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Effectiveness of an Educational Intervention in Promoting Antibiotic Awareness Among 8th to 10th Grade Students in Kerala, India

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ABSTRACT

Aim: To assess the effectiveness of a training program on the knowledge, attitude, and behavior of antimicrobial resistance determinants among high school students in Kerala, India.
Methods: This quasi-experimental study was conducted among 8th – 10th grade students for six months in a high school in Kerala, India. This study consisted of a baseline assessment of consenting participants, educational intervention using PowerPoint slides, and post-intervention assessment. Assessments were done using a validated Knowledge, Attitude, and Behavior questionnaire.
Results: Among the 223 eligible students in the selected school, 159 (71.3%) participated in the study. The follow-up rate was 93.08%. Considering a p-value of less than 0.05 to be statistically significant, there was a statistically significant difference in the knowledge (pre-intervention mean score = 6.26 ± 2.06, post-intervention mean score = 7.44 ± 1.81), attitude (pre-intervention mean score = 2.51 ± 1.13, post-intervention mean score = 3.29 ± 1.19), and behavior (pre-intervention score = 4.27 ± 1.40, post-intervention score = 4.74 ± 1.38) of study participants.
Conclusions: Educational intervention based on improving the knowledge, attitude, and behavior of school children is an effective strategy to address the growing threat of antimicrobial resistance.

***Key words**: Antimicrobial resistance, school, behavior, knowledge, attitude, antibiotics.

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Background

The discovery of antibiotics is an important landmark in man's continuing combat against infectious diseases. Often called miracle drugs or magic bullets, these drugs were instrumental in saving millions of lives.[1] However, indiscriminate prescription and misuse of these medicines have resulted in the development of antimicrobial resistance (AMR). AMR is the "phenomenon where infection-causing microorganisms, such as bacteria, can survive exposure to medicine which would normally inhibit their growth or kill them".[2] This irony, wherein life-saving drugs become life-threatening, is a mounting global public health threat. The World Health Organization has highlighted the magnitude of AMR through its inclusion in the list of ten major global health threats in 2019.[3]

This is a caveat of an unprecedented apocalypse both in terms of mortality and economic burden. Approximately 2.4 million lives in Australia, North America, and Europe are estimated to be claimed by this 'superbug crisis' soon.[4] Literature has estimated a mammoth cost of $55 billion in the US within the context of antibiotic resistance.[5] This is the cumulative cost of the impact of AMR concerning health service and loss of productivity. This economic burden encompasses prolonged hospital admissions due to delayed recovery, rapid spread of infections, development and use of alternative treatment approaches, and undue stress on the healthcare system.[4-6]

Due to the weak AMR surveillance system, the Southeast Asia region is the focal point of AMR.[7] India is one of the leading producers and consumers of antibiotics, and ipso facto accounts for a quarter of the incidence of multidrug-resistant tuberculosis.[8] The "Chennai Declaration" (2012) that resulted from the first-ever consortium of medical societies was an initiative to address the alarming rate of AMR emergence and spread. It was a demand for a national policy for regulating antibiotic prescription, dispensing, and consumption. However, India continues to have high-level mortality related to drug-resistant pathogens.[9,10]

Though global awareness has been awakened about this critical issue, attempts to resolve it are still preliminary. This can be attributed to the complexity of factors causing AMR's unavoidable consequences, like compromising our ability to treat common infections, resulting in disease prolongation, disability, and death.[2,11] Extension of this health problem beyond the confines of the hospital can be attributed to a lack of strict legislation, incorrect use of antibiotics, inappropriate knowledge of health professionals and beliefs, behaviors, and ignorance of patients.[2,6,11,12] Moreover, patients' misconception of antibiotics as 'harmless panacea' to infections often influences treatment decisions related to antibiotics prescription and consequent indiscriminate drug use.[13,14]

Being the most widely used medicine worldwide, both for prophylactic and therapeutic purposes, the rate of antibiotic use among children is exceptionally high.[15] Injudicious use of antibiotics comprising over-dosages for symptomatic relief, over-the-counter purchases, and incomplete drug courses can lead to drug resistance in children. This may result in life-threatening conditions and disease burdens to health systems. Moreover, unreasonable expectations of treatment outcomes coupled with parental influences also contribute to unnecessary antibiotic prescriptions for children.[16]

In its technical note on antimicrobial resistance 2019, the United Nations Children's Fund (UNICEF) has emphasized that "AMR is perhaps the greatest threat to child survival and health of this generation".[17] This reflects the need for immediate global actions focused on children to control the results of AMR, ranging from mortality and morbidity at the individual level to the burden of health expenditure at the community level.

