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Original study

Prevalence and patterns of asymptomatic urinary abnormalities among school children: A prospective cross-sectional screening study.

Dr. Shreyas A. C[1], Dr. Alkarani T. Patil[2], Dr. Jacqueline A. Shah[3*], Dr. Ranjitha M[3], Dr. Sathvika Chandrashekara Reddy[3]

[1]Senior Resident, Hemato oncology, B.J Wadia Hospital, India
[2]Professor and HOD, Department of Pediatrics, Indira Gandhi Institute of Child Health, Bangalore, India
[3]Assistant Professor, Department of Pediatrics, Indira Gandhi Institute of Child Health, Bangalore, India

Abstract

Background

Asymptomatic urinary abnormalities in children may represent transient changes or early manifestations of renal and urinary tract disease. School-based urine screening may facilitate early detection, but abnormal dipstick findings require confirmation because many resolve on repeat testing.

Methods

This prospective cross-sectional screening study included school children aged 5–15 years attending three government-aided schools in Bangalore, India. First-voided early-morning, midstream clean-catch urine samples were examined using multiparameter urine reagent strips. Children with an abnormal initial result underwent repeat urine-dipstick testing and blood-pressure measurement after 15 days. Children with persistent abnormalities were referred for further clinical and laboratory evaluation. Categorical variables were assessed using the chi-square test, with $p<0.05$ considered statistically significant.

Results

Of 2,000 children approached, 1,920 were included. The study population comprised 1,066 boys and 854 girls. Initial screening identified urinary abnormalities in 162 children (8.43%). Isolated proteinuria was the most frequent finding (61, 3.18%), followed by hematuria (54, 2.81%), pyuria (41, 2.14%), and combined hematuria and proteinuria (6, 0.31%). After repeat testing, 42 children (2.19%) remained positive; 25.9% of initially positive children therefore had persistent abnormalities. Ten children attended hospital follow-up, where urinary tract infection, Henoch–Schönlein purpura, ureteric calculus, and membranoproliferative glomerulonephritis were identified.

Conclusion

Urinary abnormalities were relatively common during initial school screening but declined substantially after repeat testing. Repeat urinalysis is therefore essential before extensive investigation.

Recommendation

School-based screening should incorporate properly collected first-morning urine, repeat testing of positive results, blood-pressure assessment, appropriate quantitative confirmation, and a reliable referral pathway for children with persistent abnormalities.

Keywords: *asymptomatic urinary abnormalities; school children; urine dipstick; hematuria; proteinuria; pyuria; renal screening.*
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Corresponding Author: *Dr. Jacqueline A. Shah*
*Email:**monika70mishra@gmail.com***
Assistant Professor, department of Pediatrics, Indira Gandhi Institute of Child Health, Bangalore, India

Introduction

Urinary abnormalities are frequently detected in children even when they have no visible symptoms of kidney or urinary tract disease. School-aged children may appear healthy while having microscopic hematuria, proteinuria, pyuria, glycosuria, nitrituria, or other abnormal findings on routine urine examination. Most isolated abnormalities are temporary and may disappear when the test is repeated. However, persistent abnormalities can be early signs of glomerular disease, urinary tract infection, structural urinary tract abnormalities, hereditary kidney disorders, or metabolic disease [1]. Because many kidney diseases remain clinically

silent during their early stages, urine screening offers an opportunity to identify affected children before complications develop. Hematuria and proteinuria are the two abnormalities most commonly considered during urinary screening. Microscopic hematuria may result from temporary causes such as exercise, fever, minor trauma, or infection, whereas persistent hematuria may be associated with hypercalciuria, urinary stones, IgA nephropathy, Alport syndrome, thin basement membrane disease, or other glomerular conditions [1,2]. Proteinuria may be transient following fever, dehydration, physical activity, or emotional stress. Orthostatic proteinuria is another relatively benign condition, particularly among adolescents. Persistent proteinuria, especially when accompanied by hematuria, hypertension, edema, or impaired kidney function, requires detailed evaluation [1].

