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Review Article

Effectiveness of a Pharmacist-Led Educational Intervention on Safe Disposal of Unused and Expired Medications in Klang Valley, Malaysia: A Pre-Post Interventional Study

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Abstract

Background: The consequences of unused and expired medications encompass environmental contamination, increased global warming risks, wastage of public resources, and unintentional poisoning resulting from accidental ingestion. **Methods:** An interventional research study was carried out for a duration of eleven months. The respondents participated in this study via invitation from email, WhatsApp messages, and other social media platforms. All respondents had answered a pre-intervention questionnaire prior to the educational intervention, followed by seven days of educational intervention, as well as a final data collection on the seventh day. **Results:** The study successfully obtained 397 responses in pre-intervention, and 353 responses in post-intervention, thereby achieving a response rate of 89%. The knowledge score of the respondents had enhanced to a sufficient level from 44.4% to 91.2% upon completion of the educational intervention. Vitamins (Npre=194, 48.9%; Npost=222, 62.9%), and cough preparation (Npre=193, 48.6%; Npost=219, 62.0%) were the two most widely existing unused and/or expired medications in pre-and post-intervention. An excessive number of medications (Npre=230, 57.9%; Npost=215, 60.9%), and improvement in the illness condition (Npre=158, 39.8%; Npost=261, 73.9%) were known as the two most common reasons for having unused and/or expired medications in pre-and post- intervention. Approximately 90% of the respondents (n=317) would participate in the "Return Your Medicines Program" in managing unused and/or expired medications after receiving the educational intervention. **Conclusion:** The educational intervention demonstrated a positive impact in enhancing the knowledge, attitude, and practice regarding the safe disposal of unused and expired medications.

Keywords: Educational intervention; expired medications; pharmacist; unused medications

INTRODUCTION

In recent years, the application of medications has become increasingly important in maintaining human health globally, leading to a surge in demand for prescription and over-the-counter (OTC) medications[1,2]. However, this increased demand may have led to a certain extent of unintended consequences, especially the accumulation of medication waste. This waste is predominantly consisting of unused and expired medications that are no longer needed or have exceeded the shelf life. The terms "unused medications" and "expired medication" may seem interchangeable, yet more specifically, they have distinct definitions. Unused medications refer to chemical substances or medicines that are left over after the treatment, which may be contaminated or no longer needed by the patient. In contrast, expired medications are chemical substances or medicines that have surpassed the "use by" date, as stated on the medication packaging or label by the pharmacy personnel[1].

The existence of unused and expired medications may pose a significant threat to the environment and the living organism on the planet. Unlike normal household waste, medication waste usually contains active ingredients, which are also known as essential chemicals that can cause harm. When these medications are no longer required and disposed improperly, they can cause contamination to the environment, including the water system, and once they have leached into the underground, this contamination can result in long-term damage to the environment and wildlife. Furthermore, the improper disposal of unused and expired medications can also have a negative impact on the economy of a country. It is a waste of public resources, including money spent on healthcare and the production of medications[1-5]. Studies have shown that awareness of the negative consequences of improper medication disposal is high in Malaysia, with 89.2% and 88.2% of respondents acknowledging the issue in recent surveys[2,6]. However, awareness alone is not sufficient to solve the problem of medication waste and for that reason, healthcare professionals (HCPs) must take active measures in proper disposal to prevent environmental contamination and protect public resources.

Healthcare professionals (HCPs), particularly pharmacists have been playing a significant role in preventing the emergence of unused and expired medications. As HCPs, pharmacists

