

Original Research Article

ASSOCIATION BETWEEN DIAPER USE AND THE PREVALENCE OF URINARY TRACT INFECTION AMONG INFANTS AND YOUNG CHILDREN

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ABSTRACT

Background: Urinary tract infection (UTI) is a common bacterial infection in infants and young children, with diaper use potentially influencing perineal microbial exposure and infection risk. Prolonged diaper use, inadequate diaper-changing practices, and delayed replacement after defecation may contribute to conditions that facilitate bacterial colonization and urinary infection. However, evidence regarding the association between diaper-use practices and UTI risk among young children remains limited. The study aimed to determine the prevalence of culture-confirmed UTI among diaper-wearing infants and young children and to evaluate the association between diaper-use practices and UTI occurrence.

Materials and Methods: An analytical cross-sectional study was conducted among 268 infants and young children aged 1–36 months attending the Department of Pediatrics, The Oxford Medical College, Hospital and Research Centre, Bengaluru, India, from June 2019 to June 2022. Participants were consecutively enrolled after obtaining informed consent. Demographic characteristics, clinical factors, and diaper-use practices were collected using a structured questionnaire. Urine samples were collected using age-appropriate techniques and subjected to urinalysis and quantitative culture. Associations between participant characteristics, diaper-use factors, and culture-confirmed UTI were assessed using Pearson's chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results: Among 268 participants, 52 (19.4%) had culture-confirmed UTI. *Escherichia coli* was the predominant organism isolated (65.4%), followed by *Klebsiella* spp. (11.5%) and *Enterococcus* spp. (9.6%). A previous history of UTI was significantly associated with current UTI occurrence (34.5% vs. 17.6%; p=0.030). Diaper-changing frequency showed a significant association with UTI, with higher prevalence among children whose diapers were changed fewer than four times daily compared with those changed six or more times daily (30.0% vs. 10.5%; p=0.009). Longer duration of individual diaper use (>4 hours) was associated with increased UTI prevalence (26.9% vs. 11.9%; p=0.002). Delayed diaper changing after defecation (>15 minutes) was also associated with higher UTI prevalence (26.1% vs. 14.4%; p=0.016). Diaper type was significantly associated with UTI occurrence, with the highest prevalence observed among children using superabsorbent disposable diapers (p=0.026).

Conclusion: UTI was observed in nearly one-fifth of diaper-wearing infants and young children in this study. Infrequent diaper changes, prolonged diaper use, delayed diaper replacement after defecation, and diaper type were significantly associated with UTI occurrence. Improving caregiver awareness regarding appropriate diaper hygiene practices may contribute to reducing UTI risk among young children.

Keywords: Urinary tract infection; Infants; Young children; Diaper use; Diaper hygiene; *Escherichia coli*; Pediatric infection; Cross-sectional study.

INTRODUCTION

Urinary tract infection (UTI) is one of the most common bacterial infections in children and an important cause of febrile illness during infancy and early childhood. Clinical manifestations in young children are frequently nonspecific, which can delay recognition and treatment. Febrile and recurrent UTIs are clinically important because of their association with urinary tract abnormalities and potential renal complications.^[1] Accurate diagnosis is therefore essential, with urine culture from an appropriately collected specimen remaining central to confirmation of UTI.^[2]

The burden of pediatric UTI is also evident in Indian settings. A prospective study among 504 febrile children at a tertiary care centre in Kerala reported a UTI prevalence of 11.3%, with poor hygiene and diaper use among the identified risk factors.^[3] Another Indian study from Maharashtra demonstrated the continuing predominance of *Escherichia coli* among pediatric UTI isolates and highlighted age-related differences in the occurrence of infection.^[4]

Diaper use is nearly universal during infancy and the toilet-training period, coinciding with an age of increased susceptibility to UTI. Prolonged exposure of the perineum to urine and fecal material may produce a moist environment conducive to periurethral bacterial colonization and ascending infection. Consequently, diaper-changing frequency, duration of use, diaper type and hygiene practices may represent potentially modifiable factors.

Daulay et al. reported a significant association between infrequent disposable diaper changing and UTI.^[5] Lestari et al. observed UTI in 28.9% of children using superabsorbent diapers for more than four hours compared with 10% among those using them for four hours or less.^[6] Fahimzad et al. similarly reported an association between superabsorbent diaper use and UTI, although several other diaper-care practices were not significantly associated.^[7] A scoping review subsequently concluded that changing disposable diapers fewer than four times daily and using them for more than four hours may increase UTI risk, while emphasizing inconsistencies among available studies.^[8]

Considering the widespread use of diapers and limited Indian evidence specifically addressing diaper-care practices, the present study aimed to determine the association between diaper use and the prevalence of UTI among infants and young children, with particular emphasis on diaper-changing frequency, duration of individual diaper use, diaper type and delayed diaper changing following defecation.

