Original Article

Impact of School-Based Information, Education, and Communication Strategies on Hand Hygiene Knowledge and Practices among Indian Primary School Children: A Pre–Post Intervention Evaluation

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Abstract

Background: Hand hygiene has become a critical preventive measure against communicable diseases, but schoolchildren's knowledge, attitudes, and practices have gaps. Information, Education, and Communication (IEC) strategies hold promise for enhancing hand hygiene behaviours, but evidence on their effectiveness and influencing factors in Indian school settings remains limited. The objective is to evaluate the impact of a structured IEC intervention on hand hygiene knowledge and practices among primary school children, and to examine socio-demographic determinants that influence behavioural outcomes. **Material and Methods:** A pre–post interventional study was conducted from June 2025 to November 2025 among 300 children aged 8–13 years in classes III–VII at government and government-aided schools in Jhansi, India. Participants were selected through a multistage random sampling process. Baseline and four-week post-intervention assessments employed a pre-tested questionnaire covering socio-demographics, knowledge (15 items), attitudes (10 Likert statements), and self-reported practices (12 items), alongside direct observation using a modified WHO checklist. The IEC intervention included interactive demonstrations of the WHO seven-step handwashing technique, Hindi-language visual aids, peer-led discussions, and class monitors. Data were analysed using paired t-tests, McNemar's test, chi-square tests, and logistic regression, with significance set at $p<0.05$. **Results:** Mean knowledge scores rose significantly from 11.2 ± 2.1 to 14.8 ± 1.6 ($p<0.001$). Proper handwashing with soap increased from 35.0% to 73.7% ($p<0.001$), and compliance with critical moments improved from 32.7% to 78.0% ($p<0.001$). Access to soap and water in schools improved by 28 and 24 percent, respectively ($p <.05$). Multivariate analysis has found that IEC exposure (adjusted OR 4.87; 95% CI 3.21–7.39) and parental education (adjusted OR 2.01; 95% CI 1.183.42) were independent predictors of proper hand hygiene. **Conclusion:** IEC interventions can significantly improve hand hygiene knowledge and behaviours among school-going children, with education for parents and the availability of resources affecting the results. Sustainable changes may be enabled by the inclusion of IEC in school curricula and infrastructural reinforcement.

Keywords: Hand hygiene, IEC interventions, School-based program, Knowledge and practice, Hygiene infrastructure.

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Introduction

Hand hygiene is one of the most cost-effective preventive measures against the spread of infectious diseases, as soap-washed hands can reduce diarrheal disease by 30 percent and respiratory infections by 21 percent. Young children in school-going age are also medically susceptible to infectious diseases because of their immature immune mechanisms, high social interactions, and poor hygiene, which predetermines schools as one of the most significant places of infection prevention and control.[1-5]

The global rate of hand hygiene deficiency is significant, as nearly 818 million children in schools before the COVID-19 pandemic lacked access to basic handwashing facilities. A lack of knowledge compounds this lack of infrastructure, since research has shown that only one in every quarter to half of schoolchildren exhibit sufficient hand hygiene behavior despite the facilities. The COVID-19 pandemic has also highlighted the urgency of hand hygiene as a key non-pharmaceutical intervention, sparking renewed interest in school-based hygiene promotion programs.[3,5-8]

EEC activities have emerged as potential solutions to improve schoolchildren's hand hygiene behaviors. Systematic reviews in recent years indicate that hand hygiene interventions in schools can have a significant positive impact on knowledge, opinions, and practices (standardized mean difference 2.30, 95% CI 1.17-3.44) and can increase handwashing practices by 75 per cent compared with standard curriculum interventions. Multi-component interventions, including education and

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environmental adjustments, are especially promising, and the literature on handwashing behavior has demonstrated significant gains in frequency and quality of handwashing.[1,5,8,9]

The IEC interventions are effective to varying degrees depending on implementation strategies and contextual factors. Sociodemographic factors, such as parents' education level, urban or rural residence, and grade level, also have significant effects on intervention outcomes. In later grade levels, there is evidence of improved hygiene practices (adjusted odds ratio 4.0, 95% CI 2.4-6.86), and students living in urban areas have odds of good hygiene practices 3.4 times higher than those living in rural areas. Also, the quality of school handwashing resources and late access to formal handwashing training are closely linked to better hygiene practices.[3,6,10]

