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EARLY DETECTION OF RENAL CYST ON ULTRASONOGRAPHY AND THEIR ASSOCIATED RISK FACTORS IN PESHAWAR

Original Research

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Acknowledgement: This study is supported by the Offices of Research Innovation and Commercialization (ORICS) by Khyber Medical University, (DIR/ORIC/Ref/25/00098).

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Renal cysts are fluid-filled sacs that develop within or on the kidneys, often detected incidentally during routine ultrasonographic examinations. Although usually benign, renal cysts can be associated with systemic conditions and contribute to renal dysfunction in certain cases. Identifying their prevalence and associated risk factors is essential for early diagnosis and management. Hypertension, diabetes mellitus, and age-related changes have been recognized as potential contributors to renal cyst development, yet their exact epidemiological burden varies across different populations.

Objective: To determine the prevalence of renal cysts in patients undergoing ultrasound evaluation and to assess their associated risk factors.

Methods: A cross-sectional descriptive study was conducted at the Institute of Kidney Diseases, Peshawar, Pakistan, on 344 patients referred for renal ultrasound. Convenience sampling was applied. Patients of all ages and genders were included, while those with congenital anomalies, unilateral nephrectomy, or kidney transplants were excluded. Data were collected through a pre-structured questionnaire, and statistical analysis was performed using SPSS version 20. Descriptive and inferential statistics, including chi-square tests and binary logistic regression, were applied to determine associations.

Results: Renal cysts were present in 23.8% of cases. Simple cysts were the most common type (89%), while complex and other cyst types accounted for 9.6%. Females had a higher prevalence (52.3%) than males (30.3%) (P=0.034). The left kidney was more frequently affected (52%) than the right (34%), with bilateral involvement in 14%. Cyst location was predominantly cortical (84%), followed by medullary (4.8%), renal pelvis (8.5%), and polycystic (1.2%). Solitary cysts were most common (64.6%), while double (8.5%) and multiple cysts (25.6%) were less frequent. Hypertension (P=0.000, OR=2.969) and diabetes mellitus (P=0.007, OR=2.519) were significant risk factors.

Conclusion: Simple renal cysts were the most frequently detected type, with a higher prevalence in females. Hypertension, diabetes mellitus, and renal stone history were strongly associated with cyst development. Ultrasound plays a crucial role in early detection, guiding appropriate management to prevent complications such as chronic kidney disease.

Keywords: Diabetes mellitus, Hypertension, Kidney diseases, Prevalence, Renal cyst, Risk factors, Ultrasound.

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INTRODUCTION

Renal cysts refer to fluid-filled or semisolid structures that develop on or within the kidneys, often detected incidentally through radiologic imaging (1). These cysts vary in presentation, ranging from simple benign formations to more complex lesions that may indicate underlying pathology. Given their prevalence and potential complications, early detection and appropriate management by healthcare professionals are critical, particularly in susceptible populations (2). The kidneys, located bilaterally in the posterior abdomen, are bean-shaped organs with a reddish-brown hue, primarily responsible for filtering waste from the blood and maintaining osmoregulation (3). Cystic kidney diseases encompass a spectrum of conditions leading to cyst formation in one or both kidneys, which may or may not be associated with other renal pathologies (2,3). These cysts, lined with epithelium and filled with fluids of varying compositions, are often asymptomatic. Based on etiology, renal cystic diseases are broadly classified into genetic and acquired conditions. Polycystic kidney disease (PKD) represents the most common inherited disorder within this category, characterized by the progressive expansion of multiple fluid-filled cysts, causing substantial renal enlargement (4). PKD is further subdivided into autosomal dominant polycystic kidney disease (ADPKD) and autosomal recessive polycystic kidney disease (ARPKD) (5). ADPKD is the more prevalent form, leading to multiple renal cysts that compress adjacent renal tissue, contributing to progressive kidney dysfunction (6). In contrast, ARPKD is a severe hepatorenal fibrocystic disorder marked by nonobstructive dilatation of the renal collecting ducts and malformations of the portobiliary system (6,7).

