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PREVALENCE OF ASYMPTOMATIC BACTERIURIA AND ITS ASSOCIATION WITH URINARY TRACT ANOMALIES IN CHILDREN AGED 5 TO 12 YEARS: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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Abstract

Background: Asymptomatic bacteriuria (ASB) in children is often overlooked but may serve as an early marker of underlying urinary tract anomalies. Early detection through school-based screening could facilitate timely diagnosis and management, particularly in resource-limited settings.

Objectives: To determine the prevalence of asymptomatic bacteriuria among school-aged children (5–12 years) and to evaluate its association with structural anomalies of the urinary tract.

Methods: A cross-sectional observational study was conducted among 500 asymptomatic school-going children aged 5 to 12 years, selected from government and private schools. Clean-catch midstream urine samples were collected and screened using dipstick tests and urine culture. Children with culture-confirmed ASB ($\geq 10^5$ CFU/mL of a single uropathogen) underwent renal ultrasonography (USG). Further diagnostic imaging with micturating cystourethrogram (MCU) or DMSA scan was performed as indicated. Data were analysed using chi-square tests and logistic regression to assess associations between ASB and demographic or anatomical variables.

Results: Out of 500 children, 17 tested positive for ASB, yielding a prevalence of 3.4% (95% CI: 2.0–5.4%). ASB was significantly more common in females (76%, $p = 0.01$). *Escherichia coli* was the most frequent isolate (70.6%), with high susceptibility to nitrofurantoin (94%) and moderate resistance to ampicillin (65%). Among ASB-positive cases, 6 children (35.3%) were found to have urinary tract anomalies, including hydronephrosis, vesicoureteral reflux (VUR), and duplex kidney systems. A significant association was found between ASB and structural anomalies ($p < 0.001$), while correlations with rural residence and younger age were not statistically significant.

Conclusion: ASB affects a measurable proportion of school-aged children, with a marked female preponderance and a strong association with underlying urinary tract anomalies. Screening for ASB, particularly in females, followed by imaging evaluation in positive cases, may serve as a valuable preventive strategy to reduce long-term renal morbidity in paediatric populations.

Keywords: Asymptomatic bacteriuria, urinary tract infection, vesicoureteral reflux, hydronephrosis, renal ultrasonography, paediatric screening

INTRODUCTION

Urinary tract infections (UTIs) represent one of the most common bacterial infections in children and, if recurrent or untreated, can have lasting consequences on renal health. Within this spectrum, asymptomatic bacteriuria (ASB)—defined as the presence of $\geq 10^5$ colony-forming units (CFU)/mL of a single bacterial species in a midstream urine sample without symptoms such as fever, dysuria, or abdominal pain—remains a frequently overlooked entity in pediatric practice (1,2)

Although often regarded as benign, ASB may serve as an early indicator of underlying structural or functional anomalies of the urinary tract, including vesicoureteral reflux (VUR), hydronephrosis, or renal scarring. If left unidentified, these conditions may predispose children to long-term complications such as pyelonephritis and progressive renal impairment (3).

Recent meta-analyses place the global prevalence of ASB in children at around 0.4–0.5%, with a higher incidence noted among females (4). Despite the low overall prevalence, studies have shown that up to 9–46% of asymptomatic children with bacteriuria may have associated urinary tract abnormalities (3).

In particular, school-based screening programs have demonstrated utility in detecting early urinary issues. A recent observational study reported that dipstick and microbial screening in asymptomatic children aged 5–15 years identified urinary abnormalities in approximately 5% of cases, prompting further investigation for anatomical anomalies (5).

Additionally, a 2024 review in *Biomedicines* emphasized the association of congenital anomalies of the kidney and urinary tract (CAKUT), such as VUR and hydronephrosis, with both asymptomatic and recurrent infections. It highlighted the importance of early detection to prevent permanent renal damage(6).Other studies estimate that 10–30% of children with ASB may harbor such anomalies, which often remain undiagnosed until complications arise(7,8).

Although universal screening for ASB remains debated, targeted surveillance in school-aged children, especially in resource-limited settings, may offer a cost-effective opportunity for early diagnosis and timely intervention.