MATERIALS AND METHODS

An analytical cross-sectional study was conducted among infants and young children aged 1–36 months

attending the Department of Pediatrics, The Oxford Medical College, Hospital and Research Centre, Bengaluru, India, between June 2019 and June 2022. The study evaluated the association between diaper-use practices and the prevalence of urinary tract infection (UTI) among diaper-wearing children.

Children aged 1–36 months who were regularly using diapers and attending the pediatric outpatient department, emergency department, or inpatient services were screened and consecutively enrolled after obtaining written informed consent from their parents or legal guardians. Children with congenital anomalies of the kidney and urinary tract, neurogenic bladder, significant urinary tract dysfunction, recent urinary tract instrumentation, systemic antibiotic exposure within the preceding 48–72 hours, or inability to provide an adequate urine specimen were excluded.

The sample size was calculated using the single population proportion formula, considering a previously reported UTI prevalence of 19.4%, a 95% confidence level, and 5% absolute precision. The minimum calculated sample size was 241 participants, which was increased to 268 participants after accounting for potential exclusions due to incomplete data or inadequate urine specimens. Participants were recruited using consecutive sampling.

Demographic and clinical data, including age, sex, breastfeeding status, previous history of UTI, constipation, diaper rash, and perineal hygiene practices, were collected using a pretested structured questionnaire administered to caregivers. Information regarding diaper-use practices, including diaper type, frequency of diaper changes, duration of individual diaper use, and time interval between defecation and diaper replacement, was also recorded.

Urine specimens were collected using age-appropriate methods to minimize contamination. Clean-catch urine or catheterized specimens were obtained from non-toilet-trained children, while clean-catch midstream urine samples were collected from toilet-trained children following perineal cleansing. Samples were processed in the institutional microbiology laboratory, where urinalysis and quantitative urine culture were performed according to standard laboratory protocols. Culture-confirmed UTI was defined as significant growth of a recognized urinary pathogen from an appropriately collected urine specimen, interpreted in conjunction with urinary inflammatory findings and clinical features.

The primary outcome was culture-confirmed UTI. The main exposure variables included diaper-changing frequency, duration of individual diaper use, diaper type, and delay in diaper changing following defecation. Potential confounding variables assessed included demographic and clinical characteristics.

Data were analyzed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA).

Categorical variables were summarized as frequencies and percentages. Associations between diaper-use practices and UTI were assessed using Pearson's chi-square test or Fisher's exact test, as appropriate. A two-sided p-value <0.05 was considered statistically significant.

The study was approved by the Institutional Ethics Committee of The Oxford Medical College, Hospital and Research Centre, Bengaluru. Written informed consent was obtained from all participants' parents or legal guardians, and confidentiality was maintained throughout the study.

RESULTS

A total of 268 infants and young children were included in the analysis, of whom 52 (19.4%) were diagnosed with culture-confirmed urinary tract infection (UTI), while 216 (80.6%) were UTI negative. The baseline demographic and clinical characteristics of participants according to UTI status are presented. The distribution of participants across different age groups was comparable between children with and without UTI. Although the highest proportion of UTI cases was observed among children aged 1–6 months (22.5%), followed by those aged 7–12 months (19.2%), 13–24 months (17.7%), and 25–36 months (17.5%), no statistically significant association was observed between age group and UTI occurrence ($\chi^2=0.68$, $p=0.877$). Similarly, sex was not significantly associated with UTI, although a higher proportion of females were UTI positive compared with males (21.8% vs. 16.7%; $\chi^2=1.14$, $p=0.286$). [Table 1]

A previous history of UTI was significantly associated with current UTI status. Children with a prior history of UTI had a higher prevalence of current culture-confirmed UTI compared with those without previous UTI episodes (34.5% vs. 17.6%; $\chi^2=4.73$, $p=0.030$). History of constipation showed a higher proportion of UTI among affected children (25.5% vs. 18.1%); however, this association was not statistically significant ($\chi^2=1.37$, $p=0.242$). Similarly, diaper rash showed a higher prevalence among

children with UTI compared with those without UTI (27.1% vs. 16.7%), although the association approached but did not reach statistical significance ($\chi^2=3.63$, $p=0.057$). Current breastfeeding status was not significantly associated with UTI occurrence ($\chi^2=1.79$, $p=0.181$). [Table 1]