Acquired cystic kidney disease (ACKD) is distinct from PKD and primarily develops in patients with chronic renal failure, especially those undergoing long-term dialysis. Unlike PKD, ACKD lacks a genetic predisposition and does not present with extrarenal cyst formation. Furthermore, while PKD is congenital, with cysts forming early in life, ACKD-associated cysts develop secondary to chronic kidney disease (CKD) (7). Most acquired renal cysts are idiopathic, with no identifiable underlying cause. Ultrasound imaging is instrumental in evaluating renal cysts, which are broadly categorized as simple or complex (8). Simple renal cysts (SRCs) are the most common type of acquired renal cysts, presenting as well-defined, anechoic, spherical lesions without calcifications or significant internal structures (6). These cysts typically arise in the renal cortex, often unilaterally, distorting the renal contour. SRCs are found across all age groups, with an increasing prevalence in older adults—exceeding 5% in individuals in their 40s and rising to 36% in those in their 80s—constituting up to 70% of asymptomatic renal tumors (9).

In contrast, complex renal cysts exhibit irregular morphology and additional sonographic features, such as septations, thickened or calcified walls, and internal echoes (10). These characteristics may necessitate further evaluation to differentiate benign cystic formations from malignancy. Several risk factors contribute to the development of renal cysts, including male sex, advanced age, hypertension, kidney dysfunction, and prolonged dialysis dependency (11). Given the clinical significance and potential complications of renal cysts, the objective of this research is to enhance understanding of their classification, pathophysiology, diagnostic imaging, and management strategies. By addressing the underlying mechanisms and distinguishing between benign and potentially malignant cystic formations, this study aims to contribute to improved diagnostic accuracy and therapeutic decision-making, ultimately benefiting patient care.

METHODS

This study was approved by the Clinical Research Ethics Committee of the Institute of Paramedical Sciences, Khyber Medical University (KMU), Peshawar, and the Institute of Kidney Diseases (IKD) Peshawar. Ethical approval was granted under reference number (DIR/ORIC/Ref/25/00098). Informed consent was obtained from all participants prior to data collection, ensuring compliance with ethical research guidelines. A cross-sectional descriptive study design was employed, involving 344 patients referred for renal ultrasound at the Institute of Kidney Diseases, Peshawar. Participants were included irrespective of age and gender. However, individuals with congenital renal anomalies, a history of unilateral nephrectomy, or prior kidney transplantation were excluded to ensure a homogeneous study population. The sample size was determined using the OpenEpi calculator at a 95% confidence level and a 5% level of significance (12). A non-probability convenience sampling technique was utilized for participant selection (7).

Data collection was conducted using a pre-designed, self-structured questionnaire comprising sections on patient demographics, clinical history, and ultrasound findings. The ultrasound examinations were performed by qualified sonographers using standardized imaging

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protocols to assess renal cystic formations. Data were entered and analyzed using SPSS software version 20. Continuous variables, such as age, were expressed as mean and standard deviation, while categorical variables, including gender and cyst type, were presented as frequencies and percentages. A chi-square test was used to compare categorical dependent and independent variables, while binary logistic regression analysis was conducted to assess the strength of association between variables.

RESULTS

The study included 344 participants undergoing renal ultrasound, with a mean age of 37.78 ± 17 years. The majority were female (54%), while males comprised 45.9% of the sample. Flank pain was reported in 89% of participants, while 11% were asymptomatic. Diabetes mellitus was present in 11.3% of cases, and 31.1% were hypertensive. A history of renal stones was observed in 58.1% of participants, and hematuria was reported in 23.8%. Ultrasound findings revealed normal kidney size in 92.7% of cases, small kidney size in 2.9%, and enlarged kidney size in 4.4%. Renal cysts were present in 23.8% of patients, with 34% having cysts in the right kidney, 52% in the left kidney, and 14% having bilateral renal cysts. Regarding cyst location, 84% were cortical, 4.8% were medullary, 8.5% were in the renal pelvis, and 1.2% were classified as polycystic. A single renal cyst was observed in 64.6% of cases, double cysts in 8.5%, and multiple cysts in 25.6%. Simple renal cysts were the most prevalent (89%), while complex and other cyst types each accounted for 4.8%.

Chi-square analysis demonstrated no statistically significant association between renal cyst presence and age (X^2=82.100, P=0.075) or flank pain (X^2=1.975, P=0.235). However, a significant association was found between renal cysts and gender (X^2=4.482, P=0.034), diabetes mellitus (X^2=7.158, P=0.007), hypertension (X^2=19.938, P=0.000), history of renal stones (X^2=8.967, P=0.003), and hematuria (X^2=6.442, P=0.011). Hypertension emerged as the most prevalent risk factor. Binary logistic regression analysis revealed that diabetic participants had 2.5 times higher odds of developing renal cysts, and hypertensive participants had 2.9 times greater odds. A history of renal stones and hematuria were also significantly associated with renal cyst development.