The reported prevalence of asymptomatic urinary abnormalities among school children differs considerably between countries and study populations. In a large Indian school-based study, at least one asymptomatic urinary abnormality was detected in 7.44% of participants; isolated hematuria and isolated proteinuria were reported in 5.2% and 1.9%, respectively [3]. Another Indian study involving 1,675 asymptomatic children found isolated hematuria in 1.9%, isolated proteinuria in 0.35%, and glycosuria in 0.06% during initial screening [4]. Repeat testing is important because a single abnormal dipstick result does not confirm kidney disease. In a Nepalese study of 2,243 school children, 5.5% had an abnormality during initial screening, but only 0.71% remained positive during the second screening [5]. A Lebanese study reported urinary abnormalities in 2.9% during initial testing, with abnormalities persisting in 72% of initially positive participants [6]. A Pakistani study reported abnormalities in 17.38% during first screening and 5.38% during second screening [7].

Several Asian countries have implemented school urine-screening programmes. Korean experience has demonstrated that school urinalysis can identify children with asymptomatic urinary abnormalities who may require specialist assessment [8,9]. Nevertheless, routine mass screening remains controversial because of false-positive results, anxiety, diagnostic costs, limited follow-up, and uncertainty about long-term benefit [10]. Therefore, the present study was designed to determine the prevalence and patterns of asymptomatic urinary abnormalities among school children and to evaluate the persistence of abnormal findings after repeat testing.

Materials and methods

Study design and setting

This was a prospective, cross-sectional, school-based screening study conducted from 1 January 2018 to 30 May 2019 in three government-aided schools in Wilson Garden, Bangalore, India: Hombegowda Boys High School, Smt Gangamma Hombegowda Girls High School, and Maruti Vidyalaya. Administrative permission was obtained from the Deputy Director of Public Instruction and the respective school authorities.

Study population and eligibility

The study included school-going children aged 5–15 years. Children were eligible when written informed consent was provided by a parent or legally authorised representative. Children with previously diagnosed renal disease or other systemic illnesses and those receiving long-term steroid therapy or other long-term medications were excluded.

Sample-size estimation

The sample size was estimated using a previously reported prevalence of urinary abnormalities of 5.5%. Assuming 80% statistical power, a 5% level of significance, and 10% relative precision, the minimum required sample size was calculated as 1,910 children.

Data collection and clinical assessment

Demographic and relevant clinical information was collected using a pretested, prestructured study proforma. Information included age, sex, and significant past medical history. Parents and children were instructed regarding appropriate urine collection.

Urine-sample collection

A first-voided, early-morning, midstream, clean-catch urine specimen was collected from each participant. Participants were instructed to clean the periurethral area, avoid touching the inside of the specimen container, pass the initial urine portion into the toilet, and collect the midstream portion in the provided container.

Dipstick urinalysis

Urine specimens were screened using Mission® Urinalysis Reagent Strips manufactured by ACON Laboratories, Inc., USA. The strips assessed leukocyte esterase, nitrite, urobilinogen, protein, pH, blood, specific gravity, ketones, bilirubin, and glucose. A child was considered initially positive when one or more parameters showed a positive or abnormal result.

Repeat testing and definition of persistence

Children with any positive or abnormal result during initial screening were reassessed after 15 days. Repeat dipstick testing and blood-pressure measurement were performed. A persistent abnormality was defined as a positive finding on both the initial and repeat dipstick tests.

Referral and further evaluation

Children with persistent abnormalities were advised to attend the paediatric outpatient department. Depending on the pattern of abnormality, investigations included 24-hour urinary protein estimation, spot urine protein-to-creatinine ratio, renal function tests, serum complement C3, ultrasonography of the abdomen and urinary system, and renal biopsy when clinically indicated.

Outcome measures

The primary outcome was the prevalence of urinary abnormalities detected by school-based dipstick screening. Secondary outcomes included the proportion of initially positive children who remained positive after 15 days and the distribution of abnormalities by age and sex.

Statistical analysis

Data were entered into Microsoft Excel and analysed using SPSS version 10.0.5. Categorical variables were compared using Pearson's chi-square test. A two-sided $p<0.05$ was considered statistically significant. Because several individual abnormality categories had small numbers, the chi-square assumptions should be checked against the original statistical output before final submission; Fisher's exact test may be preferable where expected counts are insufficient.

