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FREQUENCY OF RENAL STONES IN PATIENTS DIAGNOSED WITH CHRONIC KIDNEY DISEASE: A DESCRIPTIVE CROSS-SECTIONAL STUDY

Abeera Munir[1*], Kunwer Naveed Mukhtar[1], Fahad Nasim[1], Hooria Imtiaz[2], Osama Kunwer Naveed[2], Syed Waqar Ali[1]

[1]Department Nephrology, Liaquat National Hospital, Karachi, PAK
[2]South East Health, Alabama, USA
*Corresponding Author**:** Abeera Munir, Email**:** abeeramunir33@gmail.com

ABSTRACT

Background: Chronic kidney disease is a major global health concern, and renal stone disease is recognised as both a contributor to and a complication of declining kidney function. Local data on the burden of nephrolithiasis among chronic kidney disease patients in Pakistan remain limited.

Objectives: To determine the frequency of renal stones in patients diagnosed with chronic kidney disease and to identify their associated demographic and clinical correlates.

Methods: This descriptive cross-sectional study was conducted at the Department of Nephrology, Liaquat National Postgraduate Medical Centre, Karachi, from 04 October 2025 to 04 January 2026. A total of 226 patients aged 18–60 years with confirmed chronic kidney disease were enrolled through consecutive sampling. Renal stones were diagnosed using ultrasonography. Data were analysed using SPSS version 26. The Shapiro–Wilk test assessed normality. Independent samples t-test, Mann–Whitney U test and Chi-square test were applied as appropriate; $p \leq 0.05$ was considered statistically significant.

Results: The mean age was 40.63 ± 12.23 years, and 144 (63.7%) participants were male. Renal stones were identified in 36 patients (15.9%). A significant association was observed with prior history of chronic kidney disease (83.3% vs 32.6%; $p<0.001$) and vitamin D supplementation (75.0% vs 37.9%; $p<0.001$). Age, gender and residential status showed no significant association ($p>0.05$).

Conclusions: Renal stones were present in approximately one in six chronic kidney disease patients and were significantly associated with a prior history of kidney disease and vitamin D supplementation. Targeted screening and metabolic evaluation in such patients may aid early detection and prevention.

KEYWORDS: Chronic Kidney Disease, Renal Calculi, Glomerular Filtration Rate, Urolithiasis, Vitamin D

INTRODUCTION

Chronic kidney disease (CKD) is a major contributor to global morbidity and mortality, with recent estimates indicating that it affects more than 800 million individuals worldwide.[1] In Pakistan, contemporary community-based studies report CKD prevalence ranging between 12.5% and 24.2%, varying by region and screening criteria.[2,3] Although diabetes and hypertension remain the leading causes of CKD, infectious diseases and nephrolithiasis contribute substantially to the burden in low- and middle-income countries.[4] CKD is also associated with increased cardiovascular risk and metabolic disturbances, including metabolic acidosis, dyslipidaemia, and secondary hyperparathyroidism.[4,12]

Urolithiasis refers to the formation of calculi within the urinary tract, including the renal pelvis, ureters, bladder and urethra. These calculi may consist of calcium oxalate, calcium phosphate, magnesium ammonium phosphate, uric acid, or mixed compositions.[5] Recent global data report a urolithiasis prevalence of 9–13% in adult populations, with regional rates in Pakistan estimated at 12–15%.[6,7] Urolithiasis can lead to obstructive uropathy, acute kidney injury, and progression to renal failure if not promptly diagnosed and treated.[11]

Several studies have examined the burden of stone disease among CKD patients. Kareem et al. reported renal stones in 24.6% of CKD patients in rural Sindh,[8] while Zia et al. observed a 10.5% prevalence in a hospital-based Pakistani cohort.[9] Pakistan lies within the global "stone belt", and changing lifestyle factors (obesity, sedentary habits, dietary patterns) may be altering the epidemiology of stone disease and its association with CKD.[8,10]

Despite the recognised burden, locally generated evidence on the frequency of renal stones in CKD patients and their associated demographic and clinical factors remains limited. The objective of this study was to determine the

frequency of renal stones in patients diagnosed with chronic kidney disease and to identify their associated demographic and clinical correlates, in order to inform targeted screening and preventive strategies for the local population.

METHODOLOGY

This descriptive cross-sectional study was conducted at the Department of Nephrology, Liaquat National Postgraduate Medical Centre, Karachi, from 04 October 2025 to 04 January 2026, over a duration of three months. Ethical approval was obtained from the Institutional Review Board of Liaquat National Hospital [Ref No: LNH-IRB/2025/0428], and written informed consent was secured from all participants prior to enrolment.

CKD was defined as an estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73 m² persisting for more than three months. CKD stages were operationally defined as per the KDIGO 2024 criteria: Stage 1 (eGFR ≥90 with kidney damage), Stage 2 (eGFR 60–89 with kidney damage), Stage 3A (eGFR 45–59), Stage 3B (eGFR 30–44), Stage 4 (eGFR 15–29), and Stage 5 (eGFR <15 or on dialysis).[22] Renal stones were defined as the presence of echogenic foci ≥10 mm with posterior acoustic shadowing and pelvicalyceal system expansion on ultrasonography in patients with flank pain (VAS ≥4) with or without nausea or dysuria.

