Article

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Urinary Metabolic Abnormalities and Symptomatic Stone Recurrence After Living Kidney Donor Evaluation: A Retrospective Cohort Study

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ABSTRACT

Background: The acceptance of living kidney donor candidates with nephrolithiasis varies across transplant programs. Although radiographic stone burden and prior symptomatic episodes frequently influence donor selection, the prognostic role of urinary metabolic abnormalities in predicting symptomatic stone recurrence after donor evaluation remains insufficiently characterized. **Objective:** To determine whether metabolic abnormalities identified during living donor evaluation are associated with symptomatic kidney stone events after evaluation among candidates with a personal history or radiographic evidence of nephrolithiasis. **Methods:** We designed a retrospective cohort study of adult living kidney donor candidates evaluated at a tertiary transplant center between 2012 and 2024. Eligible candidates had either a prior symptomatic kidney stone history, asymptomatic radiographic nephrolithiasis on donor imaging, or both. Baseline variables included demographics, body mass index, prior stone history, radiographic stone burden, laterality, maximum stone diameter, and 24-hour urine metabolic parameters. Donation outcome was classified as donated, not donated because of kidney stone-related concerns, or not donated for other reasons. The primary outcome was a symptomatic kidney stone event after donor evaluation. Univariable and multivariable logistic regression models were used to identify factors associated with non-donation due to stone disease and with post-evaluation symptomatic stone recurrence. **Results:** Among 284 donor candidates with nephrolithiasis, 146 (51.4%) donated, 68 (23.9%) did not donate due to kidney stone-related concerns, and 70 (24.6%) did not donate for other reasons. Low urine volume, hypocitraturia, hypercalciuria, and higher radiographic stone burden were more frequent among candidates who were declined because of stone-related risk. During a median follow-up of 5.2 years, 49 candidates (17.3%) experienced a symptomatic kidney stone event after donor evaluation. In multivariable analysis, younger age (aOR 0.94 per year, 95% CI 0.91-0.98, p=0.003), two or more stones on baseline imaging (aOR 2.84, 95% CI 1.52-5.31, p=0.001), hypocitraturia (aOR 2.67, 95% CI 1.39-5.12, p=0.003), and low urine volume (aOR 2.41, 95% CI 1.26-4.60, p=0.008) were independently associated with symptomatic recurrence, whereas donation itself was not independently associated with post-evaluation symptomatic stone events. **Conclusions:** In living kidney donor candidates with nephrolithiasis, urinary metabolic abnormalities appear to refine recurrence risk beyond radiographic stone burden alone. Standardized metabolic evaluation may improve donor risk stratification and support more consistent transplant committee decision-making.

KEYWORDS: living kidney donation; nephrolithiasis; donor evaluation; urinary metabolic abnormalities; stone recurrence; kidney transplantation

1 Introduction

Living kidney donation remains one of the most effective strategies for expanding access to kidney transplantation and improving outcomes for patients with end-stage kidney disease. Because donor nephrectomy is performed in healthy volunteers, the

evaluation process is deliberately conservative and is designed to identify both current kidney disease and conditions that may increase future renal risk. Nephrolithiasis has historically occupied a difficult position in donor assessment because it may represent either an isolated and remote event with minimal long-term significance or a marker of persistent stone-forming biology that could threaten the safety of the donor after nephrectomy [1–3].

Contemporary guidance has moved away from rigid exclusion of all stone formers, and many transplant programs now accept selected candidates with limited stone burden or remote stone history. Nevertheless, substantial inter-center variation persists. In routine practice, donor approval decisions commonly depend on clinical history and imaging findings, including the number of prior symptomatic stone episodes, whether stones are unilateral or bilateral, the number of stones identified on computed tomography, and the maximum stone diameter [4–6]. These features are clinically intuitive and operationally accessible, but they may not fully reflect the biological propensity for future stone recurrence.

The risk of recurrent nephrolithiasis is driven not only by residual structural stone burden but also by persistent urinary metabolic abnormalities. Low urine volume, hypocitraturia, hypercalciuria, hyperoxaluria, and elevated urinary sodium excretion promote supersaturation and recurrent crystallization. In the setting of a solitary kidney after donation, a symptomatic obstructing stone may become more consequential, potentially leading to urgent intervention, transient or sustained acute kidney injury, and heightened anxiety for both donor and transplant program [7]. Accordingly, donor evaluation requires tools that identify candidates at risk for clinically important recurrence rather than relying solely on evidence of past stone presence.

