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Research Article

Cystic Kidney Diseases in Sudanese Children: Pattern, Clinical Presentation, and Outcome

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Abstract

Background: Cystic kidney disease (CKD) can directly lead to chronic kidney disease in children. This study aims to determine the types, clinical presentation, and outcome of CKD in Sudanese children.

Methods: This retrospective records-based study from January 2005 to December 2017 was conducted at Soba University Hospital, including patients with renal diseases coming from different parts of Sudan.

Results: A total of 105 cases of CKD were identified out of 3050 medical records reviewed in this study, resulting in a prevalence of 3.4% among all pediatric admissions to the renal unit. Male represents 57.1%, and the mean age at presentation was 36.5 ± 4.5 months. The most frequent clinical presentation was a palpable abdominal mass followed by urinary tract infection and incidental presentation. About 15.2% presented with chronic renal failure, and neonatal presentations were reported in 6.6%. The most prevalent type was polycystic kidney disease (PCKD; 40.9%), followed by multicystic dysplastic kidney (MCDK; 36.2%). Autosomal dominant polycystic kidney disease (ADPCKD) and MCDK were present mainly in age groups <1 year old, compared to the cyst of the medulla related to age groups 5–9 and 10–14 years. The clinical outcome showed the absence of symptoms and normal renal function in 59% of the patients during follow-up notes. In comparison, 29.5% developed chronic kidney disease, of whom 11.4% were stage-five and required dialysis, while 8.6% required kidney transplantation, and death was reported in 11.4%. There was a significant statistical association between the type of disease and consanguinity (P = 0.018) and the age of presentation (P = 0.012).

Conclusion: Five types of CKD were reported, with the predominance of polycystic kidney disease. Males and <1 year olds were more affected among children. Early detection and renal replacement therapy can improve the outcome in such cases.

Keywords: children, clinical presentation, cystic kidney diseases, outcome, pattern

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1. Introduction

Cystic Kidney Disease (CKD) encompasses various conditions with variable phenotypic manifestations. It is considered a direct cause of end-stage renal disease (ESRD) in children and has been observed since using imaging techniques worldwide [1]. The causes of CKD could be related to genetic predisposition, environmental factors, or associated with other systemic diseases [2]. However, recent studies have suggested the role of cilia as a cause of CKD, which led to the emergence of the ciliopathies concept [3]. The presentation of CKD varies with the underlying cause and ranges from asymptomatic incidental discovery, symptoms of urinary tract infection, flank masses, and hematuria to symptoms of chronic renal failure. In the neonatal period, respiratory distress and lung hypoplasia are associated with oligohydramnios, which can lead to neonatal death. However, antenatal diagnosis using an ultrasound scan can be employed for early detection [4]. Symptoms in childhood include high blood pressure, kidney failure, failure to thrive, and signs of ESRD below the age of 10, requiring dialysis or transplantation. While certain types of CKDs, such as autosomal recessive polycystic kidney disease (ARPKD), are commonly associated with hepatic involvement symptoms of portal hypertension, especially varices and splenomegaly, other types, like multicystic dysplastic kidney (MCDK) and simple renal cysts, typically do not present with liver disease [4]. CKD is generally incurable, although supportive management could decrease morbidity and mortality in children. Chronic kidney disease, an outcome of CKD, ranges from normal renal function based on Glomerular Filtration Rate (GFR) stage one to four that needs supportive treatment, to stage five, which necessitates dialysis or transplant [5].

The type of CKD has been developed to include clinic-pathologic correlations that reflect radiographic, functional, and genetic aspects. The following are its primary categories: (i) cysts of the medulla, including juvenile nephronophthisis, medullary cystic disease, and medullary sponge kidney; (ii) autosomal recessive polycystic kidney disease (ARPCKD) and autosomal dominant polycystic kidney disease (ADPCKD); (iii) glomerulocystic kidney disease (GCKD) including sporadic, familial hypoplastic, and autosomal dominant glomerular-cystic kidney disease; (iv) MCDK; (v) simple renal cysts; (vi) multilocular cysts; and (vii) acquired CKD. This classification has seen numerous revisions throughout the years, is still a work in progress, and certainly will undergo more changes [6, 7].