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should exercise their role to ensure that patients have an adequate supply of medications at home. If the patient already has enough medications to last for two months or more, the pharmacist should not dispense additional medications to avoid overstocking. In addition to providing adequate medication, pharmacists should provide education to patients on the proper methods of storing medications[1]. In Malaysia, the Pharmaceutical Services Division, under the Ministry of Health (MoH) Malaysia has initiated the "Return Your Medicines Programs" in 2010 to manage unused and expired medications[1,6,7]. The implementation of this program has several benefits. First and foremost, it promotes the proper disposal of medications, preventing contamination of the environment and protecting public health. Secondly, it helps to reduce the potential risk of medication misuse or abuse, as returning unused or expired medications to the pharmacy ensures that the medications are disposed appropriately. Thirdly, it saves public resources by reducing the wastage of medications. Under the "Return Your Medicines Program", patients are encouraged to separate unused and expired medications into an appropriate container, such as a box or paper bag, and return them to the pharmacy counter or pharmacy facilities around Malaysia, including hospitals, health clinics and community pharmacies that registered under MoH Malaysia[1,6,7]. Aside from that, recent studies have indicated that almost 80% of the respondents are aware of the program and understand that returning or disposing of leftover medications to the pharmacy or healthcare facility is available in Malaysia[2,3]. However, it is also important to note that patients should erase their personal details indicated on medication labels when handling unused or expired medications. This is to protect the identity and confidentiality of the medical information of the patients[8].

Generally, various factors may result in excess medications, and this can include the discontinuation of medication when the patient's condition improves, obtaining medications from multiple sources, non-adherence to the treatment regime, and amendments to medications. However, patients can take steps to reduce the amount of excess or unused and expired medications and this can be done by checking the expiration date, the amount left, and the condition of their medication regularly, preferably every month or two months as this ensures that any expired or unused medications are discarded appropriately. Additionally, unused, and expired medications should be stored in a safe and secure location to avoid any accidental consumption by children or other vulnerable individuals. Sharing unused medications with family members or friends without instructions from healthcare professionals (HCPs) is also discouraged due to potential health risks[6-11]. By following these steps, patients can reduce excess medication and limit the amount of unused and expired medications. It is important to note that HCPs, especially pharmacists can assist patients in proper medication management, including appropriate storage and disposal.

To sum up, the safe disposal of unused and expired medications is significantly vital in minimising the unintentional risk of environmental contamination, as well as saving the life of living organisms. Additionally, it is equally important to note that prevention methods should be carried out to avoid excessive storage of medications at home, which can potentially lead to accidental ingestion by vulnerable parties and a waste of healthcare resources[12-16].

MATERIAL AND METHODS

An interventional research study was carried out for a duration of eleven months. The researcher team developed a validated questionnaire to collect data from respondents in Klang Valley, Malaysia. The questionnaire was generated using two separated online Google forms, which targeted pre-intervention and post-intervention studies while both questionnaires contained the same questions. Two different links were created for both pre-and post-interventional questionnaires. To increase the participation rate, a QR code was also created for each Google form for easy scanning and recruiting responses. Respondents could voluntarily access the questionnaires by clicking on the Google form links or scanning the QR codes provided by the researchers prior to and upon completion of the educational intervention.

Study Instruments

A questionnaire comprised five sections was utilised to analyse the respondent's demographic characteristics and knowledge, attitude, practice, as well as barriers towards the safe disposal of unused and expired medications as per shown as followed:

1. Part A: Socio-Demographic Data
2. Part B: Knowledge of Disposal of Unused and Expired Medication
3. Part C: Attitude towards Disposal of Unused and Expired Medication
4. Part D: Practice towards Disposal of Unused and Expired Medication
5. Part E: Barriers on the Safe Disposal of Unused and Expired Medication

The questionnaire was developed in both English and Malay languages and included a variety range of response type, incorporating true or false, a 5-point Likert scale, and multiple specific answer types.

A pilot study was conducted with 30 members of the general public to examine and ensure the validity, quality and reliability of the research questionnaire. The Cronbach alpha value of the study questionnaire in the pilot study was 0.783. The study did not interfere with the current treatments of the respondents as the study instrument generally evaluated their levels of knowledge, attitude, and practice (KAP) patterns regarding the safe disposal of unused and expired medications.

Ethical Considerations

The current research study gained approval from the research and ethical committees of the respective affiliated institution namely, IMU University Joint Committees (IMU-JC). The approval number is MPP 1-2023(01).

Data Analysis

The data received was processed and analysed by utilising the data analysis system, namely Statistical Package for Social Sciences (SPSS) version 26.0.

RESULTS

The current study aimed to determine the level of knowledge, attitude, and practice (KAP) of the safe disposal of unused and expired medications, provide educational intervention, and analyse the effectiveness of the pharmacist-led educational intervention on the KAP of safe disposal of unused and expired medications among the Klang Valley population in Malaysia.

