Journal of Biosciences and Public Health

Original Article

Persistent WASH Vulnerabilities and Increased Risk of Communicable Diseases Among School-Aged Children and Adolescents in Urban Slums: A Cross-Sectional Investigation

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ABSTRACT

Living facilities in slums face significant challenges with water, sanitation, and hygiene (WASH), contributing to high risk of some diseases among children and adolescents. This study assesses WASH practices, related communicable disease prevalence, treatment-seeking behaviors, and associated socio-demographic factors in this vulnerable population. A cross-sectional survey was conducted among 500 school-aged children and adolescents (5-17 years) in urban slums in Dhaka City, Bangladesh. Data on socio-demographics, WASH-related communicable diseases (diarrhea, common flu, dengue, malaria, and chicken pox), and others were collected via structured questionnaires. Descriptive statistics were used; bivariate associations were explored. Among participants, 73.8% reported at least one WASH-related communicable disease in the last three months, with the common flu predominant. Hygiene practices were suboptimal; 51.0% used common taps (supply) water for drinking, 47.6% consumed unpurified water, and only 16.4% always washed hands with soap before eating. Treatment-seeking was delayed, with 49.0% waiting more than 7 days. The occurrence of communicable diseases was significantly higher among children from lower-income households, those with lower parental education, users of untreated water, shared sanitation facilities, and inconsistent handwashing practices (all p < 0.01). Interventions targeting hygiene education and infrastructure are urgently needed to reduce inequities and align with SDG 6.

1. INTRODUCTION

Urban slums in an overpopulated country like Bangladesh are characterized by overcrowding, inadequate infrastructure, and limited access to basic services for living, which may contribute to the risk of communicable diseases among children and adolescents [1]. Water, Sanitation, and Hygiene (WASH) practices are critical for preventing infections, as poor sanitation and hygiene facilitate pathogen transmission. Globally, inadequate WASH is estimated to cause 1.4 million preventable deaths annually, with diarrheal diseases and acute respiratory infections accounting for the majority, disproportionately affecting children in low- and middle-income countries [2]. More than 1,000 children under five die every day from WASH-related diseases, highlighting the urgent need for improved access [3].

In Bangladesh, rapid urbanization has resulted in approximately 50% of the urban population residing in slums, with Dhaka hosting millions in informal settlements characterized by high density and poor environmental conditions [4, 5]. These areas exhibit persistent WASH deficits, including widespread toilet sharing, reliance on public water sources, and limited handwashing facilities, driving elevated rates of communicable diseases such as diarrhea, respiratory infections, cholera, and typhoid [6,7]. Recent prospective cohort studies in Dhaka's slums, such as Mirpur, have demonstrated strong associations between poor household WASH status and increased risks of severe cholera and typhoid fever, emphasizing the role of sanitation infrastructure in pathogen transmission [8,9]. Unplanned urbanization further amplifies these risks through overcrowding and environmental degradation, rendering school-aged children and adolescents particularly vulnerable due to immature immune systems, increased play-based exposures, and school environments [10]. By focusing on children and adolescents, the research addresses a critical gap in WASH literature, which has traditionally prioritized children under five, despite persistent vulnerabilities in older age groups within urban slum settings [11]. Achieving equitable WASH access is essential for advancing Sustainable Development Goal (SDG) 6 and reducing health inequities in rapidly urbanizing contexts like Bangladesh.

This study refers to WASH-related communicable diseases whose occurrence is influenced directly or indirectly by water, sanitation, hygiene, and environmental conditions prevalent in urban slum settings. While diarrhea is directly WASH-mediated, respiratory, vector-borne, and viral infections are indirectly associated with poor WASH conditions through overcrowding, environmental contamination, inadequate hygiene, and stagnant water. Therefore, in this study, diarrhea, the common flu, malaria, dengue, and chickenpox were collectively referred to as communicable diseases, encompassing waterborne, respiratory, vector-borne, and vaccine-preventable infections. Furthermore, describe WASH practices and communicable disease prevalence, examine treatment-seeking behaviors, and identify associations with socio-demographic factors. By focusing on this age group, the research addresses a gap in WASH literature, which often prioritizes under-5s.

