



EVALUATION OF PREVALENCE & ASSOCIATION OF VARIOUS CARDIAC ABNORMALITIES WITH CHRONIC KIDNEY DISEASE IN ADULT RURAL POPULATION OF INDIA: A CROSS SECTIONAL STUDY

Dr. Jidnyasa Joshi¹, Dr. Brahamjit Singh^{2*}, Dr. Sudhir Kumar Yadav³, Dr. Seema Seth⁴

¹Assistant Professor, Department of Internal Medicine, Rohilkhand Medical College and Hospital Bareilly, UP, India. Mobile- 8275590092 jidnyasajoshi@gmail.com

^{2*}Associate Professor, Department of Medical Oncology, Rohilkhand Medical College and Hospital Bareilly, UP, India. Mobile- 9075175037 drbrahamjitsingh@gmail.com

³Assistant Professor, Department of Internal Medicine, Rohilkhand Medical College and Hospital Bareilly, UP, India. Mobile – 98372610852. drsudhir.md@gmail.com

⁴Professor and Head of the Department of Internal Medicine, Rohilkhand Medical College and Hospital Bareilly, UP, India, Mobile- 9839091800 drsethseema@gmail.com

***Corresponding Author:** Dr. Brahamjit Singh

Associate Professor, Department of Medical Oncology, Rohilkhand Medical College and Hospital Bareilly, UP, India. Mobile- 9075175037 drbrahamjitsingh@gmail.com

Abstract:

Background: Chronic kidney disease (CKD) is a global public health challenge. Cardiovascular diseases (CVD) are the leading cause of morbidity and mortality in patients with CKD. There is definite evidence that prevalence of CVD among End Stage Renal Disease (ESRD) patients is very high by the time renal replacement treatment is started and is the leading causes of death in even in renal transplant recipients.

Objective: To evaluate the prevalence and types of cardiac dysfunction associated with chronic kidney disease, with an intention to recommend management of cardiovascular disease and associated risk factors more aggressively in this subset of patients.

Methods: A prospective observational cross-sectional study conducted at Rohilkhand Medical College and Hospital. The first 76 adult patients of CKD presenting to the outpatient and inpatient department were enrolled in the study. Electrocardiogram (ECG) and Echocardiography (ECHO) were carried out to assess cardiac abnormalities, ultrasound of abdomen, and routine tests including lipid profile and 24 hour urinary protein were done to assess renal function and associated risk factors.

Results: Most of the patients with cardiac abnormalities with CKD were between 35 to 45 years ($p=0.009$) with a higher prevalence in men (56.6%). 77.6% patients had cardiac abnormalities out of which left ventricular hypertrophy (LVH) was most prevalent (39.9%) followed by valvular lesion like mitral regurgitation (27.6%), tricuspid regurgitation (26.3%), global hypokinesia (26.3%) and reduced left ventricular ejection fraction (13.6%). Risk factor analysis revealed overweight (28.9%), obesity (9.2%), and hypercholesterolemia (22.4%) as significant predictor of cardiac disease in CKD patients.

Conclusion: The study's findings strongly suggest that routine cardiovascular screening using ECG, echocardiography, and lipid profiling can facilitate early identification of high-risk patients of CKD with cardiac complications.

Key words : Chronic kidney disease, Cardiovascular disease, LVH, hypercholesteremia, obesity, rural, India

Introduction

Chronic kidney disease (CKD) is a global public health challenge, with a growing prevalence attributed to the increasing burden of diabetes, hypertension, and aging populations[1]. The prevalence of CKD varies across regions but is estimated to affect approximately 10–15% of the global population [2]. The disease burden is disproportionately high in low- and middle-income countries due to limited access to healthcare and late-stage diagnosis. Sub-Saharan Africa, South Asia, and Latin America have reported rising CKD prevalence, often linked to unregulated use of nephrotoxic medications, infections, and environmental exposures [3]. In high-income countries, CKD prevalence is primarily associated with lifestyle diseases such as diabetes and hypertension. Diabetes remains the leading cause of CKD globally, accounting for nearly 40% of cases. Hypertension contributes to another 20–25%. The aging population has further exacerbated the global burden of CKD, as renal function naturally declines with age.