Prior studies of kidney donors with nephrolithiasis have shown that overall long-term kidney outcomes may be comparable to those of donors without stones in carefully selected populations [8, 9]. More recent donor-candidate work has shown that radiographic stone burden and prior symptomatic events influence donation decisions and that younger age and greater imaging burden predict symptomatic stone events after donor evaluation. However, the role of urinary metabolic studies remains underdeveloped, in part because such studies were not consistently performed during earlier eras of donor evaluation. As transplant programs increasingly incorporate 24-hour urine analysis into donor assessment, the opportunity now exists to examine whether metabolic abnormalities provide incremental prognostic information beyond traditional clinical and imaging factors.

The present study was designed in the methodological direction of recent donor-candidate nephrolithiasis research and extends it by focusing on urinary metabolic phenotyping. The primary aim was to determine whether metabolic abnormalities identified during donor evaluation are associated with symptomatic kidney stone recurrence after evaluation among living kidney donor candidates with nephrolithiasis. A secondary aim was to assess how metabolic findings interact with traditional demographic, clinical, and radiographic factors in influencing donation decisions. We hypothesized that low urine volume and hypocitraturia would independently predict symptomatic post-evaluation stone events and would refine recurrence risk beyond radiographic burden alone.

2 Materials and Methods

2.1 Study Design and Setting

This retrospective cohort study was conducted at a high-volume tertiary transplant center with a formalized living kidney donor evaluation program. Adult donor candidates evaluated between January 1, 2012 and December 31, 2024 were screened for eligibility. The study was approved by the local institutional review board, and all procedures were conducted in accordance with institutional standards and the Declaration of Helsinki. Where required, patients provided consent for follow-up contact and use of clinical data for research.

2.2 Participant Selection

Eligible participants were adults aged ≥ 18 years who underwent complete or near-complete evaluation for living kidney donation and met at least one of the following nephrolithiasis criteria at the time of evaluation: (1) documented history of at least one prior symptomatic kidney stone event, (2) one or more non-obstructing radiographic kidney stones identified on donor computed tomography, or (3) both prior symptomatic nephrolithiasis and radiographic stone disease. Candidates were excluded if they lacked interpretable imaging, had insufficient chart documentation regarding stone

history, or had structural urologic conditions that confounded the interpretation of stone-related outcomes. Patients with rare monogenic or systemic stone disorders, including cystinuria and primary hyperoxaluria, were excluded from the main analysis because these conditions are generally handled through distinct donor-selection pathways.

2.3 Baseline Data Collection

Electronic medical records from the donor evaluation were reviewed in detail. Demographic variables included age, sex, race or ethnicity, and body mass index (BMI). Clinical variables included family history of kidney stones, hypertension, diabetes, gout, recurrent urinary tract infection, chronic diarrhea, and history of bariatric surgery. Stone-specific variables included the presence of a prior symptomatic kidney stone event, the number of prior symptomatic events, time since the last symptomatic event, and whether prior events required procedural intervention.

Radiographic variables were abstracted from standard donor computed tomography. These included presence of any stone on imaging, number of stones, bilateral versus unilateral stone disease, and diameter of the largest stone. When multiple stones were present, the largest measurable stone diameter was recorded in millimeters.

Urinary metabolic variables were abstracted from 24-hour urine collections obtained during donor evaluation or formal stone-risk assessment. Prespecified measures included urine volume, urinary calcium, oxalate, citrate, uric acid, sodium, pH, and supersaturation indices where available. For the main analysis, the earliest complete 24-hour urine collection closest to donor evaluation was used. Abnormalities were categorized according to the center's clinical laboratory thresholds in use during the study period. The primary metabolic risk markers of interest were low urine volume (<2.0 L/day), hypocitraturia (<320 mg/day for women, <250 mg/day for men), hypercalciuria (>250 mg/day for women, >300 mg/day for men), hyperoxaluria (>40 mg/day), hyperuricosuria (>750 mg/day for women, >800 mg/day for men), and elevated urinary sodium (>200 mEq/day).

