Effectiveness of a School-Based Medicine Safety Program for Children in Karachi: A Pre-Post Quasi-Experimental Study

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Abstract

Background: Educational health programs can help to deliver lifelong knowledge about the safe and appropriate use of medicines.

Objective: The study aimed to evaluate the effectiveness of an educational intervention on children's knowledge of Over-the-Counter Medicine Safety.

Methods: This school-based interventional study was conducted from October 2024 to January 2025 in a private girls' school in Karachi. Lower secondary students in classes V-VIII completed a pre- and post-questionnaire on medication safety. The educational content was adapted from publicly available resources provided by the Scholastic OTC Medicine Safety program. Student knowledge was assessed using the OTC Medicine Safety Assessment (OTC-MSA), a standardized pre-/post-intervention quiz provided in the curriculum. Paired t-test, ANOVA (analysis of variance), and post hoc tests were used to compare test scores ($P < 0.05$).

Results: Of the 724 students enrolled, 607 (83.8%) completed the over-the-counter Medicine Safety program. Knowledge scores ranged from 19.7 ± 2.9 in the pre-test and 23.5 ± 2.7 in the post-test ($p<0.001$), with an average percentage improvement of 19.1%. The effect size was enormous (Cohen's d = 1.36, 95% CI: [1.25, 1.47]). A one-way ANOVA showed a significant difference in change scores across the classes ($p<0.001$). Tukey's HSD post hoc analysis revealed a statistically significant difference in post-test scores between Class V and Class VIII, and between Class VI and Class VIII ($p<0.001$).

Conclusion: The findings indicate a statistically significant improvement in children's individual knowledge of medication safety, providing a new platform for introducing medication safety education in schools.

Keywords: *Medication safety, OTC drugs, adolescent, school awareness program, self-medication.*

INTRODUCTION

Misuse of drug prescriptions and inappropriate use of nonprescription or over-the-counter (OTC) medicines among children and adolescents is common [1, 2]. According to the World Health Organization (WHO), self-medication (SM) is "the use of drugs to treat self-diagnosed disorders or symptoms or the continuous use of a prescribed medication for chronic disease or symptoms. It can include the use of herbs, the re-use of prescription drugs, or the direct purchase of prescription-only medications without any medical consultation" [3]. This form of self-care has become a concern for the health industry due to the irresponsible use of medication.

Self-medication contributes to incorrect self-diagnosis, delays in obtaining appropriate medical care, severe adverse reactions, and drug interactions. Inappropriate administration, inaccurate dosing, and unsuitable therapy choices further increase the risk of drug dependence and misuse [4]. The issue is not only common in adults but also highly prevalent among adolescents worldwide, with rates ranging from 2% to 95% [5-7], and about 83% reported in Pakistan [8]. However, there is currently no national-level data on self-medication prevalence in Pakistan. Existing studies are mainly regional or institution-based, showing high rates among young adults and students, but these findings are not nationally representative.

Adolescence is a crucial period because most self-medication practice begins between 11 and 13 years of age [9]. Studies have shown that factors like age, gender, familial practices, easy access, low medication literacy, media, and peer influence are associated with self-medication among adolescents [10, 11]. In addition, behaviors such as neglecting to read drug labels or instructions, taking excessive dosages, and polypharmacy are also common among teens and young adults [12]. According to the literature, the most commonly used self-medication includes analgesics, vitamins, nutritional supplements, and antihistamines, typically used to relieve aches, allergies, stress, and fever [13, 14]. According to a recent analysis, OTC medications have remained the most commonly misused substances for two decades or more, and more than 80% of all reported exposure cases occurred in youth aged 13 to 18 [15]. A retrospective analysis of National Poison Data System (NPDS) annual reports from 2009 to 2019 revealed that pharmaceutical poisoning exposures have

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increased over time, particularly among adolescents aged 13–19.

Furthermore, this age group has 3.04 times higher odds of dying from pharmaceutical exposures compared to non-pharmaceutical exposures [16]. Therefore, it is crucial to raise awareness about medication safety and encourage responsible use among adolescents before they begin to self-medicate. This proactive approach helps reduce medication errors, minimize misuse, and inculcate lifelong safe practices [17].