Bias

Potential selection bias was reduced by applying predefined eligibility criteria consistently across the three participating schools. Information was collected using a standardized study proforma. Specimen-related bias was addressed through standardized instructions for first-morning, midstream, clean-catch urine collection. All initially positive children were invited for repeat testing after 15 days using the same dipstick approach. Blood pressure was assessed during repeat evaluation. Nevertheless, incomplete attendance at hospital follow-up could have introduced follow-up bias.

Ethical considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee, Department of Pediatrics, Indira Gandhi Institute of Child Health, Bangalore, Karnataka, India. Written informed consent was obtained from the parents or legally authorized representatives of all participating children. The study was conducted in accordance with the principles of the Declaration of Helsinki and applicable institutional ethical requirements.

Results

Study recruitment, urine screening, and follow-up flow

A total of 2,000 school children aged 5–15 years were approached. Eighty were excluded: parental consent was not provided for 53 children and 27 children did not submit a urine sample. Therefore, 1,920 children underwent initial urine screening. Of these, 162 had at least one urinary abnormality. After repeat testing at 15 days, 42 remained positive and 120 no longer had an abnormal finding. Thus, 25.9% of initially positive children had persistent abnormalities. Of the 42 children with persistent abnormalities, 10 attended hospital follow-up and 32 did not attend the reported follow-up. The reduction from 42 to 10 represents follow-up attendance and should not be interpreted as resolution of disease.

Figure 1. 2,000 school children approached, 1,920 underwent initial urine-dipstick screening. Urinary abnormalities were detected in 162 children during the initial screening, 42 remained positive after repeat testing at two weeks, and ten were reported to have attended the hospital for further evaluation (Table 1).

Table 1. Recruitment, urine screening and follow-up of the study population

Study stage	N	%
Children initially approached	2,000	100.0
Excluded	80	4.0
No parental consent	53	2.65
Urine sample not submitted	27	1.35
Children included	1,920	96.0
Positive during initial screening	162	8.43
Positive during repeat screening	42	2.19
Persistent among initially positive	42/162	25.9
Attended hospital follow-up	10/42	23.8

Note. Percentages for initial and repeat screening use 1,920 as denominator; persistence uses 162; hospital follow-up uses 42.