An insight into the drivers of antibiotic resistance shows that an individual's health-related attitude and behavior is the cumulative effect of observations, perceptions, and interpretations of one's family, traditions, and environment, including media.[18] As a complex issue, addressing antimicrobial resistance needs a One-health approach that warrants integration at all educational levels, especially schools.[19] Using medicines for treating an illness is an essential health-related behavior. Therefore, a health-promoting educational intervention implemented among school-aged children will enable them to adopt healthy behaviors.[13]

Global efforts towards the reduction of antimicrobial misuse among children include the e-Bugs project in European countries[13], the Bug Investigators school resource pack in the United Kingdom[14], "Do Bugs Need Drugs?" in Canada, and CDC's "Get smart about antibiotics".[20] These interventions focused on knowledge assessment and awareness generation regarding immunity, hand hygiene, and the use of antibiotics because health-related practices like the usage of drugs are caused by factors like beliefs, attitudes, and expectations of treatment outcomes. As school-aged children are ideal for developing healthy attitudes and modifying existing beliefs, an educational intervention program focused on this group will be effective. Although the current school curriculum provides basic knowledge regarding health and hygiene, topics like antibiotic use and adverse reactions to drug use are not given due importance.

Existing literature on interventions among school-going children in India shows limited evidence on school-based educational interventions to create awareness about antibiotic use and hygienic behaviors. Therefore, the present study was designed to address this gap in literature. The objective of this study was to assess the effectiveness of a training program on the knowledge, attitude, and behavior of AMR determinants among high school students in Kerala, India.

Methods

This quasi-experimental study was conducted in a high school in the southern state of Kerala, India. The school included was a government-aided high school located in a rural area. Due to then existing COVID-19 scenario, school was selected based on convenience. The institutional ethics committee approved the study (ECASM-AIMS-2021-356), and the study protocol was registered in the Clinical Trial Registry of India CTRI/2022/01/039628, registered 1 January 2022, (http://ctri.nic.in/Clinicaltrials/showallp.php?mid1=64546&EncHid=&userName=Venkitachalam). Permission from the management of the selected school was obtained. This was a census type of study wherein all students enrolled in the chosen school from grades 8 to 10 were invited to participate in the study. A participant information sheet and certificate of consent in the local language (Malayalam) were given to all eligible participants. A consent signature was obtained from both parents (or guardians) and participants. These were intended for perusal by them as well as by their parents or guardians. Non-consenting students and students whose parents did not permit them to participate in the study were excluded. The report was prepared using TREND guidelines.

The study lasted six months, from December 2021 to June 2022. It consisted of a baseline assessment of (pre-testing) the included participants, providing instructions (education module) using PowerPoint slides, and post-intervention assessment. Pre and post-intervention assessments were done using a validated Knowledge, Attitude and Behavior (KAB) questionnaires adapted from previous studies.[15,21–23]

The e-Bug educational module customized to Indian school children was used for the education intervention. E-Bug is a project by the European Union to improve knowledge of infections, immunity, and antibiotic use among school children through interactive classes, quizzes, and hands-on activities.[22] The educational module (duration – 45 minutes) was designed to promote judicious antibiotic use and healthy behavior, covering the following topics (i) Introduction to the educational module (ii) Microbes – meaning, types of microbes, useful and harmful microbes (iii) Body's defense mechanisms (iv) Infections (v)Healthy practices – hand hygiene, oral hygiene, healthy behaviors (vi) Antibiotics and (vii) Antibiotic resistance.