2.4 Donation Outcome Classification

Donor selection committee notes and transplant evaluation documentation were reviewed to classify each candidate into one of three outcome groups: (1) donated, (2) did not donate because of kidney stone-related concerns, or (3) did not donate for reasons unrelated to nephrolithiasis. If multiple reasons for non-donation were documented, candidates were classified as not donating due to stone-related concerns when nephrolithiasis was explicitly cited as a primary or contributing reason.

2.5 Outcome Definition

The primary study outcome was a symptomatic kidney stone event after donor evaluation. A symptomatic event was defined as any of the following occurring after evaluation: renal colic, gross hematuria attributed to stone passage, emergency or urgent care evaluation for nephrolithiasis, imaging-confirmed symptomatic ureteral stone, spontaneous stone passage, or stone-directed intervention such as ureteroscopy, extracorporeal shock wave lithotripsy, or percutaneous stone removal. Follow-up data were obtained through a combination of longitudinal medical record review and standardized follow-up contact by mail or telephone where permissible.

Secondary outcomes included stone-related procedures, initiation of preventive stone-directed pharmacotherapy, and diagnosis of chronic kidney disease during follow-up.

2.6 Statistical Analysis

Continuous variables were summarized as mean ± standard deviation or median with interquartile range depending on distribution. Categorical variables were summarized as counts and percentages. Baseline characteristics were compared across donation outcome categories using analysis of variance, Kruskal–Wallis testing, Pearson's chi-squared testing, or Fisher's exact testing as appropriate.

To identify factors associated with non-donation due to stone-related concerns, logistic regression models were constructed among all nephrolithiasis candidates. Candidate predictors included age, sex, BMI, family history of stones, prior symptomatic stone history, number of stones on imaging, bilateral stone disease, maximum stone diameter, and urinary metabolic abnormalities.

To identify predictors of symptomatic stone recurrence after evaluation, univariable logistic regression models were first fitted for each predictor. A multivariable model was then developed using

clinically selected covariates, with attention to collinearity among imaging and metabolic markers. The principal adjusted model included age, sex, BMI, prior symptomatic stone history, number of stones on imaging, bilateral stones, largest stone diameter, donation status, low urine volume, hypocitraturia, and hypercalciuria. Sensitivity analyses were planned using complete-case restriction, multiple imputation for missing urinary metabolic variables, and time-to-event models in the subset with exact event dates. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were reported, and two-sided $p < 0.05$ was considered statistically significant.

3 Results

3.1 Cohort Assembly and Baseline Characteristics

A total of 1,247 living kidney donor candidates were evaluated during the study period. Of these, 284 met inclusion criteria for nephrolithiasis based on prior symptomatic stone history, radiographic evidence of stones, or both (Figure 1).

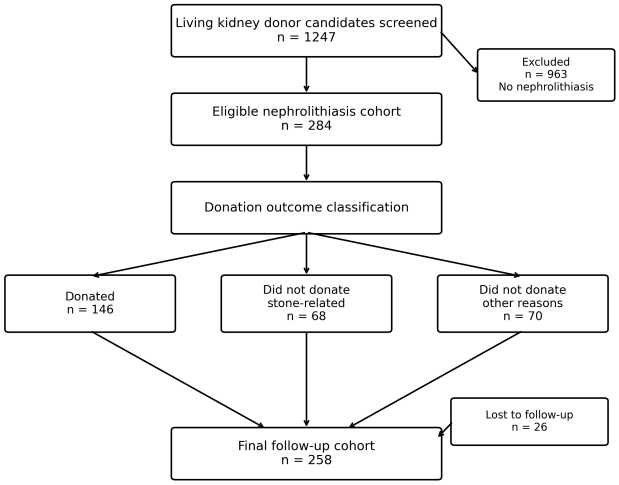

Figure 1. Study flow diagram showing screening, eligibility, exclusions, donation outcome categories, and follow-up cohort.