The clinical manifestation, types, and prognosis of CKD in Sudan are not well-documented. However, most studies in Sudan that are accessible on kidney disease appear to concentrate on chronic kidney disease generally, notably of the inherited variety [8, 9]. This study aims to assess the clinical presentation, types, and outcomes of CKD in Sudanese children in the main renal center in Sudan. The study is essential in providing primary data that could help improve pediatric renal services through early detection and management of these conditions, helping reduce morbidity and mortality in the future.

2. Materials and Methods

2.1. Design setting and participants

This retrospective study reviewed hospital records of all children admitted between January 2005

and December 2017 at Soba University Hospital in Khartoum state. The Pediatric Nephrology Unit in Soba Hospital receives children with renal diseases referred from different parts of Sudan. It is considered the central renal unit in Sudan. The inclusion criteria in this study were all records of patients <18 years old admitted or referred to the unit with the diagnosis of CKD during the study period. On the other hand, records that did not meet the inclusion criteria or were deficient in data requested for this study were excluded.

One author collected the data from March 2017 to March 2018 after getting permission from the hospital administrative authority to access patients' records.

2.2. Data collection, study variables, and definitions

Data were collected with a predesigned data extraction sheet involving vital information to assess demographic variables such as age, gender, area of origin, and parents' consanguinity. Additionally, symptoms and signs of kidney disease at presentation were reported, like palpable abdominal mass, failure to thrive, hypertension, hematuria, proteinuria, flank pain, edema (facial or generalized), polyurea, and dysuria. The information regarding laboratory investigations and imaging were also added besides each patient's provisional and final diagnosis. The seven common CKD patterns were assessed depending on the classification of kidney developmental disorders [7]. The outcome of the patients were categorized into: the absence of symptoms with normal renal function, chronic kidney disease (for dialysis or kidney transplantation), and death. The definitions of normal renal function and chronic kidney disease were classified depending on Kidney Disease Quality Outcome Initiative (KDOQI) based on the GFR level. Chronic kidney disease was defined as GFR <60 mL/min/1.73 m^2 for ≥3 months, with or without kidney damage, while normal renal function was defined as GFR >90 mL/min/1.73 m^2 [10].

2.3. Data analysis

The collected data were analyzed using the SPSS (Statistical Package for Social Sciences) software package, version 23. Descriptive statistics were used to summarize the study variables utilizing frequency and percentage for qualitative variables and mean and standard deviation for quantitative variables. Another level of data analysis, including the Chi-square test, was used to test some associations between demographic factors and the outcomes of children with CKD. A P-value < 0.05 was considered to be significant.

3. Results

A total of 105 cases of CKD were identified out of 3050 medical records reviewed in this study, resulting in a prevalence of 3.4% among all pediatric admissions to the renal unit. Of the 105 cases, 60 (57.1%) were that of males, and the male to female ratio was calculated as 1.3:1. The mean age at presentation was 36.5 ± 4.5 months, while the distribution of the age groups at presentation was as follows: 54 (51.4%) aged <1 year and only 4 (3.8%) between 15 and 18 years (Table 1).

As shown in Table 2, the most frequent clinical presentation was a palpable abdominal mass in 48 cases, which constituted 45.7% of whole presentations, followed by urinary tract infection and incidental presentation in 21 (20%) and 17 (16.2%) cases, respectively. Moreover, about 16 cases (15.2%) presented with symptoms and signs

consistent with chronic renal failure. Neonatal presentations were reported in seven patients, constituting 6.6% of whole presentations, in whom four (57.1%) had bilateral ARPCKD and presented with oligohydramnios and respiratory distress. Other features based on antenatal ultrasound performed on 73 cases revealed that the patients who underwent antenatal ultrasound were diagnosed with specific conditions of which ADPCKD constituted 4.1% and MCDK 28.8%, compared to nonspecific diagnoses with abnormal findings in the report in 16.4% of the cases. In contrast, 49.3% of ultrasound was done without diagnosis.