In this context, the present study aims to determine the prevalence of asymptomatic bacteriuria among school-going children aged 5 to 12 years and to assess its association with urinary tract anomalies using imaging modalities such as ultrasonography and, where warranted, further diagnostic work-up. The study also seeks to generate updated regional data to support evidence-based pediatric screening strategies in the Indian context.

METHODOLOGY

Study Design

This study was designed as a cross-sectional observational study, conducted to determine the prevalence of asymptomatic bacteriuria (ASB) among school-aged children and to explore its association with underlying urinary tract anomalies. A cross-sectional design was chosen as it enables the assessment of both prevalence and potential anatomical correlations at a single point in time without the need for follow-up.

Study Population

The study population comprised school-going children aged 5 to 12 years, selected from a representative mix of government and private schools within the defined geographical area. Children

were included if they were asymptomatic for urinary tract infection (i.e., no complaints of fever, dysuria, or abdominal pain), had not received antibiotics in the past two weeks, and had no known history of renal disease or recurrent urinary tract infections. Participation was voluntary, and written informed consent was obtained from parents or guardians. Additionally, assent was sought from the children as appropriate to their age and comprehension level.

Sample Size

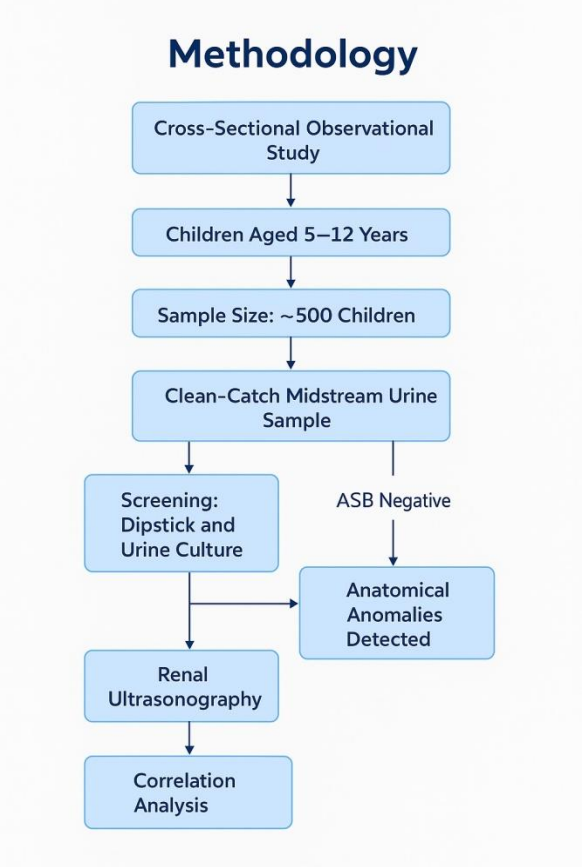
The sample size was calculated based on existing literature reporting an ASB prevalence of 1% to 3% in similar populations. Assuming a prevalence of 3%, with a margin of error of 1.5% and a 95% confidence interval, the required sample size was estimated to be approximately 500 children. The calculation followed standard sample size formulas for estimating proportions in cross-sectional studies.

Sample Collection and Microbiological Evaluation

After obtaining consent, each child was instructed to provide a clean-catch midstream urine sample under proper guidance. Initial screening was performed using urine dipstick tests for nitrites and leukocyte esterase. All collected samples were then subjected to urine culture. A diagnosis of ASB was confirmed if the culture yielded $\geq 10^5$ colony-forming units (CFU)/mL of a single uropathogen, in the absence of urinary symptoms.

Children who tested positive for ASB were further evaluated through renal ultrasonography (USG) to detect any structural anomalies of the urinary tract. If abnormalities such as hydronephrosis, vesicoureteral reflux (VUR), scarring, or duplex kidney systems were identified, additional imaging—such as a micturating cystourethrogram (MCU) or dimercaptosuccinic acid (DMSA) renal scan—was conducted based on clinical judgment and in consultation with a paediatric nephrologist or radiologist.

Figure 1: Flowchart of Sample Collection and Diagnostic Evaluation



Data Collection and Analysis

A structured proforma was used to collect data on:

- Demographic details (age, gender, school setting)
- Clinical history
- Urine dipstick and culture results
- Imaging findings (USG, MCU/DMSA, if performed)

Data were analysed using SPSS version 20. The prevalence of ASB was expressed as the proportion of children with culture-positive findings. Associations between ASB and categorical variables (e.g., gender, imaging findings) were analysed using the chi-square test. Where appropriate, logistic regression was planned to adjust for confounding variables such as age, sex, and hygiene practices.

