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Original Research Article

Assessment of knowledge and indicators of drinking water, sanitation, and hygiene practices from rural and urban schools of Belagavi, Karnataka: a cross-sectional study

Ravindra Sarawade[1], Chelikam Veeraraghavendra Reddy[2]*, Darshan Patil[1], Kalmeshwar Revagoud[1]

[1]Jawaharlal Nehru Medical college, Belgavi, Karnataka, India
[2]Indian Institute of Public Health, Bhubaneswar, Odisha, India

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***Correspondence:**
Dr. Chelikam Veeraraghavendra Reddy,
E-mail: raghuchelikum@gmail.com

ABSTRACT

Background: Adequate water, sanitation, and hygiene (WASH) in schools is essential for preventing communicable diseases and promoting health. However, gaps often persist between students' knowledge and the availability of WASH infrastructure. This study aimed to assess WASH-related knowledge among school children and to evaluate school-level WASH indicators in rural and urban schools of Belagavi district, Karnataka.
Methods: A cross-sectional study was conducted from March 2023 to May 2024 among 422 students from grades VI-VIII across 40 schools (25 rural, 15 urban). Students' WASH knowledge was assessed using a pre-tested questionnaire, while school WASH indicators were evaluated using standardised facility assessment tools. Data were analysed using descriptive statistics and chi-square tests.
Results: Overall, 51.2% of students demonstrated good WASH knowledge. Awareness that unsafe water affects health was reported by 68.2%, and 99.5% recognised the disease risk of not washing hands. All schools had drinking water and handwashing facilities; however, consistent year-round water availability was reported by only 50% of rural and 37.5% of urban schools. Soap was absent at handwashing points in over 90% of schools. Rural schools more frequently had pit latrines and fewer usable toilets, while toilet cleanliness was reported in 55% of rural and 37.5% of urban schools.
Conclusions: Moderate WASH knowledge among students coexists with substantial infrastructural gaps, particularly the lack of soap, inadequate sanitation facilities, and inconsistent water availability. Strengthening school WASH infrastructure and maintenance is critical to translate knowledge into effective hygiene practices.

Keywords: WASH, School health, Hand hygiene, Sanitation facilities, Rural-urban schools, India

INTRODUCTION

Access to water, sanitation, and hygiene (WASH) is fundamental to children's health, well-being, and educational attainment. Globally, millions of school-aged children lack safe water, functional sanitation, and handwashing facilities, which increases susceptibility to infectious diseases and leads to absenteeism and poor academic outcomes.[1,2] Ensuring adequate WASH in schools is therefore essential for safeguarding child health and promoting long-term development.

Primary school children remain highly vulnerable to communicable diseases because of their developing immune systems. Poor hand hygiene, unsafe drinking water, and inadequate sanitation significantly increase the risk of diarrheal and respiratory diseases, which remain leading causes of morbidity in developing countries.[3,4] International frameworks, including the UN Convention on the Rights of the Child and the Sustainable Development Goals (SDGs), emphasise WASH in schools as a core requirement for quality education, gender equity, and health promotion.[5] Clean toilets, safe drinking water, and accessible handwashing stations enable better attendance, learning, and overall school performance.[6]

Despite national initiatives such as the Swachh Bharat, Swachh Vidyalaya Mission, large disparities persist in WASH infrastructure across Indian schools. According to the Government of India's educational database, more than half of schools lack basic handwashing facilities, and many still fall short of minimum sanitation standards.[7] Limited access to safe water, inadequate menstrual hygiene facilities, and absence of gender-segregated toilets continue to negatively affect students, especially girls. The persistence of preventable hygiene-related illnesses highlights the need for systematic assessment of knowledge and WASH indicators in school environments.