Cardiorenal syndrome (CRS) is generally defined as pathophysiological disorder of the Heart and kidney, whereas acute or chronic dysfunction of one organ may induce acute or chronic dysfunction of the other[4]. Cardiovascular diseases are also the leading causes of death in renal transplant recipient patients [5]. The common risk factors for cardiovascular diseases such as hypertension, type 2 diabetes mellitus, dyslipidemia and obesity are highly prevalent in Chronic Kidney Disease populations.

Changes similar to cardiac remodeling like Left Ventricular hypertrophy (LVH) are highly prevalent in CKD and is associated with unfavorable cardiovascular prognosis; incidence of Left Ventricular Hypertrophy increases with a progressive reduction in renal function [6]. Left Ventricular systolic dysfunction is a strong indicator of poor prognosis in patients on renal replacement therapy [7].

Diastolic dysfunction is characterized by alteration in ventricular relaxation and compliance, mostly followed by a compensatory increase in filling pressure in advanced stages. Studies have also reported a presence of Left Ventricular diastolic dysfunction in Chronic Kidney Disease (CKD) patients varying from 50-65%, including pre-dialysis, dialysis and post- transplant populations [8].

More than 11% of the adult population worldwide have chronic kidney disease (CKD) and are facing an increased risk of end-stage renal disease (ESRD), cardiovascular (CV) disease and death [5]. Cardiovascular diseases are the leading cause of morbidity and mortality in patients with CKD. Already when glomerular filtration rate (GFR) falls below approximately 60 ml/min/1.73m² there is a graded and inverse relationship between kidney function and CV morbidity and mortality [9].

This study is conducted as part of research as very few studies have been conducted on cardiac abnormalities in chronic kidney disease patients in India.

Methods

Study Design: This was a prospective observational cross- sectional study conducted at Outpatient and In Patient Departments of Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh.

Study Population : Adult patient with chronic kidney disease presenting for the first time to the hospital for treatment and evaluation

Sample size: The sample size was calculated using the formula : $N = 4 p q / l^2$

where: p = prevalence (2%) $q = 100 - p$, l = absolute error (5%).

Based on these calculations, $N = 4 \times 2 \times 98 / 25 = 76$. Therefore, the actual sample size determined for the study was 76 participants.

Period of Study - August 2024 to December 2025. study

Inclusion criteria: All patients aged 18 years and above presenting for the first time with the diagnosis of chronic renal disease.

Exclusion criteria: All patients with known diagnosis of chronic kidney disease.

Procedure methodology:

Appropriate permissions were obtained from the Institutional Ethics Committee and after written informed consent from all of the patients. Anonymity and confidentiality with respect to the information furnished by the patients was ensured.

Laboratory evaluations were performed on 76 patients who underwent routine investigations, including complete hemogram, urine routine tests, and renal function tests, including 24 hour urinary protein, along with screening for hepatitis and HIV. Ultrasound abdomen assessments were conducted to evaluate renal size, echotexture, and corticomedullary differentiation. Electrocardiogram (ECG) and 2D echocardiography (ECHO) were performed to assess cardiac function. Diastolic dysfunction was graded using tissue and pulse Doppler techniques.

Data management and statistical analysis:

All the data were entered into Microsoft excel data sheet and were analysed using IBM SPSS version 25. Data were expressed as mean $\pm$ SD or percentage. Appropriate statistical tests (Chi-square test for categorical variables and student's t- test for continuous variables) were performed to assess differences between the groups, and a p-value of < 0.05 was considered statistically significant.

Observations & Results

Table 1. Distribution of study participants according to their age (n=76)

Age groups (years)	Frequency	Percentage
<35	14	8.4
35-44	19	25
45-54	18	23.7
55-64	11	14.5
65-74	14	18.4
Total	76	100

The study included 76 participants, with their ages distributed across five groups. The largest age group was 35-44 years, comprising 25% of the participants, followed by 45- 54 years (23.7%), and <35 years and 65-74 years, each representing 18.4%. The smallest group was 55-64 years, accounting for 14.5%.

