Effect of School-Based Educational Water, Sanitation, and Hygiene Intervention on Students' Knowledge in a Resource-Constrained Setting

Ommy Mushota
Karolinska Institutet

Aditya Mathur
RD Gardi Medical College: Ruxmaniben Deepchand Gardi Medical College

Ashish Pathak (ashish.pathak@ki.se)
Karolinska Institutet https://orcid.org/0000-0002-7576-895X

Research article

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Abstract

Background

Globally, diarrhea is one of the major causes of under-5 mortality. India accounts for the highest number of childhood deaths globally. Therefore, facilitating the implementation of water, sanitation, and hygiene (WASH)-related interventions for adolescents in schools and communities is crucial. In the present study, we investigated the effectiveness of a school-based educational WASH intervention in improving students' knowledge on prevention and management of diarrhea in Ujjain district, India.

Methods

The present pre–post intervention study with a two-stage (schools and classrooms) cluster sampling was conducted on 1781 students studying in 8th to 12th grades in schools located in Ujjain, Madhya Pradesh, India. The intervention comprised an educational training session by using a WASH training module. The means of pre- and post-intervention scores were compared using repeated measure analysis of variance. A multivariate quantile regression model was used to test the correlation between the change in score after intervention and the independent variables. A P value of <0.05 was considered statistically significant.

Results

The proportions of students possessing knowledge on the treatment of diarrhea, use of zinc tablets during an episode of diarrhea, and the symptoms and signs of severe pediatric diarrhea were 28%, 27%, and 27%, respectively, before intervention. These proportions increased significantly ($P < 0.001$) after the educational intervention to 72%, 73%, and 74%, respectively. The mean post-intervention knowledge score (34.13) was significantly higher than the mean pre-intervention score (15.17) ($F = 16513.36$, $P < 0.001$). Age was significantly associated with the knowledge score at the 25th and higher quantile (q). Gender exhibited a greater effect at $q10^{th}$. School location was positively associated at $q25^{th}$ and higher. School type was strongly associated at low quantiles ($q10^{th}$ and $q25^{th}$). School medium exhibited a greater association at low quantiles ($\leq q25^{th}$).

Conclusion

WASH- and diarrhea-related knowledge among higher secondary school students increased after the educational intervention. Further research is required to evaluate the social demographic characteristics associated with change in the knowledge score to better evaluate school-based educational WASH interventions and improve the management and prevention of diarrhea.

Background

Approximately 534,000 children under 5 years (U-5) die every year because of diarrhea [1]. Globally, nearly 1.6 billion children experience childhood diarrhea [2]. The World Health Organization (WHO) has defined diarrhea as loose watery stools occurring thrice or more per day [3]. Diarrhea is usually caused by

pathogens that are commonly transmitted through feco-oral pathways [4]. Diarrheal diseases are a common public health problem in several low- and middle-income countries (LMICs) [5]. In 2016, the majority (89%) of U-5 diarrheal deaths occurred in South Asia and sub-Saharan Africa [4, 6]. However, diarrheal deaths have declined substantially (16.6%) from 1.88 million in 2007 to 1.6 million in 2017 [2]. In the past years, efforts have been made to reduce diarrheal diseases through community- and school-based interventions, promotion of exclusive breastfeeding, and rotavirus vaccinations [1]. Despite these efforts, diarrhea continues to be one of the leading causes of global childhood mortality [7].

In India, the number of childhood diarrheal deaths is the highest, with over 400,000 cases recorded annually [8]. Diarrheal deaths are more pervasive in rural areas [9]. The efficacy of oral rehydration salts (ORS) and zinc in preventing 69% of diarrhea-associated U-5 mortality has been confirmed [9, 10]. However, only 39% of children with diarrhea in Indian health centers receive ORS and zinc treatments, whereas antibiotics are prescribed to 72% of children [10, 11]. Furthermore, nearly 600 million people lack access to safe drinking water, and less than 35% of Indian households have access to clean water from their houses [7]. Additionally, 85% of rural Indian household lack access to clean water [7].

School-going children, particularly adolescents, are considered as the key knowledge carriers, who generally take their learning from school back to their homes and communities [12]. Therefore, investing in adolescents could be an effective strategy to fight against poverty and inequalities. Furthermore, adolescents can be key change drivers in their communities if provided right opportunities, information, and tools [13]. Thus, explaining the significance of water, sanitation, and hygiene (WASH) and dissemination of health information to adolescents in schools may effectively improve knowledge on diarrhea management and prevention within communities.