Although several studies have examined WASH conditions in various Indian states, there is limited evidence on the combined assessment of students' knowledge and school-level WASH indicators in both rural and urban settings of Belagavi district. Existing studies demonstrate regional variation in WASH facilities.[7-9] but there is a lack of structured evaluation comparing knowledge and infrastructure gaps across different school types. Furthermore, previous research indicates that knowledge does not always translate into practice, especially where facilities are inadequate.[10]

Studies from India and other South Asian settings consistently report that inadequate WASH facilities correspond with poor hygiene practices among school children.[8-11] Research from Madurai found that although students had access to piped water, year-round availability and hygiene behaviour varied significantly.[8] Evidence from Chennai, Vishakhapatnam, and Ethiopia further reveals gaps between basic WASH awareness and actual practice, indicating the need for continuous monitoring and behaviour-change interventions.[10-14]

Belagavi district comprises both rural and urban schools with varying infrastructural capacities. Rural schools often face challenges such as limited water availability, pit latrines without soap, and irregular maintenance. Urban schools generally demonstrate better WASH indicators but still lack universal access to essential hygiene resources. Understanding these local disparities is crucial for informing targeted interventions.

The study aims to comprehensively assess the knowledge of WASH practices among school children while simultaneously evaluating water, sanitation, hand hygiene, and menstrual hygiene facilities in both rural and urban schools of Belagavi district. By examining children's awareness alongside actual WASH indicators in school environments, the study seeks to identify existing gaps and better understand how infrastructure and knowledge interact to influence hygiene behaviour.

METHODS

Study design

The study employed a cross-sectional design to assess the knowledge of WASH practices among school children and to evaluate WASH indicators within rural and urban schools of Belagavi district. The key elements of the study design, including participant selection, data collection, and variable assessment, were established prior to field implementation to ensure systematic and consistent data gathering.

Study setting

The study was conducted in the Belagavi district of Karnataka, India, and included both rural and urban school settings. Data collection took place between March 2023 and May 2024 across 40 schools, of which 25 were located in rural regions and 15 in urban areas. The period of recruitment corresponded with the academic calendar, ensuring that students from grades VI to VIII were available and accessible. All assessments, including knowledge evaluation and institutional WASH indicator measurement, were carried out during regular school hours to avoid disruption of academic activities.

Study participants

Participants consisted of students enrolled in grades VI, VII, and VIII in the selected rural and urban schools. Eligibility criteria required students to be present in school on the day of data collection, enrolled in the specified grade levels, and able to provide written assent, with verbal consent obtained from their class teachers. Schools that did not grant permission for participation and students absent on data collection days were excluded. A purposive sampling strategy was used to select schools representing both rural and urban settings, while all eligible students within those schools were invited to participate.

Variables

The primary outcome variable was the level of knowledge regarding WASH practices, categorised into "good" or "poor" based on scores from a pre-tested questionnaire. Additional variables included demographic characteristics such as age, gender, and grade level. Exposure variables included the WASH indicators assessed at each school, covering water source and availability, type and number of sanitation facilities, availability of handwashing resources, and menstrual hygiene management facilities. Operational definitions were used for key terms such as sanitation, hygiene, diarrhoea, and latrine to ensure consistency across study sites.

Data sources and measurement

Data were collected from two primary sources: student questionnaires and school infrastructure evaluations. Knowledge-related information was obtained using a pre-designed, pre-tested questionnaire based on WHO WASH guidelines. The questionnaire assessed recognition of water contamination risks, hygiene practices, and disease prevention. WASH indicators within each school were evaluated using the WHO core and expanded WASH facility assessment tool, which documented drinking water sources, water availability, handwashing stations, sanitation infrastructure, and menstrual hygiene provisions. All assessments were standardised across rural and urban schools to ensure comparability between groups.

Bias

Efforts were made to minimise potential sources of bias throughout the study. Selection bias was reduced by including all eligible students within selected schools rather than a selective subset. Information bias was minimised by using standardised and validated WHO questionnaires and checklists. The research team received training prior to data collection to ensure uniform administration of tools across all settings. Recording errors were minimised through supervised data entry and cross-verification of questionnaire responses with field notes.

Study size

The study size was determined using the formula for estimating proportions at a 95% confidence interval and 20% allowable error. A conservative prevalence estimate of 50% was used to maximise sample size, yielding a minimum requirement of 384 participants. To account for a potential 10% non-response or attrition rate, the sample size was increased to 422 participants. The final sample comprised 422 students, satisfying the estimated requirement.