The educational project named "Students training on Antimicrobial Resistance (STAR)" was delivered by the investigator in the Malayalam language for better comprehension by the study participants. Pre and post-test questionnaires were also administered in Malayalam.

Powerpoint presentations, hands-on demonstrations of tooth brushing, and handwashing and instruction pamphlets were part of the module. A health kit comprising of face mask, hand sanitizer, instruction pamphlets, and a health calendar was also provided to the study participants. A reinforcement stage was also included in this intervention. It involved peer education and training the teachers. Student representatives and teachers were trained to disseminate the educational module at fixed intervals – three months after the first class and reinforcement after one month. This enabled the study participants to attend three sessions of the educational module within the duration of the study (six months). The study flowchart is given in Figure 1.

Data were analyzed using IBM Statistical Package for Social Sciences (Version 20). Descriptive statistics were expressed as mean and standard deviation for continuous data and frequency and percentages for categorical data. To test the statistical significance of the change in the mean score of knowledge, attitude, and behavior of antimicrobial resistance determinants among high school students before and after the training program, a paired t-test was applied. A p-value of less than 0.05 was considered statistically significant.

Results

This quasi-experimental study was conducted in a high school in Kerala. Among the 223 eligible students in the selected school, 159 (71.3%) participated in the study. A total of 148 students participated in the post-test, resulting in a follow-up rate of 93.08%. Among the 148 students, 70% of them were males and belonged to the age group of 12 to 16 years. (Table 1)

The knowledge, attitude, and behavior sections had 11, 6, and 5 items, respectively. A score of 1 for each correct response and 0 for each wrong response was allotted, yielding the maximum possible scores for knowledge, attitude, and behavior as 11, 6, and 5. It was observed that the mean knowledge score before the intervention was 6.26± 2.06; after the intervention, the score improved to 7.44±1.81. Similarly, the mean attitude at baseline assessment was 2.51±1.13 and improved to 3.29 ± 1.19 after the intervention. A similar improvement in behavior score was noticed when the mean score for behavior changed from 4.27±1.40 to 4.74±1.38. (Table 2) (Figure 2)

Considering a p-value of less than 0.05 to be statistically significant, the study analysis results show a statistically significant difference in the knowledge, attitude, and behavior of study participants following the educational intervention. Within the context of knowledge, items like “Are there bacteria in our body which are good for our health?” showed an improved percentage of correct responses from 58.1% to 93.9%. While the baseline assessment of study participants indicated that 41.2% “have heard about Antibiotic resistance” on post-test assessment yielded a positive response rate of 83.1% (Table 3.).

Consequent to the intervention, the number of participants who felt that “antibiotics are being presently misused” improved from 28.4% to 56.8%. Regarding attitude, while 56.1% believed they had to complete the antibiotic course despite relief from their disease, the post-test assessment showed an additional 16.9% increase in the correct response. (Table 3) However, some items like “Can antibiotics cure viral infections?” and “Is washing hands with soap and water more effective in removing microbes than washing with water alone?” showed a decrease in the percentage of correct responses in the post-test. (Table 3)

Discussion

The global threat posed by antimicrobial resistance has resulted in many interventions to combat it. Of significant importance are behavioral modification interventions that focus on redefining an individual’s perceptions about health, healthcare-seeking behavior, and use of medications.[6] Evidence shows that these behavioral interventions result in desirable changes[12,20,24], thereby proving to be a cost-effective strategy to address the issue of AMR.[6] The present study was an educational intervention to improve the knowledge, attitude, and behavior of high school children regarding antibiotic use. We followed a quasi-experimental study design where the effectiveness of the educational intervention was assessed based on the change in the knowledge, attitude, and behavior of study participants.