Knowledge, attitudes, and practices (KAP) studies have been conducted in LMICs to understand and prevent diarrhea using school-based interventions [7, 14]. However, only a few intervention studies analyzed the knowledge of higher secondary school students in diarrhea management and prevention by using a WASH educational intervention [15, 16]. Thus, the present study was designed to analyze the effectiveness of WASH intervention in LMICs and provide valuable recommendations to policymakers in the prevention and management of WASH-related morbidities and mortalities in resource-constrained settings. The objective of the study was to understand the effectiveness of a school-based WASH educational intervention on students' knowledge on prevention and management of diarrhea in Ujjain district, India.

Methods

Study design and setting

The present pre–post intervention study with a two-stage (schools and classrooms) cluster sampling was conducted on 1781 students studying in 8th to 12th grades between July 2018 and December 2018. The study was conducted in Ujjain district, Madhya Pradesh, Central India. Ujjain district has 5 sub-districts, covering 6091 square km, and is a plateau [17]. The district has a population of approximately 2 million

(1986864); approximately 61% (616353) of the population resides in rural areas, with mostly an agrarian economy [17].

Sample size calculation

To calculate the sample size, a pilot study was conducted on 65 students, in which the students answered 54% of the questions correctly. Sample size calculation was performed with one sample comparison of proportion 54%, two-sided alpha of 0.05, and power of 90%. The minimum sample size obtained after calculation was 1613, to which 10% was added to account for attrition or refusal rate. Thus, the estimated sample size was 1774. The students who participated in the pilot study were not included in the main study.

Sampling strategy and data collection

A list of public and private higher secondary schools (grades 8th to 12th) along with number of students in each class was obtained from the District Education Officer. In the first sampling stage, public and private schools were selected randomly from two separate lists of all the public and private schools. Figure 1 illustrates the sampling procedure and the inclusion and exclusion criteria for the selection of schools. Of the 514 public and private higher secondary schools in the Ujjain district, 72 schools having a strength of at least 40–50 students in each class of 8th–12th grade were selected to reduce the number of visits required to obtain the estimated sample size. Among the selected schools, 12 schools from rural area and 12 schools from urban area were selected randomly by using computer-generated random numbers.

To collect data, a structured WASH-knowledge questionnaire was developed in English, which was then translated to Hindi according to the WHO recommendations for questionnaire translation [18]. The WASH-knowledge questionnaire comprised 15 questions, which were divided into 4 sections: water (1 question), sanitation (5 questions), hygiene (3 questions), and knowledge about diarrhea (6 questions on definition, causes, signs and symptoms, and community treatment). **(Additional file 1-questionnaire in English)**.

The questionnaire also included limited demographic information such as name, age, class, and gender of the participating students. Each test was completed in approximately 20 min. Each correct answer was given a score of 1. Some questions had multiple correct options. The minimum and maximum possible scores were 0 and 44, respectively. The same questionnaire was used after educational intervention to assess the effect of the intervention. The distribution and collection of the questionnaires was facilitated by 4–6 trained research assistants, who were present in class during the session. They helped the students to understand the questions in case of any difficulty; however, they did not help the students in answering the question.

Educational intervention

A visit was scheduled for each school before starting the intervention. Informed consent was obtained from both the school principal and students. The team of trained research assistants asked the students to fill-in the structured WASH-knowledge questionnaire. The team ensured that the questionnaires have been completely filled by the students; in case of any missing information, they interviewed the students and filled the missing detail. The principal researcher visited the schools to supervise the survey activities. No efforts were made to contact the students who were absent on the day of data collection.

The educational intervention consisted of an approximately 60-min practical training session, which included a training module in the form of a flip chart with appropriate diagrams and pictures to convey the WASH-related messages to the students, shown in the classroom as power point presentation. The training module was based on the “Save The Children” community intervention module for childhood diarrhea [19]. Examples of some of the figures used in the educational intervention are depicted in **Additional file 2.**

Two class periods (90 min) were used to complete the 20-min pre-intervention questionnaire, and the 60-min intervention was provided on the same day. The students were not informed about the post-intervention questionnaire. After the intervention, the students were asked to complete the same WASH-knowledge questionnaire in 20 min after a minimum gap of one month. Overall, 144 sessions were conducted in 6 months, which included 72 pre-intervention and 72 post-intervention sessions.

Fidelity of intervention

To maintain fidelity in implementation of the intervention, the research assistants received training by the principal investigator. A 4-h training session was conducted to explain the intervention module. All slides in the power point presentation, pictures, and videos were discussed with regards to content and the method of delivering the content. The concepts were reinforced by providing the research assistants an opportunity to engage in role-playing. The training session was repeated once every fortnight during the study period. A training manual was used to articulate the content and delivery of the educational practical session.