The mean age of the cohort was 44.2 ± 11.6 years, 57.4% were female, and the mean BMI was 27.8 ± 5.1 kg/m^2. A prior symptomatic kidney stone history was documented in 35.6% of candidates. Radiographic stones without prior symptomatic history were present in 47.9%, while both prior symptomatic history and radiographic evidence were present in 16.5%. Two or more stones on computed tomography were identified in 31.7% of the cohort, bilateral stones in 22.5%, and a largest stone diameter of at least 3 mm in 43.0%.

At least one abnormality on 24-hour urine testing was present in 71.5% of candidates. The most common urinary metabolic findings were low urine volume (44.4%), elevated urinary sodium (41.2%), hypocitraturia (33.8%), and hypercalciuria (27.5%). Baseline cohort characteristics stratified by donation outcome are shown in Table 1.

3.2 Factors Associated With Non-Donation Due to Stone-Related Concerns

Candidates who did not donate because of stone-related concerns had a greater baseline stone burden than donors. Specifically, they more frequently had multiple stones on imaging (51.5% vs. 23.3%, p<0.001), bilateral stone disease (39.7% vs. 15.1%, p<0.001), and a maximum stone diameter of at least 3 mm (64.7% vs. 34.2%, p<0.001). They also more often demonstrated adverse urinary metabolic features, particularly low urine volume (63.2% vs. 37.0%, p<0.001), hypocitraturia (51.5% vs. 26.7%, p<0.001), and hypercalciuria (42.6% vs. 21.2%, p=0.002).

In multivariable analysis, higher BMI (aOR 1.08, 95% CI 1.02-1.14, p=0.008), prior symptomatic stone history (aOR 2.34, 95% CI 1.21-4.52, p=0.011), two or more stones on imaging (aOR 3.12, 95% CI 1.68-5.79, p<0.001), bilateral stones (aOR 2.56, 95% CI 1.33-4.93, p=0.005), hypocitraturia (aOR 2.43, 95% CI 1.28-4.61, p=0.007), and low urine volume (aOR 2.18, 95% CI 1.15-4.13, p=0.017) were independently associated with non-donation due to stone-related concerns. These results are summarized in Table 2.

3.3 Follow-Up and Post-Evaluation Stone Outcomes

Follow-up information was available for 258 candidates, corresponding to 90.8% of the nephrolithiasis cohort. The median duration from donor evaluation to last follow-up was 5.2 years (interquartile range 2.8-7.9 years). During follow-up, 49 candidates (17.3%) experienced at least one symptomatic kidney stone event after donor evaluation.

Among those with recurrence, 67.3% required emergency or urgent evaluation, 32.7% underwent a stone-directed procedure, and 44.9% initiated preventive pharmacotherapy after the event. A diagnosis of chronic kidney disease during follow-up

Table 1. Baseline demographic, clinical, radiographic, and urinary metabolic characteristics of living kidney donor candidates with nephrolithiasis stratified by donation outcome.

Characteristic	Donated (n=146)	Did not donate due to stone-related concerns (n=68)	Did not donate for other reasons (n=70)
Number of patients	146	68	70
Age, years	46.8 ± 11.2	40.3 ± 10.9	43.5 ± 12.1
Female sex, n (%)	87 (59.6%)	36 (52.9%)	40 (57.1%)
Body mass index, kg/m^2	27.1 ± 4.8	29.3 ± 5.4	27.6 ± 5.2
Prior symptomatic stone history, n (%)	41 (28.1%)	39 (57.4%)	21 (30.0%)
Two or more prior symptomatic events, n (%)	12 (8.2%)	21 (30.9%)	6 (8.6%)
Any stone on imaging, n (%)	124 (84.9%)	65 (95.6%)	61 (87.1%)
Two or more stones on imaging, n (%)	34 (23.3%)	35 (51.5%)	21 (30.0%)
Bilateral stones, n (%)	22 (15.1%)	27 (39.7%)	15 (21.4%)
Largest stone diameter, mm	2.4 ± 1.3	3.8 ± 1.9	2.7 ± 1.5
Largest stone diameter ≥ 3 mm, n (%)	50 (34.2%)	44 (64.7%)	28 (40.0%)
Low urine volume, n (%)	54 (37.0%)	43 (63.2%)	29 (41.4%)
Hypocitraturia, n (%)	39 (26.7%)	35 (51.5%)	22 (31.4%)
Hypercalciuria, n (%)	31 (21.2%)	29 (42.6%)	18 (25.7%)
Hyperoxaluria, n (%)	16 (11.0%)	14 (20.6%)	9 (12.9%)
Elevated urinary sodium, n (%)	58 (39.7%)	30 (44.1%)	29 (41.4%)

Data presented as mean ± SD or number (%). Low urine volume: <2.0 L/day; hypocitraturia: <320 mg/day for women, <250 mg/day for men; hypercalciuria: >250 mg/day for women, >300 mg/day for men.