Improving medical safety knowledge among adolescents requires a multifaceted approach that integrates health education into school curricula, implements structured school-based programs, engages parents and caregivers, utilizes digital platforms, and involves healthcare professionals. Interactive learning, peer education, and access to reliable resources can also significantly enhance adolescents' understanding and encourage responsible use of medicines [18, 19]. In 2012, Scholastic, the American Association of Poison Control Centers (AAPCC), and the American Pharmacists Association (APhA) launched an OTC Medicine Safety program for children. The goal of the program was to promote responsible medicine use, reduce adolescent misuse, and raise awareness of Poison Centers. Research showed that students who participated in these school-based medicine safety programs improved their knowledge and safety behavior [20]. Their Over-the-Counter Medicine Safety Assessment (OTC-MSA) scores improved by 16.7 percentage points [21]. A study by Bloom *et al.* (2022) showed an improvement of 19.9 percentage points post-intervention [22]. Hence, educational health programs can help to deliver lifelong knowledge about the safe and appropriate use of medicines [23].

According to existing literature, Pakistan has acknowledged the growing issue of self-medication among older adolescents and young adults. However, there is a notable lack of data concerning self-medication practices among children without parental supervision. Furthermore, over-the-counter (OTC) medicine literacy and safe medication awareness initiatives have not yet been systematically implemented within educational institutions [24, 25]. Recognizing this gap, a study was conducted at a private school in Karachi on OTC medication safety. The overall objective was to evaluate the effectiveness of an educational intervention by comparing pre- and post-test scores across different classes.

MATERIALS AND METHODS

A pre-test/post-test quasi-experimental study was conducted from October 2024 to January 2025. This single-site study was conducted at a private girls' school in Karachi, Pakistan. The study received formal approval from the Ethics Committee of AMTF (IRB-0012/24). Permission was obtained from the school authority to survey in their settings.

Lower secondary students participated in an educational intervention inspired by the OTC Medicine Safety program developed by the American Pharmacists Association (APhA), Scholastic, and the American Association of Poison Control Centers (AAPCC) [26], which aimed to improve students' knowledge of the safe use of OTC medications. A total population sampling approach was used, enrolling all 724 students from classes V to VIII who were present at the time of data collection. No formal sample size calculation was conducted since the entire population was targeted.

Intervention and Data Collection

The educational content was adapted from publicly available resources provided by the Scholastic OTC Medicine Safety program. The curriculum comprised structured lesson plans, worksheets, and assessments specifically designed for lower secondary students. The program consisted of 4 lessons to increase the overall understanding and knowledge of the safe use of medicine: All about Medicine, Drug Facts Label and Poison Helpline, Medicine Measuring Tools and Dosage, Medicine Storage and Misuse (**Table 1**) [26]. The intervention was a 45-minute lecture delivered by the school doctor to all the students from classes V-VIII (in groups of 30). It consisted of a PowerPoint presentation and a video covering all four lessons. Participants had no prior formal instruction on the safety of OTC medicines. After the lecture, the presentation and study materials were emailed to the students.

Table 1: Description of individual lessons with lesson objectives.

Lesson	Objectives
All About Medicines	Define over-the-counter (OTC) medicines and prescription (Rx) medicines, and understand their similarities and differences. Define responsible medicine use.
Drug Fact Label and Poison Helpline	Identify the Drug Facts Label and explain its importance. Identify the steps to take in the event of a medicine mistake. Using Poison/Rescue Helpline
Medicine Measuring Tools and Dosage	Identify information found in the dosage instructions on the Drug Fact Labels (when, how, and how often to take the medicine) and its importance. Understand the importance of proper dosing tools.
Medicine Storage and Misuse	Describe what makes a location safe or unsafe for medicine storage. Identify potential consequences of medicine misuse.

Student knowledge was assessed using the OTC Medicine Safety Assessment (OTC-MSA), a standardized pre-/post-intervention quiz provided in the curriculum [26]. This tool included 29 true-false questions covering key learning outcomes such as proper storage of medicines, interpreting medication labels, identifying appropriate sources of guidance (e.g., parents, pharmacists), and safe usage practices. The questionnaire included statements reflecting common misconceptions and key safety principles

Table 2: Descriptive statistics of students' total knowledge scores from classes V-VIII (n=607).