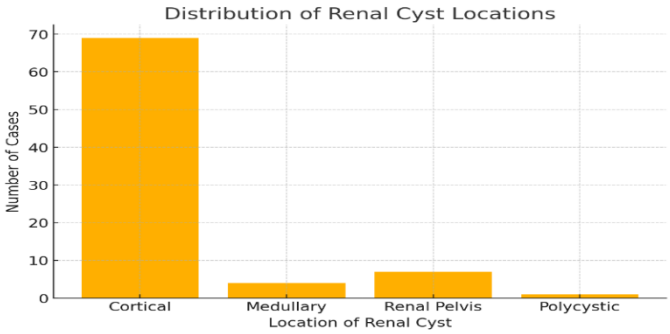


Figure 2 Distribution of Renal Cyst Locations

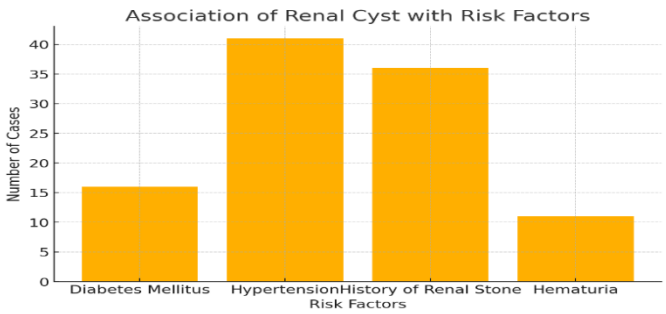


Figure 1 Association of Renal Cyst with Risk Factor

Table 1: Characteristic of participants

Sr.NO	Variables		Frequency (F)	Percentage (%)
1	Gender	Male	158	45.9
		Female	186	54
2	Flank pain	Yes	306	89
		No	38	11
3	Diabetic mellitus	Yes	39	11.3
		No	305	88.7
4	Hypertension	Yes	107	31.1
		No	237	68.9
5	History of renal stone	Yes	200	58.1
		No	144	41.9
6	Hematuria	Yes	82	23.8
		No	266	76.2

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Table 2: Ultrasound Parameters

1	**Kidney size**	**Small**	**10**	**2.9**
		Normal	319	92.7
		Enlarge	15	4.4
2	**Renal cyst**	YES	82	23.8
		NO	262	76.2
3	**Site of cyst**	Right kidney	28	34
		Left kidney	42	52
		Bilateral kidney	12	14
4	**Location of cyst**	Cortical	69	84
		Medullary	4	4.8
		Renal pelvis	7	8.5
		Polycystic	1	1.2
5	**Number of cysts**	Single	53	64.6
		Double	7	8.5
		Multiple	21	25.6
6	**Type of Cyst**	Simple	73	89
		Complex	4	4.8
		Other type	4	4.8

Table 3: Risk Factors of Renal Cysts

S.NO	**variable**		**Renal cyst(n=82)**	**X^2**	**P**
1	Gender of participants	Female	36 (43.9%)	4.482	0.034
		male	46(56%)		
2	Flank pain	yes	70 (85.3%)	1.41	0.235
		No	12 (14.6%)		
3	Diabetes mellitus	Yes	16 (19.5%)	7.158	0.007
		No	66 (80.5%)		
4	Hypertension	yes	41 (50%)	19.938	0
		No	41 (50%)		
5	History of renal stone	Yes	36 (43.9%)	8.967	0.003
		No	46 (56%)		
6	Hematuria	Yes	11 (13.4%)	6.442	0.011
		No	71 (86.6%)		

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Table 4: Binary Logistic Regression Analysis

S.NO	Variable		Renal cyst	Odds ratio (OR)	P
			F (%)		
1	Diabetes mellitus	Yes	16 (19.5%)	2.519	0.007
		No	66 (80.5%)		
2	Hypertension	Yes	41 (50%)	2.969697	0
		No	41 (50%)		
3	History of renal stone	Yes	36 (43.9%)	0.468	0.003
		No	46 (56%)		
4	Hematuria	Yes	11 (13.4%)	0.417	0.011

DISCUSSION

Renal cysts are frequently detected as incidental findings during routine ultrasound examinations, making early detection and appropriate management crucial in preventing potential complications, particularly in high-risk populations (13). The prevalence of renal cysts varies across different studies, with ultrasound-based estimations ranging from 5.0% to 20.8% in the general population (11). The current study identified a prevalence of 23.8%, suggesting a relatively higher incidence within the studied population. Age has been suggested as a contributing factor in renal cyst development, with some studies reporting a higher prevalence among older adults, particularly those aged 60 to 80 years (14). However, findings from this study did not establish a statistically significant association between age and renal cyst prevalence, suggesting that cyst development is not necessarily age-dependent. The role of gender remains debated, with some studies indicating a higher prevalence in males, while others report a greater incidence in females (3,9). The current study observed a significantly higher proportion of renal cysts among females (X^2=4.482, P=0.034), further reinforcing the need for additional research to clarify gender-specific risk factors.