Existing evidence indicates that successful school-based hand hygiene programs should use multimedia and simultaneous approaches to address a set of behavioral determinants. The most effective programs include behavior change methods at the individual, interpersonal, and organizational levels, with odds ratios up to 18.4 for better adherence. Nevertheless, there are knowledge gaps regarding the optimal intervention duration, the specific IEC factors that drive behavior change, and the sustainability of these changes over time.[8,11,12]

This research fulfilled urgent research priorities by assessing the effect of implemented structured IEC activities on school-going children's hand hygiene practices and knowledge, and on related sociodemographic factors and the availability of infrastructure. The results will be used to expand the body of evidence on school-based hygiene interventions and to guide the creation of scalable, effective initiatives to improve child health outcomes by adopting better hand hygiene practices.

Objectives: To determine the effect of Information, Education, and Communication (IEC) intervention on hand hygiene knowledge, hand hygiene practices, and related socio-demographic factors among school children using a pre- and post-intervention study.

Materials and Methods

Study Setting and Design: The study was a pre-post intervention conducted in the Department of Community Medicine, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, between June 2025 and November 2025. To determine the influence of IEC intervention on school children's hand hygiene knowledge and behaviours, the investigation adopted a cross-sectional design with two assessment points: pre- and 4 weeks after the IEC intervention.

Study Duration and Study Design: This cross-sectional interventional study was conducted over 5 months from June 2025 to Nov 2025. A pre-post intervention design was employed to assess the effectiveness of IEC activities on hand hygiene knowledge and practices among school children.

Participants: Children aged 8-13 years enrolled in classes III to VII at selected government and government-aided schools in urban Jhansi were eligible. Inclusion required regular school attendance, parental consent, and child assent. Exclusion criteria included physical impairments that hindered handwashing, chronic conditions requiring special care, absence during data collection, or lack of parental consent.

Sampling and Sample Size: A multistage random sampling strategy was used to select participants. In the first stage, a list ofall government and government-aided schools was stratified by urban location using the District Education Office roster, and systematic random sampling was used to select schools from each stratum. In the second stage, within each chosen school, simple random sampling from class registers identified children in classes III–VII. The required sample size (n=300) was computed using the formula, $n = Z^2\alpha/2 \times p \times q / d^2$, where $Z\alpha/2 = 1.96$ (95% CI), p= 0.227 (prevalence of adequate hand hygiene practicesbased on a previous study)13, q=(1-p) =0.773, and d= 0.05 (absolute precision). Incorporating a 10% non-response allowance yielded a target of 300 participants.

Intervention and Procedure: This was carried out in three stages: pre-intervention, IEC intervention, and post-intervention evaluation. The pre-intervention involved administering a structured, pretested questionnaire and conducting unobtrusive observations using a modified WHO hand hygiene checklist by trained community medicine postgraduate assistants. The questionnaire also examined socio-demographic factors, 15 knowledge items, 10 attitude items (5-point Likert scale), and 12 self-reported practice questions. Checklists were also used to record facility availability, handwashing technique, time, and adherence to the five critical moments, using observational checklists.

The intervention provided using IEC consisted of interactive 60-45-minute lessons in classrooms. Live examples of the WHO seven-step handwashing technique, pictorial flipcharts, Hindi posters, and supervised practice were included. To strengthen messages, peer-led discussions and hand hygiene monitors were implemented in the classes. The same tools and methods were used to measure post-intervention outcomes four weeks after the interventions.

Operational Variables definition.

- Sufficient Hand Hygiene Knowledge: Sufficient Hand Hygiene Knowledge: Proper answers to 80 or more of the knowledge items on timing, rationale, and technique (WHO guidelines).[5,6,14]
- Positive Attitude towards Hand Hygiene: Concurrence with ≥80% of Likert-scale statements on the significance of handwashing to health.[6,15]

Proper Hand Hygiene Practice: Demonstrate handwashing (with soap and water) for 20 seconds or more at critical times (before eating, after using the restroom, after coughing/sneezing), or use an alcohol-based hand rub when handwashing is not available.[5,15]

- • IEC Activities: Organized education activities that include teaching relating to interactions, demonstrations, presentation aids, and improvement techniques of knowledge application.[5,9]