There was a significant statistical association (P = 0.012) between the type of CKD and the age of presentation. Table 3 demonstrates the different types of CKD related to age groups. ADPCKD and MCDK were present mainly in age groups <1 year old, compared to the cyst of the medulla related to age groups 5–9 and 10–14.

Regarding the types of CKD, the most frequent type was PCKD at 40.9%, with the bilateral ADPCKD type constituting 24.8% of whole cases, as shown in Table 4. MCDK was diagnosed in 36.2% of cases, while the least frequent pattern was a multilocular cyst (1.9%). Furthermore, ADPCKD was diagnosed in two syndromes (tuberous sclerosis in two patients and Bardet Biedl syndrome in one patient). However, no cases were diagnosed as GCKD or acquired CKD among the patients.

As shown in Table 5, out of the 105 studied patients, 62 (59%) showed the absence of symptoms and normal renal function in follow-up notes after different visit periods, of which 43 cases (40.9%) were PCKD. In comparison, 31 (29.5%) developed chronic kidney disease, of whom 12 patients (11.4%) were stage five and required dialysis, and nine patients (8.6%) in stage five required kidney transplantation. Death was the outcome in 12 patients (11.4%) of the total sample, of which 9 cases were diagnosed as PCKD.

Although there was a significant statistical association (P = 0.018) between the type of diseases and consanguinity, gender showed no association (P = 0.4).

Table 1: Demographic variables of the children in the study (n = 105).

	Age group	Number	Percentage (%)
Gender	Male	60	57.1
	Female	45	42.9
Age at presentation (yrs)	<1	54	51.4
	1–4	15	14.3
	5–9	13	12.4
	10–14	19	18.1
	15–18	4	3.8
Area of origin in Sudan	Northern	52	49.5
	Central	29	27.6
	Western	21	20
	Eastern	2	1.9
	Southern	1	0.95
Parents' consanguinity	Yes	66	62.9
	No	39	37.1

Table 2: The clinical presentation in the studied patients (*n* = 105).

Type of CKD versus presentation	PCKD		Cyst of medulla	MCDK	Multilocular cyst	Simple renal cyst
	ADPCKD	ARPCKD				
Palpable abdominal mass	11 (37.9%)	7 (50%)	2 (11.8%)	6 (15.8%)	2 (100%)	0 (0%)
Urinary tract infection	4 (13.8%)	6 (42.8%)	4 (23.5%)	2 (5.2%)	2 (100%)	3 (60%)
Incidental finding	3 (10.3%)	5 (35.7%)	2 (11.8%)	4 (10.5%)	2 (100%)	1 (20%)
Chronic renal failure	2 (6.8%)	6 (42.8%)	3 (17.6%)	3 (7.9%)	1 (50%)	1 (20%)
Hypertension	2 (6.8%)	3 (21.4%)	2 (11.8%)	2 (5.2%)	1 (50%)	1 (20%)
Failure to thrive	1 (3.4%)	1 (7.1%)	0 (0%)	2 (5.2%)	2 (100%)	1 (20%)
Hematuria	0 (0%)	0 (0%)	1 (5.9%)	2 (5.2%)	1 (50%)	3 (60%)
Proteinuria	1 (3.4%)	1 (7.1%)	0 (0%)	1 (2.6%)	0 (0%)	2 (40%)
Acute renal failure	0 (0%)	1 (7.1%)	1 (5.9%)	1 (2.6%)	2 (100%)	0 (0%)
Abdominal pain	0 (0%)	0 (0%)	1 (5.9%)	2 (5.2%)	2 (100%)	0 (0%)
Polyurea	0 (0%)	0 (0%)	1 (5.9%)	3 (7.9%)	1 (50%)	0 (0%)
**Total presentations = 127 (100%)	24 (18.9%)	30 (23.6%)	17 (13.4%)	28 (22%)	16 (12.6%)	12 (9.4%)
Antenatal ultrasound diagnosis						
Reported specific diagnosis	3 (4.1%)	1 (1.4%)	0 (0%)	21 (28.8%)	0 (0%)	0 (0%)
Reported abnormal finding without specific diagnosis	12 (16.4%)					
Done without diagnosis	36 (49.3%)					
Total	73 (100%)					

PCKD, polycystic kidney disease; MCDK, multicystic dysplastic kidney
**Each type of CKD has more than one clinical presentation. The percentages were calculated from the total count of cases in each type and not the total count of presentations.