Symptomatology remains a key aspect of renal cyst evaluation, with flank pain commonly reported among affected individuals. Some literature suggests that up to 59% of individuals with renal cysts are asymptomatic, while those with symptoms frequently present with flank pain (15). However, the findings of this study demonstrated that flank pain was not significantly associated with renal cyst presence (X^2=1.975, P=0.235), indicating that renal cysts may not always be the primary cause of reported discomfort. Several metabolic and systemic factors have been implicated in renal cyst development, with diabetes mellitus being a notable risk factor. Previous research has highlighted a strong association between renal cysts and type 2 diabetes, aligning with the findings of this study, where diabetes mellitus was significantly linked to renal cyst presence (X^2=7.158, P=0.007, OR=2.519). Hypertension is another well-documented risk factor, with pathophysiological mechanisms suggesting that large renal cysts may compress renal arteries, activating the renin-angiotensin system and contributing to increased blood pressure (16). This study identified hypertension as the most significant risk factor (X^2=19.938, P=0.000, OR=2.969), reinforcing its role in cyst development and progression. Renal stone disease has also been associated with cystic kidney conditions, particularly in the context of polycystic kidney disease, where nephrolithiasis prevalence has been reported to be nearly twice as high as in the general population (17). Findings from this study support this association, as individuals with a history of renal stones were at significantly increased risk of developing renal cysts (X^2=8.967, P=0.003). Similarly, hematuria was also found to be significantly associated with renal cysts (X^2=6.442, P=0.011, OR=0.417), suggesting that cyst-related structural changes may contribute to urinary abnormalities. The role of kidney size in renal cyst development remains an area of ongoing investigation. Some studies have indicated a potential reduction in kidney size in individuals with renal cysts; however, findings from this study did not establish a statistically significant association (X^2=2.344, P=0.310) (18). Further research is needed to determine whether cyst characteristics, such as size and number, influence overall kidney morphology.

The majority of renal cysts detected in this study were simple cysts (89%), in agreement with existing literature that identifies simple renal cysts as the most common type of renal cystic disease in adults (19). The distribution of cysts varied, with the left kidney being

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more commonly affected (52%) compared to the right kidney (34%), and 14% of cases presenting with bilateral cysts. Cortical cysts were the most frequent (84%), while medullary (4.8%), renal pelvis (8.5%), and polycystic (1.2%) cysts were less common (20). A solitary cyst was observed in 64.6% of cases, while 8.5% had double cysts, and 25.6% had multiple cysts. Renal cysts, though often incidental, can lead to significant clinical consequences, including chronic kidney disease and end-stage renal failure. Early detection is essential in preventing complications and optimizing patient outcomes. Public awareness initiatives, such as seminars and workshops, should be implemented to educate individuals on the potential risks associated with renal cysts, particularly among those with predisposing conditions like hypertension and diabetes (15). Advancements in imaging techniques should be leveraged to improve the accuracy of renal cyst diagnosis, ensuring that cysts with malignant potential are identified early (4,17). Future research should focus on elucidating the underlying mechanisms linking renal cyst development to gender, metabolic disorders, and progressive renal dysfunction to enhance targeted preventive and therapeutic strategies.

CONCLUSION

Simple renal cysts emerged as the most common type, predominantly originating from the renal cortex, with single cysts being more prevalent than multiple cysts. The study highlighted a higher occurrence of renal cysts in females compared to males, with gender, hypertension, and diabetes identified as significant risk factors. Hematuria was frequently observed among affected individuals, underscoring its potential role as a clinical indicator. Ultrasound proved to be an essential tool in evaluating and classifying renal cysts, aiding in diagnosis, treatment planning, and long-term monitoring. Early detection remains crucial in preventing serious complications, including chronic kidney disease and renal failure, emphasizing the need for heightened awareness and proactive management strategies in at-risk populations.

AUTHOR CONTRIBUTIONS

Author	Contribution
Sara Kamal	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Rabia Jehangir	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Maryum Yaqoob	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Hira Tariq	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hafsa Quddos	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Bashir Ullah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Rizwan Ullah*	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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