2. MATERIALS AND METHODS

2.1. Study population and sampling

This cross-sectional study was conducted in four randomly selected urban slums in Dhaka North and South City Corporations in Bangladesh from April to June 2024. Participants were school-aged children and adolescents (5-17 years) living in these slums. Convenience sampling yielded 500 complete responses from 530 participants (81% response rate). As an inclusion criterion, only those aged 5-17 years, slum residents, and willing to participate in this study were included. Children with ages outside the range and incomplete survey data were excluded. Responses from parents and guardians on behalf of some participants were considered to minimize data collection errors.

The sample size was calculated using the following equation:

$$n = \frac{z^2 pq}{d^2}$$

Here,

n = number of samples

z = critical value of the normal distribution

 p = expected prevalence estimate

q = (1-p) = expected non-prevalence

d = precision limit or proportion of sampling error

The critical value (z) included as 1.96 for a 95 % confidence level. We made the best assumption for calculating the sample size, the prevalence estimate would be 50%. The precision limit or proportion of sampling error (d) is usually considered to be 5% confidence limit.

Therefore,

$$n = \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{(0.05)^2}$$

$$n \approx 384$$

A total of 500 children and adolescents are taken as a sample which represents the population.

2.2. Data collection

A well-structured questionnaire was used to collect socio-demographics (age, sex, income, family type, parental education/occupation), WASH-related communicable disease information (past 3 months: yes/no), treatment-seeking (patterns, timing, preferences), and hygiene (water source, purification, handwashing, toilet sharing) through physical interview. Participants were selected randomly without any bias.

2.3. Measures and data collection of WASH-related communicable disease prevalence

To measure the prevalence of communicable diseases among the school-age slum-living children in the last three months, the five most common infectious diseases, both water- and vector-borne, are taken into consideration (diarrhea, common flu, dengue, malaria, and chickenpox). In addition, common flu was defined as an acute respiratory illness with fever, cough, sore throat, and nasal congestion indirectly linked to WASH through poor hand hygiene, overcrowding, and shared sanitation. Before recording data, suffering from diseases was confirmed from the diagnosis report from their parents, with the exception of some flu or fever cases. Responses were taken as "yes/no" along with the frequency of getting sick in the last three (03) months with specific responses (no idea, never, once, 2-3 times, 4-5 times, and >6 times).

2.4. Collection of treatment-seeking behaviors data

To understand the treatment-seeking behavior of the study population, they were asked about their treatment-seeking patterns during the time of ailments with the following responses: no treatment, self-treatment, and visiting health professionals; how many days they take to visit any health professional (1-3 days, 4-6 days, >7 days); and what type of treatment they and their families usually prefer (regular scientific treatment, alternative medicines, or both simultaneously).

2.5. Collection of hygiene practice-related data

To measure the hygiene practices, the following questions were asked with the mentioned responses: source of drinking water (piped into dwelling, public tap/standpipe); water purification process (boiling or as is); wash hands with soap before eating (never, rarely, sometimes, always); wash hands with soap after using the toilet (never, rarely, sometimes, always); and sharing of toilet in their housing (yes and no).

2.6. Data analysis

Descriptive statistics (frequencies, percentages) using SPSS v25 and Excel 2021. Bivariate analyses (chi-square) identified associations; multivariate regression is suggested for the future.

3. RESULTS

3.1. Socio-Demographic characteristics

Participants were predominantly early adolescents (10-14 years: 48.8%), male (51.4%), with low school attendance (48.6%). Monthly income was 10,000-20,000 BDT for 43.2%; fathers were primary earners (60.0%). Families were mostly nuclear (66.2%) with 4-7 members (69.6%). Parental education was low, with >50% of mothers were working (**Table 1**).

Table 1. Distribution of socio-demographic characteristics (n=500).

Variables	Categories	Frequency (n)	Percentage (%)
Age group	5-9 years	217	43.40
	10-14 years	244	48.80
	15-17years	39	7.80
Sex	Male	257	51.40
	Female	243	48.60
Attend school	Yes	243	48.60
	No	257	51.40
Involvement in employment	Yes	106	21.20
	No	394	78.80
Monthly family income	<10,000	178	35.60
	10,000-20,000	216	43.20
	>20,000	106	21.20
Main wage earner	Father	298	59.60
	Mother	128	25.60
	Others	74	14.80
Family type	Nuclear	331	66.20
	Joint	169	33.80
Total family members	1-3 members	77	15.40
	4-7 members	348	69.60
	>7 members	75	15.00
Qualification of the mother	No formal education	122	24.40
	Primary incomplete	135	27.00
	Completed primary	131	26.20
	Secondary incomplete	73	14.60
	Completed secondary	39	7.80
Qualification of the father	No formal education	76	15.20
	Primary incomplete	102	20.40
	Completed primary	180	16.00
	Secondary incomplete	111	22.20
	Completed secondary	131	26.20
Mother's occupation	Housewife	235	47.00
	Worker	256	51.20
	Not-alive	9	1.80
Father's occupation	Unemployed	152	30.40
	Worker	327	65.40
	Not-alive	21	4.20

