and environmental factors (Kvasnička et al., 2025). This reinforces the importance of individualized risk assessment approaches rather than reliance on uniform clinical assumptions.

Renal function, as measured by GFR categories, demonstrated a marked concentration of patients in the most severe stage of CKD. The absence of participants in the moderate impairment category (stage 3) reflects the clinical setting of a hemodialysis unit, where patients typically present with advanced renal failure. This distribution underscores the progressive and often irreversible nature of CKD, particularly in patients who have reached the stage requiring renal replacement therapy (Stehlé et al., 2023). The predominance of stage 5 CKD highlights the critical need for early detection and intervention in earlier disease stages.

The coexistence of high cardiovascular risk scores and severely reduced GFR suggests a potential overlap in disease mechanisms affecting both systems. Vascular calcification, endothelial dysfunction, and chronic inflammation have been identified as common pathways linking cardiovascular and renal diseases (Cai et al., 2023). These shared mechanisms contribute to the amplification of risk in patients with advanced CKD. The findings support the conceptual framework of cardio-renal syndrome, where dysfunction in one organ system exacerbates the other.

The absence of moderate GFR values in this cohort also raises important considerations regarding patient selection and disease progression patterns. Hemodialysis patients often represent a subset of CKD individuals with accelerated disease trajectories and higher comorbidity burdens (Khudhair, 2025). This characteristic may explain the clustering of extreme values observed in the dataset. Such clustering emphasizes the importance of contextualizing findings within the clinical environment in which data are collected.

Table 2. Distribution of SEAR B Cardiovascular Risk Scores and GFR Categories

Variables	Frequency	Percentage (%)
SEAR B <10%	10	13.9
SEAR B 10–<20%	9	12.5
SEAR B 20–<30%	17	23.6
SEAR B 30–<40%	22	30.6
SEAR B >40%	14	19.4
GFR Stage 4 (15–29)	20	27.8
GFR Stage 5 (<15)	52	72.2

Source: Primary data, 2023.

The data presented in Table 2 demonstrate a clear skew toward higher cardiovascular risk categories and severe renal impairment stages. The concentration of patients in the highest GFR severity category aligns with findings from studies examining advanced CKD populations undergoing dialysis (Miura et al., 2025). This pattern indicates that cardiovascular risk assessment in such populations may capture cumulative disease burden rather than early-stage risk development. The integration of these findings provides a comprehensive overview of patient risk stratification.

From a metabolic perspective, elevated cardiovascular risk scores may reflect underlying dyslipidemia, insulin resistance, and systemic inflammation, all of which contribute to CKD progression. Prior research has demonstrated that lipid abnormalities and metabolic imbalances are strongly associated with reduced renal function (Cheng et al., 2022). These metabolic disturbances may act synergistically to accelerate both cardiovascular and renal deterioration. The observed data support the hypothesis that metabolic dysregulation plays a central role in shaping risk profiles.

The high prevalence of advanced CKD stages in this study also aligns with evidence linking decreased GFR to structural and functional cardiovascular abnormalities. Studies have shown that

reduced renal function is associated with impaired myocardial mechanics and increased cardiovascular morbidity (Truong et al., 2026). This relationship highlights the importance of early cardiovascular risk assessment in CKD patients before the onset of irreversible organ damage. The findings suggest that risk stratification tools such as SEAR B may have clinical utility beyond general population screening.

Behavioral and lifestyle factors, including physical inactivity and smoking, may further exacerbate the observed risk patterns. Reduced physical activity has been associated with lower GFR and poorer cardiovascular outcomes in renal populations (Ohata et al., 2023). These factors interact with biological determinants to influence disease progression and overall prognosis. Addressing modifiable risk factors remains a critical component of comprehensive patient management.

The integration of cardiovascular risk scoring with renal function assessment provides a multidimensional understanding of disease burden in hemodialysis patients. This approach aligns with contemporary models emphasizing the interconnected nature of organ systems and the need for holistic clinical evaluation (Cavalcante et al., 2023). The findings contribute to a growing body of evidence supporting the use of composite risk measures in clinical practice. Such integration has the potential to improve prognostic accuracy and guide targeted therapeutic interventions.

Inferential Association Between Cardiovascular Risk Score and Renal Function

The inferential analysis focused on evaluating the statistical association between cardiovascular risk scores and renal function using a non-parametric approach appropriate for the data distribution. The Spearman rank correlation test revealed a statistically significant relationship between SEAR B scores and estimated glomerular filtration rate values. The observed association reflects the interplay between systemic vascular risk and renal impairment in patients undergoing hemodialysis. Cross-sectional analytical designs remain suitable for identifying such associations despite their limitation in establishing causality (Mikuteit et al., 2022).