Ethical considerations

The Institutional Ethics Committee of R D Gardi Medical College, Ujjain, India approved the research protocol (IEC-RDGMC-493). Prior permission was taken from District Magistrate, Ujjain to approach the schools and to intervene. Consent to participate in the study was obtained from parents of the students, and assent was obtained from the students. All the students present on the day of data collection were asked to participate.

Data management and analysis

Data was collected in schools through paper-based questionnaires which were later entered in Epi Info^{TM} (Version 7.2). Data analysis was done using Stata (Version 16.1, Stata Corp, College Station, Texas,

USA). Descriptive statistics were used to determine the proportion of correctly answered questions by the students in the pre and post-intervention. Pearson χ^2 was used to test the significance of the difference in proportions in pre and post intervention. For continuous variables, range, mean and standard deviation was presented. Means of pre and post-test scores were compared using repeated measures analysis of variance (ANOVA). The effect size of intervention was determined by calculating Cohen's *d*. Multivariate quantile regression models were used to test the association between difference in pre and post-intervention score (outcome) and independent variables. The independent variables included Quantile regression model was chosen to capture the full distribution of the outcome- difference in pre and post-intervention score. The coefficient (b), and 95% confidence interval was estimated for 10th, 25th, 50th (median), 75th and 90th quantiles of the difference in pre and post-intervention score based on 500 bootstrap samples. The multivariate quantile regression analysis was performed using the simultaneous quantile regression command in Stata (Version 16.1, Stata Corp, College Station, Texas, USA). A *P* value <0.05 was considered significant.

Results

A total of 1806 students completed the pre intervention questionnaire out of the eligible 1850. The remaining 44 students did not provide assent. Out of these 1806 students, 25 students were absent on the day of intervention. Thus, a total of 1781 participated voluntarily in the study out of the possible 1806, giving a response rate of 96% (Fig. 1). Of the 1781 participants there were 865 (49%) boys and 916 girls (51%). The mean (± SD) age of the study participants was 15.68 (± 1.29) years. Table 1 presents the socio-demographic characteristics of the study participants.

Table 1
Socio-demographic characteristics of high school students (n = 1781) included in the study, Ujjain, India

Variables	n = 1781	%
Age category		
14 to 16	1205	68
> 16 to 18	466	26
> 18	110	6
Gender		
Boys	865	49
Girls	916	51
School location		
Urban	995	56
Rural	786	44
School type		
Private	813	46
Government	968	54
School medium		
English	678	38
Hindi	1103	62

The mean pre-intervention score was 15.17 and the mean post-intervention score was 34.13 out of maximum possible score of 44. The median pre and post intervention scores were 14 and 35, respectively. The effect size of intervention; Cohen's d was 3.43. The results of repeated measures ANOVA indicated that knowledge score significantly improved post intervention (F = 16513.36, $P < 0.001$).

Table 2 shows the proportions of correct answers by the students for definition, causes, signs/symptoms and treatment of diarrhea pre and post intervention. It was observed that only about one-third of students had knowledge on the definition of diarrhea and the causes of diarrhea pre-intervention. After the educational WASH intervention, the proportions significantly improved to 72% for both definition and causes, respectively. However, far better improvement post-intervention was noticed in knowledge of treatment of diarrhea (28% versus 73%; $P < 0.001$), use of ORS and Zinc tablets (27% versus 74%; $P < 0.001$) and the symptoms/signs of diarrhea (25% versus 75%; $P < 0.001$). Further, only 33% of the students had knowledge on benefits of continued breastfeeding in an episode of diarrhea before intervention, this significantly improved to 86% post-intervention.

Table 2
Number and percentages of correct answers by the students (n = 1781) for definition, causes, signs/symptoms and treatment of diarrhea pre and post intervention

	Pre intervention	Post intervention	Chi-square	*P* value
	n = 1781	n = 1781		
Definition of diarrhea				
Watery stools three or more times a day	559(31)	1394(78)	793.049	< 0.001
What are the causes of diarrhea in a community?				
Open defecation	555(31)	1392(78)	793.049	< 0.001
Not washing hands after defecation	664(37)	1433(80)	678.024	< 0.001
Contaminated food/water	574(32)	1371(77)	726.991	< 0.001
Germs	609(34)	1353(76)	634.505	< 0.001
Flies	548(31)	1333(75)	691.9	< 0.001
What are the symptoms/signs of severe illness in a child with diarrhea?				
Sunken eyes	567(32)	1392(78)	761.119	< 0.001
Slow skin pinch	489(27)	1362(76)	855.766	< 0.001
Irritable child	607(34)	1412(79)	733.499	< 0.001
Frequent vomiting	581(33)	1404(79)	764.517	< 0.001
Difficulty in breastfeeding /eating	547(31)	1285(72)	599.143	< 0.001
Dull or becoming unconsciousness	540(30)	1310(74)	690.514	< 0.001
Blood in Stool	445(25)	1333(75)	890.25	< 0.001
What treatment should be started on day one of diarrhea?				