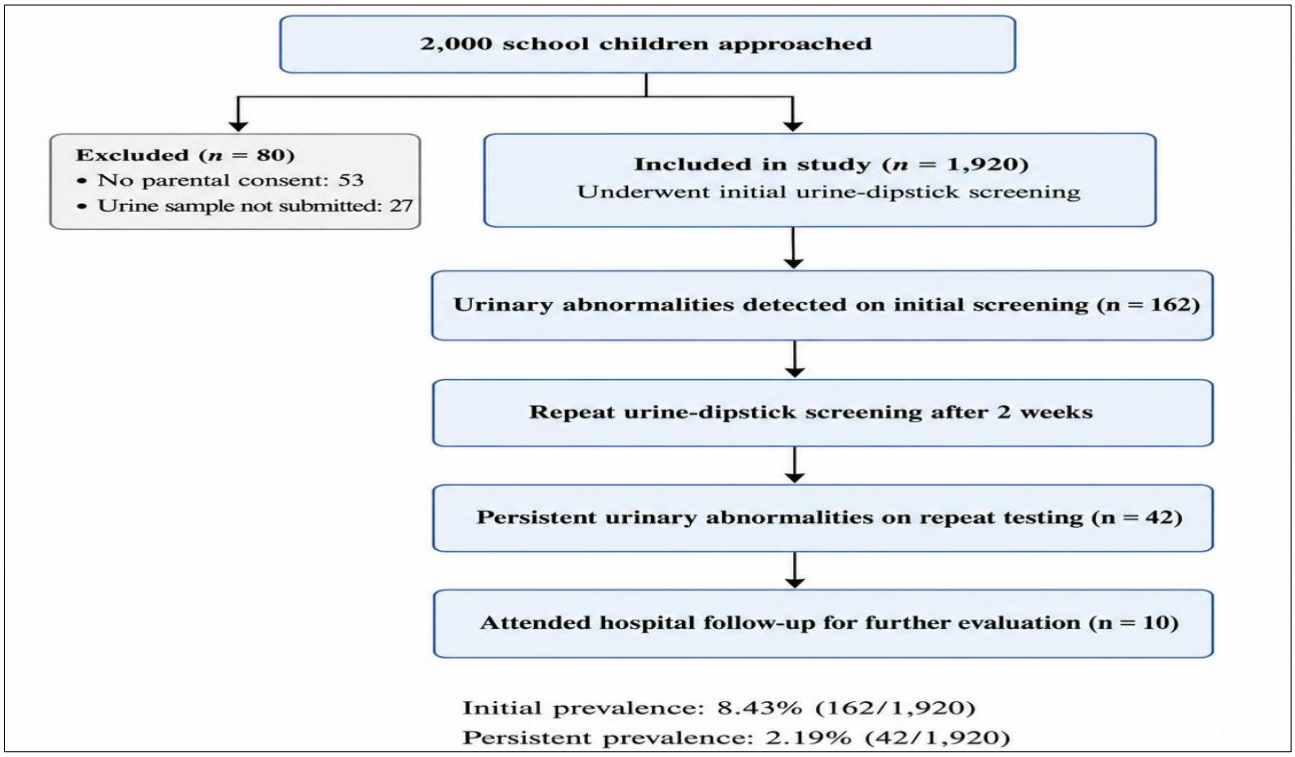

Figure 1: Study recruitment, urine-screening and follow-up flow diagram

Among the 1,920 included children, 707 (36.8%) were aged 5–10 years and 1,213 (63.2%) were aged 11–15 years. There were 1,066 boys (55.5%) and 854 girls (44.5%) (Table 2).

Table 2: Age and sex distribution of the study population

Age group	Boys, n (%)	Girls, n (%)	Total, n (%)
5–10 years	316 (44.7)	391 (55.3)	707 (36.8)
11–15 years	750 (61.8)	463 (38.2)	1,213 (63.2)
Total	1,066 (55.5)	854 (44.5)	1,920 (100.0)

Note. Sex percentages are calculated within age groups; total percentages use the complete study population.

Initial screening identified 162 children with urinary abnormalities (8.43%). Isolated proteinuria was most frequent (61, 3.18%), followed by isolated hematuria (54, 2.81%), pyuria (41, 2.14%), and combined hematuria and proteinuria (6, 0.31%) (Table 3).

Table 3: Distribution of urinary abnormalities by age during the initial screening

Urinary finding	5–10 years, n/N (%)	11–15 years, n/N (%)	Total, n/N (%)
Isolated hematuria	14/707 (1.98)	40/1,213 (3.30)	54/1,920 (2.81)
Isolated proteinuria	22/707 (3.11)	39/1,213 (3.22)	61/1,920 (3.18)
Hematuria and proteinuria	3/707 (0.42)	3/1,213 (0.25)	6/1,920 (0.31)
Pyuria	13/707 (1.84)	28/1,213 (2.31)	41/1,920 (2.14)
Any urinary abnormality	52/707 (7.35)	110/1,213 (9.07)	162/1,920 (8.43)

The prevalence of any urinary abnormality was 10.30% in girls and 6.94% in boys.

Table 4: Distribution of urinary abnormalities by sex during the initial screening

Urinary finding	Boys, n/N (%)	Girls, n/N (%)	Total, n/N (%)
Isolated hematuria	23/1,066 (2.16)	31/854 (3.63)	54/1,920 (2.81)
Isolated proteinuria	28/1,066 (2.63)	33/854 (3.86)	61/1,920 (3.18)
Hematuria and proteinuria	3/1,066 (0.28)	3/854 (0.35)	6/1,920 (0.31)
Pyuria	20/1,066 (1.88)	21/854 (2.46)	41/1,920 (2.14)
Any urinary abnormality	74/1,066 (6.94)	88/854 (10.30)	162/1,920 (8.43)

After repeat testing, 42 children remained positive. Persistent pyuria was most frequent (18, 0.94%), followed by isolated hematuria (12, 0.63%), isolated proteinuria (8, 0.42%), and combined hematuria and proteinuria (4, 0.21%) (Table 4).

