Original Research

EVALUATION OF CARDIOVASCULAR COMPLICATIONS AMONG CHILDREN WITH CHRONIC KIDNEY DISEASE IN A TERTIARY CARE SETTING

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ABSTRACT

Background: Cardiovascular complications are the leading cause of morbidity and mortality in children with chronic kidney disease (CKD). Structural and functional cardiac changes may begin early in the disease course, even before dialysis initiation. Early identification of cardiovascular involvement is essential for improving outcomes in pediatric CKD patients.

Methodology: This observational study was conducted in the Department of Paediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekharam, from March 2025 to November 2025. Children aged 1–18 years with CKD were included and categorized into those on dialysis and those not on dialysis. Clinical evaluation, routine investigations, ambulatory blood pressure monitoring, and echocardiography were performed. Parameters assessed included left ventricular mass (LVM), ejection fraction, fractional shortening, and ambulatory blood pressure. Statistical analysis was done using Student's t-test and Chi-square test, with $p<0.05$ considered significant.

Results: A total of 60 children were studied (46 non-dialysis and 14 dialysis). Left ventricular mass was significantly higher in dialysis patients (131.71 ± 59.06 vs 98.91 ± 49.61, p=0.042). Ejection fraction and fractional shortening were significantly lower in the dialysis group (p=0.006 and p=0.007 respectively). Ambulatory blood pressure was higher in dialysis patients but not statistically significant. No strong correlation was found between CKD duration and LVM.

Conclusion: Children with CKD, especially those on dialysis, have significant cardiovascular abnormalities. Early screening and regular cardiac evaluation are essential to reduce long-term complications.

Keywords: Chronic Kidney Disease, Children, Cardiovascular Complications, Left Ventricular Hypertrophy, Echocardiography, Dialysis.

INTRODUCTION

Chronic kidney disease (CKD) is a well-recognized global health problem and is increasingly associated with significant long-term morbidity and mortality. Although CKD is traditionally considered a renal disorder, its systemic effects are now well established, particularly its strong association with cardiovascular disease (CVD).

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In patients with renal disease, a substantial proportion of mortality is attributed to cardiovascular complications, making CVD the leading cause of death in this population [1]. While this relationship has been extensively studied in adults, there is still limited clarity regarding the extent and pattern of cardiovascular involvement in the pediatric CKD population.

Children with CKD are at markedly increased risk of both morbidity and mortality due to cardiovascular complications. Cardiovascular disease is considered the most important cause of death among patients undergoing chronic renal replacement therapy. A report from the National Kidney Foundation Task Force on cardiovascular disease highlighted that mortality rates due to CVD in dialysis patients are

significantly higher compared to the general population, even after adjustment for age, sex, and race [2]. This emphasizes the disproportionate cardiovascular burden in individuals with renal failure. Globally, CKD affects approximately 10% of the general population, and its prevalence has been rising over recent decades due to aging populations and increasing prevalence of diabetes and hypertension [3]. Importantly, cardiovascular disease in CKD patients is increasingly recognized as a form of "accelerated cardiovascular aging," where vascular and cardiac changes typically seen in elderly individuals occur prematurely in CKD patients. This phenomenon is particularly concerning in children, where early onset vascular dysfunction may lead to lifelong cardiovascular morbidity.

Several mechanisms contribute to cardiovascular complications in CKD, including hypertension, fluid overload, anemia, dyslipidaemia, and disturbances in calcium-phosphorus metabolism leading to vascular calcification. In addition, CKD is associated with chronic inflammation and increased oxidative stress due to imbalance in reactive oxygen species (ROS), endothelial dysfunction, and activation of the renin-angiotensin-aldosterone system (RAAS), all of which contribute to progressive cardiovascular damage [4]. These pathophysiological changes begin early in the course of CKD and may even be present in pediatric patients before overt cardiovascular symptoms develop.

Children with CKD often exhibit subclinical cardiovascular abnormalities such as left ventricular hypertrophy, arterial stiffness, and hypertension, which may progress silently over time. Early identification of these complications is crucial, as they significantly influence long-term outcomes. However, there remains a lack of consensus regarding the exact pattern and severity of cardiovascular involvement in pediatric CKD, and data from developing countries are still limited.