Investigation and Data Collection: The instrument used to collect the information about the socio-demographic attributes (age, gender, class, parental education, family income),

knowledge (15 multiple-choice items), attitudes (10 Likert-scale statements), and self-reported hand hygiene behaviors (12 items) was a pre-tested, structured questionnaire that was based on and adapted to the validated tools in recent hand hygiene studies. At the same time, actual hand hygiene behaviour was observed with the help of postgraduate research assistants who were trained and applied a modified version of the WHO hand hygiene observation tool that is suitable for school situations and recorded the presence of facilities, the availability of soap and water, technique, time spent, and the compliance with critical moments.[5,6,14,15] Before deployment, data collection protocols were standardized through a 2-day workshop, during which inter-observer reliability was evaluated. Questionnaires were distributed during school time in a silent classroom setting within periods of 20-25 minutes each. To enhance representativeness, observational measures were made on various days during normal occasions, such as before the mid-day meal and after toilet visits. Observations without interruptions took place during the day. The paper forms that had been completed were duly confirmed to be complete before they were electronically keyed into REDCap to ensure data integrity and reduction of transcription errors.

Statistical Analysis: SPSS v26 was used in data processing and analysis. The data were summarized by using descriptive statistics (means, standard deviations, frequencies, percentages). Continuous scores were compared using paired t-tests, and the McNemar test was used to assess changes in practices involving categorical data. Chi-square tests were used to test the relationships between practices and socio-demographic factors. The mean scores in the subgroups were compared using independent t-tests. Multivariable logistic regression identified independent predictors (poor hand hygiene) after adjustment for age, gender, parental education, socioeconomic status, and schooling type. Two-sided p-values below 0.05 were considered statistically significant, and Cohen's d effect sizes were reported.

Results

The study used a sample of 300 schoolchildren aged 8 to 13 years. The average age of the participants was 10.2 ± 1.6 years. The study sample consisted of 52.7 percent males and 47.3 percent females. There was an equal representation of classes III to VII. There was a representation of parents by education level, with 24% of parents being uneducated and 16.6% of students having a high socioeconomic status. The sample of eligible students had equal gender representation, with a slight bias towards males. Almost 50 percent of respondents were in the lower socio-economic strata, and parental education was heterogeneously distributed across educational levels [Table 1].

Table 1: Baseline Socio-Demographic Characteristics of Study Participants (N=300)

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	8-10	172	57.3
	11-13	128	42.7
Gender	Male	158	52.7
	Female	142	47.3
Grade	III	62	20.7
	IV	66	22.0
	V	58	19.3
	VI	57	19.0
	VII	57	19.0
Parental education	No formal education	72	24.0
	Primary	91	30.3
	Secondary	68	22.7
	Graduate and above	69	23.0
Socioeconomic status	Low	140	46.7
	Middle	110	36.7
	High	50	16.6

Table 2: Comparison of Hand Hygiene Knowledge Scores Before and After IEC Intervention

Knowledge Assessment	Mean ± SD	95% CI
Pre-intervention	11.2 ± 2.1	10.9–11.5
Post-intervention	14.8 ± 1.6	14.6–15.0
Mean difference	3.6 ± 1.8	3.4–3.8
p-value*	<0.001	-

*Paired t-test applied.

[Table 2] shows a substantial difference in the mean score for knowledge about hand washing practices between pre-intervention and post-intervention, i.e., 11.2 ± 2.1 versus 14.8 ± 1.6 (p = 0.001), and a substantial effect size, indicating successful transfer of knowledge. The decrease in standard deviation after the intervention implies a reduction in variability and a better overall understanding among people.

Table 3: Comparison of Hand Hygiene Practices Before and After IEC Intervention

Hand Hygiene Practice	Pre-intervention n (%)	Post-intervention n (%)	p-value*
Proper handwashing with soap	105 (35.0)	221 (73.7)	<0.001
Handwashing at critical moments	98 (32.7)	234 (78.0)	<0.001
Correct handwashing technique	89 (29.7)	198 (66.0)	<0.001

Duration ≥20 seconds	76 (25.3)	185 (61.7)	<0.001

*McNemar's test applied.

The whole set of measured practice indicators showed substantial improvement, with absolute increases of 31.4-38.7, indicating that knowledge was well translated into behavior change. The most significant improvement was handwashing at critical times, indicating increased awareness of when hand hygiene is most vital [Table 3].