Table 5: Distribution of persistent urinary abnormalities by age during repeat screening

Urinary finding	5–10 years, n/N (%)	11–15 years, n/N (%)	Total, n/N (%)
Isolated hematuria	4/707 (0.57)	8/1,213 (0.66)	12/1,920 (0.63)
Isolated proteinuria	3/707 (0.42)	5/1,213 (0.41)	8/1,920 (0.42)
Hematuria and proteinuria	2/707 (0.28)	2/1,213 (0.16)	4/1,920 (0.21)
Pyuria	7/707 (0.99)	11/1,213 (0.91)	18/1,920 (0.94)
Any persistent abnormality	16/707 (2.26)	26/1,213 (2.14)	42/1,920 (2.19)
Urinary finding	**Boys, n/N (%)**	**Girls, n/N (%)**	**Total, n/N (%)**
Isolated hematuria	4/1,066 (0.38)	8/854 (0.94)	12/1,920 (0.63)
Isolated proteinuria	3/1,066 (0.28)	5/854 (0.59)	8/1,920 (0.42)
Hematuria and proteinuria	2/1,066 (0.19)	2/854 (0.23)	4/1,920 (0.21)
Pyuria	6/1,066 (0.56)	12/854 (1.41)	18/1,920 (0.94)
Any persistent abnormality	15/1,066 (1.41)	27/854 (3.16)	42/1,920 (2.19)

Ten children attended detailed assessment. One child with persistent microscopic hematuria had purpuric rash and joint tenderness and was diagnosed with Henoch–Schönlein purpura. Another had persistent microscopic hematuria associated with a right ureteric calculus. Several children were diagnosed with urinary tract infection and improved following antibiotic treatment. One eight-year-old boy with combined hematuria and proteinuria had hypertension, impaired renal function and persistently reduced C3; renal biopsy demonstrated membranoproliferative glomerulonephritis.

Table 6: Distribution of persistent urinary abnormalities by sex during repeat screening

Urinary finding	Boys, n/N (%)	Girls, n/N (%)	Total, n/N (%)
Isolated hematuria	4/1,066 (0.38)	8/854 (0.94)	12/1,920 (0.63)
Isolated proteinuria	3/1,066 (0.28)	5/854 (0.59)	8/1,920 (0.42)
Hematuria and proteinuria	2/1,066 (0.19)	2/854 (0.23)	4/1,920 (0.21)
Pyuria	6/1,066 (0.56)	12/854 (1.41)	18/1,920 (0.94)
Any persistent abnormality	**15/1,066 (1.41)**	**27/854 (3.16)**	**42/1,920 (2.19)**

Chi-square analysis

Pearson chi-square tests calculated from the counts presented in Tables 3–6 are shown below. These values should be reconciled with the original SPSS output before submission.

Comparison	χ^2	df	P
Initial hematuria by age	2.836	1	.092
Initial proteinuria by age	0.016	1	.901
Initial combined hematuria/proteinuria by age	0.449	1	.503
Initial pyuria by age	0.471	1	.492
Initial any abnormality by age	1.697	1	.193
Initial hematuria by sex	3.761	1	.053
Initial proteinuria by sex	2.361	1	.124
Initial combined hematuria/proteinuria by sex	0.074	1	.785
Initial pyuria by sex	0.771	1	.380
Initial any abnormality by sex	6.940	1	.008
Persistent hematuria by age	0.063	1	.802
Persistent proteinuria by age	0.002	1	.968
Persistent combined hematuria/proteinuria by age	0.299	1	.584
Persistent pyuria by age	0.033	1	.855
Any persistent abnormality by age	0.030	1	.863
Persistent hematuria by sex	2.407	1	.121
Persistent proteinuria by sex	1.056	1	.304
Persistent combined hematuria/proteinuria by sex	0.049	1	.824
Persistent pyuria by sex	3.622	1	.057
Any persistent abnormality by sex	6.821	1	.009

Statistical verification note: the manuscript's original narrative stated that proteinuria was significantly associated with sex. However, the counts shown in Table 4 yield χ^2=2.361, p=.124. Therefore, the original thesis/SPSS output should be checked and the final manuscript should use the verified analysis rather than retaining an unsupported significance claim.