Class	Number of Students	Pre-Test Score (mean±SD)	Post-Test Score (mean±SD)	Mean Score Difference	Improvement (%)	p-value
V	146	19.1 ± 2.7	22.9 ± 2.7	3.8	19.9	<0.001
VI	152	19.6 ± 3.1	23.2 ± 2.6	3.6	18.6	<0.001
VII	164	19.9 ± 2.9	23.6 ± 3.0	3.7	18.5	<0.001
VIII	145	20.2 ± 2.8	24.1 ± 2.4	3.9	19.3	<0.001
Pooled	607	19.7 ± 2.9	23.5 ± 2.7	3.8	19.1	<0.001

related to OTC and prescription medicines. Examples included: 'Children over 12 can take OTC medicine without a parent's permission if they carefully read the label,' 'One gulp from a bottle equals one tablespoon of medicine,' and 'Prescription medicine can be found on store shelves.' Both the pre-test and post-test were administered to students online via Google Forms in the schools' ICT labs (during school hours and under teacher supervision) before and 2 months after the intervention. It was mandatory to answer every question, and a 15-minute time limit was enforced. The total assessment score was the sum of correct answers, ranging from 0 to 29. Data collection focused on the questionnaire's true/false responses. Socio-demographic information of the students was not recorded as parental consent was not obtained. The same questionnaire was used for both assessments to enable direct comparison. Pre/post-test scores were not revealed to students to prevent bias, avoid undue pressure, and ensure the integrity of the intervention and follow-up assessments.

Descriptive statistics were used to summarize participant characteristics (age, class, and their pre-/and post-test scores). Measures of central tendency (mean) and dispersion (standard deviation) were calculated for age and scores, while frequency and percentage distributions were reported for class levels (Classes V to VIII). The normality of the data distribution was assessed using the Shapiro–Wilk test before conducting parametric tests. Paired t-test, ANOVA (one-way analysis of variance) and post hoc tests were applied for class-wise comparison of test scores and to assess the effectiveness of the intervention; however, the scores were not further classified into qualitative categories such as low, moderate, or high knowledge, as the questionnaire used did not include predefined cutoff points for such classifications or validated benchmarks for such classifications. McNemar's test was applied to each true/false question to evaluate changes in the proportion of correct responses before and after the intervention. All analyses were performed using R statistical software (version 4.5.1; R Foundation for Statistical Computing, Vienna, Austria). P-value ≤0.05 was deemed statistically significant.

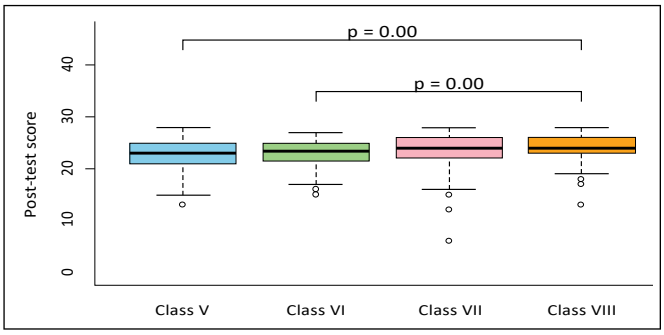

Fig. (1): Box Plot of post-test scores across classes with significant Tukey HSD pairings.

RESULTS

Of the 724 students enrolled in the study, 607 (83.8%) were included in the analysis as they completed both the pre- and post-tests. The ages ranged from 9 to 15 years (mean age of 11.5 ± 1.2 years). Knowledge scores ranged from 19.7 ± 2.9 in the pre-test and 23.5 ± 2.7 in the post-test, with an average percentage improvement of 19.1% (**Table 2**).

Overall, the paired t-test showed statistically significant improvement following the intervention (p<0.001) (**Table 2**). The effect size was enormous (Cohen's d = 1.36, 95% CI: [1.25, 1.47]), indicating a substantial positive impact of the program. This significant effect also supports the adequacy of the sample, despite the absence of a prior power calculation. A one-way ANOVA showed a significant difference in change scores across the classes (p<0.001). Tukey's HSD post hoc analysis revealed a statistically significant difference in post-test scores between Class V and Class VIII, as well as between Class VI and Class VIII (p<0.001) (**Fig. 1**).

Overall, the majority of items showed an increase in correct responses following the educational intervention, with statistically significant improvements observed in 26 of 29 questions (p<0.05). These improvements highlight the program's effectiveness in enhancing students' knowledge of key medication safety topics, including proper dosage, safe storage, and recognizing trusted adults. However, the remaining three questions did not show an improvement in responses, and the changes were not statistically significant (p>0.05). These were the questions related to medication expiry dates, the role of pharmacists, and the use of poison/rescue helplines. (**Table 3**).