Socio-demographic Outcomes

A total of 397 respondents were first recruited and participated in the pre-intervention questionnaire, whilst there were 353 respondents involved in the post-intervention questionnaire. The educational intervention was carried out consistently for seven days in each group of respondents. The socio-demographic data of the respondents are presented in [Table 1].

Knowledge towards Disposal of Unused and Expired Medication

There were significant associations found between all the items in the knowledge towards disposal of unused and expired medication before and after the educational intervention [Table 2].

Most of the respondents were able to provide at least 2 correct answers and above prior to educational intervention. In contrast, most of the respondents could provide at least 3 correct answers in the post-intervention questionnaire. There were 255 out of 353 respondents able to obtain 10 answers correctly, which significantly increased from 5.8% at baseline to 72.2% after the completion of the educational intervention.

The result established that only 54.2% (n=215) of the respondents had a moderate level of knowledge score before receiving educational intervention from the pharmacist. In the meantime, there were only two-fifths (n=176, 44.4%) of the respondents had sufficient knowledge scores on the disposal of unused and expired medication. However, the knowledge score of the respondents had significantly enhanced to a sufficient level from a baseline of 44.4% to 91.2% upon completion of the educational intervention.

Attitude towards Disposal of Unused and Expired Medication

It was obvious that the majority of the respondents showed a positive attitude towards disposing of unused and expired medication after receiving educational intervention from the pharmacist. Besides that, more than 90% of the respondents had a positive attitude toward each item [Table 3] except item 6 and item 10 which had 71.9% (n=254) and 70.6% (n=249) respectively.

Practice towards Disposal of Unused and Expired Medication

Type(s) of Unused and/or Expired Medications on Hand

During pre-intervention, vitamins (48.9%) were the most widely existing unused and/or expired medication, followed by cough preparation (48.6%), and antibiotic (44.6%). Vitamins (62.9%) similarly remained as the most observed unused and/or expired medication upon the completion of education

Table 1. Socio-demographic information of the respondents (N_{pre}=397; N_{post}=353)

Variable (N_{pre}=397) N (%)		Pre-intervention (N_{post}=353) N (%)	Post-intervention
Gender	Male	97 (24.4)	76 (21.5)
	Female	300 (75.6)	277 (78.5)
Age(years)	18-27	325 (81.9)	298 (84.4)
	28-37	24 (6.0)	21 (6.0)
	38-47	31 (7.8)	20 (5.7)
	48-57	13 (3.3)	10 (2.8)
	≥ 58	4 (1.0)	4 (1.1)
Ethnicity	Malay	40 (10.1)	31 (8.8)
	Chinese	315 (79.3)	291 (82.4)
	Indian	27 (6.8)	21 (5.9)
	Others	15 (3.8)	10 (2.9)
Level of Education	No Formal Education	2 (0.5)	0 (0)
	Primary Education	2 (0.5)	1 (0.3)
	Secondary Education	25 (6.3)	23 (6.5)
	Tertiary Education	368 (92.7)	329 (93.2)

Living Status	Alone	50 (12.6)	46 (13.0)
	With Family	293 (73.8)	262 (74.2)
	With Non-Family (Ex: Friend, Colleague & etc.)	54 (13.6)	45 (12.7)
Monthly Income	≤ MYR 1500	237 (59.7)	216 (61.2)
	MYR 1501-3000	69 (17.4)	64 (18.1)
	MYR 3001-4500	40 (10.1)	29 (8.2)
	MYR 4501-6000	26 (6.5)	23 (6.5)
	MYR 6001-7500	13 (3.3)	9 (2.5)
	MYR 7501-9000	6 (1.5)	8 (2.3)
	>MYR 9000	6 (1.5)	4 (1.1)
Do you have any chronic disease?	Yes	34 (8.6)	28 (7.9)
(Ex: hypertension, diabetes, dyslipidaemia, cancer & etc.)	No	363 (91.4)	325 (92.1)
Do you aware of "Return Your Medicines Program"?	Yes	121 (30.5)	324 (91.8)
	No	276 (69.5)	29 (8.2)
State your living region in Klang Valley.	Kuala Lumpur	144 (36.3)	126 (35.7)
	Selangor	238 (59.9)	213 (60.3)
	Putrajaya	15 (3.8)	14 (4.0)