Sample size calculation

The sample size was calculated using the formula:

$$\boldsymbol{N} = \frac{\boldsymbol{Z}^2 \times \boldsymbol{P} \times \boldsymbol{Q}}{\boldsymbol{L}^2}$$

Where
$\boldsymbol{Z} = \mathbf{1.96}$(95% CI),
$\boldsymbol{P} = \mathbf{0.5}$,
$\boldsymbol{Q} = \mathbf{1} - \boldsymbol{P} = \mathbf{0.5}$,
$\boldsymbol{L} = \mathbf{0.2}$.

Substituting values:

$$\boldsymbol{N} = \frac{(\mathbf{1.96})^2 \times \mathbf{0.5} \times \mathbf{0.5}}{(\mathbf{0.2})^2} = \mathbf{384}$$

Adding 10% for non-response, the final sample size was 422.

Quantitative variables

Quantitative variables, including knowledge scores and counts of WASH indicators, were analysed using descriptive statistics. Knowledge scores were dichotomised into “good” and “poor” categories based on predetermined scoring cutoffs, selected to ensure meaningful interpretation and comparison between demographic groups. WASH indicators were expressed as frequencies and percentages to describe infrastructure distribution across rural and urban schools.

Statistical methods

Data were entered into Microsoft Excel and analysed using SPSS version.[20] Descriptive statistics, including frequencies, percentages, and cross-tabulations, were used to summarise participant characteristics and WASH indicators. Inferential statistical tests, including chi-square analysis, were applied to examine associations between categorical variables such as knowledge level and demographic characteristics. No major confounders were identified requiring adjustment; however, stratified analysis between rural and urban settings was conducted to compare WASH indicator distributions. Missing data were minimised during collection, and any incomplete records were excluded from specific analyses without affecting overall sample integrity. The sampling strategy was accounted for through proportional representation of rural and urban schools. Sensitivity analyses were not required given the uniformity of the sampling method and the cross-sectional nature of the data.

RESULTS

Socio-demographic characteristics of participants

A total of 422 school children participated in the study. Most participants were aged 12–13 years (61.1%), while 38.9% were aged 13.1–14 years. Male students constituted 60.2% of the sample, and females accounted for 39.8%. With respect to class distribution, 26.5% were from class 6, 35.1% from class 7, and 38.4% from class 8.

Knowledge levels of wash practices

Overall, 51.2% of students demonstrated good WASH knowledge, while 48.8% had poor knowledge. Among students aged 12-13 years, 44.2% had good knowledge and 55.8% had poor knowledge. In the 13.1-14-year age group, 62.2% had good knowledge and 37.8% had poor knowledge. Among males, 52.0% had good knowledge and 48.0% had poor knowledge, whereas among females, 50.0% had good knowledge and 50.0% had poor knowledge. By class, good knowledge was observed in 45.5% of class 6 students, 43.2% of class 7 students, and 62.3% of class 8 students.

Table 1: Socio-demographic characteristics of participants.

Characteristics	Category	Frequency	Percentage (%)
Age (years)	12–13	258	61.1
	13.1–14	164	38.9
	Total	422	100
Gender	Male	254	60.2
	Female	168	39.8
	Total	422	100
Class	6	112	26.5
	7	148	35.1
	8	162	38.4
	Total	422	100

Table 2: Knowledge levels by demographics.

Variable	Category	Good (%)	Poor (%)	Total (%)
Age (years)	12–13	114 (44.2)	144 (55.8)	258 (100)
	13.1–14	102 (62.2)	62 (37.8)	164 (100)
	Overall	216 (51.2)	206 (48.8)	422 (100)
Gender	Male	132 (52)	122 (48)	254 (100)
	Female	84 (50)	84 (50)	168 (100)
	Overall	216 (51.2)	206 (48.8)	422 (100)
Class	6	51 (45.5)	61 (54.5)	112 (100)
	7	64 (43.2)	84 (56.8)	148 (100)
	8	101 (62.3)	61 (37.7)	162 (100)
	Overall	216 (51.2)	206 (48.8)	422 (100)

Table 3: Wash knowledge indicators.