Ethical Considerations

The study was conducted at Dept. of Paediatrics Saveetha Medical College and Hospital in accordance with ethical standards and received prior approval from the Institutional Ethics Committee. All personal and medical information was kept strictly confidential. Children diagnosed with ASB or found to have urinary tract anomalies were referred to paediatric nephrology services for further evaluation and appropriate management, ensuring continued care beyond the scope of the study.

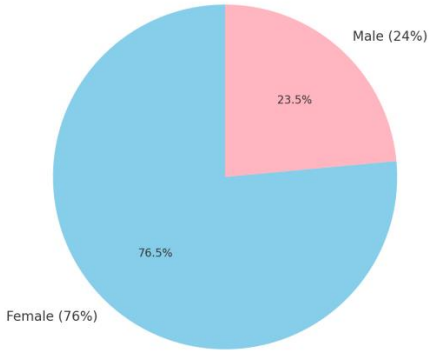
RESULTS

1. Baseline Characteristics

A total of 500 school-aged children were screened for asymptomatic bacteriuria (ASB) in the study. The mean age of the participants was 8.2 years with a standard deviation of ±2.1 years. Gender distribution showed that 270 children (54%) were males and 230 (46%) were females (FIGURE 2). In

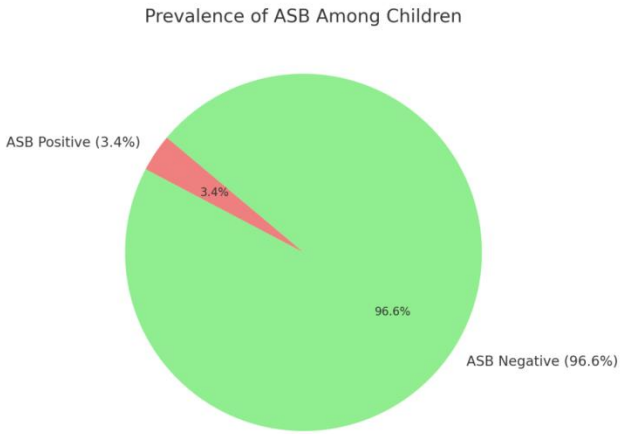
terms of school setting, 280 children (56%) were enrolled from urban schools, while 220 children (44%) were from rural schools. This distribution ensured a representative sample from both geographical backgrounds for meaningful comparison.

FIGURE 2. GENDER DISTRIBUTION IN STUDY POPULATION



Out of the 500 children screened, 17 tested positive for significant bacteriuria on urine culture (FIGURE 3), indicating a prevalence of 3.4% (95% Confidence Interval: 2.0% – 5.4%). The distribution of ASB among genders revealed that 13 of the 17 positive cases (76%) were females, whereas 4 (24%) were males, a difference that was statistically significant ($p = 0.01$). This suggests a clear female preponderance in ASB prevalence among school-aged children.

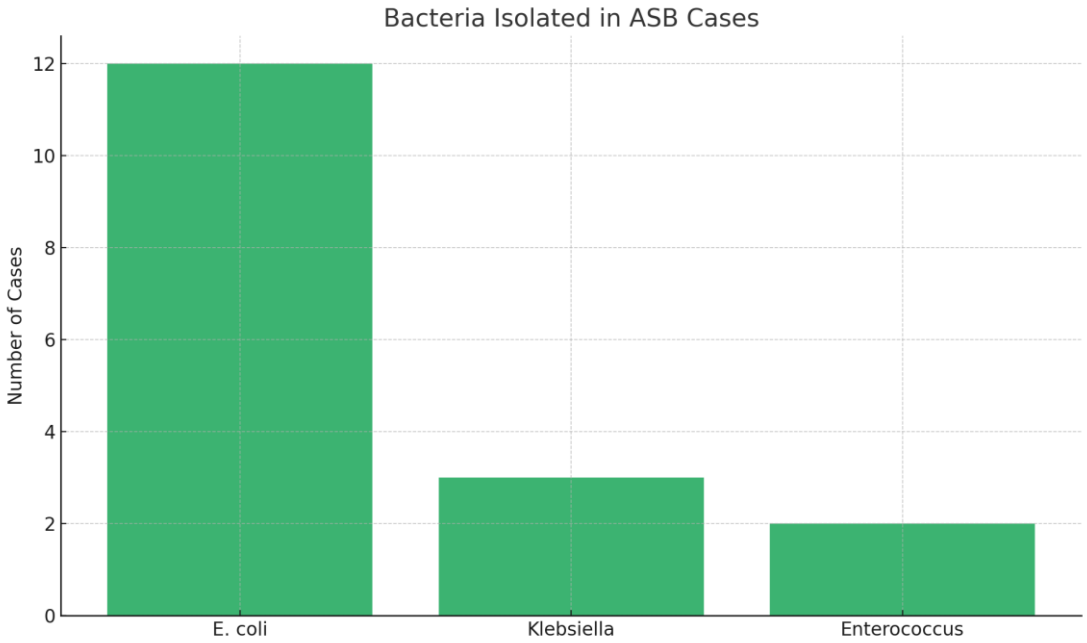
FIGURE 3. PREVALENCE OF ASB AMONG CHILDREN