Discussion

The present prospective school-based study evaluated asymptomatic urinary abnormalities among 1,920 children aged 5–15 years. Initial screening identified abnormalities in 8.43%, while only 2.19% remained positive after repeat testing. Isolated proteinuria was the most frequent initial abnormality, whereas pyuria was the most frequent persistent finding. Girls had a higher prevalence of overall urinary abnormalities than boys, and clinically important conditions were identified among children who attended follow-up. The initial prevalence of 8.43% lies within the broad range reported in school urine-screening studies, although direct comparisons should be made cautiously because studies differ in dipstick thresholds, specimen collection, age groups and definitions of abnormality. Okur et al. reported isolated hematuria in 4.9%, isolated proteinuria in 0.8%, and combined hematuria and proteinuria in 0.5% among Turkish school children [11]. A Taiwanese study reported hematuria and proteinuria in 4.1% and 5.7%, respectively [12]. The reduction from 162 initially positive children to 42 persistent cases is clinically important. Only 25.9% of initially positive children remained positive. This supports confirmation before labelling a child as having persistent renal or urinary disease. Transient abnormalities may occur because of physical activity, fever, dehydration, concentrated urine, orthostatic protein excretion or contamination. Vehaskari and Rapola found that proteinuria was considerably less frequent when repeated specimens were considered than when a single specimen was used [13].

Initial proteinuria affected 3.18% of children but decreased to 0.42% after repeat testing. Persistent proteinuria is more

clinically important than a single positive dipstick result and should be quantified with an appropriate first-morning protein-to-creatinine or albumin-to-creatinine ratio. The absence of quantitative protein measurement in all positive

children limited detailed classification. Microscopic hematuria was present in 2.81% initially and persisted in 0.63%. Persistent hematuria can be associated with urinary stones, hypercalciuria, urinary tract infection, IgA nephropathy and other renal disorders [2,11]. The ureteric calculus and Henoch–Schönlein purpura detected during follow-up reinforce the importance of evaluating persistent hematuria. Pyuria was detected in 2.14% initially and persisted in 0.94%. Pyuria or leukocyte esterase positivity alone does not establish urinary tract infection; contamination and nonbacterial inflammatory conditions can also cause leukocytes in urine. Urine culture is required when infection is suspected. A meta-analysis found asymptomatic bacteriuria to be substantially less common than pyuria reported in many screening populations [15].

The higher prevalence of urinary abnormalities among girls may reflect sex-related differences in urinary infection risk or specimen contamination. Menstrual contamination may influence hematuria among adolescents, but menstrual status was not recorded. The observed sex association should therefore be interpreted cautiously. The most clinically important individual finding was membranoproliferative glomerulonephritis in an eight-year-old boy with combined hematuria and proteinuria, hypertension, impaired renal function and low C3. School screening has been reported to identify children with membranoproliferative glomerulonephritis at an earlier stage and with potentially more favourable clinical features [17]. Combined hematuria and proteinuria, particularly with hypertension, reduced complement or impaired renal function, should therefore prompt urgent specialist assessment. Only 10 of 42 children with persistent abnormalities attended hospital follow-up. This limits diagnostic confirmation and illustrates a central challenge of school screening: screening is only clinically useful when linked to counselling, referral, affordable investigations and reliable follow-up.

The value of universal urinary screening remains debated. Japanese experience supports structured screening in selected settings [18], whereas cost-effectiveness work has questioned routine dipstick screening in primary care [19]. Recent Japanese modelling also found that cost-effectiveness is sensitive to screening costs, false-positive effects, disease incidence and the likelihood of diagnosis without screening [20]. Decisions about screening should therefore be based on local disease burden and the capacity to provide confirmatory evaluation and follow-up.

Generalizability

The findings may be relevant to other urban Indian school populations where school-based health screening can be organized. The large reduction in positive findings after repeat testing is particularly generalizable to programmes using dipstick urinalysis, because transient abnormalities can otherwise lead to unnecessary investigation. However, generalization should be cautious. The study involved only three government-aided schools in one area of Bangalore. Results may differ in private schools, rural or tribal populations, other geographic regions, or populations with different socioeconomic, environmental and healthcare-access characteristics. Differences in urinary infection patterns, nutrition, specimen collection, and screening thresholds may also affect prevalence. The study is therefore best interpreted as evidence supporting a staged approach to urinary screening rather than as a definitive estimate of urinary abnormality prevalence for all Indian children. Larger multicentre studies including diverse urban and rural populations would improve external validity.