	Pre intervention	Post intervention	Chi-square	*P* value
	n = 1781	n = 1781		
Both ORS and zinc	505(28)	1307(73)	721.175	< 0.001
For how many days zinc tablets should be taken?				
Fourteen days	483(27)	1321(74)	786.704	< 0.001
Should a child continued to breastfeed during diarrhea?				
Yes	579(33)	1535(86)	1037.748	< 0.001
How many steps are there for washing hands?				
Seven	641(36)	1276(72)	464.478	< 0.001

The characteristics of WASH related knowledge of the study participants are presented in Table 3. Lowest proportions of correct answers were observed on questions regarding the use of toilets (25%), washing hands after use of toilet (37%) and benefits of regularly cleaning the toilet (30%) in the preintervention, which improved to 77%, 76%, and 72%, respectively post intervention.

Table 3
Number and percentages of correct answers by the students (n = 1781) for water, sanitation and hygiene(WASH) related questions pre and post intervention

	Pre intervention	Post intervention	Chi-square	*P* value
	n = 1781	n = 1781		
When is it critical to wash hands with soap and water?				
Before cooking/serving/eating	547(31)	1440(81)	903.257	< 0.001
Before feeding/breastfeeding children	610(34)	1346(76)	634.505	< 0.001
After defecation	1549(87)	1636(92)	23.693	< 0.001
After clearing child's stool	864(49)	1500(84)	489.533	< 0.001
After contact with a sick person	592(33)	1372(77)	696.373	< 0.001
After touching animals	472(27)	1293(73)	753.508	< 0.001
What is the need of toilet/latrine?				
Use of toilets ensures privacy/security	520(29)	1295(73)	689.685	< 0.001
No need to walk very far for defecation	590(33)	1394(78)	729.935	< 0.001
It keeps our surroundings clean	680(38)	1359(76)	524.488	< 0.001
It helps the old, children and disabled members	615(35)	1357(76)	605.936	< 0.001
There is no spread of germs by flies	539(30)	1391(78)	825.739	< 0.001
Feces will not be seen in open spaces/sewage	445(25)	1377(77)	963.28	< 0.001
What should be used for washing hands after using toilet?				
Soap and water	659(37)	1362(76)	550.939	< 0.001
What are the benefits of regularly cleaning the toilet?				

	Pre intervention	Post intervention	Chi-square	*P* value
	n = 1781	n = 1781		
The use of toilets increases	542(30)	1282(72)	628.412	< 0.001
Flies do not sit on the toilet	700(39)	1372(77)	527.718	< 0.001
Surrounding environment remains clean	717(40)	1354(76)	473.631	< 0.001
Where should be the child's feces be disposed off?				
Bury in a pit	627(35)	1399(79)	703.192	< 0.001
What are the measures for preventing diarrhea?				
Keeping water pot covered in household	607(34)	1417(80)	768.572	< 0.001
Not dipping fingers in glass of drinking water	625(35)	1356(76)	605.936	< 0.001
Using utensil with handle to take water from pot.	560(31)	1433(80)	865.468	< 0.001
Covering food items	534(30)	1421(80)	899.242	< 0.001
Boiling drinking water	592(33)	1278(72)	542.986	< 0.001
Where should we dispose our household waste?				
Separating wet and dry garbage in separate boxes	629(35)	1450(81)	773.304	< 0.001
In the municipal garbage box/vehicle	532(30)	1396(78)	825.739	< 0.001
What is the importance of keeping the house clean?				
It helps to keep environment clean	799(45)	1480(83)	557.952	< 0.001
Flies will not be able to spread germs	691(39)	1369(77)	527.718	< 0.001
Children and household members do not get sick often	693(39)	1456(82)	688.805	< 0.001

Table 4 reports the results of the multivariate quantile regression analysis of the association between the independent variables and the outcome-difference in pre and post intervention scores. Age was significantly associated with knowledge score at 25th and higher quantile; (b) = 0.50; p = 0.004, (b) = 0.60; $P < 0.001$, (b) = 0.65; $P < 0.001$, (b) = 0.87; $P < 0.001$. Gender (boys versus girls, with boys as reference) had an impact on the outcome. Boys performed better than girls only at lower quantiles of the outcome (10th and 25th). School location (urban versus rural, with urban as reference) also had an impact on the outcome. Urban schools were positively associated with difference in pre and post intervention scores at 25th quantile and higher (75th or more), (b) = 1.32; $P = 0.007$, (b) = 2.70; $P < 0.001$, (b) = 3.53; $P < 0.001$, (b) = 3.98; $P < 0.001$. School type (private versus public, with private as reference) was significantly negatively associated with outcome difference in pre and post intervention score across all quantiles. School medium (English versus Hindi, with English as reference) was positively associated across all quantiles, a greater association was seen in the lower quantiles (≤ 25th quantile) (b) = 6.70; $P < 0.001$, (b) = 6.33.; $P < 0.001$.