Table 3: Pre- and Post-test correct responses on the OTC medicine safety assessment (OTC-MSA).

Item#	Questions	Pre-Test Correct Responses n(%)	Post-Test Correct Responses n(%)	p-value
Q1	Medicine that a doctor prescribes.	546 (89.9)	572 (94.2)	<0.05
Q2	Medicine you can buy without a prescription.	401 (66.0)	499 (82.2)	<0.05
Q3	Kitchen spoons are accurate.	403 (66.4)	550 (90.6)	<0.05
Q4	OTC meds are always safe.	389 (64.0)	445 (73.0)	<0.05
Q5	Same meds together are safe.	468 (77.1)	544 (89.6)	<0.05
Q6	Sharing others' medicine.	444 (73.1)	538 (88.6)	<0.05
Q7	Leftovers are safe to re-use.	368 (60.6)	508 (83.7)	<0.05
Q8	Ignore medicine labels	542 (89.3)	561 (92.4)	<0.05
Q9	Active ingredient relieves symptoms.	544 (89.6)	556 (91.6)	<0.05
Q10	Drug Facts show symptoms treated.	399 (65.7)	469 (77.2)	<0.05
Q11	Drug Facts give dosage info.	339 (55.8)	429 (70.7)	<0.05
Q12	Pharmacists answer OTC questions.	487 (80.2)	460 (75.8)	>0.05
Q13	Medicines expire.	566 (93.2)	557 (91.7)	>0.05
Q14	Kids need adults' permission for medicine.	572 (94.2)	563 (92.7)	<0.05
Q15	Keep medicine out of reach of kids.	590 (97.1)	598 (98.5)	<0.05
Q16	Same age doesn't mean the same safe dose.	422 (69.5)	485 (79.9)	<0.05
Q17	Prescription meds need doctor's okay.	491 (80.8)	532 (87.6)	<0.05
Q18	Keep medicine in original container.	560 (92.2)	568 (93.5)	<0.05
Q19	One gulp not equal to one tablespoon.	430 (70.8)	505 (83.2)	<0.05
Q20	OTC meds can be harmful if misused.	541 (89.1)	550 (90.6)	<0.05
Q21	Some stores sell prescription meds.	176 (28.9)	254 (41.8)	<0.05
Q22	Prescriptions for one user only.	176 (28.9)	254 (41.8)	<0.05
Q23	Poison/rescue Helpline for overdose	442 (72.8)	493 (81.2)	<0.05
Q24	Store meds on counters.	305 (50.2)	419 (69.0)	<0.05
Q25	More medicine does not mean faster cure.	572 (94.2)	576 (94.9)	<0.05
Q26	Same ingredient meds mean faster relief.	496 (81.7)	550 (90.6)	<0.05
Q27	Do not ask friends about meds.	231 (38.0)	255 (42.0)	<0.05
Q28	Poison/rescue Helpline can be called anytime.	101 (16.6)	99 (16.3)	>0.05
Q29	Kids 12 and older still need permission.	303 (49.9)	330 (54.3)	<0.05

DISCUSSION

In developing countries like Pakistan, where disease burden is high and health literacy is low, school-based health programs can address both individual and environmental factors, thereby improving health and educational outcomes. These health education interventions typically target areas such as oral health, hygiene, mental well-being, substance abuse prevention, and both communicable and non-communicable diseases [27]. Health programs that focus on overall medication safety practices and their usage during early adolescence are limited. Early education on the safety of OTC medicines plays a vital role in preventing misuse as children begin to make independent health choices. According to the Centers for Disease Control and Prevention National Health Education Standards (CDC NHES), by the end of eighth grade, students should be able to access reliable health information and use decision-making skills to reduce health risks, like reading drug labels and understanding safe medication use [28].

Hence, this study adds to the existing body of knowledge, particularly in a resource-limited environment. It demonstrates a statistically significant improvement in students' knowledge regarding OTC medication safety (at an individual level) with an overall improvement of 19.1%. Despite overall gains in knowledge, students did not show improvement on questions concerning the expiry date on medication packaging, the role of pharmacists in providing OTC guidance, and the availability of the poison/rescue helpline. These findings reflect not only gaps in the intervention but also a broader lack of public awareness in Pakistan regarding the importance of checking expiry dates, consulting pharmacists for OTC medicines, and using poison helplines. Since these practices are not widely promoted or modeled at home or in the community, students may have had difficulty understanding or valuing their importance.

