Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/ap5qnb77

CHRONIC KIDNEY DISEASE IN THE PEDIATRIC AND ADOLESCENT POPULATION: ETIOLOGY AND CLINICAL PRESENTATION

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ABSTRACT

Children with chronic kidney disease (CKD) are associated with a number of problems that can affect the extra-renal and renal systems. This study aimed to identify the risk factors associated with poorer outcomes in children with CKD.

Methods: This is a cross-sectional study. This study was conducted at the University Hospital. The duration of this study was six months, from August 2023 to January 2024. In total, 300 participants (N=300) participated in this study. The age of the participants was 1-19 years including both boys and girls. Biochemical parameters were determined.

Results: CKD was diagnosed in 160 (53.3%) boys and 140 (46.6%) girls with some form of chronic renal disease. 86.6% were non-glomerular and 10% had glomerular disorders. Congenital anomalies of the kidney and urinary tract (CAKAUT) affected 36.6% of the participants, followed by obstructive uropathy (30%), reflux nephropathy (30%), stone disease (8%), and cystic disease (15%). In latter stages 3-5 of chronic kidney disease (CKD), the overall incidence of hypertension among the participants was 33.3%. Several factors that were statistically significantly associated with negative consequences were anemia, proteinuria, growth failure, and mineral bone disorders.

Conclusion: Chronic kidney disease (CKD) is a complex illness with a wide range of etiologies and unpredictable outcomes. With a noteworthy prevalence of growth failure and comorbidities, such as proteinuria, hypertension, anemia, and mineral bone problems, our study emphasizes the substantial impact of CKD on pediatric populations.

Keywords: Chronic, Kidney, Protein, and Anemia.

INTRODUCTION

Chronic kidney disease (CKD) is a serious health issue that affects development, growth, and general health. Compared with adults, only a small percentage of children have CKD; however, this condition

is becoming more common. Globally, the prevalence of CKD in children is estimated to be between 15 and 74 per million. Children's CKD has different causes than that of adult CKD. Common causes include congenital anomalies of the kidney and urinary tract (CAKUT), acquired kidney diseases and inherited conditions like polycystic kidney disease, glomerular diseases like nephrotic syndrome and glomerulonephritis, and systemic diseases like systemic lupus erythematosus [1].

A child's quality of life can be significantly affected by a variety of clinical manifestations that may be associated with childhood chronic kidney disease (CKD). Hormonal imbalances, malnutrition, and the impact of chronic illnesses on metabolic processes are some of these causes. Psychosocial difficulties may arise from growth failure, which can affect children's social connections and sense of self [2-3]. A child's appetite, dietary restrictions (such as limiting their consumption of protein, potassium, and phosphorus), and body's capacity to absorb nutrients can all be affected by chronic kidney disease (CKD) [4]. Growth failure can be worsened by malnutrition and vitamin shortage, which can weaken the immune system and make a person more vulnerable to infections and other problems. A condition known as chronic inflammation, oxidative stress, dyslipidemia, and endothelial dysfunction are linked to chronic kidney disease (CKD) and accelerate the development of atherosclerosis [5]. The accumulation of plaque in arteries, known as atherosclerosis, can cause blood vessels to constrict and stiffen, raising the risk of cardiovascular events, including heart attacks and strokes.

One common CKD complication is hypertension or high blood pressure, which is also a significant risk factor for cardiovascular disease [6]. Chronic hypertension increases the risk of heart failure, coronary artery disease, and stroke by damaging the blood vessels and heart. Vitamin D, phosphate, and calcium levels become aberrant as a result of CKD's disruption of mineral metabolism. Renal osteodystrophy and other mineral and bone diseases linked to chronic kidney disease (CKD) raise the risk of cardiovascular events and vascular calcification [7].

About 1-3 children under the age of 16 are newly diagnosed with idiopathic nephrotic syndrome (NS), which is defined by significant proteinuria, hypoalbuminemia, and/or the presence of edema. After starting daily oral prednisolone/prednisone (PDN) treatment at the recommended dosages, over 85% of cases showed complete remission of proteinuria. Steroid-resistant NS was assumed to be present in patients who did not achieve remission after 4-6 weeks of therapy [8].

Numerous psychological issues such as anxiety, despair, social isolation, and trouble managing the demands of the illness and its treatment can affect children with chronic kidney disease (CKD). Due to food restrictions or physical changes, they may feel different from their classmates, which could cause low self-esteem and feelings of estrangement [9]. A child's education may be affected by chronic kidney disease (CKD) and associated treatment plans because of frequent hospital stays, missing school days, and doctor visits. This can lead to stress and feelings of inadequacy and impact peer relationships, academic performance, and overall educational attainment [10].