Conclusion

Asymptomatic urinary abnormalities were relatively common during initial school screening but declined substantially after repeat testing. Repeat examination is therefore essential before extensive investigation. Persistent hematuria, proteinuria, pyuria and especially combined hematuria-proteinuria can identify a small but clinically important group requiring further evaluation. Properly collected first-morning urine, repeat testing, quantitative confirmation, blood-pressure assessment and reliable referral may provide greater clinical value than decisions based on a single screening result.

Limitations

The study was conducted in only three government-aided schools in one area of Bangalore, limiting generalizability. Urine microscopy, culture and quantitative protein measurement were not performed for all positive children. Recent fever, strenuous exercise, menstruation, hydration status and specimen contamination were not comprehensively documented. Only 10 of 42 children with persistent abnormalities attended hospital follow-up, limiting diagnostic confirmation and introducing possible follow-up bias. The analysis relied mainly on chi-square testing without multivariable adjustment, effect estimates or confidence intervals, and school-level clustering was not addressed. The cross-sectional design and short follow-up prevented assessment of long-term renal outcomes.

Recommendations

School-based urinary screening should not rely on a single positive dipstick result. A staged strategy should begin with properly collected early-morning urine and repeat testing of abnormal results. Children with persistent hematuria, proteinuria, pyuria or combined abnormalities should undergo blood-pressure assessment and appropriate confirmatory investigations. Quantitative protein assessment, urine microscopy, urine culture when clinically indicated, renal-function testing and renal imaging should be guided by the pattern and severity of the abnormality. Children with combined hematuria and proteinuria, hypertension, impaired

renal function, reduced complement or other concerning findings should be referred promptly to paediatric nephrology. Future studies should involve larger and geographically diverse populations, standardized confirmatory testing, longer follow-up, documentation of recent illness and menstruation, multivariable analysis, and mechanisms for referral tracking and affordable follow-up.

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List of abbreviations

Abbreviation		Meaning
C3	:	Complement component 3
CKD	:	Chronic kidney disease
IgA	:	Immunoglobulin A
IRB	:	Institutional Review Board
SPSS	:	Statistical Package for the Social Sciences
UTI	:	Urinary tract infection

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Conflict of interest

The supplied manuscript does not contain a conflict-of-interest declaration. The authors should confirm the final statement. If applicable: “The authors declare that they have no conflict of interest.”

Data availability

The data generated and/or analysed during the present study are not available in a public repository. Subject to institutional and ethical restrictions, relevant de-identified data may be made available from the corresponding author upon reasonable request.

Author contributions

Dr. Shreyas A. C.: Study conception, study design, data collection, data interpretation and manuscript preparation.

Dr. Alkarani T. Patil: Study supervision, clinical oversight, interpretation of findings and critical revision of the manuscript.

Dr. Jacqueline A. Shah: Study supervision, clinical assessment, interpretation of findings, manuscript revision and corresponding-author responsibilities.

Dr. Ranjitha M.: Data collection, clinical assessment, interpretation of findings and manuscript review.

Dr. Sathvika Chandrashekara Reddy: Data collection, clinical assessment, interpretation of findings and manuscript review.

All authors reviewed and approved the final manuscript and agreed to be accountable for the work. AUTHOR CONFIRMATION IS REQUIRED because individual contribution details were not explicitly supplied in the source manuscript.

Author biographies

Dr. Shreyas A. C. is a Senior Resident in Hemato-Oncology at B.J. Wadia Hospital, India. His professional interests include clinical medicine and the evaluation and management of hematological and oncological disorders.

Dr. Alkarani T. Patil is Professor and Head of the Department of Pediatrics at Indira Gandhi Institute of Child Health, Bengaluru, India. His professional work focuses on pediatric healthcare, clinical assessment and management of childhood disorders.

Dr. Jacqueline A. Shah is an Assistant Professor in the Department of Pediatrics at Indira Gandhi Institute of Child Health, Bengaluru, India. Her professional interests include pediatric clinical care, child health assessment and pediatric research.

Dr. Ranjitha M. is an Assistant Professor in the Department of Pediatrics at Indira Gandhi Institute of Child Health, Bengaluru, India. Her professional work includes pediatric clinical care, assessment and academic research.

Dr. Sathvika Chandrashekara Reddy is an Assistant Professor in the Department of Paediatrics at Indira Gandhi Institute of Child Health, Bengaluru, India. Her professional interests include pediatric healthcare, clinical assessment and academic research.

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