The directionality of the association was negative, indicating that higher cardiovascular risk scores correspond to lower renal function values. This inverse relationship aligns with the conceptual framework linking cardiovascular burden and progressive nephron loss. The strength of association observed suggests a clinically meaningful interaction rather than a weak or incidental correlation. Similar patterns have been reported in studies examining cardiovascular biomarkers and renal decline (Elsawwah et al., 2025).

The scatter plot visualization further illustrates the distribution of SEAR B scores across varying levels of GFR. A downward trend is visually apparent, supporting the statistical findings derived from the correlation analysis. The clustering of higher SEAR B scores at lower GFR ranges reinforces the inverse relationship between the variables. Visual analytics such as scatter plots enhance interpretability of non-linear associations in clinical datasets (Stehlé et al., 2023).

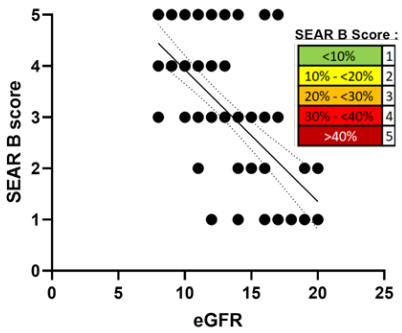

Figure 1. Scatter Plot Correlation of SEAR B Score and GFR
Source: Primary data processed by the authors (2023).

The graphical representation demonstrates a consistent decline in SEAR B score categories as GFR increases across observed values. The dispersion of points indicates variability within risk categories, suggesting that individual-level heterogeneity remains significant. This variability may be influenced by additional unmeasured clinical factors such as inflammation or metabolic status. Prior

investigations highlight that multifactorial influences contribute to cardiovascular risk stratification in CKD populations (Cai et al., 2023).

The statistical results of the correlation analysis are summarized in Table 3, which presents both the correlation coefficient and the corresponding p-value. The correlation coefficient (r = -0.637) indicates a strong inverse relationship between the two variables. The p-value of 0.000 confirms that the association is statistically significant within the predefined threshold. These findings provide robust evidence supporting the study hypothesis regarding the linkage between cardiovascular risk and renal function.

Table 3. Correlation of SEAR B Score and GFR

Variable	Correlation Coefficient (r)	p-value
GFR	-0.637	0.000

Source: Primary data processed using Spearman rank correlation (2023).

The magnitude of the correlation suggests that cardiovascular risk burden is closely intertwined with renal impairment severity. This observation is consistent with pathophysiological mechanisms involving endothelial dysfunction and vascular calcification. Chronic exposure to cardiovascular risk factors accelerates renal microvascular damage, thereby reducing filtration capacity. Studies have demonstrated similar associations in both diabetic and non-diabetic CKD populations (Al-Dwairi et al., 2025). From a mechanistic perspective, vascular stiffness and impaired perfusion contribute to progressive nephron loss in high-risk individuals. Cardiovascular risk factors such as hypertension and dyslipidemia exacerbate intraglomerular pressure, leading to structural kidney damage. These processes are often compounded in patients undergoing hemodialysis due to chronic systemic inflammation. Evidence indicates that cardiovascular and renal pathologies share overlapping biological pathways (Cheng et al., 2022).

The strength of the observed correlation also reflects the suitability of the SEAR B scoring system in capturing clinically relevant cardiovascular risk dimensions. The integration of demographic and clinical variables within the score enhances its predictive value. Risk prediction models have increasingly been utilized to identify high-risk populations in resource-limited settings. The WHO SEAR B framework has been validated for diverse populations, including Southeast Asia (WHO, 2007). The findings also align with broader epidemiological evidence linking cardiovascular burden with renal disease progression. Studies involving large population datasets have reported consistent associations between lifestyle risk profiles and declining kidney function. The concept of shared risk factors underscores the importance of integrated disease management strategies. Recent analyses emphasize the role of composite risk indices in predicting CKD outcomes (Wang et al., 2026).

Clinical implications of these findings highlight the importance of early cardiovascular risk assessment in patients with compromised renal function. Identifying high-risk individuals may enable targeted interventions aimed at slowing disease progression. Preventive strategies focusing on modifiable risk factors could reduce both cardiovascular and renal morbidity. National health policies have emphasized integrated approaches to managing chronic diseases, including CKD (Ministry of Health Republic of Indonesia, 2018). Despite the strength of the association, the cross-sectional nature of the study limits causal inference. Temporal relationships between cardiovascular risk and renal decline cannot be definitively established within this design. Longitudinal studies are required to confirm whether elevated SEAR B scores predict subsequent reductions in GFR. Future research should incorporate cohort methodologies to explore causal pathways more rigorously (Lazarova et al., 2025).