Table 4

Multivariate quantile regression analysis of the association between independent variables and outcome-difference in pre and post intervention scores among 1781 high school students in Ujjain, India

	q10		**q25**		**q50 (median)**		**q75**		**q90**	
	b (95% CI)	**P value**	**b (95% CI)**	**P value**	**b (95% CI)**	**P value**	**b (95% CI)**	**P value**	**b (95% CI)**	**P value**
Age (years)										
Continuous variable	0.34 (-0.21 to 0.89)	0.222	0.50 (0.16 to 0.84)	0.004	0.60 (0.37 to 0.83)	< 0.001	0.65 (0.34 to 0.96)	< 0.001	0.87 (0.59 to 1.15)	< 0.001
Gender										
Boys (ref)										
Girls	1.94 (0.55 to 3.34)	0.006	1.21 (0.47 to 1.95)	0.001	0.58 (-0.09 to 1.26)	0.090	0.21 (-0.48 to 0.89)	0.554	0.19 (-0.61 to 0.98)	0.648
School location										
Urban (ref)										
Rural	0.93 (-0.59 to 2.44)	0.232	1.32 (0.35 to 2.29)	0.007	2.70 (1.74 to 3.66)	< 0.001	3.53 (2.67 to 4.40)	< 0.001	3.98 (2.93 to 5.03)	< 0.001
School type										
Private(ref)										
Public	-6.95 (-9.61 to -4.29)	< 0.001	-6.74 (-7.98 to -5.50)	< 0.001	-5.02 (-6.55 to -3.48)	< 0.001	-4.73 (-6.03 to -3.44)	< 0.001	-4.03 (-5.20 to -2.87)	< 0.001
School medium										
English(ref)										
Hindi	6.70 (3.48 to 9.92)	< 0.001	6.33 (4.77 to 7.90)	< 0.001	3.85 (2.14 to 5.57)	< 0.001	2.97 (1.47 to 4.47)	< 0.001	2.26 (0.69 to 3.82)	0.005

q = quantiles, b = beta coefficient, CI = Confidence Interval, ref = Reference, %=percentage

Discussion

The present study was an attempt to understand the effectiveness of a school-based WASH educational intervention on students' knowledge on the WASH-based prevention and management of diarrhea, and the study was conducted in Ujjain district, India. The mean age of the 1781 high school students included in the study was 15.68 years. The difference in the mean knowledge score between pre- and post-intervention groups was statistically significant (15.17 versus 34.13, respectively; F = 16513.36; $P < 0.001$; Cohen's d = 3.43). Conventionally, a Cohen's d value of > 0.8 indicates a large effect size [20]. The intervention resulted in a significantly large effect size of the knowledge score of higher secondary school students on WASH-related factors in the prevention and management of diarrhea. The quantile regression results indicated that the change in knowledge score after intervention (outcome variable) is associated with age and is significantly associated with knowledge score at 25th quantile and higher quantiles. At q10th [(b) = 1.94], boys demonstrated a larger effect on outcome than girls. Urban location of school was positively associated at q25th and higher quantiles (q75th or more). Private schools had a negative effect on the outcome across all quantiles compared with public schools. English medium schools outperformed Hindi medium schools across all quantiles.

Prior to the intervention, a lower percentage of students was familiar with the treatment of diarrhea, use of zinc tablets during an episode of diarrhea, and the symptoms and signs of severe diarrhea in children; this percentage increased after intervention. A study conducted in Mumbai, India, demonstrated that the percentage of students possessing knowledge on ORS or zinc as treatments during an episode of diarrhea is insufficient (14%); however, the percentage increased significantly to 69% after intervention [21]. Another study conducted in Philippines revealed that a low proportion (21%) of primary students possesses knowledge on the significance of ORS or zinc in the treatment of diarrhea; however, only a moderate improvement (54%) in the proportion of these students was observed after intervention [14]. One explanation for the ignorance regarding the use of ORS or zinc as treatment options for diarrhea among students in the present study may be the lack of knowledge regarding these treatments in resource-poor settings [22]. Studies conducted in resource-poor countries have demonstrated that although communities and healthcare providers in these regions are aware of ORS or zinc, the utilization rates of these treatments are low at both the community and prescriber levels [8, 23, 24]. Additionally, knowledge of students on breastfeeding was satisfactory before intervention and improved significantly after intervention. The awareness of the influence of breastfeeding on child health can be attributed to culture and religion [25].

