https://nephropathol.com DOI: 10.34172/jnp.28727 J Nephropathol. 2027;16(1):e28727

Journal of Nephropathology

Hematuria as a predictor of renal and ureteral calculi in children; a diagnostic cross-sectional study

Milad Rastegar, Mohammad Golshan Tafti, Ahmad Shajari*

Department of Medicine, YMS. C., Islamic Azad University, Yazd, Iran

ARTICLE INFO

Article type:
Original Article

Article history:
Received: 14 May 2026
Revised: 6 Jul. 2026
Accepted: 23 Jul. 2026
Published online: 1 Aug. 2026

Keywords:
Hematuria
Pediatric nephrolithiasis
Renal calculi
Ureteral stones
Urinalysis
Ultrasound

ABSTRACT

Introduction: Pediatric nephrolithiasis is increasingly recognized worldwide and often presents with nonspecific symptoms that can delay diagnosis and treatment. Early identification of renal and ureteral calculi is essential to prevent complications such as obstruction, infection, and long-term renal impairment. Ultrasound is the preferred imaging modality in children, but its availability and cost may limit routine use in some settings. Hematuria is a common and easily assessed finding in suspected stone disease, yet its standalone diagnostic value in the pediatric population remains uncertain.

Objectives: This study aimed to evaluate the performance of hematuria as a predictor of renal and ureteral calculi in children, using ultrasound as the reference standard.

Materials and Methods: We conducted a retrospective diagnostic cross-sectional study of children aged 1–12 years with suspected nephrolithiasis who were referred to two tertiary hospitals in Yazd between January 2018 and January 2020. Clinical data, urinalysis results for hematuria, and renal ultrasound reports were extracted from medical records using predefined eligibility criteria and a standardized data collection form. Hematuria was classified as present or absent on urinalysis, while ultrasound served as the reference standard for confirming or excluding renal or ureteral calculi. The diagnostic performance of hematuria was evaluated by calculating sensitivity, specificity, positive and negative predictive values (PPV and NPV), accuracy, likelihood ratios (LRs), and Cohen's kappa coefficient.

Results: Among 70 children aged 1–12 years with suspected nephrolithiasis, hematuria demonstrated good diagnostic performance against ultrasound, with an accuracy of 81.4%, sensitivity of 80.8%, specificity of 81.8%, PPV of 72.4%, and NPV of 87.8%.

Conclusion: Hematuria demonstrated good overall diagnostic accuracy for detecting pediatric nephrolithiasis compared with ultrasound and may serve as a simple, accessible screening tool in suspected cases. Nevertheless, due to residual false-positive and false-negative results, imaging remains necessary for definitive diagnosis and management.

Implication for health policy/practice/research/medical education:
Hematuria demonstrated acceptable diagnostic accuracy for detecting nephrolithiasis in children when benchmarked against ultrasound, indicating that routine urinalysis may provide a practical initial screening approach in suspected cases. In contexts with constrained resources or high patient volumes, this simple test could help prioritize children who warrant prompt imaging evaluation. Nonetheless, the presence of misclassified cases means that hematuria cannot be relied upon as a standalone diagnostic method, and radiologic imaging remains indispensable for confirming stone disease and guiding subsequent management.

Please cite this paper as: Rastegar M, Golshan Tafti M, Shajari A. Hematuria as a predictor of renal and ureteral calculi in children; a diagnostic cross-sectional study. J Nephropathol. 2027;16(1):e28727. DOI: 10.34172/jnp.28727.