Table 2. Distribution of study participants according to their sex (n=76)

Sex	Frequency	Percentage
Female	33	43.4
Male	43	56.6
Total	76	100

Of the 76 participants, 56.6% were male, while 43.4% were female

Table 3. Distribution of study participants according to their BMI (kg/m²) (n=76)

BMI	Frequency	Percentage
18.5-24.9	47	61.8
25-29.9	22	28.9
30 and above	7	9.2
Total	76	100

Majority of patients (61.8%) had a normal BMI range of 18.5-24.9 kg/m². Overweight patients (BMI 25-29.9) constituted 28.9%, while 9.2% were classified as obese (BMI ≥30).

Table 4. Distribution of study participants according to their ECG findings (n=76)

ECG findings*	Frequency	Percentage
LVH	37	48.7
ST elevation	4	5.3
Poor R progression	5	6.6

ECG findings revealed left ventricular hypertrophy (48.7%) as the most common abnormality. ST elevation and poor R progression were noted in 5.3% and 6.6% of participants, respectively. Multiple abnormalities were observed in some cases.

Table 5. Distribution of study participants according to their 2D echocardiography findings (n=76)

Echo findings*	Frequency/ mean	Percentage/ SD
TR	20	26.3
MR	21	27.6
LVDD	16	21.1
DCMP	2	2.6
Concentric LVH	30	39.5
Global hypokinesia	20	26.3
Mean LVEF (%)	47.4	13.6

Echocardiography findings included concentric LVH in 39.5% of participants and mitral regurgitation in 27.6%. Tricuspid regurgitation and global hypokinesia were each observed in 26.3%. The mean left ventricular ejection fraction was 47.4% ± 13.6%, reflecting varied cardiac function.

Table 6. Distribution of study participants according to prevalence of cardiac disease as per both ECG and Echocardiography (n=76)

Cardiac disease	Frequency	Percentage
Yes	59	77.6
No	17	22.4
Total	76	100

Cardiac disease was present in 77.6% of participants based on combined ECG and echocardiography findings, while 22.4% showed no evidence of cardiac involvement.

Table 7. Association between age and cardiac disease in CKD (n=76)

Age	Cardiac disease absent (n=17)	Cardiac disease present (n=59)	Unpaired t-test value	p-value
Mean	41.7	51.9	-2.688	0.009*
SD	16.2	14.6		

*Statistically significant

Inference: The association between age and the presence of cardiac disease in chronic kidney disease (CKD) patients was analyzed. The mean age of patients without cardiac disease was 41.7 years (SD = 16.2), whereas the mean age of those with cardiac disease was significantly higher at 51.9 years (SD = 14.6). The unpaired t-test yielded a value of -2.688, with a p-value of 0.009, indicating a statistically significant association.

Table 8. Association between sex and cardiac disease in CKD (n=76)

Sex	Cardiac disease absent (n=17)	Cardiac disease present (n=59)	Chi-square value	p-value
Male	8 (47.1)	35 (59.3)	0.808	0.369
Female	9 (52.9)	14 (40.7)		
Total	17 (100)	59 (100)		

Inference: Sex distribution was examined concerning the presence of cardiac disease in CKD patients. Among those without cardiac disease, 47.1% were male and 52.9% were female, whereas

among those with cardiac disease, 59.3% were male and 40.7% were female. The unpaired t-test value was 0.808, and the p-value was 0.369, indicating no statistically significant association between sex and the presence of cardiac disease.

Table 9. Association between hypercholesterolemia and cardiac disease in CKD (n=76)

Hypercholesterolemia	Cardiac disease absent (n=17)	Cardiac disease present (n=59)	Chi-square value	p-value
Yes	0 (0)	13 (22)	4.519	0.034*
No	17 (100)	46 (78)		
Total	17 (100)	59 (100)		

*Statistically significant

Inference: Hypercholesterolemia was examined as a potential risk factor for cardiac disease in CKD. None of the patients without cardiac disease had hypercholesterolemia, whereas 22% of those with cardiac disease had this condition. The unpaired t-test value was 4.519, and the p-value was 0.034, indicating a statistically significant association.