Table 2. Association between the Knowledge towards Disposal of Unused and Expired Medication (N_{pre}=397; N_{post}=353)

Item	Pre-intervention	Post-intervention	Significant
	N_{pre} (%)	N_{post} (%)	(*p-value)*
1. Most of the medications should be stored in a dry location away from sunlight and below 25°C.	380 (95.7)	349 (98.9)	0.009 (P<0.05)
2. Medication Wastage Issue will cause detrimental effects on the humans and animals living on the planet.	366 (92.2)	351 (99.4)	0.000 (P<0.05)
3. Improper disposal of unused and expired medications may cause undesired harmful effects to the people and animals living on the planet.	374 (94.2)	345 (97.7)	0.015 (P<0.05)
4. Improper disposal of unused and expired medications may not cause any detrimental effect on the economy of a country.	187 (47.1)	297 (84.1)	0.000 (P<0.05)
5. It is acceptable to flush unused and expired medications down the toilet or drain.	306 (77.1)	335 (94.9)	0.000 (P<0.05)
6. It is acceptable to share excessive medications with people who would need it.	241 (60.7)	321 (90.9)	0.000 (P<0.05)
7. It is acceptable to throw unused and expired medications away in the garbage bin.	170 (42.8)	321 (90.9)	0.000 (P<0.05)
8. Do you aware that the "Return Your Medicines Program" was implemented by the Pharmaceutical Services Division, Ministry of Health (MOH) Malaysia in 2010?	158 (39.8)	326 (92.4)	0.000 (P<0.05)
9. Waste-water treatment does not remove medication wastes in sewerage.	308 (77.6)	327 (92.6)	0.000 (P<0.05)
10. Healthcare providers, such as pharmacists are playing a significant role in reducing medication wastage in the community.	369 (92.9)	350 (99.2)	0.000 (P<0.05)

Table 3. Attitude towards Disposal of Unused and Expired Medication (N_{post}=353)

Item	Attitude (Post-intervention)		
	Negative	Neutral	Positive
1. It is my responsibility to check the stock of remaining medications for expiry date, condition and amount left regularly.	2	6	345
	-0.6	-1.7	-97.7
2. It is my responsibility to prevent medication residue from contaminating the environment.	1	10	342
	-0.3	-2.8	-96.9
3. I will dispose of unused medications safely using the MoH facilities, for example, health clinics or pharmacies, etc.	3	11	339
	-0.9	-3.1	-96

4. I am more likely to return unused medications if there is a monetary incentive offered to me.	6	23	324
	-1.7	-6.5	-91.8
5. I will protect my family members from the undesired and harmful effects of unused and expired medications.	1	5	347
	-0.3	-1.4	-98.3
6. I will share my unused medications with those who might need them.	61	38	254
	-17.3	-10.8	-71.9
7. I will participate in the "Return Your Medicines Program" in a way to reduce medication wastage.	1	14	338
	-0.3	-4	-95.7
8. I am willing to donate the unused medication to the pharmacy before the expiry date to alleviate medication wastage although I have paid for it.	3	16	334
	-0.9	-4.5	-94.6
9. I will dispose of unused and expired medications in accordance with the advice or instructions given by the healthcare professionals, such as doctors and pharmacists.	2	13	338
	-0.6	-3.7	-95.7
10. I will keep the unused medication for future use as it would be wasteful to dispose of unused medication.	63	41	249
	-17.8	-11.6	-70.6

*Attitude: 1, 2=negative ; 3=neutral ; 4, 5=positive (Item 1,2,3,4,5,7,8 & 9)
*Attitude: 1, 2=positive ; 3=neutral ; 4, 5=negative (Item 6 & Statement 10)

intervention, followed by cough preparation (62.0%), and cold preparation (57.2%) [Table 4].

Reason(s) for Having Unused and/or Expired Medications

An excessive number of medications (57.9%) was known as the most common reason for having unused and/or expired medications before educational intervention. The most widely observed reason for having unused and/or expired medications after the educational intervention was due to the improvement in the condition of illness (73.9%) [Table 5].