Table 2. Univariable and multivariable logistic regression analysis of factors associated with non-donation due to stone-related concerns.

Predictor	Univariable OR (95% CI), p value	Multivariable aOR (95% CI), p value
Age (per 1-year increase)	0.95 (0.92-0.97), <0.001	0.97 (0.94-1.00), 0.082
Male sex	1.31 (0.74-2.31), 0.354	1.22 (0.64-2.33), 0.547
Body mass index (per 1-unit increase)	1.09 (1.03-1.15), 0.002	1.08 (1.02-1.14), 0.008
Prior symptomatic stone history	3.34 (1.85-6.03), <0.001	2.34 (1.21-4.52), 0.011
Two or more prior symptomatic events	4.89 (2.36-10.14), <0.001	2.11 (0.91-4.89), 0.082
Two or more stones on imaging	3.58 (1.97-6.50), <0.001	3.12 (1.68-5.79), <0.001
Bilateral stones	3.53 (1.90-6.55), <0.001	2.56 (1.33-4.93), 0.005
Largest stone diameter ≥ 3 mm	3.58 (1.97-6.50), <0.001	1.89 (0.96-3.72), 0.065
Low urine volume	2.96 (1.63-5.37), <0.001	2.18 (1.15-4.13), 0.017
Hypocitraturia	2.97 (1.64-5.36), <0.001	2.43 (1.28-4.61), 0.007
Hypercalciuria	2.78 (1.50-5.16), 0.001	1.86 (0.94-3.67), 0.073
Elevated urinary sodium	1.21 (0.67-2.19), 0.524	1.09 (0.56-2.11), 0.803

was uncommon (2.8% overall) and did not differ materially according to donation status.

Symptomatic stone recurrence occurred in 12.3% of donors, 28.0% of non-donors who were declined due to stone-related concerns, and 14.3% of non-donors who did not donate for other reasons. Crude recurrence rates therefore appeared highest in candidates declined due to stone-related risk; however, this association was attenuated after adjustment for baseline imaging and metabolic factors.

3.4 Predictors of Symptomatic Stone Recurrence After Donor Evaluation

On univariable analysis, younger age, two or more stones on imaging, bilateral stone disease, low urine volume, hypocitraturia, hypercalciuria, and non-donation due to stone-related concerns were associated with symptomatic stone recurrence after evaluation. Prior symptomatic history demonstrated a weaker association than radiographic and metabolic markers.

In the final multivariable model, younger age (aOR 0.94 per year, 95% CI 0.91-0.98, p=0.003), presence of two or more stones on imaging (aOR 2.84, 95% CI 1.52-5.31, p=0.001), hypocitraturia (aOR 2.67, 95% CI 1.39-5.12, p=0.003), and low urine volume (aOR 2.41, 95% CI 1.26-4.60, p=0.008) remained independently associated with symptomatic post-evaluation stone events. Donation status was not independently associated with recurrence after adjustment (aOR 0.91, 95% CI 0.47-1.78, p=0.784). These findings are shown in Tables 3 and 4; Figure 2.

Table 3. Comparison of baseline factors among candidates with versus without symptomatic kidney stone recurrence after donor evaluation.

