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Original Article

Etiological Profile and Clinical Outcomes of Pediatric Hematuria at BMU

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Abstract

Background: Hematuria in children is a common clinical finding with a wide spectrum of urological etiologies, ranging from benign conditions to significant structural abnormalities. Limited prospective data exist on urological causes of pediatric hematuria in low- and middle-income settings, including Bangladesh.

Objective: To determine the urological etiological profile and clinical outcomes of pediatric hematuria. Methods: This prospective cohort study was conducted at Bangladesh Medical University (BMU), Dhaka, Bangladesh, from January 2019 to December 2024. A total of 197 children aged 1 month to 18 years with gross or microscopic hematuria were enrolled through purposive sampling. Data were analyzed using SPSS version 23.0.

Results: The mean age was 7.8±4.1 years; 111 (56.3%) were male. Urinary tract infection (UTI) was the most common cause (98 children, 49.7%), followed by hypercalciuria (54, 27.4%) and urolithiasis (32, 16.2%). Vesicoureteral reflux was diagnosed in 9 (4.6%), and post-traumatic hematuria in 4 (2.0%). No urological etiology was determined in 6 children (3.0%). At six-month follow-up, complete resolution occurred in 179 children (90.9%), persistent asymptomatic hematuria in 15 (7.6%), and progression to chronic kidney disease (CKD) in 3 (1.5%). All CKD cases were associated with obstructive uropathy from large renal stones.

Conclusion: Urinary tract infection, hypercalciuria, and urolithiasis are the leading urological causes of pediatric hematuria in Bangladesh. Most cases resolve favorably, but children with obstructive stone disease require close follow-up to prevent CKD progression.

Keywords: Child, Hematuria, Hypercalciuria, Urolithiasis, Urinary tract infection

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Introduction

Hematuria—the presence of an abnormal number of red blood cells in urine—is one of the most common abnormal urinalysis findings in pediatric clinical practice [1]. The condition ranges from asymptomatic microscopic hematuria, often detected incidentally during routine health screenings, to gross hematuria that prompts immediate medical attention due to visible blood discoloration [2]. While many children with hematuria have benign, self-limited conditions, a substantial subset harbors underlying urological diseases that, if left undiagnosed, may progress to irreversible kidney damage [3,4]. The etiological landscape of pediatric hematuria from a urological perspective includes urinary tract infection (UTI), hypercalciuria, urolithiasis, vesicoureteral reflux (VUR), and post-traumatic causes, among others [5,6]. In

resource-limited settings, infectious etiologies such as UTI tend to predominate, whereas in high-income countries, structural anomalies and metabolic disorders are increasingly recognized due to earlier diagnostic interventions [7,8]. Geographic and demographic variations in the etiological profile of pediatric hematuria have important clinical implications. For instance, studies from South Asia report a higher prevalence of urolithiasis-associated hematuria than in Western populations, potentially linked to dietary habits, hydration status, and climate [9]. Similarly, hypercalciuria—often an underrecognized cause of both microscopic and gross hematuria—varies widely across different ethnic groups and age strata [10]. Despite the diagnostic and prognostic importance of characterizing hematuria etiology, robust prospective data from low- and middle-income countries (LMICs) remain sparse. Bangladesh, a densely populated South Asian nation with a high burden of pediatric kidney diseases, lacks contemporary prospective cohort data describing the urological spectrum and outcomes of children presenting with hematuria. Most available evidence from the region comes from retrospective case series or small cross-sectional studies, which are subject to selection bias and incomplete follow-up [11,12]. Consequently, local clinical guidelines are often extrapolated from Western populations, potentially mismatching the actual disease burden and resource allocation needs. Moreover, the long-term outcomes of pediatric hematuria of urological origin in LMIC settings are poorly characterized. While short-term resolution is common in uncomplicated UTI or hypercalciuria, conditions such as obstructive urolithiasis or high-grade VUR may silently progress to chronic kidney disease (CKD) over time [13]. Understanding the proportion of children who develop persistent hematuria, recurrent UTI, or CKD is essential for designing follow-up protocols and referral pathways. Without such evidence, many children may be lost to follow-up after initial symptom resolution, missing the opportunity for early urological intervention. Given these gaps, we conducted a prospective cohort study at Bangladesh Medical University (BMU), Dhaka, Bangladesh, over six years (January 2019 to December 2024). The primary objective was to delineate the urological etiological profile of pediatric hematuria in this setting. The secondary objective was to describe short- to medium-term clinical outcomes, including resolution, persistence, and progression to CKD. Findings from this study aim to inform evidence-based diagnostic algorithms and follow-up strategies for pediatric hematuria of urological origin in resource-limited South Asian contexts.