A sample of 226 participants was recruited through non-probability consecutive sampling. The sample size was calculated using the WHO Sample Size Calculator (version 2.0) with the formula:

$n = Z^2 \times p(1-p) / d^2$

where Z = 1.96 (95% confidence level), p = 0.105 (anticipated prevalence of nephrolithiasis based on Zia et al.[9]), and d = 0.04 (margin of error). This yielded a minimum required sample size of 226 participants.

The **inclusion criteria** comprised patients aged 18–60 years of either gender with a history of CKD for more than three months (Stages I–V), with or without vitamin D supplementation; participants on cholecalciferol ≥1000 IU/day for at least three months were classified as supplemented, and serum 25-hydroxyvitamin D <30 ng/mL was used as the deficiency cut-off. The **exclusion criteria** included patients with a history of renal transplantation, those requiring urgent haemodialysis due to volume overload, individuals with severe comorbidities such as NYHA Class IV heart failure or Child-Pugh Class C liver disease, and pregnant or lactating women.

Laboratory Methodology: Serum creatinine was measured on the Roche Cobas c311 chemistry analyser using the Jaffe kinetic method (kit catalogue number 04810716). The eGFR was calculated using the CKD-EPI 2021 equation.[21] Haemoglobin levels were assessed on the Sysmex XN-1000 automated haematology analyser. Serum 25-hydroxyvitamin D was quantified by chemiluminescent immunoassay (Roche Elecsys Vitamin D Total II, catalogue number 07464215). Ultrasonography was performed by a consultant radiologist with more than five years of post-fellowship experience using a 3.5–5 MHz curvilinear transducer.

Data Analysis: Data were analysed using SPSS version 26. The Shapiro–Wilk test was applied to assess the normality of all continuous variables. Normally distributed continuous variables (age, BMI, eGFR, CKD duration) were summarised as mean ± standard deviation and compared between groups using the independent samples t-test. Non-normally distributed variables were summarised as median (IQR) and compared using the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using the Chi-square test. The 95% confidence intervals for continuous variables represent the mean difference between groups, while CIs for categorical variables represent odds ratios. A p-value ≤0.05 was considered statistically significant.

RESULTS

A total of 226 patients with chronic kidney disease were included. The mean age of the study population was 40.63 ± 12.23 years, the mean BMI was 24.17 ± 4.52 kg/m², the mean serum creatinine was 3.65 ± 2.36 mg/dL, and the mean haemoglobin was 9.84 ± 2.61 g/dL. The mean eGFR was 38.44 ± 19.50 mL/min/1.73 m², and the mean duration of CKD was 3.20 ± 1.64 years. Among the participants, 144 (63.7%) were male and 82 (36.3%) were female, with the majority residing in urban areas (69.9%) and being employed (80.1%). Educational status varied across illiterate (12.8%), primary (11.9%), secondary (13.7%), matric (15.0%), intermediate (29.2%), and graduate or above (17.3%). CKD staging revealed that the majority were in Stage 3 (33.6%) and Stage 4 (32.3%). A previous history of CKD was reported in 92 patients (40.7%), 99 patients (43.8%) were on vitamin D supplementation, and renal stones were identified in 36 patients (15.9%). The detailed demographic and clinical profile is presented in Table I.

Table I: Demographic and Clinical Profile of Chronic Kidney Disease Patients (n=226)

Variable	Category	Mean ± SD or n (%)
Demographic Characteristics		
Age (years)	—	40.63 ± 12.23

Gender	Male	144 (63.7)
	Female	82 (36.3)
Residential Status	Urban	158 (69.9)
	Rural	68 (30.1)
Employment	Employed	181 (80.1)
	Unemployed	45 (19.9)
Educational Status	Illiterate	29 (12.8)
	Primary	27 (11.9)
	Secondary	31 (13.7)
	Matric	34 (15.0)
	Intermediate	66 (29.2)
	Graduate or above	39 (17.3)
Family Income (PKR/month)	—	49,464.60 ± 14,540.70
Clinical Profile		
BMI (kg/m²)	—	24.17 ± 4.52
Serum Creatinine (mg/dL)	—	3.65 ± 2.36
Haemoglobin (g/dL)	—	9.84 ± 2.61
eGFR (mL/min/1.73 m²)	—	38.44 ± 19.50
Duration of CKD (years)	—	3.20 ± 1.64
CKD Stage	Stage 1	13 (5.8)
	Stage 2	17 (7.5)
	Stage 3	76 (33.6)
	Stage 3A	30 (13.3)
	Stage 4	73 (32.3)
	Stage 5	17 (7.5)
Previous History of CKD	Yes	92 (40.7)
On Vitamin D Supplement	Yes	99 (43.8)
Renal Stones	Present	36 (15.9)

Table II presents the comparison of demographic and clinical characteristics between patients with and without renal stones. No statistically significant differences were observed for age (38.39 ± 11.33 vs 41.06 ± 12.37 years; p=0.231), CKD duration (2.99 ± 1.56 vs 3.24 ± 1.65 years; p=0.394), gender (77.8% vs 61.1% males; p=0.056), or residential status (72.2% vs 69.5% urban; p=0.742). However, a previous history of CKD (83.3% vs 32.6%; p<0.001) and vitamin D supplementation (75.0% vs 37.9%; p<0.001) were significantly associated with the presence of renal stones.