Table 10. Association between urinary protein and cardiac disease in CKD (n=76)

Renal insufficiency	Cardiac disease absent (n=17)	Cardiac disease present (n=59)	Chi-square value	p-value
1+	5 (29.4)	11 (18.6)	1.539	0.680
2+	8 (47.1)	31 (52.5)		
3+	1 (5.9)	8 (13.6)		
None	3 (17.6)	9 (15.3)		
Total	17 (100)	59 (100)		

Inference: Urinary protein levels were analyzed to determine their relationship with cardiac disease. Among patients without cardiac disease, 29.4% had 1+ proteinuria, 47.1% had 2+, and 5.9% had 3+. In contrast, among those with cardiac disease, 18.6% had 1+ proteinuria, 52.5% had 2+, and 13.6% had 3+. The unpaired t-test value was 1.539, and the p-value was 0.680, indicating no significant association between urinary protein levels and cardiac disease.

Discussion

The study was carried out understand the various cardiac abnormalities in patients with chronic kidney disease (CKD), emphasizing their prevalence, and associated factors. Cardiac complications are well-documented among CKD patients, with both conditions exhibiting bidirectional interplay

through mechanisms like neurohormonal activation, oxidative stress, and vascular remodeling. The demographic analysis in this study revealed that the majority of participants were aged between 35-54 years, representing over 48% of the sample. This age range reflects the onset of middle adulthood which is statistically significant ($p=0.009$) phase associated with the emergence of both chronic kidney disease (CKD) and cardiac complications. Shah et al. in their longitudinal study, CKD was also predominantly observed in adults aged 40-60, with cardiovascular complications becoming evident during the same period [10]. The results align with these findings, emphasizing the interplay between advancing age and disease burden. Older participants in the study (aged 55 years and above) exhibited higher rates of cardiac disease.

The male predominance observed in the study (56.6%) is consistent with patterns reported by Fabbian et al. [11] who also noted that men with CKD were more likely to develop cardiac complications than women. This discrepancy may be attributed to hormonal differences, lifestyle factors, and varying levels of healthcare engagement between genders. Men are also more likely to engage in behaviors such as smoking and alcohol consumption, which exacerbate cardiovascular and renal dysfunction. Additionally, **Gigante et al.** ⁴ emphasized that male sex is an independent risk factor for left ventricular hypertrophy (LVH) and other cardiac abnormalities in CKD [12].

A significant proportion of participants had a BMI within the normal range, although 28.9% were overweight and 9.2% obese. Obesity was a significant predictor of cardiac disease in this cohort, as previously highlighted by Reddy et al. [13] and Prothasis et al. [14], who linked obesity to adverse cardiovascular outcomes in CKD patients due to its role in promoting systemic inflammation and left ventricular hypertrophy (LVH).

The study's findings highlighted a high prevalence of cardiac abnormalities among CKD patients, with 77.6% showing confirm evidence of cardiac involvement by non invasive specific investigations like ECG and echocardiography findings.

Left ventricular hypertrophy (LVH) emerged as the most common abnormality, with ECG findings showing LVH in 48.7% of participants and echocardiography revealing concentric LVH in 39.5%. These findings align with the observations of Suresh et al. [15], who reported LVH as a hallmark of CKD-related cardiovascular changes, resulting from increased cardiac workload, systemic hypertension, and chronic volume overload. Mitral regurgitation (27.6%) and tricuspid regurgitation (26.3%) were other significant findings, consistent with the study by Lourenco et al. which noted that valvular abnormalities frequently accompany CKD due to systemic hypertension and calcium-phosphate metabolism disturbances [16]. These valvular issues contribute to worsening cardiac function by imposing additional strain on the heart, ultimately leading to heart failure if left unmanaged. Global hypokinesia was observed in 26.3% of participants, reflecting myocardial dysfunction. This finding aligns with Palazzuoli et al. , who identified global hypokinesia as a marker of uremic cardiomyopathy, a condition driven by the accumulation of uremic toxins and oxidative stress in CKD patients [17].