A low proportion of students lacked understanding on the significance of toilets and latrines in the prevention of diarrhea. In a study conducted on students' knowledge regarding risk factors for diarrhea in Rwanda, merely 11% and 15% of the students reported that drinking dirty water and poor sanitation and hygiene, respectively, are the causative factors, whereas 73% were not aware of the causes of diarrhea [26]. The findings of the present study are consistent with those of a study that assessed KAP of hygiene among students in Ethiopia, where 48% of the students had poor knowledge related to hygiene and sanitation; the finding was associated with the illiteracy levels of parents and poor socioeconomic backgrounds [27]. Studies conducted in resource-poor settings exhibited that communities face financial challenges regarding hardware installation (latrines/toilets), whereas others still lack the basic understanding of using a toilet to defecate due to cultural norms [25, 27–32]. Students' knowledge

regarding the significance of maintaining a clean house and hand washing was comparable to that observed in studies conducted in Kenya and Turkey, which indicated that students are aware of the significance of such practices and possess moderate knowledge on the importance of handwashing [15, 33].

Findings on social demographic characteristics that were found to be associated with change in the knowledge score can be useful for further research. Age was found to change the outcome in the knowledge score. The score of older students was higher than that of younger students both before and after intervention because of the fact that older students may be slightly more knowledgeable than younger students. However, in a study conducted in Chile, the score of younger students was found to be higher than that of older students [34]. Gender (boys versus girls, with boys as the reference) had a larger effect at lower quantiles (q10th and q25th) on the outcome. Findings suggest that girls may require additional training to improve their knowledge. However, evidence from various international contexts suggests a clear gender gap in academic achievement, with boys lagging behind [27]. Furthermore, students from urban areas outperformed those from rural areas. A study from Nigeria also reported that the academic performance of students from urban areas is superior to that of rural areas [35]. This can be attributed to inequalities such as lack of amenities (e.g., roads and hygienic drinking water), sanitation, school infrastructure and teachers, and uninterrupted electricity faced by rural students. Students from private school did not perform well in the present study. Similar to our findings, a literature review on studies conducted in resource-poor countries indicated that students from public schools are more likely to work harder and have a more disciplined work ethics than their peers from private schools [28]. The medium of instruction refers to the language that is used to teach the contents of the educational curriculum. The education system in India uses either English or other regional languages [36] as the medium of teaching. The students from English medium schools outperformed in the present study. According to a study, education becomes more meaningful when learners are able to both receive and act and then transfer and integrate their learning [37]. Therefore, children adapt more quickly to the learning environment if the language of teaching is similar to the one in which they are capable of expressing themselves.

Methodological Considerations

The strength of our study is that it focused on assessing the effects of the intervention on adolescents in a resource-constrained setting. Studies have been conducted on KAP in communities, but only a few studies have focused on adolescents as knowledge carriers in the prevention and management of diarrhea. Moreover, our study used quantile regression modeling to capture the full distribution of the outcome-difference in pre- and post-intervention scores, which is superior to an arbitrary binary cut-off for pass or fail.

However, our study also has some limitations. First, we used the same questionnaire during the pre–post interventions, which might have allowed students to memorize the questions. Second, the study had an inclusion criterion of having a class with up to 50 students due to limited resources (time and logistics)

available for data collection. This could have led to exclusion of some small schools having smaller class size and ultimately to the potential selection bias. Follow-up longitudinal studies would be required to evaluate the long-term effects of educational interventions on diarrhea and WASH-related outcomes and to assess whether the improved knowledge among adolescents translates into meaningful behavioral changes in their communities.

Conclusions

A significant increase in WASH- and diarrhea-related knowledge can be achieved among higher secondary school adolescents after an educational intervention. The effect size of the intervention was large. As diarrhea continues to be one of the leading causes of U-5 mortality, people-centered interventions are required to effectively manage and prevent diarrhea in poor-resource settings. The study has crucial policy implications such as use of adolescents as knowledge carriers for WASH-related community interventions. Future research should focus on long-term follow-up to better evaluate knowledge retention and assess whether the enhanced knowledge translates into meaningful behavioral change in communities.