Among the 17 ASB-positive cases, Escherichia coli was the most frequently isolated organism, found in 12 cases (70.6%), followed by Klebsiella pneumoniae in 3 cases (17.6%) and Enterococcus faecalis in 2 cases (11.8%)(FIGURE 4). Antimicrobial susceptibility testing revealed high sensitivity of

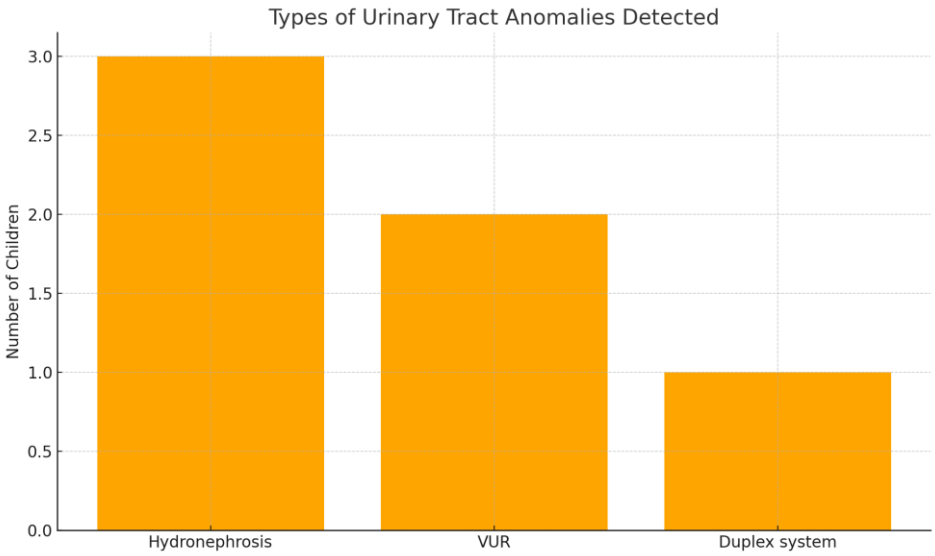
isolates to nitrofurantoin (94%), indicating it as an effective empirical treatment. Conversely, there was moderate resistance to ampicillin (65%), raising concerns about its empirical use in pediatric urinary tract infections.

FIGURE 4.TYPE OF MICROBE ISOLATED IN URINE SAMPLES



All 17 children diagnosed with ASB underwent renal ultrasonography (USG) for the evaluation of possible underlying urinary tract anomalies. Among them, 6 children (35.3%) were found to have structural abnormalities. The specific anomalies included hydronephrosis (3 cases), vesicoureteral reflux (2 cases, confirmed via micturating cystourethrogram - MCU), and a duplex kidney system (1 case) (FIGURE 5). Of the children with anomalies, 5 were females, and 4 belonged to rural areas, suggesting a possible gender and regional predisposition to undiagnosed urinary tract anomalies among ASB-positive children.