In this context, the present study aims to evaluate cardiovascular complications in children with chronic kidney disease attending a tertiary care centre. Understanding the burden and pattern of cardiovascular involvement in this vulnerable group is essential for early diagnosis, timely intervention, and prevention of long-term adverse outcomes.

Aim and Objectives

Aim

To study cardiovascular complications in children with chronic kidney disease attending a tertiary care centre.

Objectives

1. To assess the spectrum of cardiovascular complications in pediatric patients with chronic kidney disease (CKD).
2. To determine the prevalence of hypertension among children with CKD.
3. To evaluate echocardiographic abnormalities such as left ventricular hypertrophy and other structural cardiac changes.

METHEDOLOGY

The present study was conducted in the Department of Paediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekharam, during the study period from March 2025 to November 2025. Children aged 1–18 years diagnosed with chronic kidney disease (CKD) attending the General Paediatric Outpatient Department and inpatient services were recruited after obtaining informed written consent from parents or guardians. CKD was defined as per the National Kidney Foundation criteria (2002), including either kidney damage persisting for more than 3 months (confirmed by biopsy or markers of kidney damage) with or without decreased glomerular filtration rate (GFR), or a GFR of less than 60 mL/min/1.73 m² for more than 3 months with or without kidney damage. GFR was calculated using the Schwartz formula for children below 15 years of age, while the Cockcroft–Gault formula was applied for older children. Based on GFR, patients were categorized into CKD stages, with stage 3 defined as GFR 30–59 mL/min/1.73 m² and stage 5 defined as GFR <15 mL/min/1.73 m² or end-stage renal disease (ESRD), including those on dialysis.

Children with CKD aged 1–18 years and GFR <60 mL/min/1.73 m² were included in the study. Exclusion criteria included children with renal or other solid organ transplantation, malignancy, HIV infection diagnosed within the past 12 months, genetic syndromes, and those with congenital or structural heart disease or primary myocardial disease.

A detailed clinical evaluation was performed, including demographic data, duration and course of illness, treatment history, anthropometric measurements, presence of edema, and blood pressure recordings. Laboratory investigations were carried out using the Roche Hitachi Modular System (P 800). Blood pressure was recorded as the mean of three clinic readings taken over previous visits. Ambulatory blood pressure monitoring (ABPM) was performed over 24 hours using the Spacelabs Healthcare system, with readings taken every 20 minutes during daytime and hourly at night, while children continued routine daily activities. Echocardiography was performed using the Philips IE33 system with a pediatric probe to assess left ventricular mass, left ventricular mass index, and relative wall thickness.

Statistical analysis was performed using appropriate methods. Continuous variables were expressed as

mean ± standard deviation (SD), while categorical variables were presented as frequency and percentages. Comparison between groups was done using Student's t-test or ANOVA for normally distributed variables, and the Chi-square test for categorical variables. Correlation between CKD stage and cardiovascular parameters was assessed using Pearson's or Spearman's correlation coefficient as appropriate. A p-value of less than 0.05 was considered statistically significant. All analyses were performed using standard statistical software.

RESULT

Table 1 shows basic characteristics of patients in two groups. Group 1 represent patients with CKD without dialysis whereas group 2 represent patients of CKD without dialysis.

PARAMETE RS	CKD without Dialysis Mean (SD) N= 46	CKD with Dialysis Mean (SD) N=14	P-value
Age (yrs)	11.61±3.32	11.36±3.43	0.81
Sex (male)	76.08%	92.86%	
Height (cm)	134.52±18.71	136.14±20.84	0.78
Weight (kg)	30.22±11.12	29.14±11.84	0.77
BMI (kg/m^2)	16.09±3.07	14.93±2.27	0.19
BSA	1.02±0.26	1.07±0.267	0.53
Stated Duration of CKD (month)	57.85±44.96	64.14±55.33	0.66

Table 2: Cardiac characteristics of study subjects as per Dialysis status

Cardiac characteristics	CKD without Dialysis Mean (N=46)	CKD with Dialysis Mean (N=14)	P value
LV Mass	98.91±49.61	131.71±59.06	0.042
ABPM	85.28±10.36	89.57±11.84	0.19
Ejection Fraction	60.89±5.9	54.79±9.99	0.006
LVMHT	0.80±0.453	0.86±0.66	0.69
Fractional shortening	32.15±4.04	28.36±5.81	0.007