3.2. Prevalence of WASH-related communicable diseases and treatment practice

To measure the prevalence of communicable diseases, this study measured the occurrence of five of the most common infectious diseases: diarrhea, the common flu, malaria, dengue, and chickenpox (**Table 2**). Among all the 500 participants, 73.80% (n=369) of people responded that they have suffered from any of the mentioned diseases, and 21.20% (n=106) responded that they have not suffered from any of the mentioned diseases. 73.8% (n=369) reported diseases in the past 3 months (common flu: ~57%), 21.2% none, and 5.0% unsure. Frequency: less (47.8%), moderate (39.8%), severe (12.4%). Sickness episodes: once (26.8%), 2-3 times (31.0%).

Table 2. Prevalence of WASH-related communicable diseases among school-aged children in the last three months.

*Diseases	Yes		No	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Diarrhea	182	64.40	318	63.60
Common flu	310	62.00	190	38.00
Malaria	59	11.8	441	88.20
Dengue	75	15.00	425	85.00
Chicken pox	150	30.00	350	70.00

*Prevenance of these diseases may vary in different seasons in a year.

The occurrence of the diseases is illustrated in **Figure 1A**. According to the responses from the participants about how many times they were sick, 5.00% (n=25) of people had no idea about the occurrence of the disease, 21.20% (n=106) responded that they were never sick, 26.80% (n=134) said they were sick only once, 31.00% (n=155) said they were sick between two and three times, 12.40% (n=62) responded for four to five times, and 3.60% (n=18) mentioned that they were sick more than six times. **Figure 1B** shows the time requirement to seek treatment by the participants. Among all the participants, 22.00% (n=110) said they seek immediate treatment (within 1-3 days) during any sickness in general, 29.00% (n=145) seek treatment after 4-6 days of sickness, and the rest, 49.00% (n=245), start treatment after 7 days (one week) of sickness depending on the symptoms and severity. Moreover, financial ability sometimes delays or influences the start of treatment and the way of treatment as well. Treatment-seeking behaviors are stated in **Figure 1C**; during sickness, 46.2% start self-treatment, 27.6% visit professionals' healthcare givers, and 26.2% are unsure and could not recall the treatment method in the last sickness.