Question / indicator	Response	Frequency	Percentage (%)
Water quality affects health	Yes	288	68.2
	No	134	31.8
Most common effect of unsafe water	Diarrhoea	210	49.8
	Fever	115	27.2
	Other	97	23
Water can get contaminated	Yes	311	73.7
	No	56	13.3
	Maybe	55	13
Received WASH info in past 6 months	Yes	422	100
Type of information	Hand hygiene	229	54.3
	Water quality	60	14.2
	Latrine use	46	10.9
	Sanitation	87	20.6
Risk of not washing hands	Exposed to diseases	420	99.5
	Not exposed	2	0.5

Wash knowledge indicators

A total of 68.2% of students reported that water quality affects health, while 31.8% reported that it does not. Regarding the perceived effects of unsafe water, 49.8% identified diarrhea, 27.3% reported fever, and 23.0% reported other effects. Water contamination was acknowledged by 73.7% of students, while 13.3% responded negatively and 13.0% reported uncertainty. All students (100%) reported receiving WASH-related information in the previous six months. The most common type of information received was related to hand hygiene (54.3%), followed by sanitation (20.6%), water quality (14.2%), and latrine use (10.9%). Nearly all students (99.5%) reported that not washing hands exposes individuals to diseases.

School drinking water indicators (n=40 schools)

All surveyed schools reported piped water as the main drinking water source. Drinking water was available on the day of the survey in all schools, and water availability throughout each school day during the past two weeks was reported by all schools. Drinking water availability throughout the school year was reported by 50.0% of rural schools and 37.5% of urban schools, while 12.5% of rural schools reported uncertain availability. One to three drinking water points were reported in 62.5% of rural schools and 7.5% of urban schools, whereas 30.0% of urban schools had four to seven drinking water points. All schools reported treating drinking water from the main source. Filtration was used in 47.5% of rural schools and 37.5% of urban schools, while 15.0% of rural schools used other treatment methods.

Hand hygiene facilities (n=40 schools)

Handwashing facilities were present in all surveyed schools. Availability of only water at handwashing points was reported in 62.5% of rural schools and 27.5% of urban schools. Availability of both water and soap was reported in 10.0% of urban schools, while none of the rural schools reported the presence of soap at handwashing points.

Table 4: Water indicators (n=40 schools).

Indicator	Domicile	Category	Frequency (%)	Total	P-value
Main drinking water source	Rural	Piped	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		
Drinking water available today	Rural	Yes	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		
Water available throughout each school day (past 2 weeks)	Rural	Yes	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		
Drinking water available throughout the school year	Rural	Yes	20 (50.0)	40 (100%)	0.065
		Maybe	5 (12.5)		
	Urban	Yes	15 (37.5)		
Number of drinking water points	Rural	1–3 points	25 (62.5)	40 (100%)	<0.001
	Urban		3 (7.5)		

Table 5: Hand hygiene indicators (n=40 schools).

Indicator	Domicile	Category	Frequency (%)	Total	P-value
Presence of handwashing facility	Rural	Yes	25 (62.5)	40 (100%)	-
	Urban	Yes	15 (37.5)		
Availability of water and soap at handwashing points	Rural	Water only	25 (62.5)	40 (100%)	0.007
		Water + soap	0 (0.0)		
	Urban	Water only	11 (27.5)		
		Water + soap	4 (10.0)		

Sanitation and menstrual hygiene facilities (n=40 schools)

Pit latrines with slabs were reported in 62.5% of rural schools and 27.5% of urban schools, while flush or pour-flush toilets were reported in 10.0% of urban schools. One to three usable toilets were reported in 55.0% of rural schools, whereas four to seven usable toilets were reported in 37.5% of urban schools. Separate toilets for boys and girls were present in all schools.

Water and soap in girls' toilets were reported in 10.0% of rural schools and 22.5% of urban schools, while water only was reported in 52.5% of rural schools and 15.0% of urban schools. Covered bins for menstrual waste were present in all schools, and all schools reported having a disposal mechanism for menstrual waste. Emptying of latrines or septic tanks was reported by all schools. Anal cleansing materials were available in all toilets across all schools. Toilets were accessible during all school hours in all schools. Clean toilets were reported in 55.0% of rural schools and 37.5% of urban schools, while somewhat clean toilets were reported in 7.5% of rural schools. Toilet cleaning once per week was reported in all schools.

Table 6: Sanitation and menstrual hygiene indicators (n=40 schools).