CONCLUSION

The findings demonstrate a clinically significant inverse association between cardiovascular disease risk and renal function among patients undergoing hemodialysis, indicating that higher predicted cardiovascular risk corresponds to more advanced impairment of glomerular filtration capacity. The distribution of clinical characteristics reflects a population burdened by metabolic and vascular risk factors that contribute to both cardiovascular complications and progressive kidney dysfunction. Statistical analysis confirms that cardiovascular risk estimation using a validated regional model provides meaningful insight into disease severity within this population. These results reinforce

the concept of shared pathophysiological pathways linking cardiovascular and renal disorders, highlighting the importance of integrated risk assessment in clinical practice. Incorporating standardized cardiovascular risk scoring into routine management may enhance early identification of high-risk individuals and support more targeted therapeutic interventions to mitigate adverse outcomes in chronic kidney disease patients undergoing hemodialysis.

REFERENCES

Al-Dwairi, A., Al-Shboul, O., Alqudah, M., & Al-U'Datt, D. A. G. (2025). Determinants of estimated glomerular filtration rate in patients with type 2 diabetes mellitus: A cross-sectional study. *Biomedical Reports*, *23*(6), 194. https://doi.org/10.3892/br.2025.2072

Bhagat, N., Dawman, L., Naganur, S., Tiewsoh, K., Kumar, B., Pratyusha, K., ... & Gupta, K. L. (2022). Impact of anemia on the cardiovascular status in children with chronic kidney disease: A pilot study. *Clinical Nutrition ESPEN*, *47*, 283-287. https://doi.org/10.1016/j.clnesp.2021.11.031

Bjornstad, P., Richard, G., Choi, Y. J., Nowak, K. L., Steele, C., Chonchol, M. B., ... & Gitomer, B. (2024). Kidney energetics and cyst burden in autosomal dominant polycystic kidney disease: a pilot study. *American Journal of Kidney Diseases*, *84*(3), 286-297. https://doi.org/10.1053/j.ajkd.2024.02.016

Cai, J., Zhang, L., Chen, C., Ge, J., Li, M., Zhang, Y., ... & Song, B. (2023). Association between serum Klotho concentration and heart failure in adults, a cross-sectional study from NHANES 2007–2016. *International Journal of Cardiology*, *370*, 236-243. https://doi.org/10.1016/j.ijcard.2022.11.010

Cavalcante, M. G., Gomes, P. E. A. D. C., Parente, M. D. S. R., Meneses, G. C., Silva Junior, G. B. D., Neto, R. D. J. P., ... & Daher, E. D. F. (2023). Monitoring renal function in HIV patients without kidney disease using endothelial biomarkers: a prospective pilot study. *AIDS Research and Human Retroviruses*, *39*(9), 468-474. https://doi.org/10.1089/aid.2022.0113

Cheng, Y., Zhang, H., Zheng, H., Yin, H., Wang, Y., Wang, H., ... & Yin, D. (2022). Association between serum uric acid/HDL-cholesterol ratio and chronic kidney disease: a cross-sectional study based on a health check-up population. *BMJ open*, *12*(12), e066243. https://doi.org/10.1136/bmjopen-2022-066243

Elsawwah, M., Rabie, M. M., Abdelaziz, A. F., & Abdelbaky, M. S. E. (2025). Correlation Between Carotid Artery Intima-Media Thickness and Both Gamma Carboxyglutamic Acid Rich Protein and Glomerular Filtration Rate in Chronic Kidney Disease Children. *GEGET*, *20*(2), 78-87. https://doi.org/10.21608/geget.2025.483570

Etaee, F., Naguib, T., Goldust, M., Daveluy, S., & Maibach, H. (2022). Role of skin autofluorescence in managing renal and cardiac diseases in outpatient dermatology. *Skin Research and Technology*, *28*(6), 889-905. https://doi.org/10.1111/srt.13211

Hsu, P. C., Liao, P. Y., Huang, S. W., Chang, H. H., Chiang, J. Y., & Lo, L. C. (2025). Nailfold capillary abnormalities as indicators of diabetic nephropathy progression: a cross-sectional study in type 2 diabetes. *Annals of Medicine*, *57*(1), 2458766. https://doi.org/10.1080/07853890.2025.2458766