Table 3: Distribution of CKD types by age group at presentation (*n* = 105).

Pattern of CKD		Age (yrs)					Total	P-value
		<1	1–4	5–9	10–14	15–18		0.012
PCKD	ADPCKD	12 (41.4%)	6 (20.7%)	3 (10.3%)	7 (24.1%)	1 (3.4%)	29 (100%)	
	ARPCKD	6 (42.9%)	2 (14.3%)	1 (7.1%)	5 (35.7%)	0 (0%)	14 (100%)	
Cyst of medulla		3 (17.6%)	0 (0%)	6 (35.3%)	6 (35.3%)	2 (11.8%)	17 (100%)	
MCDK		33 (86.8%)	4 (10.5%)	1 (2.6%)	0 (0%)	0 (0%)	38 (100%)	
Multilocular cyst		1 (50%)	1 (50%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)	
Simple renal cyst		0 (0%)	2 (40%)	2 (40%)	1 (20%)	0 (0%)	5 (100%)	

PCKD, polycystic kidney disease; MCDK, multicystic dysplastic kidney; CKD, cystic kidney disease; *P*-value significant < 0.05

Table 4: Types of cystic kidney disease in the studied patients (n = 105).

Pattern	Number	Percentage (%)
PCKD	43	40.9
Bilateral ADPCKD	26	
Bilateral ARPCKD	14	
Right ADPCKD	2	
Left ADPCKD	1	
Cyst of medulla	17	16.2

Table 4: Continued).

Pattern	Number	Percentage (%)
Medullary sponge	5	
Nephronophthisis	12	
MCDK	38	36.2
Right side	16	
Left side	22	
Multi locular cyst	2	1.9
Simple renal cyst	5	4.8

ADPCKD, autosomal dominant polycystic kidney disease; ARPCKD, autosomal recessive polycystic kidney disease; MCDK, multicystic dysplastic kidney

Table 5: Types of cystic kidney diseases versus outcome (n = 105).

	Outcome			
Type	Absence of the symptoms with normal renal function	Chronic kidney disease	Death	Total
	Frequency (Percentage %)			
PCKD	17 (39.5%)	17 (39.5%)	9 (21.0%)	43 (100%)
Cyst of medulla	3 (17.6%)	12 (70.6%)	2 (11.8%)	17 (100%)
MCDK	35 (92.1%)	2 (5.2%)	1 (2.6%)	38 (100%)
Multilocular cyst	2 (100%)	0 (0%)	0 (0%)	2 (100%)
Simple renal cyst	5 (100%)	0 (0%)	0 (0%)	5 (100%)

PCKD, polycystic kidney disease; MCDK, multicystic dysplastic kidney; CKD, cystic kidney disease; P-value = 0.013

4. Discussion

Although many CKD first manifest symptoms in childhood and adolescence, patients frequently visit the adult nephrology clinic without a diagnosis or, in rare instances, develop symptoms for the first time in adulthood [11]. The underlying cause of the disease affects how a patient with CKD clinically presents. For example, in patients with ADPKD, flank pain, renal failure, hypertension, or palpable masses are frequent initial symptoms rarely seen in acquired CKD during a physical examination [12]. Although polycystic kidney disease includes different types, the clinical presentation showed the same symptoms and signs uniformly, making it difficult to distinguish between different patterns [13]. In the current study, the most frequent clinical presentation was palpable abdominal mass followed by symptoms of urinary tract infection, and it was also reported to be discovered as an incidental presentation. Furthermore, early detection was manifested in some cases during the neonatal period with oligo-hydramnios and respiratory distress or earlier than this based on antenatal ultrasound diagnosis.

Although renal cystic disease comprises various inherited and acquired conditions, the most prevalent hereditary cystic kidney illnesses are polycystic kidney diseases, which are divided into two categories based on their clinical features and manner of inheritance, either autosomal dominant or recessive [14]. In the current study, the most prevalent type of CKD seen in children was PCKD, followed by MCDK, while the least frequent type was multilocular cyst. ADPCKD constituted the frequent type that doubled the cases of ARPCKD

in the studied children. It is known that both ADPCKD and ARPCKD disorders can manifest in both children and adults, even though they were traditionally classified as “adult” (ADPKD) or “infantile/pediatric” (ARPKD) [14].