Characteristic	Symptomatic recurrence after evaluation: Yes (n=49)	Symptomatic recurrence after evaluation: No (n=235)
Number of patients	49	235
Donated, n (%)	18 (36.7%)	128 (54.5%)
Age, years	38.7 ± 11.4	45.3 ± 11.3
Female sex, n (%)	27 (55.1%)	136 (57.9%)
Body mass index, kg/m^2	28.5 ± 5.6	27.6 ± 5.0
Prior symptomatic stone history, n (%)	21 (42.9%)	80 (34.0%)
Two or more stones on imaging, n (%)	27 (55.1%)	63 (26.8%)
Bilateral stones, n (%)	18 (36.7%)	46 (19.6%)
Largest stone diameter $\geq$ 3 mm, n (%)	28 (57.1%)	94 (40.0%)
Low urine volume, n (%)	34 (69.4%)	92 (39.1%)
Hypocitraturia, n (%)	28 (57.1%)	68 (28.9%)
Hypercalciuria, n (%)	20 (40.8%)	58 (24.7%)
Preventive pharmacotherapy during follow-up, n (%)	22 (44.9%)	38 (16.2%)
Stone-directed procedure during follow-up, n (%)	16 (32.7%)	8 (3.4%)
Chronic kidney disease during follow-up, n (%)	2 (4.1%)	6 (2.6%)

Table 4. Multivariable predictors of symptomatic kidney stone recurrence after donor evaluation.

Predictor	Multivariable aOR (95% CI), p value
Donation status (donated vs. not donated)	0.91 (0.47-1.78), 0.784
Age (per 1-year increase)	0.94 (0.91-0.98), 0.003
Body mass index (per 1-unit increase)	1.03 (0.97-1.09), 0.382
Prior symptomatic stone history	1.31 (0.67-2.58), 0.428
Two or more stones on imaging	2.84 (1.52-5.31), 0.001
Bilateral stones	1.67 (0.84-3.32), 0.144
Largest stone diameter $\geq$ 3 mm	1.43 (0.74-2.75), 0.285
Low urine volume	2.41 (1.26-4.60), 0.008
Hypocitraturia	2.67 (1.39-5.12), 0.003
Hypercalciuria	1.62 (0.83-3.17), 0.157

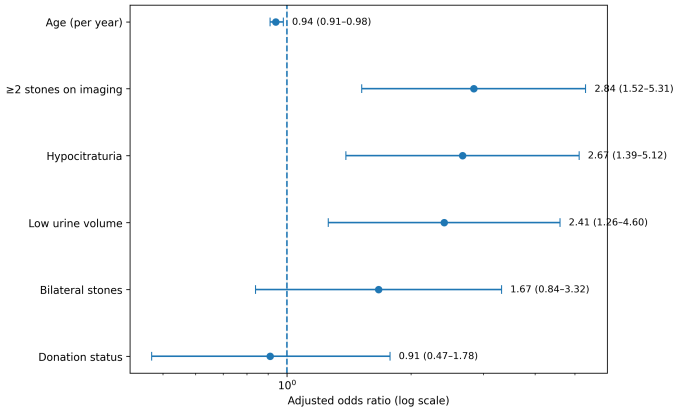

Figure 2. Adjusted odds ratios for symptomatic kidney stone recurrence after donor evaluation.

3.5 Sensitivity Analyses

Sensitivity analyses restricted to candidates with complete urinary metabolic panels yielded estimates consistent with the primary analysis. When repeated 24-hour urine collections were available and averaged values were used, the direction and magnitude of associations were materially unchanged. In the subset with exact recurrence dates, Cox regression analysis similarly demonstrated shorter recurrence-free survival among candidates with hypocitraturia and low urine volume (log-rank p=0.002), supporting the stability of the main findings (Figure 3).

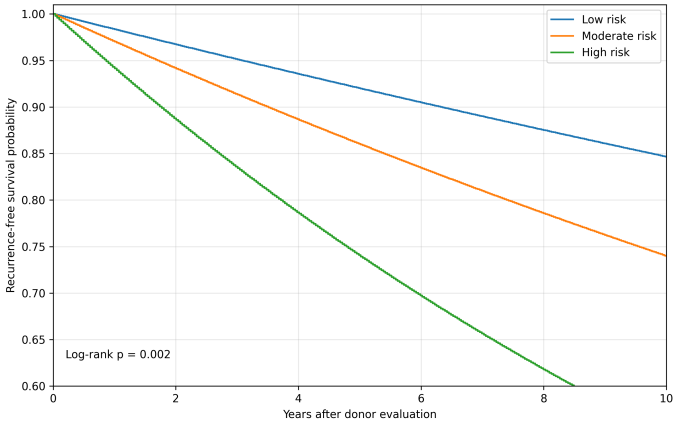

Figure 3. Kaplan–Meier recurrence-free survival according to urinary metabolic risk category, based on low urine volume and hypocitraturia status.