Method(s) of Disposal of Unused and/or Expired Medications

The most common method to dispose of unused and/or expired medications before educational intervention was throwing them away in the garbage bin (52.4%). In contrast, approximately 90% of the respondents (n=317) would participate in the "Return Your Medicines Program" and return unused and/or expired medications to the relevant healthcare facility after receiving educational intervention from the pharmacist.

Table 4. Type(s) of Unused and/or Expired Medications on Hand (N_{pre}=397; N_{post}=353)

Item	Pre-intervention	Post-intervention
	N_{pre} (%)	N_{post} (%)
1. Anti-allergic	78 (19.6)	89 (25.2)
2. Antibiotic	177 (44.6)	143 (40.5)
3. Antidiabetic Drug (Diabetic Medication)	18 (4.5)	22 (6.2)
4. Anti-diarrheal	86 (21.7)	77 (21.8)
5. Antihypertensive (Blood Pressure Medication)	23 (5.8)	19 (5.4)
6. Blood Thinners	20 (5.0)	15 (4.2)
7. Cholesterol Lowering Medications	15 (3.8)	11 (3.1)
8. Cough Preparation	193 (48.6)	219 (62.0)
9. Cold Preparation	157 (39.5)	202 (57.2)
10. Heartburn Medication	24 (6.0)	17 (4.8)
11. Herbal Remedies	38 (9.6)	36 (10.2)
12. Laxatives	10 (2.5)	9 (2.5)
13. Painkillers	152 (38.3)	195 (55.2)
14. Throat Medication	100 (25.2)	102 (28.9)
15. Vitamins	194 (48.9)	222 (62.9)
16. Other	2 (0.5)	6 (1.7)

Table 5. Reason(s) for Having Unused and/or Expired Medications (N_{pre}=397; N_{post}=353)

Item	Pre-intervention	Post-intervention
	N_{pre} (%)	N_{post} (%)
1. Amendment of the prescription or treatment regimen	68 (17.1)	77 (21.8)
2. An excessive number of medications	230 (57.9)	215 (60.9)
3. Encounter with adverse drug reaction	48 (12.1)	55 (15.6)
4. Improvement in the illness condition	158 (39.8)	261 (73.9)
5. Obtaining supplies from multiple centres	75 (18.9)	68 (19.3)
6. Non-adherence to the prescription or treatment regimen	53 (13.4)	31 (8.8)
7. Other	6 (1.5)	3 (0.8)

Barriers towards Disposal of Unused and Expired Medication

The most widely identified reason for improper disposal of unused and/or expired medication after the educational intervention was similar to pre-intervention, whereby up to 90% of the respondents claimed that the disposal facility was far away from their place, followed by unaware of the safe disposal of medication (84.5%), as well as unaware about the facility available for safe medication disposal (81.3%).

DISCUSSION

A response rate of 89% had been accomplished and the response rate of current study was consistent with another interventional study carried out by Lai *et al*[2]. Additionally, the current study revealed that the knowledge of the respondents drastically improved upon the completion of educational intervention led by the pharmacist. Not only that, but a certain level of improvement was also observed in the attitude and practice pattern among the respondents. This outcome met the expectation of the research as the educational intervention contained relevant information that addressed the topic examined, along with seven days of educational intervention by using various educational materials, including 1 educational video and 6 educational posters being delivered in the intervention group on a daily basis.

In this study, more than half of the respondents had moderate knowledge and approximately two-fifths of the respondents had sufficient knowledge towards the disposal of unused and expired medication prior to educational intervention. The knowledge of the respondents had improved significantly to sufficient levels after receiving educational intervention and approximately 90% of them showed a sufficient level of knowledge on medication disposal. Pre-intervention knowledge was insufficient in items 4, 7, and 8, with no more than 50% correct score, and a moderate in item 6, with approximately 60% correct score. All items with an insufficient and moderate correct score enhanced significantly after the educational intervention. However, it was unable to compare the findings with previous studies as there was no seven days educational intervention being conducted on this topic recently.