Indicator	Domicile	Category	Frequency (%)	Total	P-value
Type of toilets/latrines for students	Rural	Pit latrine with slab	25 (62.5)	40 (100%)	0.007
	Urban	Flush/pour flush	4 (10.0)		
		Pit latrine with slab	11 (27.5)		
Number of usable toilets	Rural	1–3	22 (55.0)	40 (100%)	<0.001
		4–7	3 (7.5)		
	Urban	4–7	15 (37.5)		
Separate toilets for boys and girls	Rural	Yes	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		
Water and soap in girls' toilets	Rural	Water + soap	4 (10.0)	40 (100%)	0.001
		Water only	21 (52.5)		
	Urban	Water + soap	9 (22.5)		
		Water only	6 (15.0)		
Covered bins for menstrual waste	Rural	Yes	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		
Disposal mechanism for menstrual waste	Rural	Yes	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		
Emptying of latrines/septic tanks	Rural	Yes	25 (62.5)	40 (100%)	-
	Urban	Yes	15 (37.5)		
Availability of anal cleansing materials	Rural	All toilets	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		
Toilet accessibility during school hours	Rural	All times	25 (62.5)	40 (100%)	-
	Urban	All times	15 (37.5)		
Toilet cleanliness	Rural	Clean	22 (55.0)	40 (100%)	0.262
		Somewhat clean	3 (7.5)		
	Urban	Clean	15 (37.5)		
Frequency of toilet cleaning	Rural	Once per week	25 (62.5)	40 (100%)	-
	Urban		15 (37.5)		

DISCUSSION

This study assessed knowledge of WASH practices among school children and evaluated school-level WASH indicators across rural and urban schools in Belagavi district, Karnataka. The findings indicate moderate overall WASH knowledge among students (51.2% good knowledge), alongside substantial deficiencies in critical WASH infrastructure, particularly the availability of soap at handwashing points, adequacy of sanitation facilities, and consistent year-round water availability. By simultaneously examining student knowledge and institutional indicators, this study provides quantitative evidence of the gap between awareness and enabling environments in school settings.

Knowledge of wash practices among school children

Overall, 216 out of 422 students (51.2%) demonstrated good WASH knowledge, while 206 (48.8%) had poor knowledge. Knowledge levels showed a clear age gradient: good knowledge was reported by 62.2% of students aged 13.1-14 years compared to only 44.2% among those aged 12-13 years. Similarly, good knowledge increased with grade level, from 45.5% in class 6 and 43.2% in class 7 to 62.3% in class 8. These findings are consistent with studies from Delhi, Kolkata, and Madurai, which report improved WASH awareness with increasing age and schooling.[1,4,7,13]

Gender-wise differences were minimal, with good knowledge reported by 52.0% of boys and 50.0% of girls, indicating relatively equitable dissemination of WASH information. Awareness of the health implications of unsafe water was reported by 68.2% of students, while 31.8% did not recognise this association. Nearly half of the students (49.8%) correctly identified diarrhoea as the most common outcome of unsafe water, followed by fever (27.2%). Water contamination was acknowledged by 73.7% of students, whereas 13.3% denied contamination and 13.0% were unsure.

All students (100%) reported receiving WASH-related information in the preceding six months, with hand hygiene being the most frequently cited topic (54.3%), followed by sanitation (20.6%), water quality (14.2%), and latrine use (10.9%). Almost universal recognition (99.5%) that not washing hands leads to disease exposure highlights the effectiveness of health messaging, even though knowledge gaps persist in specific areas.

Drinking water availability and infrastructure

At the school level, all 40 surveyed schools (100%) reported piped water as the main drinking water source, and drinking water was available on the day of survey and throughout the school day in the preceding two weeks in all schools. However, consistent availability throughout the school year was reported by only 50.0% of rural schools and 37.5% of urban schools, with 12.5% of rural schools reporting uncertainty regarding year-round availability. Similar challenges with seasonal water reliability have been documented in rural schools in Karnataka, Kathua, and Ethiopia.[3,14,15]

The adequacy of drinking water points differed markedly by location. In rural schools, 62.5% had only one to three drinking water points, whereas 30.0% of urban schools had four to seven points. Limited water points may restrict access during peak hours and have been associated with reduced water consumption and hygiene compliance in previous studies.[12-16] Although all schools reported treating drinking water, filtration was used in only 47.5% of rural and 37.5% of urban schools, indicating variability in treatment practices.