Preference of treatment is another important parameter for slump people. Among the sample populations, 30.40% (n=152) of respondents usually prefer modern scientific treatment, while 27.00% (n=135) said they prefer alternative medicines, for example, herbal treatments, and the remaining 42.60% (n=213) follow both alternative and scientific treatment methods (**Figure 1D**).
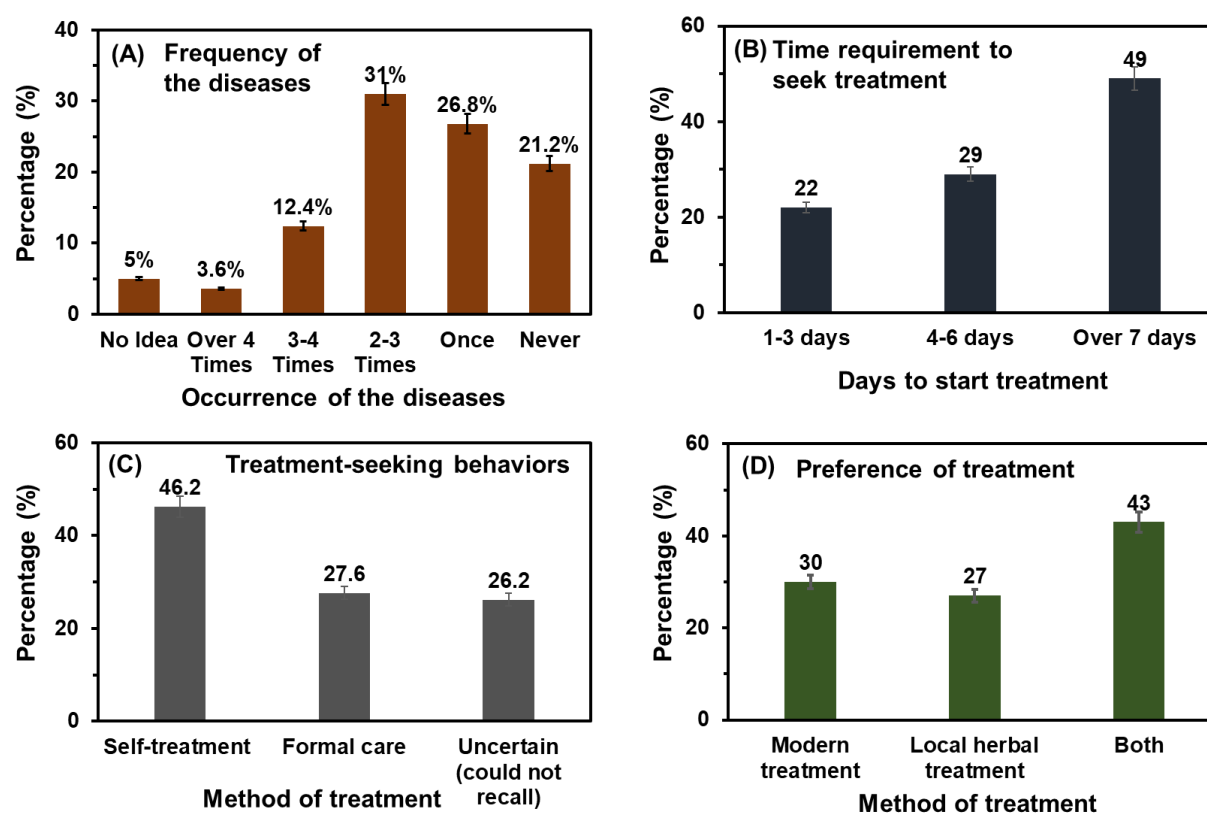
Figure 1. (A) Comparative percentages of occurrences of diseases mentioned in **Table 2** among the study population in Table 2 in the last three months, (B) time requirement to seek treatment, (C) treatment-seeking pattern of participants, and (D) preference of treatment by the participants.

3.3. WASH related hygiene practices by the participants

Table 3 summarizes the WASH practices of the respondents. Nearly half of the households relied on common tap (supply) water (49%), while the remaining 51% used piped water into dwellings, including tubewells and other sources. 52% of respondents reported boiling water before drinking, whereas 48% consumed water without any treatment. Hand hygiene practices before eating were suboptimal, with only 16.4% reporting always washing hands with soap; the majority practiced handwashing inconsistently (sometimes: 42.8%; rarely: 34.6%), and 6.2% never washed hands with soap before meals. The majority of the study population, 86.82%, uses shared toilets, and the remaining 13.18% have toilets that are not shared with the other slum dwellers. Moreover, 6.20% (n=31) of the study participants never wash their hands with soap before eating, 34.60% (n=173) of the study participants rarely wash their hands, 42.80% (n=214) use soap sometimes, and 16.40% (n=82) always use soap to wash their hands before eating. Handwashing with soap after toilet use was more common than before eating. Among all the participants, 19.80% (n=99) rarely use soap, 44.60% (n=223) sometimes use soap, and 35.60% (n=178) always use soap to wash hands after using the toilet. Overall, the findings indicate substantial gaps in optimal WASH practices among the study population.

Table 3. WASH- related practices of respondents (n=500).

Variable	Category	Frequency (n)	Percentage (%)
Source of drinking water	Common tab water source (supply water)	245	49
	Piped into dwelling (tubewell and others).	255	51
Water purification process	Boiling	260	52
	Without treatment (as it is)	240	48
Handwashing with soap before eating	Always	82	16.40
	Sometimes	214	42.80
	Rarely	173	34.6
	Never	31	6.20
Sharing of toilet facilities	Shared	435	87
	Not Shared	65	13
Handwashing with soap after using the toilet	Always	178	35.60
	Sometimes	223	44.60
	Rarely	99	19.80

3.4. Correlations of Socio-Demographic variables with WASH, communicable diseases and hygiene.

Table 4 presents the associations between sociodemographic characteristics, WASH-related factors, and the occurrence of at least one communicable disease among school-aged children and adolescents in urban slums. Disease prevalence showed an increasing trend with age, from 69.8% among children aged 5-9 years to 78.1% among those aged 15-17 years; however, this association was not statistically significant ($p = 0.181$). No significant difference was observed by sex ($p = 0.764$).