Introduction

Nephrolithiasis, the formation of calculi within the renal collecting system or ureter, has traditionally been considered a disease of adults; however, its prevalence in the pediatric population has risen dramatically over the past two decades (1,2). Population-based data demonstrate a steady annual increase in the incidence of kidney stones among children and adolescents, with a concurrent

*Corresponding author: Ahmad Shajari,
Email: dr.shajari@iau.ac.ir

Original Article

rise in emergency department visits, hospitalizations, and associated healthcare costs (2,3). Unlike adults, children with nephrolithiasis often present with atypical symptoms, including nonspecific abdominal pain, urinary tract infection, or dysuria, making early and accurate diagnosis particularly challenging (4). If left undiagnosed or inadequately managed, pediatric nephrolithiasis may lead to obstructive uropathy, recurrent infections, and long-term impairment of renal function (5).

Hematuria, defined as the abnormal presence of red blood cells in the urine detectable by dipstick or urine microscopy, is one of the most frequently encountered urological findings in clinical practice (6). It may be classified as gross hematuria, visible to the naked eye, or microscopic hematuria, detected only through urinalysis, and is associated with a broad spectrum of underlying conditions ranging from benign causes to serious urological disease (7). In pediatric patients, hematuria is a particularly common presenting complaint and may serve as an important indicator of underlying renal or urinary tract pathology, including glomerulonephritis, urinary tract infection, trauma, and urolithiasis (8). Standard evaluation involves urinalysis with microscopy, and microscopic hematuria is conventionally defined as three or more red blood cells per high-power field on a properly collected specimen (6,7).

Given the increasing prevalence of nephrolithiasis in children and the need for accessible diagnostic tools, the role of hematuria as a predictor of renal and ureteral calculi has attracted growing clinical interest (9). Studies have demonstrated that hematuria is present in the majority of patients with urolithiasis; however, a non-negligible proportion of patients with stones lack this finding, limiting its standalone diagnostic utility (9,10). In the pediatric population specifically, the prevalence of microscopic hematuria in confirmed stone disease has been reported to be lower than in adults, raising questions about its reliability as a diagnostic marker in this age group (10). Ultrasound remains the recommended first-line imaging modality in children suspected of having urinary calculi owing to its lack of ionizing radiation and widespread availability (11). However, its sensitivity is variable, particularly for ureteral stones (12,13). This study, therefore, aimed to evaluate the diagnostic performance of hematuria as a screening test, with ultrasound as the reference standard, for detecting renal and ureteral calculi in a pediatric cohort.

Objectives

This study aimed to rigorously assess the diagnostic utility of hematuria as a non-invasive marker for pediatric urolithiasis. Specifically, we sought to determine the sensitivity, specificity, predictive values, and overall accuracy of hematuria in identifying renal and ureteral calculi among children presenting with suspected nephrolithiasis, using renal ultrasonography as the reference standard. In doing so, the study intended to clarify the extent to which routine urinalysis could contribute to early detection and triage of pediatric stone disease, particularly in settings where access to imaging may be limited or delayed.

Materials and Methods

Study design and participants

This diagnostic cross-sectional study included 70 pediatric patients who were referred to Shahid Sadoughi and Shohadaye Kargar hospitals in Yazd between January 2018 and January 2020 with a clinical suspicion of nephrolithiasis. Children aged 1–12 years who had undergone both urinalysis and renal ultrasonography as part of their diagnostic work-up were eligible for inclusion, and their data were extracted from hospital records using a predefined protocol.

Inclusion and exclusion criteria

Children were eligible for inclusion if they were between 1 and 12 years of age, had a clinical suspicion of nephrolithiasis, and had both urinalysis for hematuria and renal ultrasonography performed during the same diagnostic episode at Shahid Sadoughi or Shohadaye Kargar hospitals between January 2018 and January 2020. Patients were excluded if their medical records were incomplete for key study variables, if imaging or laboratory data were missing or non-interpretable, or if they had known underlying renal or urologic anomalies, prior stone surgery, or other conditions that could confound the interpretation of hematuria or ultrasound findings.