4 Discussion

This study indicates that urinary metabolic abnormalities provide clinically meaningful information beyond radiographic stone burden in living kidney donor candidates with nephrolithiasis. While imaging remains central to donor evaluation, our findings suggest that active stone-forming physiology, particularly low urine volume and hypocitraturia, more directly identifies candidates at heightened risk of clinically significant stone recurrence after evaluation. In this respect, metabolic phenotyping refines risk estimation rather than merely duplicating the information conveyed by structural stone burden.

The observed relationship between multiple stones on imaging and symptomatic recurrence is consistent with prior work showing that greater radiographic burden predicts future stone events. However, our

data further suggest that radiographic burden alone is an incomplete surrogate for ongoing stone risk. A donor candidate with minimal residual radiographic burden may still harbor substantial recurrence risk if the underlying urinary environment remains strongly lithogenic. This distinction is especially important when nephrectomy would leave the individual with a solitary kidney.

Another important finding is that donation itself was not independently associated with symptomatic recurrence after multivariable adjustment. This supports the interpretation that post-evaluation stone events are driven primarily by baseline patient-level risk factors rather than by nephrectomy alone. In clinical terms, this suggests that carefully selected stone formers may still be appropriate donors provided that they have low recurrence risk on integrated assessment. Conversely, younger candidates with multiple stones and adverse urinary metabolic profiles may warrant more cautious review, more intensive counseling, and preventive treatment before a final donor decision is made.

The study also has practical implications for donor selection committees. In many centers, 24-hour urine findings are reviewed qualitatively, without a standardized framework for integrating them with imaging and clinical history. Our results support a more structured approach in which low urine volume and hypocitraturia are recognized as substantive recurrence markers, especially when they coexist with bilateral or multiple radiographic stones. A composite evaluation model incorporating age, prior stone history, radiographic burden, and metabolic abnormalities may yield more consistent and individualized donor decisions than traditional threshold-based exclusions.

Several limitations merit consideration. First, this was a retrospective single-center analysis, and local evaluation practices may limit generalizability. Second, urinary metabolic studies were not uniformly available for all candidates, introducing the possibility of selection bias and incomplete phenotyping. Third, some symptomatic stone events may have been managed outside the study institution, although efforts were made to improve ascertainment through follow-up contact. Fourth, variables such as dietary adherence, longitudinal fluid intake behavior, and stone composition were not consistently available. Fifth, the study may have been underpowered to detect modest associations with chronic kidney disease or rare severe renal complications.

Despite these limitations, the study offers several strengths. It focuses on a clinically relevant and understudied donor subgroup, integrates both radiographic and metabolic risk domains, and evaluates outcomes over an interval sufficient to capture clinically meaningful recurrence. It also addresses a question of direct practical importance: which findings available at donor evaluation are most informative for future stone events.

Future multicenter studies should validate these observations and support development of formal recurrence prediction tools tailored to living kidney donor candidates. Such tools may improve fairness, transparency, and reproducibility in donor selection while identifying individuals who could benefit from targeted preventive intervention before or after donation.

5 Conclusion

Among living kidney donor candidates with nephrolithiasis, urinary metabolic abnormalities appear to improve recurrence risk stratification beyond clinical history and radiographic stone burden alone. Younger age, multiple stones on imaging, hypocitraturia, and low urine volume were the factors most strongly associated with symptomatic kidney stone events after donor evaluation, whereas donation itself was not an independent predictor after adjustment. These findings support incorporation of standardized metabolic assessment into donor evaluation protocols and may help transplant programs make more consistent, evidence-informed decisions for candidates with kidney stone disease.

Ethics approval and consent to participate

Institutional review board approval was obtained before study initiation (IRB Protocol #2021-089). Consent procedures for follow-up contact were implemented in accordance with institutional policy.

Consent for publication

Not applicable.

Availability of data and materials

The data supporting the findings of this study are available from the corresponding author on

reasonable request, subject to institutional and privacy restrictions.

Competing interests

The authors declare no competing interests.

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