Table 4: Assessment of Hand Hygiene Facilities in Schools (N=25 schools)

Facility	Baseline n (%)	Post-intervention n (%)	p-value*
Running water availability	18 (72.0)	24 (96.0)	0.032
Soap availability	15 (60.0)	22 (88.0)	0.018
Clean towels/paper	6 (24.0)	13 (52.0)	0.041
Handwashing stations functional	16 (64.0)	23 (92.0)	0.012
Waste disposal bins	8 (32.0)	17 (68.0)	0.008

*Chi-square test

[Table 4] indicates that hand hygiene-related environmental enablers experienced significant change, with the highest level observed in soap availability (28%). The intervention was effective in reducing infrastructure barriers, especially in the supply of clean towels and the operational waste-disposal systems, which increased twofold.

Table 5: Multivariable Analysis of Factors Associated with Proper Hand Hygiene Practices

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Age group (11-13 vs 8-10)	1.42 (0.96–2.11)	1.38 (0.89–2.14)	0.149
Gender (Female vs Male)	1.18 (0.79–1.76)	1.15 (0.74–1.79)	0.526
Parental education (Graduate vs No formal)	2.34 (1.45–3.78)	2.01 (1.18–3.42)	0.010
Socioeconomic status (High vs Low)	1.89 (1.12–3.19)	1.72 (0.98–3.02)	0.058
IEC intervention (Post vs Pre)	5.12 (3.45–7.59)	4.87 (3.21–7.39)	<0.001

Parental education at the graduate level was the only sociodemographic variable found to explain proper hand hygiene practices after adjusting for confounding variables. IEC intervention showed the most significant correlation with the enhanced practices, where the odds of adequate compliance with hand hygiene increased practically five times after the intervention [Table 5].

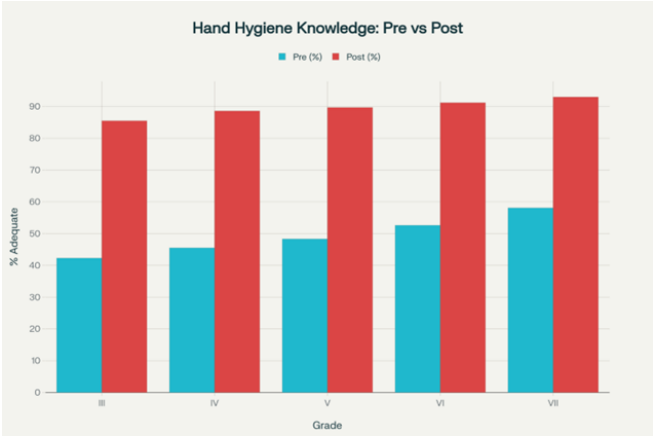

Figure 1. Improvement in Hand Hygiene Knowledge Scores by Grade Level

The increase in knowledge was progressive across all levels of learning, with higher grades showing better baseline knowledge and a higher percentage change in [Figure 1]. The intervention was universal in improving knowledge and did not change the old grade-based gradient, indicating appropriate knowledge acquisition at the age.

[Figure 2] shows that gender inequalities in hand hygiene practices during the intervention period were insignificant, indicating equal program effects. Children born to parents who had graduated showed improvements in baseline practices and retained their differences after the intervention, indicating continued educational gradients in health practices after universal program implementation.

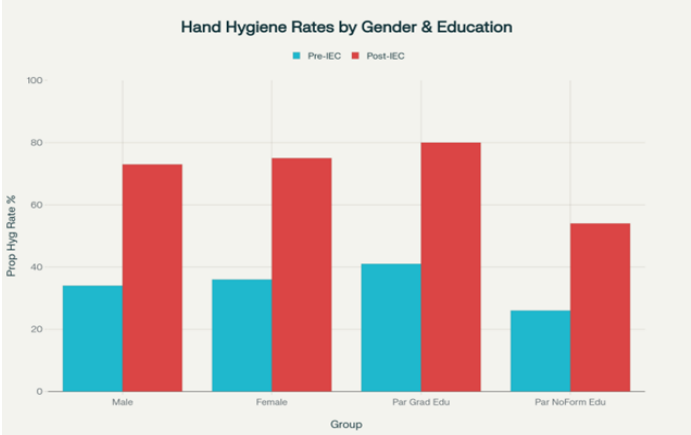

Figure 2. Trend in Proper Hand Hygiene by Gender and Education of the parent.

Discussion

The current IEC intervention study conducted in schools has shown significant progress not only in hand hygiene knowledge but also in practice, which is in line with recent international and regional studies over the last five years. The significant change in school badges of knowledge after the intervention, along with the success in adopting the correct handwashing technique, underscores the immense potential of multicomponent, participatory health education interventions.