Data collection

Data for this diagnostic cross-sectional study were collected retrospectively from the medical records of pediatric patients presented with suspected nephrolithiasis. For each eligible child, demographic characteristics (age and sex), clinical features (including the presence or absence of dysuria), and any documented family history of nephrolithiasis in first-degree relatives were extracted using a standardized data collection form. Laboratory records were reviewed to obtain urinalysis results for hematuria, and radiology reports were examined to determine renal and ureteral stone status based on ultrasound findings. Ultrasound served as the reference standard for classifying patients as having or not having nephrolithiasis, and hematuria results were subsequently compared with sonographic diagnoses to assess agreement and diagnostic performance.

Hematuria definition

Hematuria in this study was defined as the presence of red blood cells in the urine detected on routine urinalysis, including both gross hematuria visible to the naked eye and microscopic hematuria identified only by laboratory testing of the urine sediment. True microscopic hematuria was defined as at least three red blood cells per high-power field on urine microscopy performed on a catheterized specimen, in line with thresholds commonly recommended in the literature for clinically significant microscopic hematuria (14).

Outcome measurement

The primary outcome measure was the diagnostic performance of hematuria for identifying nephrolithiasis in children, using renal ultrasound as the reference standard. Hematuria was classified as present or absent based on urinalysis, and nephrolithiasis status was determined from ultrasound reports as stone present or absent. From these paired classifications, we calculated sensitivity, specificity, positive and negative predictive values (PPV and NPV), overall diagnostic accuracy, likelihood ratios (LRs), and the diagnostic odds ratio (DOR).

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages, and age was described using mean and standard deviation. The diagnostic performance of hematuria for detecting nephrolithiasis, with ultrasound as the reference standard, was evaluated by calculating sensitivity, specificity, PPV, and NPV, overall accuracy, LR, and the DOR. Likelihood ratios were interpreted with LR+ values greater than 10 and LR– values less than 0.1 considered strong indicators of diagnostic strength. Agreement between hematuria and ultrasound findings was assessed using Cohen's kappa statistic and its corresponding P value, with kappa values above 0.60 indicating substantial agreement and a two-sided *P* value < 0.05 considered statistically significant.

Table 1. Demographic characteristics and clinical data

Variable			Frequency	Percent
Gender	Male		41	58.6
	Female		29	41.4
Dysuria	Yes		14	20
	No		56	80
Family history of nephrolithiasis	No		45	64.3
	Yes	Father	10	14.3
		Mother	4	5.7
		Sibling	11	15.7
Nephrolithiasis diagnosis (Ultrasound)	Yes		26	37.1
	No		44	62.9
Nephrolithiasis diagnosis (Hematuria)	Yes		29	41.4
	No		41	58.6
Age (year), Mean ± SD			4.98 ± 2.96	

SD: Standard deviation.

Results

The study population consisted of 70 pediatric patients (mean age: 4.98 ± 2.96 [1 - 12] years), with a majority of male gender. Some patients presented with dysuria, whereas the majority did not report this symptom. A portion of the children had a positive family history of nephrolithiasis involving first-degree relatives such as fathers, mothers, or siblings, while the rest had no such history. Nephrolithiasis was identified in a subset of patients on ultrasound, whereas others had no sonographic evidence of stones. Similarly, hematuria-based assessment suggested nephrolithiasis in part of the cohort, while the remaining patients did not meet this criterion (Table 1).

The analysis indicated that hematuria showed a moderate to substantial level of agreement with ultrasound in the diagnosis of nephrolithiasis. In most children with sonographic evidence of stones, hematuria was also present, while a large majority of those without stones on ultrasound had no hematuria, reflecting good overall concordance between the two diagnostic modalities (Table 2).

Using ultrasound as the reference test, hematuria demonstrated good overall diagnostic performance for nephrolithiasis. It correctly classified most children with or without stones, with balanced sensitivity and specificity, and a particularly high NPV, indicating that the absence of hematuria substantially reduced the likelihood of stones. The false-positive and false-negative rates were relatively low, and the LRs showed that a positive hematuria result meaningfully increased, while a negative result markedly decreased, the post-test probability of nephrolithiasis. The DOR further reflected a good overall discriminatory ability of hematuria in distinguishing between children with and without ultrasound-confirmed stones (Table 3).