Hand hygiene facilities and practice enablers

While all schools (100%) reported the presence of handwashing facilities, functionality was notably poor. In rural schools, 62.5% had handwashing points with water only and none had soap available. In urban schools, 27.5% had water only and just 10.0% had both water and soap at handwashing points. These findings indicate that more than 90% of schools lacked soap at handwashing stations, despite 99.5% of students recognising the importance of handwashing.

This discrepancy mirrors findings from studies in Mumbai, Kinshasa, Bishoftu town, and eastern Ethiopia, where soap availability was consistently identified as the weakest WASH component in schools.[12,14,16-18] Given that handwashing with soap can reduce diarrhoeal disease by up to 40%, the absence of soap substantially undermines the potential health benefits of existing facilities.[2-11]

Sanitation and menstrual hygiene management facilities

Sanitation facilities showed pronounced rural-urban disparities. Pit latrines with slabs were reported in 62.5% of rural schools and 27.5% of urban schools, while flush or pour-flush toilets were reported in only 10.0% of urban schools. Regarding adequacy, 55.0% of rural schools had only one to three usable toilets, compared to 37.5% of urban schools having four to seven usable toilets. These figures align with earlier studies from Odisha and Visakhapatnam documenting inadequate toilet-to-student ratios in rural schools.[9-16]

Separate toilets for boys and girls were available in all schools (100%). However, water and soap in girls' toilets were available in only 10.0% of rural schools and 22.5% of urban schools, while water alone was reported in 52.5% of rural and 15.0% of urban schools. Although covered bins and menstrual waste disposal mechanisms were universally present (100%), limited access to soap and water may restrict effective menstrual hygiene practices, as reported in studies from Ethiopia and Kolkata.[13,16,19]

Toilet cleanliness remained suboptimal, with only 55.0% of rural and 37.5% of urban schools reporting clean toilets. All schools reported toilet cleaning once per week, which may be insufficient to maintain hygiene standards, particularly in high-use school settings.

Interpretation and policy implications

The findings quantitatively demonstrate that moderate-to-high awareness of WASH practices among students coexists with significant infrastructural and maintenance deficiencies within schools. Despite universal access to piped water and handwashing facilities, critical enabling components-such as soap, adequate numbers of toilets, and year-round water availability-remain insufficient. Similar gaps between knowledge and infrastructure have been consistently reported across Indian and international school WASH studies.[1,11,12] Addressing these deficiencies requires shifting focus from awareness generation alone to sustained provision, monitoring, and maintenance of WASH facilities, particularly in rural schools.

Interpretation assumes that self-reported knowledge reflects actual understanding and that school-reported infrastructure availability represents routine conditions. As with other cross-sectional studies, responses may be influenced by social desirability and reporting bias.[6-10] Nevertheless, the alignment of these findings with multiple external studies supports their credibility. Given the inclusion of 40 schools across both rural (62.5%) and urban (37.5%) settings, the findings are generalisable to similar mixed rural-urban districts in Karnataka and comparable regions of India. However, differences in local governance, funding, and programme implementation may limit direct extrapolation to districts with substantially different contexts.

Limitations

The cross-sectional design limits causal inference between WASH knowledge and infrastructure. Knowledge was self-reported and may be influenced by social desirability bias. WASH facilities were assessed at a single time point and may not reflect seasonal variability. The study was confined to selected schools in one district, limiting generalisability, and did not include direct observation of practices or health outcomes.

CONCLUSION

In conclusion, the findings of this study highlight that while school children in Belagavi district possess a moderate level of WASH knowledge, there remains a significant gap between awareness and the institutional infrastructure required to support healthy behaviours. Despite universal access to piped water and handwashing stations, critical deficiencies persist, most notably the absence of soap in over 90% of schools and inconsistent year-round water availability. Pronounced rural-urban disparities further underscore the need for targeted improvements in rural sanitation facilities and toilet-to-student ratios. These results suggest that health education alone is insufficient; future initiatives must prioritise the sustained provision of hygiene consumables, regular facility maintenance, and reliable infrastructure to effectively translate students' knowledge into lasting health-promoting practices.

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