Health-related practices like the usage of drugs are caused by factors like beliefs, attitudes, and expectations of treatment outcomes. Studies show a significant relationship between antibiotic consumption and antibiotic resistance in the community.[25] This is further aggravated by behaviors like the inappropriate use of antibiotics without physician consultation and non-completion of prescribed dosages of medicine, particularly on early relief from the health condition has been estimated as significant drivers of antibiotic resistance development.[6,26,27] These detrimental habits can be attributed to ignorance, long waiting hours in hospitals, inaccessibility to the healthcare provider, over-expectations on the effectiveness of antibiotics, and ease of over-the-counter access to medications.[6]

The e-Bug project, an educational project by the European Union, has proven to improve children's knowledge regarding hygiene and antimicrobial use in multiple countries.[28] A study that aimed to assess the possibilities of global implementation of e-Bug project and the possible challenges to its broader implementation was conducted in 14 countries. It was found that most of these countries favored its endorsement through their ministries.[29] Upgradation of knowledge about personal hygiene and disease prevention is a recognized solution to the growing AMR.[30] This evidence strengthened our selection of the educational resource. The present study’s e-Bug educational module was customized for Indian school children.

Child health research has highlighted that an individual's health beliefs and practices during childhood are a crucial determinant of one's health status in adulthood.[31] Resonating with this finding, we focused our educational intervention on school children. Human behaviors are affected by complex factors like attitudes and beliefs that are susceptible to changes over time.[21] In the present study, a baseline assessment using a Knowledge, Attitude, and Behavior questionnaire was done, which served as a reference to the evaluation of the effectiveness of the intervention.[32]

Our study focus on schoolchildren from grades 8 to 10 because they are in the transition phase to adulthood. The World Health Organization has highlighted that adolescence is the window of opportunity for developing good health.[33] In the context of health beliefs and use of antibiotics, high school students are the ideal population as they are in the formative stages of critical thinking and independent decision making. Moreover, this phase is highly influenced by peer pressure. By targeting high school students, we can leverage their social networks and encourage the adoption of responsible antibiotic use practices. They can serve as agents of change, spreading awareness and correct information about antibiotic use among their peers and within their communities.

To ensure sustainability, this study incorporated a reinforcement strategy involving peer training and teacher training. Peer education is effective in behavior modification interventions like smoking[34], diet, and physical activity.[35,36] Since the 'educator' is a person from the participant group, they will have enhanced trust, rapport, and interest in the program.[15] Besides being mutually beneficial to the 'student-educator' and the 'taught,' it improved students' confidence and communication skills. A feasibility study on the effectiveness of peer education in delivering e-Bug modules showed that high school students revealed that it was an effective method for improving knowledge regarding antibiotic use.[36]

Similarly, the "training the teachers" strategy was also adopted to ensure the educational module's sustainability beyond the study's duration. A schoolteacher who volunteered for the same was trained to impart the educational module. Children are accustomed to their teachers in academics, which favors their compliance if teachers are stakeholders in the reinforcement of the educational intervention. Public Health England undertook similar training to improve students' awareness regarding antibiotic use.[15]

Another unique feature of this study was the emphasis on the "prevention of diseases," for which we included hand washing and oral hygiene lessons. Oral diseases are one of the chronic diseases of childhood, often resulting in loss of school days and antibiotic use.[37] Similarly, the Centers for Disease Control and Prevention (CDC) has recognized hand hygiene – either by handwashing or using an alcohol-based hand sanitizer as an important method to keep school children healthy. Consequently, the CDC has recommended teachers reinforce these habits through Early Care and Education programs.[38] Such healthy behaviors would lessen the risk of infections among children, indirectly reducing the need for antibiotics.

In terms of the effectiveness of the educational module, an improvement in knowledge, attitude, and behavior were observed. School-based health interventions have had mixed results in different settings. This result is in accordance with the study conducted in the United States of America, which showed positive changes in students' knowledge of microbes and microbial transmission.[39] Similarly, Fonseca *et al.*[24] showed that education activities improve awareness of antibiotic resistance and the importance of cautious antibiotic use.