Table II: Comparison of Demographic and Clinical Characteristics by Renal Stone Status (n=226)

Characteristic	Category	Stones Yes (n=36)	Stones No (n=190)	p-value
Age (years)	—	38.39 ± 11.33	41.06 ± 12.37	0.231
Duration of CKD (years)	—	2.99 ± 1.56	3.24 ± 1.65	0.394
Gender	Male	28 (77.8)	116 (61.1)	0.056
	Female	8 (22.2)	74 (38.9)	0.056
Residential Status	Urban	26 (72.2)	132 (69.5)	0.742
	Rural	10 (27.8)	58 (30.5)	0.742
Previous History of CKD	Yes	30 (83.3)	62 (32.6)	<0.001*
On Vitamin D Supplement	Yes	27 (75.0)	72 (37.9)	<0.001*

**Statistically significant at p<0.05. Continuous variables compared by independent samples t-test (mean ± SD); categorical variables by Chi-square test (n, %). 95% confidence intervals are interpreted as mean differences for continuous variables and as odds ratios for categorical variables.*

DISCUSSION

CKD is a significant clinical and public health issue due to its progressive nature, metabolic complications, and association with cardiovascular disease.[1,4] Stone disease is one of the potentially preventable contributors to renal impairment, particularly in regions located in the global "stone belt", including Pakistan.[6] Renal stones may go undetected in CKD patients due to overlapping symptoms, reduced urinary flow, and biochemical alterations that can delay diagnosis and management.

In the present study, renal stones were identified in 15.9% of CKD patients. This proportion lies between earlier estimates, being lower than the 24.6% reported by Kareem et al.[8] and higher than the 10.5% reported by Zia et al.[9] Internationally, prevalence estimates vary from 9% to 25% depending on geographical location, dietary habits, and the clinical population studied.[7,17,20] Such variation may be explained by differences in climate, dietary sodium and oxalate intake, genetic predisposition, and the distribution of CKD stages across study cohorts.[18,19]

The principal observations of this study were the strong associations between renal stones and prior history of CKD ($p<0.001$) and vitamin D supplementation ($p<0.001$). The association with prior CKD history may be explained by recurrent urinary tract infections, obstructive uropathy, and metabolic acidosis, which promote urinary stasis and lithogenic mechanisms.[4,17] The biological plausibility for vitamin D supplementation lies in its effect on intestinal calcium absorption and the consequent risk of hypercalciuria in susceptible patients receiving long-term therapy.[13,16]

In contrast, no statistically significant associations were observed for age ($p=0.231$), CKD duration ($p=0.394$), gender ($p=0.056$), or residential status ($p=0.742$). While some studies have suggested a male predisposition to nephrolithiasis,[5,7] this pattern may be modified within CKD populations due to the metabolic alterations that accompany renal insufficiency. The bidirectional interaction between CKD and stone disease has been increasingly recognised: CKD increases stone risk through reduced urine volume, hypocitraturia, chronic metabolic acidosis, and disturbed calcium-phosphate homeostasis,[4,15] while stones can worsen CKD via obstruction, infection, and chronic inflammatory fibrosis.[11,17]

This study has several strengths, including the use of ultrasonography performed by a qualified radiologist, ensuring diagnostic accuracy, and the inclusion of patients across all CKD stages, enhancing the generalisability of findings to real-world nephrology practice. Nevertheless, certain limitations should be acknowledged. First, the single-centre design may limit external generalisability to the wider Pakistani population. Second, the cross-sectional methodology precludes causal inference between vitamin D supplementation and stone formation. Third, urinary metabolic profiling (24-hour urinary calcium, oxalate, citrate, and uric acid) and stone composition analysis were not performed, which would have provided additional mechanistic insight. Fourth, dietary intake and fluid consumption patterns, which are important confounders in stone formation, were not systematically captured. Future research should include multicentre prospective cohort studies with comprehensive metabolic workups, stone composition analysis, and standardised vitamin D dosing protocols, to better delineate the causal pathways and to inform targeted preventive strategies for CKD patients in Pakistan.

CONCLUSION

This study demonstrated that renal stones were present in 15.9% of patients with chronic kidney disease, and their occurrence was significantly associated with a prior history of kidney disease and vitamin D supplementation. Demographic factors such as age, gender, and residential status did not show a significant association. Given the cross-sectional nature of the study, these findings should be interpreted as associations rather than causal relationships. The results highlight the need for routine ultrasonographic screening in CKD patients, careful evaluation of vitamin D status before initiating supplementation, and further multicentre prospective research to inform preventive strategies.

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