Managing symptoms, avoiding complications, maximizing growth and development, and slowing the disease course are the goals of pediatric CKD treatment. Medication (such as phosphate binders, erythropoiesis-stimulating medicines for anemia, and blood pressure control) along with dietary changes (such as limiting protein, salt, and phosphorus) and treating underlying causes are possible treatment options [11]. Dialysis or kidney transplantation may be required in more severe disease stages. The underlying reason, stage of diagnosis, and efficacy of treatment are among the variables that affect a child's CKD prognosis. While early identification and treatment can help afflicted children live better lives, some may develop end-stage renal disease (ESRD), which requires dialysis or kidney transplantation [12]. The aim of our study to identify risk factors associated with poorer outcomes in children with CKD.

METHODOLOGY

This is a cross-sectional study. This study was conducted in a hospital. The duration of this study was 6 months, from Aug 2023 to Jan 2024. A total number of participants was (N=300) in this study. The age of participants was 1-15 years included both boys and girls. The inclusion criteria: including 1-19 years, CKD stage 1-5, increased eGFR>90 ml/min, and both male and female sex. The exclusion

criterion was acute kidney injury to revert to normal kidney function during follow-up. Data on the patients' clinical status, demographics, laboratory results at presentation and follow-up, any surgical treatment, kidney function at the final visit, and the outcome at the last follow-up were recorded. Data were statistically analyzed using SPSS software. 26. Chi-square, odd ratio and percentage were used to display the category data. The variables were considered to be significant, as indicated by a p-value of <0.05.

RESULTS

The total number of participants included in the study was 300. Both boys and girls were between the ages of 1 and 15. In our study, CKD was diagnosed in 160 (53.3%) boys and 140 (46.6%) girls with some form of chronic renal disease. The median age at diagnosis was 11 years (IQR: 6–14 years). No additional kidney problems were found in 10% of participants with glomerular disorders. Among the underlying illnesses causing CKD, 86.6% were non-glomerular disorders. The most common cause of chronic kidney disease (CKD) is congenital abnormalities of the kidney and urinary tract (CAKAUT), which affects 110 patients (36.6%), followed by obstructive uropathy (30%), reflux nephropathy (30%), stone disease (8%), and cystic disease (15%) (Table 1).

Table 1. Demographic variables

Variables	**N=300**	**%**
Age		
1-7 years	10	3.3%
8-15 years	200	66.6%
≥16 years	90	30%
Gender		
Boys	160	53.3%
Girls	140	46.6%
Glomerular diseases	30	10%
Non-Glomerular diseases	270	86.6%
● **Congenital anomalies of kidney and urinary tract (CAKAUT)**	110	36.6%
● **Obstructive Uropathy**	90	30%
● **Reflux nephropathy**	30	10%
● **Stone diseases**	24	8%
● **Cystic diseases**	15	5%

Our findings indicate that 13.3% and 16.6% of the subjects were in stages 1-2 of the CDK, respectively. As shown in Table 2, the majority of individuals were in stages 3-5, which included CKD (26.6%, 25%, and 18.3%, respectively).

Table 2. CKD disease of participants

CKD stage	**N=300**	**%**
1	40	13.3
2	55	16.6
3	80	26.6
4	75	25
5	50	18.3

A total of According to our results, 56.6% of the participants had stable follow-up. 13.3% of the patients had poor outcomes while receiving dialysis (Table 3). Of the subjects, 6.6% had confirmed death, and 23.3% were lost to follow-up. At the 10-year follow-up, we discovered that 60% (90/150)

of the patients had previously experienced CKD, had undergone urologic surgery, and had a 94% kidney survival rate (85/90). Another interesting finding was that 60% of participants with posterior urethral valves, which are known to be associated with worse outcomes, had stable dialysis-free results across time, even though 2% of participants had an eGFR of 30 ml/min/1.73 m2 or below. The incidence of death and loss to follow-up was 2/120 person-years among patients with early stage CKD. Children with glomerular disease leading to CKD had worse outcomes (death or loss to follow-up) than those with CAKUT, who had the greatest outcomes. For children with 3% stone disease, the outcomes ranged (see Table 4).

Table 3. Outcomes at final follow up

	N	**%**
Stable in follow up	170	56.6
Dialysis	40	13.3
Lost to follow up	70	23.3
Mortality rate	20	6.6

Even after considering factors such as age and sex, patients with late CKD/ESRD had a death unfavorable outcome rate that was 6.5 times greater [(95% CI: (3.1-11.5)] than those with early CKD. Table 4 displays the statistically significant (p=0.000) hazards ratio for age, which was 2.5 [(95% CI: (1.1-5.5)]. This was because higher rates of poor outcomes were related to older age at diagnosis.

Table 4. Adjusted results from Hazard ratio model for dialysis and death in patients

	Adjusted (95%CI)
Age	2.5(1.1-5.5)
Sex	0.8(0.1-3.3)
Late CKD/ESRD	6.5 (3.1-11.5)

According to our results, the prevalence of hypertension in the participants was 33.3% in later CKD stages 3-5. The prevalence of proteinuria was 29.6% in the later CKD 3-5 stages among the participants. Different factors such as anemia, proteinuria, growth failure, and mineral bone disorder were significantly associated with adverse effects (Table 5).