The school-based educational intervention had a positive effect on knowledge[13,28,40,41], attitude[13,42], and behavior.[42,43] Knowledge of the correct use of antibiotics for bacterial diseases among school children improved from 43% to 73% after the computerized slide show presentation-based intervention.[13] The junior e-Bug teaching pack[28] and picture drawing intervention[42] significantly improved students' knowledge. Education intervention by student volunteers trained as peer leaders delivered to their classmates had reported antibiotic use for colds and flu in a positive direction.[43]

However, Farrell *et al.*[44] demonstrated no significant improvement in knowledge and attitude after the online e- Bug junior game-based intervention focused on the basic principles of hand and respiratory hygiene and antibiotic resistance in 9-12-year-old children. The authors attribute this observation to a high drop-out rate or a higher number of participants answering the pre-and post-game questions correctly, thereby not reflecting as an improvement.

Our study was the first quasi-experimental study among schoolchildren in the state of Kerala focused on improving health literacy regarding antibiotic use and antimicrobial resistance. This study's strengths are regular follow-up, high response rate, reinforcement sessions through peer education and teacher training, and the emphasis on "disease prevention" through hand washing and oral hygiene lessons. This broad coverage of the education module amplifies our study's public health relevance, particularly during the ongoing COVID-19 conditions. The study was not without its limitations. Due to the existing Covid-19 pandemic situation during the time of conduct of the study, only one school selected by convenience was included. Interactive teaching methods like group activities and demonstrations had to be restricted to adhere to social distancing norms.

While this study showed favorable and encouraging outcomes, replication and scaling up of such educational intervention for improving health, like that of antimicrobial resistance, is required to ensure sustainability.