The findings of this study align with previous research involving class six students across various locations, where a pre- and post-assessment of the OTC Literacy Program conducted in 17 schools showed a statistically significant improvement of 16.7 percentage points in the average total score [21]. A study by Bloom *et al.* (2022) on the retention of over-the-counter (OTC) medication safety knowledge among fifth and sixth-grade students across three schools demonstrated a statistically significant improvement of 19.9 percentage points in the intervention group compared to the control group, ten weeks post-intervention [22]. By comparison, research from India demonstrated similar improvements in

students' knowledge retention (aged 13-15 years) after repeated teacher-led lectures [29].

Meanwhile, a study in Thailand implemented a "Medication Safety and Healthy Lifestyle" program for class VI students through live discussions, hands-on demonstrations, and interactive activities. The results demonstrated a 30-point increase in scores, indicating that the use of diverse educational tools can significantly improve students' understanding of medication safety principles [30]. Similarly, a study in Malaysia implemented a "Know Your Medicine" program for school children aged 10 to 12. The mean knowledge score increased from 6.88 at baseline to 7.85 after the intervention, indicating a statistically significant improvement in medication knowledge [31].

Similar results were found in a systematic review demonstrating that implementing medication teaching yields positive outcomes; however, effective learning requires stronger collaboration between educators and researchers to develop age-appropriate materials that enhance understanding among children [32, 33].

All the studies discussed above showed that educational interventions can increase awareness of OTC medicines and promote safe use. However, the level of impact depends on the time interval between the intervention and the post-test, as well as the frequency of educational sessions. Hence, further research is required to evaluate different techniques for improving long-term retention (for example, repeat lessons, review of key program concepts, and co-production of intervention development) [34]. Also, the development of national guidelines and school-based curricula on OTC medication safety, modeled on frameworks such as those of the FDA [35], is essential to improve children's health literacy from a young age and promote safe medicine practices early in life.

STRENGTHS AND LIMITATIONS

Although a prior sample size calculation was not performed owing to the census-based design, this methodology ensured comprehensive inclusion of the target population, thereby minimizing selection bias. Moreover, the observed large effect size (Cohen's d = 1.36) provides robust post hoc evidence supporting the study's statistical power and the validity of the findings; hence, it can play a vital role in shaping future policies. As this was a single-site study with only girls in the sample, the findings may not be generalizable to all school-aged children in Pakistan. Although knowledge scores were analyzed at the class level, they were not categorized into predefined knowledge bands (*e.g.*, satisfactory *vs.* unsatisfactory), which may limit the interpretability of knowledge levels. Also, socio-demographic data such as parental education, socioeconomic status, or home environment were not collected, which may influence children's awareness and attitudes toward medication safety. Future studies should consider including these factors with appropriate parental consent to allow for more comprehensive subgroup analysis.

Despite these limitations, the study presents valuable insights. It provides a practical snapshot of medication safety awareness among young school-aged girls using educational materials from a recognized health education program. The use of pre- and post-intervention assessment offers a preliminary look at how such sessions can influence student knowledge. This research can serve as a foundational effort for more extensive studies and inform future school-based health education strategies.

CONCLUSION

In conclusion, this study demonstrated a statistically significant improvement in the students' knowledge regarding OTC medication safety (at an individual level), providing a new platform to introduce medication safety education in schools. However, further research is needed on the co-production of health education curricula in resource-poor settings to enable schools to become health-promoting institutions and improve health outcomes.

ETHICS APPROVAL

The research was approved by the Ethical Review Board of Afzaal Memorial Thalassemia Foundation Karachi, Ref. No. AMTF/IRB/-0012/24 dated 15th September 2024. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and the principles outlined in the Declaration of Helsinki.

CONSENT FOR PUBLICATION

Permission was obtained from the school authority to conduct the study in their settings.

AVAILABILITY OF DATA

The authors confirm that data supporting the results of this study are available in the article.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

This study was conceived and designed by RS and HD. RS conducted the literature review, data collection, assembly, and manuscript writing. FA did data analysis and interpretation. HD and FA did the final critical review and corrections. All authors have significantly contributed to the development and writing of this manuscript and have read, reviewed, and approved the final manuscript. RS is the corresponding author on behalf of all other authors.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used ChatGPT (GPT-4, OpenAI) only for language suggestions and minor proofreading. All content was reviewed, edited, and approved by the authors, who take full responsibility for the final published version.

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