Abbreviations

ANOVA
Analysis of Variance
DEO
District Education Officer
GBD
Global Burden of Disease
KAP
Knowledge Attitudes and Practices
LMICS
Low- and Middle-Income Countries
ORS
Oral Rehydration Salts
SSA
Sub Saharan Africa
UNICEF
United Nations Children’s Emergency Fund
U-5
Under Five
WASH
Water Sanitation and Hygiene
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

The Institutional Ethics Committee of R D Gardi Medical College, Ujjain, India approved the research protocol (IEC-RDGMC-493). The study was carried out in accordance with the Declaration of Helsinki, taking into consideration local regulations and standards. Prior permission was taken from District Magistrate, Ujjain to approach the schools and to intervene. Consent to participate in the study was obtained from parents of the students, and assent was obtained from the students. All the students present on the day of data collection were asked to participate.

Consent for publication

Obtained

Availability of data and materials

The dataset used and/or analysed during the current study is available from the corresponding author on reasonable request. Individual data can due to confidentiality reasons not be made public. All enquiries regarding data sharing should be made to- The Chairman, Institutional Ethics Committee, R D Gardi Medical College, Agar Road, Ujjain, India 456006 (E-mail uctharc@sancharnet.in). The name of data set corresponding to the study is School_dia_intervention data.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AP conceptualized and designed the study. AM did data collection. AP supervised data collection. OM, AM and AP performed the statistical analysis and drafted the manuscript. OM, AM, and AP revised the paper critically for substantial intellectual content. All authors read and approved the final manuscript.