Discussion

In this retrospective diagnostic cross-sectional study of children with suspected nephrolithiasis, hematuria demonstrated good overall diagnostic performance when compared with ultrasound as the reference standard, with balanced sensitivity and specificity and an overall accuracy above 80%. These findings indicate that hematuria was present in most children with ultrasound-detected stones and absent in most children without sonographic evidence of stones. In practical terms, these findings are consistent

Table 2. Agreement between hematuria and ultrasound findings in the diagnosis of nephrolithiasis

Diagnostic modality		Ultrasound (Standard reference)			Kappa	*P* value
		Yes (n = 26)	**No** (n = 44)	**Total**		
Hematuria	Yes, N (%)	21 (80.8)	8 (18.2)		0.611	<0.001*
		21 (72.4)	8 (27.6)	N = 29		
	No, N (%)	5 (19.2)	36 (81.8)			
		5 (12.2)	36 (87.8)	N = 41		

*Cohen's kappa coefficient.

with the broader clinical understanding that hematuria is commonly associated with urinary stone disease but should be interpreted within the context of imaging and overall clinical assessment (8,15).

The present findings are broadly in line with previous reports showing that hematuria is a frequent but imperfect marker of renal or ureteral stones. Adult-based studies evaluating hematuria against imaging-confirmed urolithiasis have generally reported reasonably good sensitivity but incomplete specificity, and they have emphasized that the absence of hematuria does not fully exclude stone disease (9,10). Although pediatric-specific evidence remains more limited than the adult literature, reviews of pediatric nephrolithiasis similarly describe hematuria as a common presenting finding rather than a definitive diagnostic test, which accords with the false-positive and false-negative results observed in our cohort (2,15). Accordingly, the current study adds pediatric data supporting the concept that hematuria may function best as an adjunctive screening marker rather than a standalone determinant of diagnosis.

An important feature of the present results is the relatively high NPV, suggesting that the absence of hematuria was associated with a lower probability of ultrasound-confirmed nephrolithiasis in this cohort. This observation may have practical relevance in settings where access to immediate imaging is limited, because urinalysis is inexpensive, widely available, and rapidly performed. At the same time, the PPV was lower than the NPV, indicating that hematuria alone cannot reliably confirm the presence of stones, as blood in the urine may also accompany other pediatric urinary tract conditions. This interpretation is consistent with prior pediatric literature emphasizing that hematuria is a nonspecific sign with a broad differential diagnosis and therefore should not replace imaging when nephrolithiasis is clinically suspected (8,16).

Table 3. Diagnostic performance of hematuria compared with sonography, using ultrasound as the reference standard for the diagnosis of nephrolithiasis

Diagnostic parameter	Value (%)
Accuracy	81.4
Sensitivity	80.8
Specificity	81.8
PPV	72.4
NPV	87.8
False positive	18.2
False negative	19.2
LR+	4.44
LR–	0.23
DOR	19.30

PPV: Positive predictive value; NPV: Negative predictive value; LR+: Positive likelihood ratios; LR–: Negative likelihood ratios; DOR: Diagnostic odds ratio.

The findings should also be interpreted in light of the selected reference standard. Ultrasound is widely recommended as the initial imaging modality for children with suspected nephrolithiasis because it avoids ionizing radiation and is suitable for repeated use in pediatric practice (16). However, prior literature has noted that ultrasound sensitivity may be variable, particularly for smaller calculi or ureteral stones, which means that any comparison using sonography as the reference standard should be interpreted with appropriate caution (2,13). Even so, because ultrasound represents the most clinically relevant first-line imaging approach in children, its use as the comparator in the present study remains appropriate and strengthens the applicability of the findings to routine pediatric care. In this context, the observed agreement between hematuria and ultrasound supports the potential role of urinalysis as an initial screening component within a broader diagnostic pathway rather than as a substitute for radiologic evaluation.