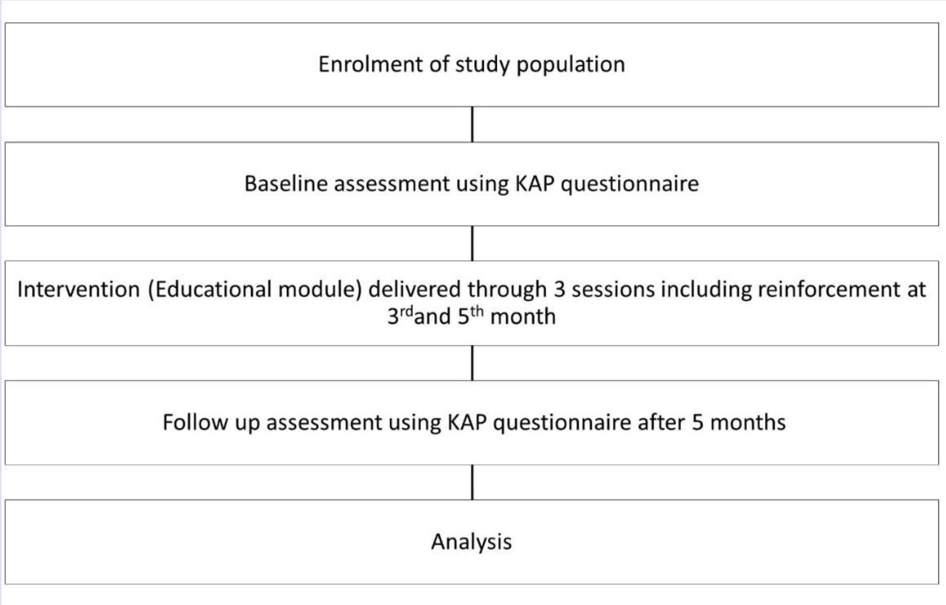

Figure 1. *Study flow diagram*

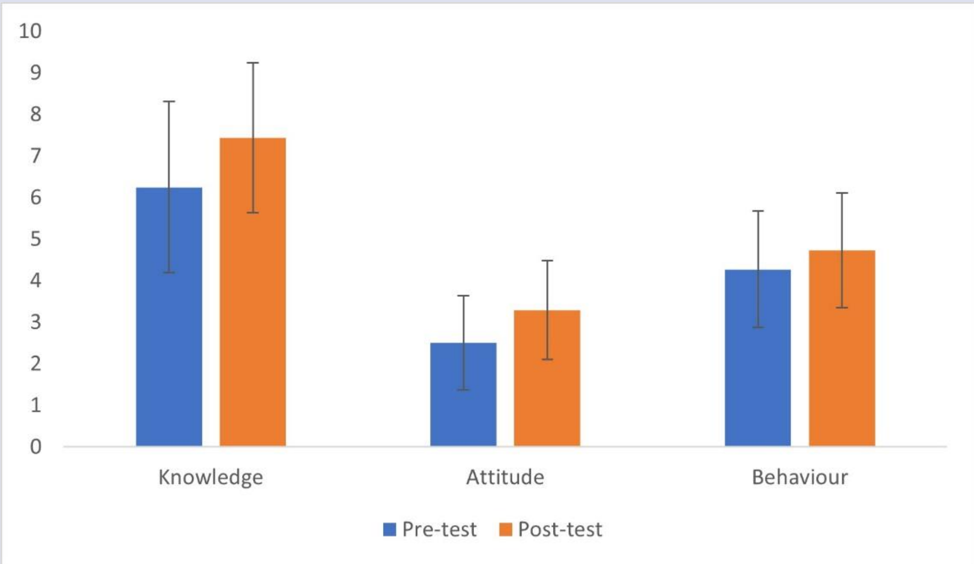

Figure 2. *Comparison of knowledge, attitude, and behavior pre and post intervention*

Table 1. Descriptive characteristics of study participants (n=148)

Variable		Number
Gender	Males	103 (70%)
	Females	45 (30%)
Class	8th	30 (20.3%)
	9th	60 (40.5%)
	10th	58 (39.2%)

Table 2. Comparison of pre ad post-intervention knowledge, attitude, and behavior scores

Variables		N	Mean	SD	p-value
Domains	Comparison				
Knowledge	Pre - intervention	143	6.25	2.06	0.001*
	Post - intervention	143	7.44	1.81	
Attitude	Pre - intervention	145	2.51	1.13	0.001*
	Post - intervention	145	3.29	1.19	
Behavior	Pre - intervention	147	4.27	1.40	0.002*
	Post - intervention	147	4.74	1.38	

Table 3. Comparison of pre and post-intervention correct responses (%)

Item	Correct response	
	Pre-test (%)	Post-test(%)
K1. Are microbes found everywhere?	69.6	82.3
K2. Are there bacteria in our body which are good for our health?	58.1	93.9
K3. Can antibiotics cure bacterial infections?	45.3	71.4
K4. Can antibiotics cure viral infections?	28.4	22.4
K5. Have you heard of 'Antibiotic Resistance'?	41.2	83.1
K6. Can frequent antibiotic use decrease its effect?	26.4	54.7
K7. Can the effect of antibiotics increase, if it is newer and more costly?	41.2	32.7
K8. Can unclean hands cause diseases?	87.2	87.8
K9. Is washing hands with soap and water more effective in removing microbes than washing with water alone?	95.3	75.7
K10. Can microbes spread by sneezing or coughing?	91.2	93.9
K11. Are good bacteria killed by antibiotics?	29.1	44.2
A1. Do you think that antibiotics are being presently misused?	28.4	56.8
A2. Is antibiotic resistance a problem in India?	14.9	21.6
A3. Does unnecessary antibiotic use increase the bacterial resistance towards them?	20.9	45.3
A4. Can antibiotic resistance affect you and your family's health?	19.6	35.6
A5. Is it necessary to get more education about antibiotics?	79.7	83.7
A6. Do you prefer getting antibiotics from friends or relatives than seeing a doctor?	87.2	85.8
B1. Do you use antibiotics without doctor's instructions?	75.7	87.8
B2. When you feel better, do you stop taking antibiotics without completing the full course?	56.1	73.0
B3. Do you store antibiotics at home for future needs?	66.9	81.8
B4. Do you always (or often) use antibiotics for common cold?	74.3	55.4
B5. Do you wash your hands before meals?	87.2	89.2
B6. Do you brush your teeth twice daily (at morning and before bedtime) with toothpaste?	68.2	84.4

Conclusions

This quasi-experimental study showed increased knowledge, attitude, and behavior scores following a structured educational module on antimicrobial resistance among 8th to 10th-grade children.

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Conflict of Interest

The authors declare no conflict of interest

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