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Figures

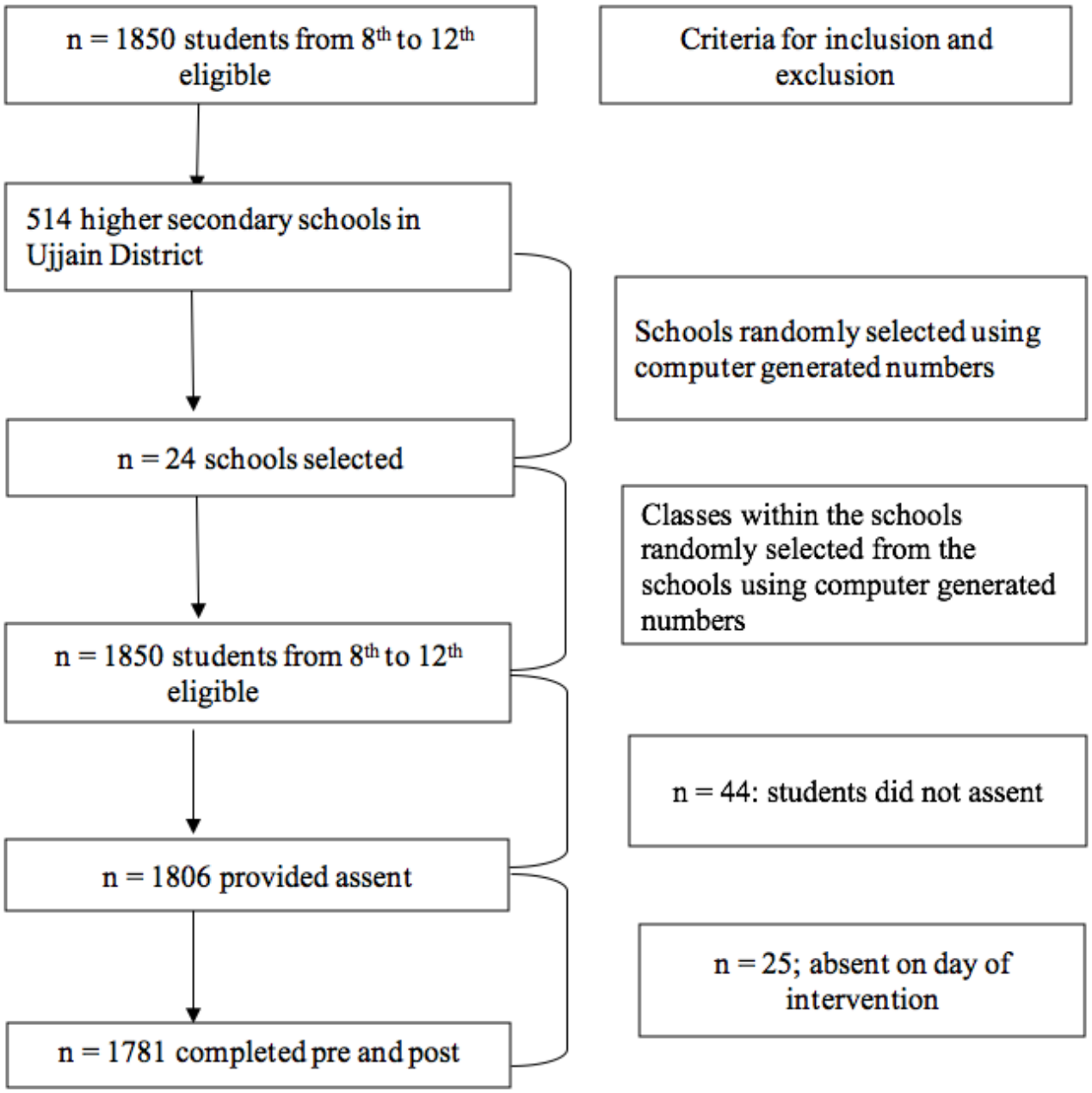

Figure 1

Process of enrolment of participants

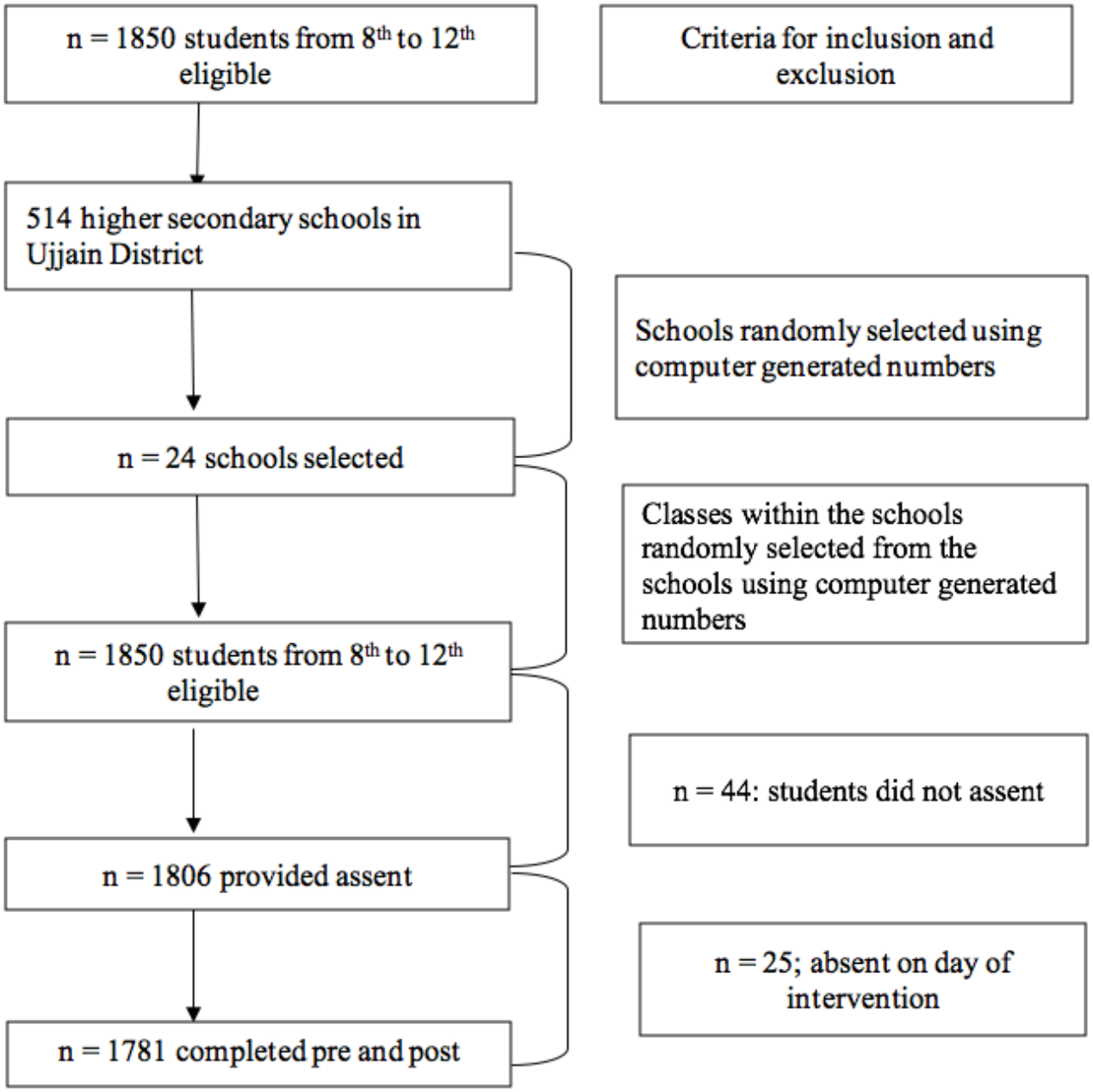

Figure 1

Process of enrolment of participants

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