Jiang, J., Huang, W., Lan, L., Zheng, X., Luo, S., Ding, Y., ... & Yang, D. (2025). Related factors for kidney disease and high chronic kidney disease progression risk in adult-onset type 1 diabetes mellitus patients from China: a multi-center cross-sectional study. *Renal Failure*, *47*(1), 2483389. https://doi.org/10.1080/0886022X.2025.2483389

Khudhair, A. S. (2025). Risk factors for chronic kidney disease among haemodialysis patients in Al-Basrah: A cross-sectional study. *Babcock University Medical Journal*, *8*(2), 378-384. https://doi.org/10.38029/babcockuniv.med.j..v8i2.1079

Kvasnička, A., Friedecký, D., Piskláková, B., Rozhon, J., Pavelka, K., & Stibůrková, B. (2025). Ceramide-based risk score: A novel laboratory tool for cardiovascular risk stratification in hyperuricemia and gout. *Vascular Pharmacology*, *159*, 107495. https://doi.org/10.1016/j.vph.2025.107495

Lazarova, M., Urinovska, R., Kacirova, I., Grundmann, M., Dodulik, J., & Vaclavik, J. (2025). Serum concentrations of valsartan and sacubitrilat, the active metabolite of sacubitril, in patients with heart failure with reduced ejection fraction: results of a pilot cross-sectional study. *Expert*

Review of Clinical Pharmacology, *18*(6), 397-406. https://doi.org/10.1080/17512433.2025.2519644

Mikuteit, M., Gueler, F., Pollmann, I., Pflugrad, H., Dirks, M., de Zwaan, M., & Weissenborn, K. (2022). Assessment of cognitive functioning after living kidney donation: A cross-sectional pilot study. *PLoS One*, *17*(2), e0264284. https://doi.org/10.1371/journal.pone.0264284

Ministry of Health of the Republic of Indonesia. (2018). *The role of government in the prevention and control of kidney disorders*. Trop Disease in Indonesia.

Miura, M., Owada, S., Ito, O., & Kohzuki, M. (2025). Safety and efficacy of belt-type electrical stimulation for preventing disuse syndrome in elderly hemodialysis patients: a pilot study. *Frontiers in Rehabilitation Sciences*, *6*, 1559077. https://doi.org/10.3389/fresc.2025.1559077

Ohata, T., Kishikawa, H., Tamaki, A., Matsuzawa, R., Katsuno, T., & Miyamoto, T. (2023). Relationship between physical activity and estimated glomerular filtration rate in renal transplant recipients: a cross-sectional study analyzing isotemporal substitution model. *Journal of Renal Nutrition*, *33*(6), 755-763. https://doi.org/10.1053/j.jrn.2023.05.008

Shan, Y., Lin, M., Gu, F., Ying, S., Bao, X., Zhu, Q., ... & Wang, M. (2023). Association between fasting stress hyperglycemia ratio and contrast-induced acute kidney injury in coronary angiography patients: a cross-sectional study. *Frontiers in Endocrinology*, *14*, 1300373. https://doi.org/10.3389/fendo.2023.1300373

Stehlé, T., Ouamri, Y., Morel, A., Vidal-Petiot, E., Fellahi, S., Segaux, L., ... & Pigneur, F. (2023). Development and validation of a new equation based on plasma creatinine and muscle mass assessed by CT scan to estimate glomerular filtration rate: a cross-sectional study. *Clinical kidney journal*, *16*(8), 1265-1277. https://doi.org/10.1093/ckj/sfad012

Truong, D. Q., Binh, T. Q., Thao, H. N. P., Hoang, T. M., Trang, N. T. T., Nhat, P. T. H., & Khoi, L. M. (2026). Risk Factors for Impaired Left Ventricular Global Longitudinal Strain in Chronic Kidney Disease Patients: A Cross-Sectional Study. *Journal of Diagnostic Medical Sonography*, *42*(2), 111-119. https://doi.org/10.1177/87564793251380854

Wang, Y., Zhou, Z., Han, X., Ji, G., Li, H., & An, Z. (2026). Association Between Life's Crucial 9 and the Risk of Chronic Kidney Disease: A Cross-Sectional Study from NHANES 2005 to 2018. *medRxiv*, 2026-02. https://doi.org/10.64898/2026.02.02.26345422

World Health Organization (WHO). (2007). *Prevention of cardiovascular disease: Pocket guidelines for assessment and management of cardiovascular risk*. WHO Press.