Table 5. Prevalence of manifestation in last stage of CKD

Factors	**CKD stage 3-5**	
	Yes	**No**
	N=30	N=270
Anemia	11 (36.6%)	30 (11.1%)
Proteinuria	10 (33.3%)	80 (29.6%)
Growth failure	2 (6.6%)	40 (14.8%)
Hypertension	3 (10%)	90 (33.3%)
Mineral bone disorder	4 (13.3%)	25 (9.2%)

DISCUSSION

Children with chronic kidney disease (CKD) may have serious consequences that affect many aspects of their health and well-being. The kidneys continue to be damaged by the underlying disease process if chronic kidney disease (CKD) is not identified or diagnosed for a long time. This increases the risk of developing end-stage renal disease (ESRD), in which the kidneys are unable to function well enough to support life and can cause irreparable kidney damage [13].

According to our results, non-glomerular illnesses accounted for the majority (86.6%) of children with chronic kidney disease (CKD). These data imply that CKD in these children was caused by a wide spectrum of disorders. Non-glomerular conditions represent a range of kidney diseases and conditions

that mainly affect the kidney's tubules, which are the filtering units [14]. Notably, 36.6% of pediatric cases of chronic kidney disease (CKD) are caused by congenital abnormalities of the kidney and urinary tract (CAKUT). Urinary stasis, hydronephrosis, and irreversible kidney injury can result from anomalies, such as occlusion of the posterior urethral valves 15. Urine travels backward from the bladder into the ureters and kidneys in patients with vesicoureteral reflux disease (10 %). Urinary reflux disease (GERD) can be caused by persistent UTIs and gradual kidney damage, which can result in chronic kidney disease [16, 17]. Unfortunately, owing to a lack of routine prenatal imaging or the inability to undertake advanced prenatal diagnostics in some contexts, many of these defects may go unnoticed during pregnancy. If prenatal care and diagnosis are not provided, congenital urologic abnormalities [18].

According to our results, 8% of children had urolithiasis or kidney stones. Solid crystalline crystals, called kidney stones, develop in the kidneys as a result of chemicals found in the urine. Kidney stones can also occur in children, although they are more frequently linked with adults. In fact, their frequency in pediatric populations seems to be rising [19, 20]. Chronic kidney disease (CKD) in children has glomerular abnormalities as the underlying cause in 10% of study participants. Heavy proteinuria, hypoalbuminemia, edema, and hyperlipidemia are hallmarks of nephrotic syndrome [21]. Hemolytic anemia, thrombocytopenia, and acute kidney injury are three uncommon but serious illnesses known as hemolytic uremic syndromes. For the proper diagnosis, assessment, treatment, and management of childhood CKD, it is imperative to understand the incidence of glomerular abnormalities as a cause of the disease [22]. High blood pressure is a prevalent outcome and risk factor for the progression of chronic kidney disease (CKD). In children in later stages 3–5 of CKD, the prevalence of hypertension increases to 86.6%, indicating a considerable increase in the risk of acquiring hypertension with declining kidney function [23].

Stable dialysis-free outcomes were reported by 56% of patients with posterior urethral valves (PUV); this number is noteworthy, albeit slightly less than the previously reported 62%. The aforementioned discovery emphasizes the significance of prompt identification and management of PUV cases to maximize enduring renal capacity and reduce the likelihood of developing end-stage renal disease necessitating dialysis [24]. To improve long-term outcomes for patients with PUV and related CKD, comprehensive management options that address these factors, such as blood pressure control, anemia management, and treatment for mineral bone disease, may help reduce the risk of CKD development. Proactive management of these comorbidities and early identification may be essential to improve renal survival and general health in this patient population [25]. Notably, children with growth failure accounted for 14.8% of cases of chronic kidney disease (CKD), suggesting that growth impairment is highly prevalent in this population. A prominent sign of chronic kidney disease (CKD) in children is growth failure, which has multiple causes, including low growth hormone secretion, malnourishment, and chronic illness. To encourage growth and development in affected children, this may entail intensive management of CKD-related problems, hormone therapy, and nutritional support [26].

CONCLUSION

Children's chronic kidney disease (CKD) is a complex illness with a wide range of etiologies and unpredictable results. With a noteworthy prevalence of hypertension, growth failure, and comorbidities, such as proteinuria, hypertension, anemia, and mineral bone problems, our study emphasizes the substantial impact of CKD on pediatric populations. These elements increase death rates and lower kidney survival in affected children. For pediatric patients to have better long-term results, early detection and thorough therapy for chronic kidney disease (CKD) are essential. This includes managing comorbidities and promoting healthy growth and development.

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