In summary, the present study suggests that hematuria has useful diagnostic value in children with suspected renal or ureteral calculi, showing good accuracy and moderate to substantial agreement with ultrasound. However, because both false-positive and false-negative classifications were observed, hematuria should be regarded as a supportive screening finding rather than a definitive diagnostic test. Ultrasound and other appropriate imaging modalities, therefore, remain essential for confirming nephrolithiasis and guiding management in pediatric patients.

Conclusion

The results indicated that hematuria showed good diagnostic performance for identifying pediatric nephrolithiasis compared to ultrasound as the reference standard. These findings suggest that urinalysis for

hematuria can serve as a useful, readily available screening tool in children with suspected nephrolithiasis, particularly in resource-limited or high-volume settings. However, given the non-negligible rates of false-positive and false-negative results, hematuria alone cannot replace imaging, and radiologic modalities remain essential for definitive diagnosis and further management decisions.

Limitations of the study

First, the retrospective nature of the study and the relatively modest sample size may limit the precision and generalizability of the findings, particularly across different age groups and clinical settings. Second, the sample size was relatively modest, which may reduce the precision of the diagnostic estimates and preclude robust subgroup analyses by age, sex, stone location, or stone size. Third, hematuria assessment relied on routine clinical urinalysis and microscopy of catheterized specimens, without central laboratory re-reading or standardized timing in relation to symptom onset, which could lead to misclassification. Fourth, ultrasound was used as the reference standard may have resulted in some degree of misclassification if small or ureteral stones were not detected, and the study design does not permit assessment of temporal changes in hematuria relative to symptom onset. Finally, potential confounders such as urinary tract infection, recent trauma, vigorous exercise, or coexisting renal disease were not systematically excluded, which could have influenced hematuria results independently of stone status.

Acknowledgments

We would like to express our sincere appreciation to the medical records and information technology staff of Shahid Sadoughi and Shohadaye Kargar Hospitals in Yazd, whose assistance in retrieving and organizing archived clinical, laboratory, and imaging data made this retrospective analysis possible. We also thank the radiology teams for their careful performance and documentation of ultrasound examinations, and the laboratory personnel for maintaining the quality of urinalysis services on which our findings are based.

Authors' contribution

Conceptualization: Milad Rastegar and Ahmad Shajari.
Data curation: Milad Rastegar and Mohammad Golshan Tafti.
Formal analysis: Mohammad Golshan Tafti.
Investigation: Ahmad Shajari and Mohammad Golshan Tafti.
Methodology: Mohammad Golshan Tafti.
Project Management: Ahmad Shajari.
Resources: All authors.
Supervision: All authors.
Validation: Milad Rastegar.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Ethical issues

The research was conducted in accordance with the principles of the Declaration of Helsinki. This study was conducted at Shahid Sadoughi and Shohadaye Kargar hospitals in Yazd. It was derived from the thesis work of Milad Rastegar (Thesis #98004), approved by the ethics committee of the Islamic Azad University - Isfahan, Iran (ethical code number: IR.IAU.KHUISF.REC.1398.275; https://ethics.research.ac.ir/form/xx98eqge1g74eb.pdf) registered on January 8, 2020. Written informed consent was obtained from the parents or legal guardians of all children included in the study. Additionally, the authors adhered to ethical standards, including the prevention of plagiarism, data fabrication, data falsification, and duplicate publication.

Conflicts of interest

The authors declare no conflict of interest.

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of generative artificial intelligence (AI) and AI-assisted technologies in the writing process

While preparing this work, the authors utilized AI (Grammarly and Perplexity) to refine grammar points and language style. Subsequently, they thoroughly reviewed and edited the content as necessary, assuming full responsibility for the publication's content.