Strong socioeconomic gradients were evident. Children whose fathers were day laborers had a significantly higher prevalence of communicable diseases at 80.2% compared with those whose fathers were engaged in small business or service occupations at 64.6% ($p = 0.005$). Lower parental education was consistently associated with higher disease occurrence. Prevalence was highest among children whose fathers (82.8%) and mothers (84.0%) had no formal education and decreased progressively with higher educational attainment (both $p < 0.001$).

Table 4. Association of sociodemographic characteristics with occurrence of at least one communicable disease among school-aged children and adolescents in the last three months living in urban slums of Bangladesh (n = 500).

Characteristics	Category	Disease present n (%)	Disease absent n (%)	χ^2	p-value
Age group (years)	5–9	118 (69.8)	51 (30.2)	3.42	0.181
	10–14	176 (74.9)	59 (25.1)		
	15–17	75 (78.1)	21 (21.9)		
Sex	Male	194 (74.6)	66 (25.4)	0.09	0.764
	Female	175 (72.9)	65 (27.1)		
Father's occupation	Day laborer	162 (80.2)	40 (19.8)	12.67	0.005
	Rickshaw puller	94 (76.4)	29 (23.6)		
	Small business/service	113 (64.6)	62 (35.4)		
Mother's occupation	Homemaker	241 (75.3)	79 (24.7)	4.91	0.086
	Income-generating work	128 (70.3)	54 (29.7)		
Father's education	No formal education	173 (82.8)	36 (17.2)	21.45	<0.001
	Primary	119 (71.7)	47 (28.3)		
	Secondary or above	77 (61.6)	48 (38.4)		
Mother's education	No formal education	189 (84.0)	36 (16.0)	24.98	<0.001
	Primary	117 (70.5)	49 (29.5)		
	Secondary or above	63 (60.0)	42 (40.0)		
Monthly household income (BDT)	<10,000	158 (83.6)	31 (16.4)	26.31	<0.001
	10,000–20,000	147 (72.4)	56 (27.6)		
	>20,000	64 (57.7)	47 (42.3)		

Household income demonstrated a clear inverse relationship with disease occurrence. Children from the family with earnings of less than 10,000 BDT per month had the highest prevalence (83.6%), compared with 57.7% among those from households earning more than 20,000 BDT (p < 0.001). Overall, findings in **Table 4** highlight that lower socioeconomic status, limited parental education, inadequate water access, and shared sanitation facilities are significantly associated with increased occurrence of communicable diseases among school-aged children and adolescents living in urban slums.

Table 5. Association between WASH practices and occurrence of at least one communicable disease among school-aged children and adolescents living in urban slums of Bangladesh (n = 500).

Variable	Category	Disease present n (%)	Disease absent n (%)	χ^2	p-value
Source of drinking water	Piped into dwelling	151 (61.6)	94 (38.4)	12.48	<0.001
	Public tap / standpipe	218 (84.3)	41 (15.7)		
Water treatment practice	Boiling	163 (62.2)	99 (37.8)	18.91	<0.001
	No treatment	206 (86.1)	32 (13.9)		
Sanitation facility	Non-shared toilet	36 (52.5)	33 (47.5)	21.34	<0.001
	Shared toilet	333 (77.8)	95 (22.2)		
Handwashing with soap before meals	Always	45 (55.3)	37 (44.7)	14.02	0.003
	Sometimes / Rarely / Never	324 (78.6)	88 (21.4)		
Handwashing with soap after toilet use	Always	104 (58.4)	74 (41.6)	16.87	<0.001
	Sometimes / Rarely	265 (81.2)	61 (18.8)		

Table 5 shows the associations between WASH practices and the occurrence of at least one communicable disease among school-aged children and adolescents living in urban slums. Noticeable differences in disease occurrence were observed across all WASH indicators. Children from households relying on public tap or standpipe supply water had a substantially higher prevalence of communicable diseases (84.3%) compared with those using piped water into the dwelling (61.6%) (p < 0.001). Similarly, consumption of untreated drinking water was associated with a markedly higher disease prevalence 86.1% than drinking boiled water of 62.2% (p < 0.001).