Lipid profile analysis revealed dyslipidemia in 22.4% of participants, with hypercholesterolemia being a significant predictor of cardiac disease. Dyslipidemia in CKD patients has been linked to accelerated atherosclerosis and vascular calcification, as described by Tsuruya et al. [18]. Elevated cholesterol levels contribute to endothelial dysfunction and plaque formation, compounding the cardiovascular burden in CKD patients. The association between dyslipidemia and cardiac disease emphasizes the need for aggressive lipid-lowering strategies in CKD management. Statin therapy has been shown to reduce cardiovascular events in CKD patients, particularly those with dyslipidemia, as noted by Gigante et al. [12], however, the utility of lipid- lowering therapies in advanced CKD remains an area of ongoing research. This study identified hypercholesterolemia ($p=0.034$) and obesity ($p=0.043$) as significant predictors of cardiac disease among CKD patients. These findings align with observations from Fabbian et al. and Shah et al. ,who emphasized the role of metabolic disturbances in driving cardiovascular morbidity in CKD populations [11,10]. Obesity contributes to systemic inflammation, insulin resistance, and increased cardiac workload, all of which exacerbate cardiac dysfunction in CKD patients.

Interestingly, proteinuria, a recognized marker of CKD progression did not show a significant association with cardiac disease in this cohort. This contrasts with studies by Banerjee et al. and Bhattacharya et al who identified proteinuria as a key determinant of cardiovascular outcomes [19, 20]. The discrepancy may reflect differences in population characteristics or the extent of proteinuria among participants.

This study therefore highlights the significant prevalence of cardiac abnormalities among CKD patients, emphasizing the intricate interplay between renal and cardiovascular dysfunction. Systolic dysfunction, left ventricular hypertrophy, valvular abnormalities (MR,TR) were prominent findings, with hypercholesterolemia identified as key predictors of cardiac disease. The results underscore the critical need for early cardiovascular screening and targeted management to mitigate risk factors like dyslipidemia and obesity. Routine use of echocardiography, ECG, and lipid profiling can facilitate timely intervention, improving outcomes. Comprehensive, multidisciplinary care tailored to CKD patients' unique risks is essential to address the dual burden of kidney and cardiac disease.

Recommendations

This study highlights the need for targeted interventions to manage cardiac abnormalities in patients with chronic kidney disease (CKD). Regular cardiovascular screening, including echocardiography and ECG, is essential for early detection of abnormalities like left ventricular hypertrophy, valvular defects, and systolic dysfunction. Effective management of modifiable risk factors such as obesity, dyslipidemia, and hypertension should be prioritized through lifestyle modifications, pharmacological interventions, and patient education

Conclusion

The study provides critical insights into the types of cardiac abnormalities prevalent in CKD patients, their associated risk factors, and the implications for clinical practice. Left ventricular hypertrophy (LVH) emerged as the most prominent cardiac abnormality, identified in nearly half of the participants through ECG (48.7%) and in 39.5% via echocardiography as concentric LVH. This finding aligns with existing literature highlighting LVH as a hallmark of CKD-related cardiovascular changes. The prevalence of structural and functional cardiac abnormalities in this cohort reflects the systemic nature of CKD, which involves interrelated mechanisms such as fluid overload, chronic inflammation, uremic toxin accumulation, and oxidative stress. The study's findings therefore suggest that routine cardiovascular screening using ECG, echocardiography, and lipid profiling can facilitate early identification of high-risk patients. Targeted management of modifiable risk factors such as obesity, dyslipidemia, and hypertension is essential to improve outcomes. Emerging therapies targeting uremic toxins, oxidative stress, and endothelial dysfunction may offer additional avenues for improving cardiovascular outcomes in this population. Multidisciplinary care involving nephrologists, cardiologists, and dietitians is essential to provide tailored interventions that address the complex needs of CKD patients

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