Among the 268 participants, 52 children had culture-confirmed UTI, resulting in an overall prevalence of 19.4%. *Escherichia coli* was the predominant organism isolated, accounting for 34 (65.4%) of positive urine cultures. Other identified organisms included *Klebsiella* spp. (11.5%), *Enterococcus* spp. (9.6%), *Proteus* spp. (5.8%), and *Pseudomonas* spp. (3.8%). Other bacterial organisms collectively accounted for 3.8% of isolates. [Table 2]

The frequency of diaper changes demonstrated a significant association with UTI occurrence ($\chi^2=9.42$, $p=0.009$). Children whose diapers were changed fewer than four times per day had the highest prevalence of UTI (30.0%), followed by those changed four to five times per day (19.6%). The lowest prevalence was observed among children with diaper changes occurring six or more times daily (10.5%), suggesting a significant inverse relationship between diaper-changing frequency and UTI prevalence. [Table 3]

Diaper-use practices and diaper type were significantly associated with UTI occurrence. Children who wore the same diaper for more than four hours had a significantly higher prevalence of UTI compared with those whose diapers were changed within four hours (26.9% vs. 11.9%; $\chi^2=9.54$, $p=0.002$). Similarly, delayed diaper replacement following defecation was associated with increased UTI prevalence, with children experiencing a delay of more than 15 minutes demonstrating a higher prevalence compared with those changed within 15 minutes (26.1% vs. 14.4%; $\chi^2=5.76$, $p=0.016$). [Table 4]

Diaper type was also significantly associated with UTI prevalence ($\chi^2=7.31$, $p=0.026$). The highest proportion of UTI was observed among children using superabsorbent disposable diapers (26.2%), followed by standard disposable diapers (15.0%) and cloth/reusable diapers (11.3%). [Table 4]

Table 1: Baseline demographic and clinical characteristics of study participants according to UTI status (N=268)

Characteristics		Total N=268, n (%)	UTI positive n=52, n (%)	UTI negative n=216, n (%)	χ^2	p-value
Age group (months)	1–6	71 (26.5)	16 (22.5)	55 (77.5)	0.68	0.877
	7–12	78 (29.1)	15 (19.2)	63 (80.8)		
	13–24	79 (29.5)	14 (17.7)	65 (82.3)		
	25–36	40 (14.9)	7 (17.5)	33 (82.5)		
Sex	Male	126 (47.0)	21 (16.7)	105 (83.3)	1.14	0.286
	Female	142 (53.0)	31 (21.8)	111 (78.2)		
Previous history of UTI	Yes	29 (10.8)	10 (34.5)	19 (65.5)	4.73	0.030*
	No	239 (89.2)	42 (17.6)	197 (82.4)		
History of constipation	Yes	47 (17.5)	12 (25.5)	35 (74.5)	1.37	0.242
	No	221 (82.5)	40 (18.1)	181 (81.9)		
Diaper rash	Yes	70 (26.1)	19 (27.1)	51 (72.9)	3.63	0.057
	No	198 (73.9)	33 (16.7)	165 (83.3)		
Currently breastfed	Yes	151 (56.3)	25 (16.6)	126 (83.4)	1.79	0.181
	No	117 (43.7)	27 (23.1)	90 (76.9)		

Pearson's Chi-square

Table 2: Prevalence of urinary tract infection and microbiological profile among study participants

Organism isolated among UTI-positive children (n=52)	Frequency (n)	Percentage (%)
Escherichia coli	34	65.4
Klebsiella spp.	6	11.5
Enterococcus spp.	5	9.6
Proteus spp.	3	5.8
Pseudomonas spp.	2	3.8
Other organisms	2	3.8
Total isolates	52	100

Prevalence of UTI = $52/268 \times 100 = 19.4\%$.

