Original Article www.pjkd.com.pk

Association of Metabolic Diseases with Renal Stones among Patients with Chronic Kidney Disease and Non-Chronic Kidney Disease

Gohar Rehman, Shoukat Memon, Faiza Saeed, Ashar Alam, Javeria Chughtai, Salman Imtiaz.

Department of Nephrology, The Indus Hospital and Health Network, Karachi, Pakistan

Abstract

Objective: To determine the association between metabolic disease and renal stones in patients with and without chronic kidney disease.

Introduction: Significant associations have been observed between obesity, diabetes mellitus, hyperlipidemia, and renal stone formation. This association is highlighted by shared risk factors such as insulin resistance and dyslipidemia. Its specific impact on patients who progress to chronic kidney disease (CKD) remains under-explored. Recognizing this interplay is vital for comprehensive management and prevention strategies for renal stones in both CKD and non-CKD patients.

Methods: This cross-sectional prospective study was conducted over 178 adult patients of both genders visiting Nephrology CKD-Stone disease OPD at The Indus Hospital, Karachi July 10, 2023 to January 9, 2024. After taking the informed consent, Patients were categorized into two groups i.e. renal stone with reduced glomerular filtration rate (GFR) renal stone with normal GFR. Metabolic disease screening was conducted for all patients. Data was recorded in the provided proforma and used electronically for research.

Results: The mean age of kidney stone with reduced and normal GFR were as 49.64 ± 14.41 and 39.33 ± 14.24 years. Male and female were 74.2% and 25.8% in former and 57.3% and 42.7% later group. Metabolic disease was found 21.9% in former and 69.5% in later group with statistically significant difference -p value of <0.001 (95% CI: 0.062 – 0.246)

Conclusion: An inverse association between metabolic disease and renal stone occurrence was observed in the study population. However, these findings differed from previously published literature and should therefore be interpreted cautiously. Further large-scale studies are needed to better clarify this relationship.

Keywords: Association, Chronic Kidney Disease, Metabolic Disease, Renal Stones

Corresponding Author:
Dr. Shoukat Memon
Department of Nephrology
The Indus Hospital and Health Network, Karachi, Pakistan
Email: shoukat.memon@tih.org.pk

DOI: https://doi.org/10.53778/pjkd101354
Received 26 May 2026 and accepted 30 June 2026 PJKD 2026;10(2):29-33

Introduction:

Kidney stone disease (KSD) is a common and increasingly prevalent health problem worldwide, resulting in a substantial clinical and economic burden. Studies have shown a rising incidence and prevalence of kidney stones globally, with a lifetime risk approaching 10% in some populations.[1-3] Renal stones can lead to significant complications such as ureteral obstruction, recurrent urinary tract infections, and severe consequences including septic shock. Furthermore, stone disease has been recognized as a potential contributor to chronic kidney disease (CKD) progression.[4] The pathogenesis of nephrolithiasis is multifactorial and involves complex interactions among genetic, environmental, dietary, and metabolic factors.[5]

Metabolic abnormalities have increasingly been recognized as important contributors to stone formation. Obesity and increased body mass index (BMI) are associated with a higher risk of nephrolithiasis due to increased adipose tissue and inflammatory mediators contributing to metabolic syndrome.[6-8] Diabetes mellitus (DM), particularly type 2 DM, has also been associated with an increased risk of kidney stones, especially uric acid stones, because of metabolic alterations affecting urinary composition.[9] Hypertension has demonstrated a bidirectional relationship with kidney stone disease, with hypertensive individuals having a greater risk of stone formation and stone formers being more likely to develop hypertension.[10] Dyslipidemia has also emerged as a potential independent risk factor for nephrolithiasis.[11,12]

Despite the established association between metabolic abnormalities and nephrolithiasis, limited data are available regarding the relationship of metabolic disease in renal stone patients with and without CKD, particularly in local populations. Therefore, this study aims to determine the association of metabolic disease with renal stones in patients with and without CKD.

Methods:

Study Design:

Comparative cross-sectional study.

Data Collection:The study was conducted after obtaining approval from the Research Department of the College of Physicians and Surgeons Pakistan (CPSP) and the Institutional Ethical Review Committee **IHHN-IRB #**IHHN_IRB_2024_08_002, Dated 12 Aug, 2024.. All patients presenting with renal stones in the outpatient department and fulfilling the inclusion criteria were enrolled in the study. After obtaining informed consent, baseline demographic and clinical information was recorded on a predesigned proforma. Patients were screened for chronic kidney disease and categorized into two groups: renal stone patients with reduced GFR (CKD group) and renal stone patients with normal GFR (non-CKD group). All patients were further screened for metabolic diseases according to predefined operational criteria. Baseline variables including age, gender, residential status, height, weight, body mass index (BMI), stone size, number of stones, stone laterality, duration of renal stone disease, and metabolic diseases were recorded.