In line with our results, a randomized controlled study involving

school kids conducted by Ashraf H et al. (2021) showed that, with the help of visual aids, hands-on educational programs led to significant knowledge increase and behavioral changes in observed hand washing practices, which advocates the role of practical demonstration and ordered IEC sessions in enhancing skills. Equally, Enkhbat M et al. (2025) in a longitudinal study conducted in Mongolia demonstrated that the promotion of critical hand hygiene knowledge (23% to 80.4%), as a result of the implementation of health promotion activities during the COVID-19 pandemic, and converted into proper handwashing at critical times, which is influenced by school-based promotions and participatory pedagogy. Within the context of our study, we also confirm these methods as applied within the Indian context, and these gains are also similar in terms of knowledge and practice that is achieved at the post-intervention stage.[1,16]

The strong growth in the percentage of students engaging in correct handwashing, from 35 to 73.7 per cent, represents meaningful changes in other school interventions worldwide. For example, Sultana F et al. (2021) in Bangladesh reported that post-intervention soap handwashing use increased from 4 percent at baseline to 74 percent following the introduction of a BCC-based IEC campaign in conjunction with environmental changes, validating the relevance of education and infrastructure. Similar results were reported in our investigation: there was an increased access to soap, water, and towels after intervention, which is in close connection with the results laid out by Gupta V et al. (2023), who emphasized the facilitating role of the location and sufficiency of the facilities on the hygiene behavior of schoolchildren in the rural part of India. Additionally, meta-analytical data demonstrate that hygiene interventions in schools increase handwashing rates by 75% and significantly reduce infection-related school absence rates, supporting community health guidelines for integrated school health programs.[8,17,18]

Our multivariable analysis showed that parental education used alone as a predictor of proper hand hygiene practice and was similar to the findings of Kuandyk U et al. (2025) and Enkhbat M et al. (2025), who reported the significant relationships between higher parental education, socioeconomic status, and better KAP outcomes in students. These gradients have been recorded several times across various contexts and point to the importance of the home setting and social capital for the efficacy of school-based interventions. Nevertheless, in line with Kuandyk U et al. (2025), gender did not affect the probability of proper hand hygiene after adjustment for other factors, suggesting that interventional measures aimed at closing behavioral gaps can be successful.[15,16]

Infrastructure gaps were present despite these improvements. Even though soap and running water became nearly ubiquitous, access to towels and waste bins was ranked lower than optimal, similar to infrastructural constraints mentioned by Gupta V et al. (2023) and Sultana F et al.(2021), who reported the necessity of maintaining and usability as a factor in long-term behavioral transformation. The long-term sustainability and continued use of a behavior also require greater consideration, as post-pandemic researchers, including Sultana F et al. (2021) and Enkhbat M et al. (2025), indicate that the benefits of behavioral change can be reduced after discontinuing an intervention or increasing the intensity of the message to the population.[16-18]

The study has strong points, such as a highly powered methodology, standardized instruments, and firsthand observation of practice, which overcome the limitations of self-report bias identified in various recent studies. Nevertheless, some limitations exist: generalizability may be confined to settings with similar resources, such as overloaded schools, and the post-intervention analysis did not cover the duration of behavior retention. Nonetheless, our results contribute substantively to knowledge of IEC practices in Indian school settings and support the need for infrastructural improvement coupled with health education.

Conclusion

Combined with enabling environments, school-based IEC interventions play a great role in promoting hand hygiene knowledge and practices amongst children. The changes were consistent across socio-demographic levels, although discrepancies in education and infrastructure remained. Positive behavioral change cannot be achieved without continuous reinforcement and investment in school hygiene facilities. These results highlight the importance of implementing comprehensive initiatives to foster healthy lifestyles and prevent the spread of infectious diseases among schoolchildren.

Recommendations

The suggested measures to guarantee lasting change in hand hygiene are to ensure the implementation of organized IEC modules and active learning engagements in the basic school curriculum throughout the year. At the same time, periodic audits and cleanliness infrastructure, such as continuous provision of soap, running water, towels, and an operative waste bin, should be adopted. Involving parents and other community stakeholders is advantageous, especially in less educated populations, to increase and sustain program effects. Lastly, continuous monitoring and feedback mechanisms will be introduced to reinforce correct handwashing practices and ensure long-term compliance.

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Conflicts of interest

There are no conflicts of interest.

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