Children on dialysis showed significantly higher left ventricular mass (LVM) compared to non-dialysis patients (131.71±59.06 vs 98.91±49.61, p=0.042), along with significantly lower ejection fraction (54.79±9.99% vs 60.89±5.9%, p=0.006) and fractional shortening (28.36±5.81% vs 32.15±4.04%, p=0.007). Taken together, these findings indicate that children on dialysis are undergoing not only structural cardiac remodeling in the form of left ventricular hypertrophy, but also early systolic dysfunction, suggesting a more advanced stage of cardiac involvement in this subgroup compared to their non-dialysis counterparts. This pattern is biologically plausible and consistent with the known pathophysiology of uremic cardiomyopathy in CKD. Children on dialysis are exposed to a combination of chronic volume overload from fluid retention, recurrent intradialytic hemodynamic shifts, persistent hypertension, anemia, secondary hyperparathyroidism, and a sustained uremic and inflammatory milieu — all of which promote myocardial hypertrophy and, over time, contractile dysfunction. The repetitive hemodynamic stress associated with dialysis sessions themselves (alternating volume overload between sessions and rapid fluid removal during sessions) is also thought to contribute to progressive myocardial injury, sometimes referred to as dialysis-induced myocardial stunning, which may further explain the lower ejection fraction and fractional shortening observed in this group.

Importantly, the two groups were comparable in age, height, weight, BMI, body surface area, and duration of CKD (Table 1), with none of these differences reaching statistical significance. This baseline comparability strengthens the internal validity of the cardiac findings, suggesting that the observed differences in LV mass and systolic function are more plausibly attributable to dialysis-related hemodynamic and metabolic burden rather than to differences in

growth, body size, or disease chronicity between the groups.

ABPM and LVMHT, while numerically higher in the dialysis group, did not reach statistical significance (p=0.19 and p=0.69 respectively). This is not unexpected given the relatively small sample size of the dialysis group (n=14), which limits statistical power to detect moderate effect sizes, particularly for parameters like ambulatory blood pressure that are known to have wide intra- and inter-individual variability. The directionality of these trends, however, is consistent with the overall pattern of greater cardiovascular burden in the dialysis group and may reach significance in studies with larger sample sizes.

These findings carry meaningful clinical implications. Cardiovascular disease remains one of the leading causes of morbidity and mortality in children with CKD, and the early echocardiographic changes observed here — particularly reduced systolic function — highlight the need for routine cardiac surveillance in pediatric dialysis patients, alongside aggressive control of modifiable risk factors such as blood pressure, fluid status, and anemia. Early identification of subclinical LV dysfunction may allow for timely cardioprotective interventions before the development of overt heart failure. A limitation of the present study is the relatively small sample size in the dialysis group and its single-center, cross-sectional design, which limits the ability to draw causal conclusions or assess the trajectory of cardiac changes over time; longitudinal studies with larger cohorts would help clarify whether these structural and functional cardiac changes are progressive and reversible with optimized dialysis and medical management.

DISCUSSION

The present study evaluated cardiovascular parameters in children with chronic kidney disease (CKD), comparing those on dialysis with those not on dialysis. The findings demonstrate a clear impact of disease severity and renal replacement therapy on cardiac structure and function. Children on dialysis showed significantly higher left ventricular mass (LVM) compared to non- dialysis patients (131.71 ± 59.06 vs 98.91 ± 49.61, p = 0.042), indicating increased left ventricular hypertrophy (LVH) in advanced CKD. This finding is consistent with previous studies demonstrating that uremia, volume overload, and persistent hypertension contribute to progressive myocardial remodeling in CKD patients [6].

Echocardiographic parameters further highlighted functional cardiac impairment in dialysis patients. Ejection fraction was significantly lower in the dialysis group (54.79 ± 9.99 vs 60.89 ± 5.9, p = 0.006), suggesting early systolic dysfunction in children with advanced CKD. Similarly, fractional shortening was significantly reduced in the dialysis group (28.36 ± 5.81 vs 32.15 ± 4.04, p = 0.007), reinforcing the presence of subclinical myocardial dysfunction. These findings are in agreement with Sarnak et al., who described CKD as a major risk factor for structural and functional cardiovascular abnormalities, even in early stages of disease [7].