Table 3: Association between frequency of diaper changing and urinary tract infection (N=268)

Frequency of diaper change	Total n (%)	UTI positive n (%)	UTI negative n (%)	χ^2	p-value
<4 times/day	70 (26.1)	21 (30.0)	49 (70.0)	9.42	0.009*
4–5 times/day	112 (41.8)	22 (19.6)	90 (80.4)		
≥6 times/day	86 (32.1)	9 (10.5)	77 (89.5)		
Total	268 (100.0)	52 (19.4)	216 (80.6)		

Pearson Chi square

Table 4: Association of diaper-use practices and diaper type with urinary tract infection (N=268)

Diaper-related factor		UTI positive n (%)	UTI negative n (%)	χ^2	p-value
Duration of individual diaper use	≤4 hours (n=134)	16 (11.9)	118 (88.1)	9.54	0.002*
	>4 hours (n=134)	36 (26.9)	98 (73.1)		
Delay in diaper change after defecation	≤15 minutes (n=153)	22 (14.4)	131 (85.6)	5.76	0.016*
	>15 minutes (n=115)	30 (26.1)	85 (73.9)		
Type of diaper	Cloth/reusable (n=62)	7 (11.3)	55 (88.7)	7.31	0.026*
	Standard disposable (n=80)	12 (15.0)	68 (85.0)		
	Superabsorbent disposable (n=126)	33 (26.2)	93 (73.8)		

Pearson's Chi-square test.

DISCUSSION

The present study demonstrated a UTI prevalence of 19.4% among 268 infants and young children. Significant associations were observed between UTI and diaper-changing frequency, duration of individual diaper use, delay in changing following defecation and diaper type. Previous UTI was also significantly associated with current infection, whereas age, sex, constipation, breastfeeding and diaper rash were not significantly associated.

The observed prevalence was higher than the 11.3% reported among febrile children in the Kerala study,^[3] but was closer to the 16% culture positivity reported by Shrestha et al.^[9] Differences in prevalence between studies may result from variations in age, clinical setting, participant selection and diagnostic criteria.

A significant association was observed between diaper-changing frequency and UTI ($\chi^2=9.424$, $p=0.009$). UTI prevalence decreased from 30.0% among children whose diapers were changed <4 times/day to 19.6% among those changed 4–5 times/day and 10.5% among those changed ≥6 times/day. This is consistent with Daulay et al.,^[5] who reported a significant association between infrequent disposable diaper changing and UTI. Less frequent changing may prolong perineal exposure to urine and fecal organisms, potentially facilitating periurethral bacterial colonization.

Similarly, UTI was significantly more frequent among children wearing an individual diaper for >4 hours than ≤4 hours (26.9% vs. 11.9%; $\chi^2=9.544$, $p=0.002$). Lestari et al.^[6] reported a comparable

pattern, with UTI occurring in 28.9% and 10% of children with longer and shorter diaper exposure, respectively. These findings suggest that duration of exposure may be an important diaper-related factor. Delayed diaper changing following defecation was also associated with UTI (26.1% vs. 14.4%; $p=0.016$). Although Fahimzad et al.,^[7] did not demonstrate a significant association with delay following defecation, prolonged contact with fecal organisms provides a biologically plausible mechanism for ascending infection. The Kerala study also identified poor hygiene and diaper usage among relevant risk factors for pediatric UTI, providing supportive evidence from an Indian population.^[3] Diaper type was significantly associated with UTI ($\chi^2=7.313$, $p=0.026$), with the highest prevalence among superabsorbent diaper users (26.2%). Fahimzad et al.,^[7] similarly reported increased UTI occurrence with superabsorbent diapers. However, previous findings regarding diaper type are inconsistent,^[6,8] and diaper-changing frequency and duration may be more important than diaper material itself.

Escherichia coli was the predominant organism in the present study, accounting for 65.4% of isolates. This finding agrees with Indian data from Maharashtra, where E. coli accounted for 69% of pediatric UTI isolates,^[4] and another Indian study reported E. coli in 62% of culture-positive children.^[10] The predominance of an enteric organism further supports the importance of perineal hygiene in diaper-wearing children.

The study findings have practical implications because diaper-care practices are potentially

modifiable. Frequent diaper changing, avoiding prolonged continuous use and prompt replacement following defecation may reduce conditions favoring bacterial colonization. However, the cross-sectional design does not establish causality, and caregiver-reported practices may be affected by recall bias. Larger prospective Indian studies are required to confirm these associations.

CONCLUSION

The present study demonstrates a significant association between diaper-use practices and urinary tract infection among infants and young children. Infrequent diaper changing, prolonged use of an individual diaper for more than four hours, delayed diaper changing following defecation, and the type of diaper used were significantly associated with a higher prevalence of UTI. *Escherichia coli* was the predominant uropathogen isolated. These findings emphasize the importance of appropriate diaper hygiene, including frequent diaper changes, avoiding prolonged diaper use, and prompt replacement after defecation. Caregiver education regarding appropriate diaper practices may represent a simple and practical measure for reducing UTI risk in young children.

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