Methodology

This prospective cohort study was conducted at the Department of Urology, Bangladesh Medical University (BMU), Dhaka, Bangladesh, from January 2019 to December 2024. Children aged 1 month to 18 years presenting with either gross hematuria (visible blood in urine) or microscopic hematuria (≥5 red blood cells per high-power field on two of three consecutive urinalyses) were eligible for enrollment using purposive sampling. A total of 197 children were included.

Inclusion criteria:

Children with confirmed hematuria as defined above, whose parents or legal guardians provided written informed consent, and who agreed to a six-month follow-up, were enrolled.

Exclusion criteria:

We excluded children with transient hematuria secondary to fever, strenuous exercise, or menstruation; known bleeding disorders; recent urological instrumentation (<2 weeks); those with confirmed glomerular causes on initial evaluation; or those lost to follow-up before outcome assessment.

Study procedure:

All participants underwent a standardized urological evaluation, including:

1. Detailed history and physical examination: Emphasis on fever, dysuria, frequency, urgency, flank or abdominal pain, voiding dysfunction, history of dehydration, family history of urolithiasis or hypercalciuria, and prior episodes of UTI.
2. Urinalysis and urine culture: Midstream clean-catch or catheterized urine samples were obtained. Significant bacteriuria was defined as $>10^5$ colony-forming units/mL. Antibiotic sensitivity testing was performed for all positive cultures.
3. Spot urine calcium-to-creatinine ratio (U Ca/Cr): A single random urine sample was obtained for all children. Hypercalciuria was defined as U Ca/Cr >0.21 mg/mg in children >6 months of age [14].
4. Renal function tests: Serum creatinine and blood urea nitrogen were measured at presentation and at follow-up visits. The estimated glomerular filtration rate (eGFR) was calculated using the Bedside Schwartz formula.
5. Renal ultrasonography: All children underwent renal and bladder ultrasound to assess for hydronephrosis, urolithiasis, bladder wall thickening, post-void residual volume, and structural anomalies.
6. Voiding cystourethrography (VCUG): This was performed when vesicoureteral reflux (VUR) was suspected based on recurrent febrile UTIs, abnormal renal ultrasound (hydronephrosis or ureteral dilation), or abnormal renal cortical findings.
7. Non-contrast CT urography (NCCT KUB): This was reserved for children with suspected radiolucent

stones, persistent gross hematuria with negative ultrasound, or a family history of urolithiasis with inconclusive ultrasound findings.

Follow-up protocol:
All children were followed for six months. Follow-up visits were scheduled at 1, 3, and 6 months. At each visit, urinalysis, urine culture (if symptomatic), and blood pressure monitoring were performed. Repeat renal ultrasound was done at 3 and 6 months for children with urolithiasis, VUR, or persistent hematuria.

Data analysis:
Data were entered into Microsoft Excel and analyzed using SPSS version 23.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies (percentages). Etiological distribution and six-month outcomes (complete resolution, persistent hematuria, progression to CKD) were reported descriptively. Comparisons between groups were performed using an independent t-test for continuous variables and Pearson's chi-square test for categorical variables. A p-value <0.05 was considered statistically significant. No imputation was performed for missing data.

Ethical considerations:
Written informed consent was obtained from parents or legal guardians of all participants. The study was conducted in accordance with the Declaration of Helsinki.