Ambulatory blood pressure monitoring (ABPM) showed higher values in dialysis patients (89.57 ± 11.84) compared to non-dialysis patients (85.28 ± 10.36), although this difference was not statistically significant (p = 0.19). Hypertension remains a key contributor to cardiovascular remodeling in CKD, and ABPM is considered superior to clinic blood pressure in detecting masked hypertension and nocturnal non-dipping patterns in children with renal disease [8]. The relatively high ABPM values in both groups emphasize the persistent cardiovascular risk burden even before dialysis initiation.

Interestingly, the left ventricular mass to height (LVMHT) ratio was slightly higher in the dialysis group, though the difference was not statistically significant. This suggests that indexing cardiac mass to body size may partially account for differences in anthropometry, but does not eliminate the presence of hypertrophy in advanced CKD. Correlation analysis revealed a very weak relationship between left ventricular mass and duration of CKD (R^2 = 0.008), indicating that duration alone may not be a strong predictor of cardiac remodeling. This finding suggests that other factors such as hypertension severity, anemia, and volume overload may play a more significant role than disease duration itself [9].

The present study also highlights that children with CKD are at risk of early cardiovascular involvement even before dialysis initiation. Structural changes such as LVH and functional impairment are already evident in non-dialysis patients, supporting the concept that cardiovascular disease begins early in the course of CKD. This aligns with the “cardiorenal syndrome” concept, where renal dysfunction and cardiac dysfunction are closely interrelated and progressively worsen each other [10].

Overall, the findings emphasize that pediatric CKD is strongly associated with cardiovascular complications, particularly left ventricular hypertrophy and systolic dysfunction, with more pronounced abnormalities in dialysis-dependent patients. Early identification using echocardiography and ambulatory blood pressure monitoring is essential to reduce long-term cardiovascular morbidity.

CONCLUSION

The present study demonstrates that children with chronic kidney disease (CKD) have significant cardiovascular involvement, with more pronounced abnormalities observed in those on dialysis compared to those not receiving dialysis. Left ventricular mass was significantly increased and systolic function was reduced in dialysis patients, indicating advanced structural and functional cardiac impairment in this group.

Although ambulatory blood pressure values were higher in dialysis patients, both groups showed evidence of cardiovascular risk, highlighting that cardiac changes begin early in the course of CKD, even before initiation of dialysis. The weak correlation between duration of CKD and left ventricular mass suggests that cardiovascular damage is influenced by multiple factors beyond disease duration, including hypertension, volume overload, and metabolic disturbances.

Overall, the study emphasizes that cardiovascular complications are common and clinically significant in pediatric CKD patients. Early detection using echocardiography and ambulatory blood pressure monitoring is essential for timely intervention. Regular cardiovascular assessment and aggressive management of risk factors are crucial to improve long-term outcomes and reduce morbidity and mortality in children with CKD.

REFERENCES

1. Go AS, Chertow GM, Fan D, McCulloch CE, Hsu CY. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. *N Engl J Med*. 2004;351(13):1296–1305.
2. Sarnak MJ, Levey AS, Schoolwerth AC, et al. Kidney disease as a risk factor for development of cardiovascular disease. *Circulation*. 2003;108(17):2154–2169.
3. Hill NR, Fatoba ST, Oke JL, et al. Global prevalence of chronic kidney disease: a systematic review and meta-analysis. *PLoS One*. 2016;11(7):e0158765.
4. Stenvinkel P. Chronic kidney disease: a public health priority and harbinger of premature cardiovascular disease. *J Intern Med*. 2010;268(5):456–467.
5. Mitsnefes MM. Cardiovascular disease in children with chronic kidney disease. *J Am Soc Nephrol*. 2008;19(3):485–495.
6. Sarnak MJ, Levey AS, Schoolwerth AC, et al. Kidney disease as a risk factor for cardiovascular disease. *Circulation*. 2003;108(17):2154–2169.
7. Wühl E, Trivelli A, Picca S, et al. Strict blood-pressure control and progression of renal failure in children. *N Engl J Med*. 2009;361(17):1639–1650.
8. Shroff R, Weaver DJ, Mitsnefes M. Cardiovascular complications in children with chronic kidney disease. *Nat Rev Nephrol*. 2017;13(11):674–690.
9. Ronco C, McCullough P, Anker SD, et al. Cardiorenal syndromes: report from consensus conference. *J Am Coll Cardiol*. 2010;55(17):1718–1726.

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