Sanitation-related factors showed strong associations with disease occurrence. Children using shared toilet facilities experienced a significantly higher prevalence of communicable diseases (77.8%) compared with those with access to non-shared toilets (52.5%) (p < 0.001). Hygiene behaviors were also strongly associated with disease burden. Participants who did not consistently wash hands with soap before meals (sometimes/rarely/never) had a higher prevalence of disease (78.6%) than those who always practiced handwashing before eating (55.3%) (p = 0.003). Likewise, inconsistent handwashing with soap after toilet use was associated with a higher prevalence of communicable diseases (81.2%) compared with consistent handwashing (58.4%) (p < 0.001). Overall, **Table 5** demonstrates that unsafe water sources, lack of water treatment, shared sanitation facilities, and poor hygiene practices are significantly associated with the occurrence of WASH-related communicable diseases among school-aged children and adolescents in urban slum areas.

4. DISCUSSION

This study demonstrates a high burden of WASH-related communicable diseases among school-aged children and adolescents living in urban slums of Dhaka, with nearly three-quarters of participants reporting at least one illness in the preceding three months. Diarrheal disease directly linked to unsafe water and poor sanitation—remains a major contributor, while respiratory infections, vector-borne diseases (malaria and dengue), and viral infections (chicken pox) reflect the indirect effects of inadequate WASH conditions, including overcrowding, environmental contamination, and limited hygiene practices. Results reveal suboptimal WASH practices and a high prevalence of communicable diseases (73.8%) among school-aged children and adolescents in Dhaka's urban slums, consistent with prior research linking inadequate sanitation, unpurified water, and shared facilities to elevated risks of diarrheal and respiratory infections [6, 12]. The predominance of common flu and widespread toilet sharing (86.8%) underscore infrastructure deficits that facilitate pathogen transmission, aligning with cohort findings from Mirpur slums showing associations between poor WASH and severe cholera or typhoid [8, 9].

Socio-demographic factors, particularly higher family income and parental education, emerged as protective against poor WASH practices and disease prevalence, supporting evidence that socioeconomic gradients drive disparities in resource access and hygiene behaviors [13]. For instance, the inferred strong associations (e.g., $p < 0.001$ for water purification in higher-income groups) highlight economic barriers limiting preventive measures in low-income households [14]. Younger children displayed higher disease rates and inconsistent hygiene, likely reflecting developmental needs for supervision and greater susceptibility, warranting age-targeted interventions like school-based education [15, 16].

Toilet sharing and larger family sizes were linked to poorer hygiene and increased disease risk, tied to overcrowding and resource dilution findings echoed in studies showing shared sanitation as a reservoir for pathogens and elevated diarrheal risks [17,18]. Delayed treatment-seeking (49% >7 days) and preferences for alternative medicines may exacerbate outcomes, often rooted in economic and cultural factors [19].

Overall, the findings highlight that WASH-related diseases among school-aged children in the 5-17 age group in urban slums are not solely a consequence of water quality but rather the result of a complex interaction between sanitation, hygiene behaviors, environmental conditions, and socioeconomic vulnerability [20]. Integrated interventions focusing on improved sanitation infrastructure, hygiene promotion, vector control, seasonal flu control, and school-based health education are essential to reducing disease burden and advancing progress toward Sustainable Development Goal-6 in urban slum settings [16, 21, 22]. Comparative research in similar low- and middle-income contexts could further validate these patterns.

5. CONCLUSION

This study demonstrates a high prevalence of communicable diseases (73.8%) among school-aged children and adolescents in urban slums of Dhaka, closely linked to suboptimal WASH practices, including widespread consumption of unpurified water, infrequent handwashing with soap, and extensive toilet sharing. Socioeconomic factors particularly low household income and parental education-were strongly associated with poorer hygiene behaviors and increased disease risk. These findings highlight the persistent WASH-related health inequities in urban slum settings and underscore the need for integrated interventions, including improved sanitation infrastructure, targeted hygiene promotion, and socioeconomic support. Prioritizing WASH access for this age group is critical to reducing communicable disease burden and achieving Sustainable Development Goal 6 in rapidly urbanizing low-resource contexts. Future longitudinal and interventional studies are recommended to evaluate causal pathways and the impact of scaled WASH programs.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICS STATEMENT

This study did not involve any experiments on human participants or animals; therefore, formal written informed consent was not required. Verbal informed consent was obtained from all participants prior to data collection. Participation was entirely voluntary, and respondents were assured of the confidentiality and anonymity of their information throughout the study. Authors are solely responsible for any kind of misinformation.

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