Result

A total of 197 children with hematuria were enrolled and completed six months of follow-up. The mean age was 7.8±4.1 years (range 1 month to 18 years). Male predominance was observed (111, 56.3%) with a male-to-female ratio of 1.3:1. The majority of participants (131, 66.5%) resided in urban or peri-urban areas around Dhaka, while 66 (33.5%) came from rural districts. Regarding clinical presentation, gross hematuria was the initial complaint in 84 children (42.6%), whereas microscopic hematuria was detected incidentally in 113 (57.4%). Concomitant fever (temperature >38.5°C) was present in 71 children (36.0%) at enrollment. Flank or abdominal pain was observed in 64 (32.5%), and dysuria in 52 (26.4%). Family history of urolithiasis or hypercalciuria was positive in 29 cases (14.7%). The urological etiological distribution of hematuria is summarized in Table 2. Urinary tract infection (UTI) was the most common cause, identified in 98 children (49.7%), followed by hypercalciuria in 54 (27.4%) and urolithiasis in 32 (16.2%). Among UTI cases, Escherichia coli was the predominant uropathogen (71/98, 72.4%). Vesicoureteral reflux (VUR) was diagnosed in 9 children (4.6%), with grade III being the most common (4 cases). Post-traumatic hematuria was identified in 4 children (2.0%). No urological etiology was determined in 6 children (3.0%) despite complete evaluation. Comparison of clinical characteristics between major etiological groups (UTI vs. hypercalciuria vs. urolithiasis) is shown in Table 3. Significant differences were observed in age distribution: UTI was more common in younger children (1 month–5 years: 55.1%), while hypercalciuria and urolithiasis predominated in older age groups (p<0.001). Female sex predominance was noted in UTI (59.2%), whereas male sex predominated in hypercalciuria (70.4%) and urolithiasis (71.9%) (p=0.003). Gross hematuria was most frequent in urolithiasis (62.5%, p<0.001). Laboratory findings at presentation according to etiological category are presented in Table 4. Serum creatinine was highest in the urolithiasis group (0.71±0.38 mg/dL), and eGFR was lowest in this group (95.6±22.4 mL/min/1.73m²). Urine calcium-to-creatinine ratio was elevated as expected in the hypercalciuria group (0.28±0.09). Hemoglobin was lowest in the UTI group (10.9±1.6 g/dL), reflecting the higher prevalence of younger age and chronic infection. Table 5 shows the distribution of UTI and hypercalciuria by age and sex. UTI was most common in children aged 1 month–5 years (55.1%), while hypercalciuria peaked in the 6–12 years age group (51.9%). Female predominance was observed in UTI (59.2%), whereas male predominance was seen in hypercalciuria (70.4%) and urolithiasis (71.9%). At six-month follow-up (Table 6), complete resolution of hematuria without any residual abnormality occurred in 179 children (90.9%). Persistent asymptomatic hematuria without proteinuria or hypertension was noted in 15 (7.6%). Progression to chronic kidney disease (CKD) stages 1–3 occurred in 3 children (1.5%). All three CKD cases were associated with obstructive uropathy from large bilateral renal stones (staghorn calculi) that required multiple surgical interventions. No child progressed to end-stage renal disease within the follow-up period.

Table 1: Baseline demographic and clinical characteristics of participants (N=197)

Characteristic	Category	n	%
Age group	1 month–5 years	62	31.5
	6–12 years	86	43.7
	13–18 years	49	24.9
Sex	Male	111	56.3
	Female	86	43.7
Residence	Urban/peri-urban	131	66.5
	Rural	66	33.5
Type of hematuria	Gross	84	42.6
	Microscopic	113	57.4
Fever	Yes	71	36.0
	No	126	64.0
Flank/abdominal pain	Yes	64	32.5
	No	133	67.5
Dysuria	Yes	52	26.4
	No	145	73.6
Family history	Positive	29	14.7
	Negative	168	85.3

Table 2: Urological etiological distribution of participants

Etiology	n	%
Urinary tract infection (UTI)	98	49.7
Hypercalciuria	54	27.4
Urolithiasis	32	16.2
Vesicoureteral reflux (VUR)	9	4.6
Post-traumatic	4	2.0
No cause identified	6	3.0

Table 3: Comparison of clinical features between UTI, hypercalciuria, and urolithiasis groups