Data Analysis: Data were entered and analyzed using SPSS version 26. Continuous variables were assessed for normality using the Shapiro – Wilk test. Quantitative variables were summarized using appropriate descriptive statistics and are presented as mean ± standard deviation (SD) or median with interquartile range (IQR) where appropriate. Categorical variables were summarized as frequencies and percentages. Associations between metabolic diseases and renal stone status were assessed using the Chi-square test or Fisher' s exact test where appropriate. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Stratified analyses according to age and stone size were also performed. A two-sided P-value ≤0.05 was considered statistically significant.

Results:

A total of 178 patients with renal stones were enrolled and divided into two groups: Group I (renal stone patients with chronic kidney disease; n=89) and Group II (renal stone patients without chronic kidney disease; n=89). Baseline demographic and clinical characteristics of the study population are presented

in Table 1. Stratified analyses evaluating the association between metabolic disease and renal stone status according to age and stone size are shown in Tables 2 and 3.

Table 1: Demographic and Clinical Characteristics of 178 patients with kidney stone disease.

Characteristics	Kidney Stone with Reduced GFR (n=89)	Kidney Stone with Normal GFR (n=89)
Gender, n (%)		
Male	66 (74.2%)	51 (57.3%)
Female	23 (25.8%)	38 (42.7%)
Residential Status, n (%)		
Urban	48 (53.9%)	52 (58.4%)
Rural	41 (46.1%)	37 (41.6%)
Stone Location, n (%)		
Right	41 (46.1%)	49 (55.1%)
Left	48 (53.9%)	40 (44.9%)
Family History of Renal Disease, n (%)		
Yes	16 (18.0%)	10 (11.2%)
No	73 (82.0%)	79 (88.8%)
Duration of Renal Stone (months), Median (IQR)	13.0 (25)	11.0 (20)

Table.2 Stratification of Metabolic Disease by Age Group among 178 patients with kidney stone disease.

Age Group (Years)	Metabolic Disease	Kidney Stone with Reduced GFR n (%)	Kidney Stone with Normal GFR n (%)	Odds Ratio (95% CI)	P-value
18–40 (n=77)	Yes	6 (17.1)	17 (40.5)	0.304 (0.104–0.890)	0.026
	No	29 (82.9)	25 (59.5)		
>40 (n=101)	Yes	10 (26.3)	56 (88.9)	0.045 (0.015–0.130)	<0.001
	No	28 (73.7)	7 (11.1)		

Table.3 Stratification of metabolic disease by stone size among 178 patients with kidney stone disease.

Stone Size (mm)	Metabolic Disease	Kidney Stone with Reduced GFR n (%)	Kidney Stone with Normal GFR n (%)	Odds Ratio (95% CI)	P-Value
2 – 14	Yes	5 (11.1)	41 (64.1)	0.07	< 0.001

(n=109)	No	40 (88.9)	23 (35.9)	(0.024– 0.203)	
> 14 (n=69)	Yes	11 (39.3)	32 (78.0)	0.182	<0.001
	No	17 (60.7)	9 (22.0)	(0.063– 0.525)	

Discussion:

Evidence is accumulating regarding the contribution of metabolic diseases such as dyslipidemia, diabetes mellitus, and hypertension to nephrolithiasis. The underlying mechanisms involve shared pathophysiological pathways including insulin resistance, altered urinary composition, systemic inflammation, and crystal formation.[13 – 16] In patients with chronic kidney disease (CKD), these metabolic disturbances may be further aggravated by impaired renal function and altered mineral metabolism, creating a complex interaction that may predispose to stone formation.[17,18] Among individuals with no CKD (normal GFR), obesity and metabolic syndrome are recognized risk factors for nephrolithiasis through mechanisms involving urinary abnormalities and insulin resistance.[7,16] Diabetes mellitus, particularly type 2 diabetes, contributes to nephrolithiasis through mechanisms such as hypercalciuria, glycosuria, and acidic urinary pH.[9] Dyslipidemia has also been implicated in renal stone formation through its influence on urinary calcium excretion and crystal aggregation.[11,12] Furthermore, metabolic syndrome itself has been proposed as an important contributor to both nephrolithiasis and renal dysfunction.[16,17]

In the present study, the mean age was 49.64 ± 14.41 years in the reduced GFR group (CKD) and 39.33 ± 14.24 years in the normal GFR (No- CKD) group. Males predominated in both groups, accounting for 74.2% and 57.3%, respectively. Metabolic disease was identified in 21.9% of patients in the reduced GFR and 69.5% of patients in the normal GFR group, demonstrating a statistically significant inverse association (OR=0.123; 95% CI: 0.062 – 0.246, p<0.001). Although previous studies have generally reported a positive association between metabolic diseases and nephrolithiasis, the present study demonstrated an inverse relationship that differed from earlier findings. Furthermore, findings from our preliminary pilot study involving 40 participants (20 in each group) demonstrated a higher prevalence of metabolic disease among renal stone patients with CKD (75%) compared with renal stone patients with normal GFR (55%), which was also not entirely consistent with the findings of the present study. These discrepancies may be attributable to differences in sample size, study population characteristics, selection bias, or variations in the distribution of metabolic risk factors. Previous studies have reported an increased risk of nephrolithiasis among diabetic patients, with relative risks ranging from 1.31 – 1.67.[9] Dyslipidemia has similarly been associated with an increased risk of stone formation, with a reported hazard ratio of 2.2.[12]