FIGURE 5. TYPES OF URINARY TRACT ANOMALIES IN STUDY GROUP



Statistical analysis was performed to identify potential associations between demographic variables and ASB positivity. Female sex showed a significant correlation with ASB, with 76% of ASB cases being females, compared to 45% in the ASB-negative group ($p = 0.01$). Presence of abnormal findings on USG was also significantly associated with ASB (35.3% vs 0.4%, $p < 0.001$). Although ASB was more frequent among children from rural areas (59%) compared to urban (43%), this was not statistically significant ($p = 0.18$). Similarly, children below 8 years of age had a slightly higher rate of ASB (65%) compared to older children (53.8%), but this difference was not statistically significant ($p = 0.37$).

The study found a 3.4% prevalence of asymptomatic bacteriuria among school-aged children. Female children were significantly more affected, underscoring a gender-related vulnerability. Importantly, a strong association was found between ASB and structural urinary tract anomalies, emphasizing the need for radiological evaluation in ASB-positive cases. The microbiological profile highlighted E. coli as the predominant organism, with high sensitivity to nitrofurantoin, suggesting it as a reliable first-line empirical therapy in suspected pediatric urinary infections. These findings collectively support the importance of early detection and evaluation of ASB to prevent potential long-term renal complications.

DISCUSSION

Principal Findings

This cross-sectional study assessed the prevalence of asymptomatic bacteriuria (ASB) among 500 school-aged children and examined its association with urinary tract anomalies. The overall prevalence of ASB was 3.4%, which is consistent with previously reported rates ranging from 1% to 5% in paediatric populations (9,10). A significant gender disparity was noted, with females constituting 76% of ASB-positive cases ($p = 0.01$), highlighting the well-documented anatomical predisposition of females to lower urinary tract colonization (11,12).

Microbiological and Antimicrobial Insights

The most common organism isolated was *Escherichia coli* (70.6%), followed by *Klebsiella pneumoniae* and *Enterococcus faecalis*. This distribution mirrors established findings where *E. coli* dominates paediatric urinary isolates (13). Antimicrobial susceptibility testing revealed high sensitivity to nitrofurantoin (94%), affirming its role as a first-line empirical agent. Conversely, moderate resistance to ampicillin (65%) echoes global concerns about increasing resistance to older antibiotics used in paediatric urinary tract infections (14).

Structural Anomalies in ASB-Positive Children

A significant clinical observation was the detection of urinary tract anomalies in 35.3% of ASB-positive children. Identified anomalies included hydronephrosis, vesicoureteral reflux (VUR), and a duplex kidney system. These findings are in agreement with previous reports suggesting that 10–30% of children with ASB may have associated congenital anomalies of the kidney and urinary tract (CAKUT) (9,15). The strong association between ASB and ultrasonographic abnormalities ($p < 0.001$) supports the recommendation for imaging in all children diagnosed with ASB.

Demographic Correlations

Although a higher proportion of ASB-positive children were from rural areas (59%) and were younger than 8 years, these associations were not statistically significant. This may be due to sample size limitations within these subgroups or the influence of additional unmeasured variables such as hygiene practices, sanitation access, and health education, warranting further investigation in larger studies.

Strengths and Limitations

Key strengths of this study include its adequate sample size and the inclusion of participants from both rural and urban backgrounds, providing a representative sample. Additionally, the use of culture-based confirmation and radiological assessment enhances the clinical validity of the findings.

However, certain limitations must be acknowledged. The cross-sectional nature of the study precludes causal inference or longitudinal follow-up. Only ASB-positive children underwent imaging, limiting the ability to estimate the background prevalence of urinary anomalies in the general population. Logistic regression was not conducted, restricting the adjustment for potential confounders. Lastly, reliance on a single urine sample could have led to misclassification due to transient bacteriuria or contamination.

Clinical and Public Health Implications

These findings reinforce the clinical importance of ASB screening, especially in female children and potentially in underserved regions. Given the significant association between ASB and urinary tract anomalies, renal ultrasonography should be routinely considered in ASB-positive cases, with further investigations (e.g., MCU, DMSA scans) as indicated. Early identification through such strategies may help prevent long-term renal complications, particularly in settings with limited healthcare access.

CONCLUSION

This study demonstrates that asymptomatic bacteriuria affects a significant minority of school-aged children, with a strong association noted between ASB and underlying urinary tract anomalies—particularly in females. Incorporating screening and radiological evaluation in ASB-positive cases may serve as an effective preventive approach to reduce long-term morbidity in paediatric populations.

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