Clinical feature	UTI (n=98)	Hypercalciuria (n=54)	Urolithiasis (n=32)	P-value
Mean age (years, ±SD)	5.2±3.6	8.9±3.5	11.2±3.8	<0.001
Male sex, n (%)	40 (40.8)	38 (70.4)	23 (71.9)	0.003
Gross hematuria, n (%)	29 (29.6)	27 (50.0)	20 (62.5)	<0.001
Fever, n (%)	61 (62.2)	6 (11.1)	4 (12.5)	<0.001
Flank/abdominal pain, n (%)	18 (18.4)	27 (50.0)	28 (87.5)	<0.001
Dysuria, n(%)	41 (41.8)	7 (13.0)	4 (12.5)	<0.001
Family history positive, n (%)	8 (8.2)	12 (22.2)	9 (28.1)	0.004

P-value calculated using ANOVA for age and Pearson's chi-square test for categorical variables. SD = standard deviation.

Table 4: Laboratory findings at presentation according to etiological category

Laboratory parameter	UTI	Hypercalciuria	Urolithiasis	P-value
	Mean ± SD			
Serum creatinine (mg/dL)	0.48±0.18	0.51±0.19	0.71±0.38	<0.001
eGFR (mL/min/1.73m²)	114.2±18.5	110.3±17.2	95.6±22.4	<0.001
Urine calcium-to-creatinine ratio	0.11±0.07	0.28±0.09	0.22±0.11	<0.001
Hemoglobin (g/dL)	10.9±1.6	11.8±1.3	11.5±1.5	0.001

P-value calculated using ANOVA. eGFR = estimated glomerular filtration rate using the Bedside Schwartz formula.

Table 5: Distribution of UTI, hypercalciuria, and urolithiasis by age and sex

Parameter	UTI	Hypercalciuria	Urolithiasis	P-value
Age group, n (%)				
1 month–5 years	54 (55.1)	5 (9.3)	3 (9.4)	<0.001
6 – 12 years	32 (32.7)	28 (51.9)	13 (40.6)	
13 – 18 years	12 (12.2)	21 (38.9)	16 (50.0)	
Sex, n (%)				
Male	40 (40.8)	38 (70.4)	23 (71.9)	0.003
Female	58 (59.2)	16 (29.6)	9 (28.1)	
Gross hematuria, n (%)	29 (29.6)	27 (50.0)	20 (62.5)	<0.001

P-value calculated using Pearson's chi-square test.

Table 6: Six-month clinical outcomes stratified by urological etiological category

Outcome	UTI (n=98)	Hypercalciuria (n=54)	Urolithiasis (n=32)	No cause (n=6)	P-value
	n (%)				
Complete resolution	94 (95.9)	51 (94.4)	24 (75.0)	6 (100)	<0.001
Persistent asymptomatic hematuria	4 (4.1)	3 (5.6)	5 (15.6)	0 (0)	0.048
Progression to CKD	0 (0)	0 (0)	3 (9.4)	0 (0)	<0.001

P-value calculated using Pearson's chi-square test. CKD = chronic kidney disease (stages 1–3). Note: Percentages for the "No cause" group are omitted due to a small sample size.

Discussion

This prospective cohort study of 197 children with hematuria at a tertiary care hospital in Bangladesh provides contemporary data on the urological etiology and short-term outcomes in a South Asian setting. The findings demonstrate that urinary tract infection (UTI) is the predominant cause, accounting for nearly half of all cases (49.7%), followed by hypercalciuria (27.4%) and urolithiasis (16.2%). Importantly, the overall prognosis was favorable, with 90.9% of children achieving complete resolution within six months. However, 1.5% of children progressed to chronic kidney disease (CKD), all of whom had obstructive uropathy from large bilateral renal stones [3,13]. The predominance of UTI (49.7%) as a cause of hematuria in this cohort aligns with reports from other low- and middle-income countries, where delayed presentation and limited sanitation infrastructure contribute to higher UTI prevalence [15]. The proportion is comparable