The findings of the present study highlight the importance of identifying and addressing metabolic risk factors in renal stone patients with and without CKD. Lifestyle modifications, dietary interventions, weight management, and optimization of metabolic abnormalities may contribute to reducing stone recurrence and improving renal outcomes.[17,19] Further multicenter studies with larger sample sizes are

needed to clarify the relationship and underlying mechanisms between metabolic diseases and nephrolithiasis.

Conclusion:

The study demonstrated an inverse association between metabolic disease and renal stone occurrence in the study population. However, since these findings are not entirely consistent with previously published literature, the results should be interpreted cautiously, and further studies are needed to validate and better understand this relationship.

Conflict of interest: none declared

References

1. Raheem OA, Khandwala YS, Sur RL, Ghani KR, Denstedt JD. Burden of urolithiasis: trends in prevalence, treatments, and costs. Eur Urol Focus. 2017;3(1):18 – 26.
2. Huang WY, Chen YF, Carter S, Chang HC, Lan CF, Huang KH. Epidemiology of upper urinary tract stone disease in a Taiwanese population: a nationwide, population-based study. J Urol. 2013;189(6):2158 – 2163.
3. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol. 2010;12(2 – 3):e86 – e96.
4. Rule AD, Bergstralh EJ, Melton LJ III, Li X, Weaver AL, Lieske JC. Kidney stones and the risk for chronic kidney disease. Clin J Am Soc Nephrol. 2009;4(4):804 – 811.
5. Ziemba JB, Matlaga BR. Epidemiology and economics of nephrolithiasis. Investig Clin Urol. 2017;58(5):299 – 306.
6. Després JP, Lemieux I, Bergeron J, Pibarot P, Mathieu P, Larose E, et al. Abdominal obesity and the metabolic syndrome: contribution to global cardiometabolic risk. Arterioscler Thromb Vasc Biol. 2008;28(6):1039 – 1049.
7. Taylor EN, Stampfer MJ, Curhan GC. Obesity, weight gain, and the risk of kidney stones. JAMA. 2005;293(4):455 – 462.
8. Inci M, Demirtas A, Sarli B, Akinsal E, Baydilli N. Association between body mass index, lipid profiles, and types of urinary stones. Ren Fail. 2012;34(9):1140 – 1143.
9. Taylor EN, Stampfer MJ, Curhan GC. Diabetes mellitus and the risk of nephrolithiasis. Kidney Int. 2005;68(3):1230 – 1235.
10. Kittanamongkolchai W, Mara KC, Mehta RA, Vaughan LE, Denic A, Knoedler JJ, et al. Risk of hypertension among first-time symptomatic kidney stone formers. Clin J Am Soc Nephrol. 2017;12(3):476 – 482.
11. Torricelli FC, De SK, Gebreselassie S, Li I, Sarkissian C, Monga M. Dyslipidemia and kidney stone risk. J Urol. 2014;191(3):667 – 672.
12. Masterson JH, Woo JR, Chang DC, Chi T, L'Esperance JO, Stoller ML, et al. Dyslipidemia is associated with an increased risk of nephrolithiasis. Urolithiasis. 2015;43(1):49 – 53.
13. Shoag J, Halpern J, Goldfarb DS, Eisner BH. Risk of chronic and end stage kidney disease in patients with nephrolithiasis. J Urol. 2014;192(5):1440 – 1445.
14. Chou YH, Li CC, Hsu H, Chang WC, Liu CC, Li WM, et al. Renal function in patients with urinary stones of varying compositions. Kaohsiung J Med Sci. 2011;27(7):264 – 267.
15. Ahmed MH, Barakat S, Almobarak AO. The association between renal stone disease and cholesterol gallstones: the easy to believe and not hard to retrieve theory of the metabolic syndrome. Ren Fail. 2014;36(6):957 – 962.
16. Hess B. Metabolic syndrome, obesity and kidney stones. Arab J Urol. 2012;10(3):258 – 264.
17. Scurt FG, Ganz MJ, Herzog C, Bose K, Mertens PR, Chatzikyrkou C. Association of metabolic syndrome and chronic kidney disease. Obes Rev. 2024;25(1):e13649.
18. Muntner P. Longitudinal measurements of renal function. Semin Nephrol. 2009;29(6):650 – 657.
19. Yuan C, Jin X, He Y, Liu Y, Xiang L, Wang K. Association of dietary patterns with gut microbiota in kidney stone and non-kidney stone individuals. Urolithiasis. 2022;50(4):389 – 399.