The outcome of the patients in the current study demonstrated that more than half of the patients with CKD reported the absence of symptoms and normal renal function in their follow-up; however, 29.5% developed chronic kidney disease that required dialysis or transplantation, while a considerable proportion (11.4%) of the studied children died. As noticed in the current study, about 20% of patients developed stage-five kidney failures, and no reports detected the presence of early stages of kidney failure, indicating the lack of early detection of the disease. This delay could be attributed to deficient community awareness regarding symptoms of kidney disease or difficulty accessing healthcare facilities, which is another possibility [15]. These results were comparable to a previous Sudanese study involving children with chronic kidney disease in which about 63% had end-stage renal failure, 25.9% were receiving dialysis, 25% were receiving conservative care, 3.9% had transplants, and 23.4% died, indicating a delay in the diagnosis of kidney diseases in Sudan generally [8].

In this study, certain factors had a significant statistical association with the type of CKD. PCKD and MCDK were reported to present in more minor ages, <1 year, compared to other types of CKD. However, most cases of cysts of the medulla predominate in the age groups 5–9 and 10–14. On the other hand, consanguinity marriage was present in 62.9% of the parents of the total studied sample, which was reported to have a significant influence on the CKD type. This result was consistent with an earlier study in Lebanon, which demonstrated that the type of kidney disease linked with consanguinity appears to be different from that of the general population in that it manifests earlier illness onset and diagnosis as well as a markedly increased risk for familial renal disease [16]. In regions with a high proportion of consanguineous marriages, diseases with genetic susceptibility, particularly those with an autosomal recessive transmission, may be more prevalent. Based on data from a Saudi study, polycystic kidney disease, familial juvenile nephronophthisis, congenital urological malformations, and familial nephrotic syndrome are more common among children [17].

Our research would be the foundation for an ongoing registry of CKD among children in Sudan. However, a few limitations came up when gathering the data. First, despite the hospital’s good file recording systems, essential data were missed, including the patient’s socioeconomic status, family history of renal disease, and involvement of other systems, such as the liver (that can be affected in PCKD). Second, the research may have been disadvantageous because its retrospective nature makes it difficult to assess exposure and requires a considerable sample size to detect rare outcomes. Third, a sufficient follow-up period is needed to measure prognosis and outcomes accurately. However, this was difficult to achieve in this study because patients were referred from different parts of Sudan, and most failed to reach the target hospital to achieve these measurements.

5. Conclusion

Our data reflect the presentation, types, and outcomes of CKD among Sudanese children who were admitted to Soba University Hospital. This study showed that PCKD is the most common type,

with young age at presentation and consanguinity appearing as factors significantly associated with CKD in our patients. The absence of symptoms with normal renal function was noticed among many patients in the follow-up visits. However, there is still a high mortality rate among the studied patients. More work and research are needed to understand the causes of CKD and its development and the differences in its occurrence between different regions of Sudan. Therefore, promoting kidney care in children and educating healthcare professionals to raise community awareness would help in the early recognition and treatment of these disorders, reducing morbidity and mortality rates.

Declarations

Acknowledgements

None.

Ethical Considerations

Ethical approval from the Research Ethics Committee (REC) of the Sudan Medical Specialization Board, Council of Pediatric and Child Health was obtained. The researchers requested a waiver of informed consent for the research, as the data were extracted from medical records without interviewing the participants.

Competing Interests

None declared.

Availability of Data and Material

All data are available in the manuscript.

6. Funding

None.

Abbreviations and Symbols

CKD: Cystic kidney disease

ESRD: End-stage renal disease

PCKD: Polycystic kidney disease

ARPCKD: Autosomal recessive polycystic kidney disease

ADPCKD: Autosomal dominant polycystic disease

GCKD: Glomerulo-cystic kidney disease

MCDK: Multicystic dysplastic kidney disease

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