to studies from India (45–50%) but exceeds the 25–30% typically reported in high-income settings [10]. Escherichia coli was the predominant uropathogen (72.4%), consistent with global patterns of pediatric UTI bacteriology [16]. The higher frequency of UTI in younger children (55.1% in 1 month–5 years) and female predominance (59.2%) observed in our study are well-recognized epidemiological features [17]. Hypercalciuria was identified in 27.4% of children, emerging as the second most common urological cause of hematuria in this cohort. This figure is notably higher than the 12–16% reported from some Indian studies but comparable to the 22–30% range described in Middle Eastern populations [18]. The male predominance among hypercalciuric children (70.4%) in our study contrasts with the equal sex distribution described in some Western literature, a discrepancy that warrants further investigation [19]. Gross hematuria was present in half of the hypercalciuric children (50.0%), supporting the concept that hypercalciuria should be considered in the differential diagnosis of both microscopic and gross hematuria, even in the absence of frank urolithiasis [20]. Urolithiasis was diagnosed in 16.2% of children, a proportion higher than the 5–10% reported from most Western pediatric series but consistent with recent reports from other South Asian countries, where climate, dietary habits, and low fluid intake contribute to stone formation [9]. The predominance of gross hematuria (62.5%) and flank/abdominal pain (87.5%) in the urolithiasis group reflects classic presenting features [21]. Notably, 9.4% of children with urolithiasis progressed to CKD within six months, all of whom had large bilateral staghorn calculi causing obstructive uropathy. This finding underscores the importance of timely diagnosis and intervention for pediatric stone disease, as delayed management can lead to irreversible renal damage [22]. Vesicoureteral reflux (VUR) was identified in 4.6% of children, all of whom presented with recurrent febrile UTIs. This proportion is consistent with the 3–8% prevalence reported in pediatric hematuria studies, in which VUR is a secondary finding rather than a primary cause of hematuria [23]. Post-traumatic hematuria accounted for 2.0% of cases, reflecting the expected frequency of minor renal trauma in the pediatric age group [24]. Despite a complete urological evaluation, no definitive etiology was determined in 6 children (3.0%). This proportion is lower than the 10–15% reported in many pediatric hematuria series, possibly due to the comprehensive nature of our diagnostic workup [25]. Some of these cases may represent transient benign hematuria of unknown etiology or very small radiolucent stones not visualized on ultrasound [5]. Several practical lessons emerge from our findings. First, the high prevalence of UTI as a cause of hematuria emphasizes the importance of routine urine culture in all children presenting with hematuria, particularly those under five years of age [26]. Second, the substantial proportion of hypercalciuria (27.4%) supports routine screening with spot urine calcium-to-creatinine ratio in children with unexplained hematuria, as this condition is easily treatable with increased fluid intake and dietary modification [14]. Third, the finding that 9.4% of children with urolithiasis progressed to CKD highlights the need for prompt urological referral and intervention for pediatric stone disease, particularly when stones are bilateral or large [27]. Our findings differ substantially from earlier retrospective studies from Bangladesh, which reported higher proportions of glomerular diseases as causes of pediatric hematuria [11]. This discrepancy reflects the difference in study design (prospective vs. retrospective), referral patterns, and the exclusion of glomerular causes in the present study. When compared with purely urological case series from India and Pakistan, our UTI and hypercalciuria proportions are broadly similar, though our urolithiasis rate (16.2%) is somewhat higher, possibly due to the hot climate and dietary habits prevalent in Bangladesh [12].

Limitations

Purposive sampling may introduce selection bias. A six-month follow-up is insufficient for slowly progressive renal damage from chronic obstruction. CT urography was not performed in all children due to cost and radiation concerns.

Conclusion

Pediatric hematuria of urological origin in Bangladesh is predominantly caused by urinary tract infection, hypercalciuria, and urolithiasis. Overall prognosis is favorable, with 90.9% achieving complete resolution within six months. However, children with obstructive uropathy from large bilateral renal stones remain at risk of progressing to chronic kidney disease. Systematic urological evaluation, including urine culture, renal ultrasound, and calcium-to-creatinine ratio screening, is essential for optimal outcomes.

Recommendation

We recommend routine urine culture for all hematuria cases, calcium-to-creatinine ratio screening for unexplained hematuria, and prompt urological referral for children with urolithiasis to prevent chronic kidney disease progression.

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Ai Declaration

Artificial intelligence tools contributed marginally to manuscript preparation and development. All core scientific content was human-verified.

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