Funding/Support

This study was supported by the Islamic Azad University - Isfahan, Iran (Grant #98004).

References

1. Sas DJ. An update on the changing epidemiology and metabolic risk factors in pediatric kidney stone disease. Clin J Am Soc Nephrol. 2011;6:2062–8. doi: 10.2215/cjn.11191210.
2. Hernandez JD, Ellison JS, Lendvay TS. Current Trends, Evaluation, and Management of Pediatric Nephrolithiasis. JAMA Pediatr. 2015;169:964–70. doi: 10.1001/jamapediatrics.2015.1419.
3. Tasian GE, Copelovitch L. Evaluation and medical management of kidney stones in children. J Urol. 2014;192:1329–36. doi: 10.1016/j.juro.2014.04.108.
4. Persaud AC, Stevenson MD, McMahon DR, Christopher NC. Pediatric urolithiasis: clinical predictors in the

emergency department. Pediatrics. 2009;124:888–94. doi: 10.1542/peds.2008-2427.
5. Scoffone CM, Cracco CM. Pediatric calculi: cause, prevention and medical management. Curr Opin Urol. 2018;28:428–32. doi: 10.1097/mou.0000000000000520.
6. Mohr DN, Offord KP, Owen RA, Melton LJ, 3rd. Asymptomatic microhematuria and urologic disease. A population-based study. JAMA. 1986;256:224–9.
7. Sharp VJ, Barnes KT, Erickson BA. Assessment of asymptomatic microscopic hematuria in adults. Am Fam Physician. 2013;88:747–54.
8. Bignall ONR, 2nd, Dixon BP. Management of Hematuria in Children. Curr Treat Options Pediatr. 2018;4:333–49. doi: 10.1007/s40746-018-0134-z.
9. Nagendra V, Dhande R, Mishra G, Reddy NG, Gowda H. Hematuria as a sign of kidney stone disease evaluated using computed tomography: a review. cureus. 2023;15:e38064. doi: 10.7759/cureus.38064.
10. Alnazari M, Bakhsh A, Shaqroon HA, Rajih ES, Al-Nakshabandi NA, Rabah DM. Hematuria: Is it useful in predicting renal or ureteral stones in patient presenting to emergency department with flank pain? Urol Ann. 2024;16:71–4. doi: 10.4103/ua.ua_66_23.
11. Köksoy AY, Nalcacioglu V, Önal HG. Ultrasonography in pediatric urinary stone diagnosis: clinical utility and diagnostic limitations in light of CT findings. Pediatr Nephrol. 2026;41:1069–78. doi: 10.1007/s00467-025-07031-6.
12. Bold MS, Boyum JH, Potretzke AM, Rose CH, Atwell TD, Sviggum EB, et al. Detection of distal ureteral stones in pregnancy using transvaginal ultrasound. J Ultrasound. 2021;24:397–402. doi: 10.1007/s40477-020-00504-4.
13. Xia J, Peng J, Wang G, Zheng T, Xu Q. Rapid localization of ureteral calculi in patients with renal colic by "ultrasonic ureteral crossing sign". Sci Rep. 2020;10:1927. doi: 10.1038/s41598-020-58805-x.
14. Chen A, Caron A, Jackson NJ, Kanji F, Kuhlmann P, Le CH, et al. Defining properly collected urine: thresholds to improve the accuracy of urinalysis for microscopic hematuria evaluation in women. J Urol. 2022;207:385–91. doi: 10.1097/ju.0000000000002200.
15. Cao B, Daniel R, McGregor R, Tasian GE. Pediatric Nephrolithiasis. Healthcare (Basel). 2023;11:552. doi: 10.3390/healthcare11040552.
16. Strohmaier WL. Imaging in pediatric urolithiasis-what's the best choice? Transl Pediatr. 2015;4:36–40. doi: 10.3978/j.issn.2224-4336.2015.01.01.