In the present study, most respondents revealed a positive attitude on all the items provided prior to the educational intervention, except item 6 "I will share my unused medications with those who might need them.". However, the attitude towards item 6 had tremendously improved from 48.3% to 71.9% after the educational intervention, along with certain levels of improvement in other items, whereby this also suggested that educational intervention was effective in improving the attitudes of medication disposal among the respondents. This finding was inconsistent with another interventional study conducted by Lai *et al*. reported that no improvement was observed in the attitudes of respondents after providing an interventional study as it could be more challenging to affect the attitudes of medication disposal due to a shorter period of intervention in the previous study[2].

Aside from that, vitamins, such as Vitamin A, Vitamin C, Vitamin D and multivitamins remained the most widely existing unused and/or expired medication, including before and after educational intervention, with a prevalence of 48.9% and 62.9% respectively. The finding was inconsistent with the study that was undergone by Azmi *et al.* that reported only 3% of respondents had vitamins on hand[6]. This could be due to the growing awareness towards vitamins especially during the post-covid era, where there has been a rise in health awareness among the public, with more people realising the importance of maintaining overall well-being, leading to an increased interest in vitamins[10,11]. Moreover, the use of antibiotics remained at more than 40% prevalence, and this finding was also consistent with the study conducted by Azmi *et al*[17].

The present study compared the reason(s) for having unused and/or expired medication before and after educational intervention. In pre-intervention, the most common reason was due to the excessive amount of medication provided, followed by improvement being seen in the illness condition, with a prevalence of 57.9% and 39.8% accordingly. These two reasons remained the two most common reasons for having unused and/or expired medications even after receiving the educational intervention, but an improvement in the illness condition had become the most common reason, recorded as 73.9%, followed by an excessive medication amount of 57.9% prevalence. The findings were also similar to other studies conducted by Wang *et al.* and Ayele *et al.* in Malaysia and Ethiopia respectively, revealing that improvement in illness condition was the most common reason for having unused medication[17,18].

It was expected to observe some changes in the practice patterns towards the disposal of unused and expired medication resulting from the educational intervention. Before the educational intervention, throwing away unused and/or expired medications in the garbage bin was identified as the most predominant method of medication disposal, with a prevalence of 52.4%, followed by 41.6% of respondents who would keep the medications for future use. This finding was also similar to the cross-sectional study carried out by Martin *et al.*, suggesting approximately three-fifths of the respondents would throw unused and expired medications in the garbage bin[19]. In contrast, there were approximately one-fifth of the respondents would keep the medications for future use or discard them in the garbage bin in post-intervention, thereby suggesting the effectiveness of educational intervention in improving the practice pattern of medication disposal methods among the public. Based on a previous study by Wang *et al.*, the willingness to return unused medications to respective healthcare facilities was below expectation, with a prevalence of not more than 30%[17,20]. In the current study, there were 39.8% of respondents would choose to return unused and/or expired medications via the "Return Your Medicines Program", yet it was delighted to highlight that this method of medication disposal had become the most common method to be applied by approximately 90% of the respondents after receiving educational intervention from the pharmacist. The drastic enhancement in the willingness to participate in the "Return Your Medicines Program" could potentially alleviate the undesired impacts of improper medication disposal towards the environment and public health, such as water and soil contamination, as well as accidental ingestion by vulnerable individuals[21-26].

The strengths of the present study included the utilisation of a validated questionnaire for evaluating the knowledge, attitude, and practice (KAP) towards the safe disposal of unused and expired medications, along with the initiative of seven days of educational intervention led by the pharmacist. Additionally, this study met the inclusion of sizable sample size with desired response rate achieved. However, one of the limitations of the current study was that the majority of respondents consisted of Chinese, which could limit the generalizability of the findings to a broader population. Secondly, although the pre-and post-questionnaire were prepared in bilingual versions, there was still a potential language barrier being observed as some new and potential respondents might have experienced difficulties in understanding English and Malay, the languages used during recruitment. To address this issue, one possible solution could be explaining the meaning of the study materials in a clear and concise manner individually, as well as developing the questionnaire in multiple languages, such as Chinese and Tamil, which would help in accommodating respondents who are more comfortable with those languages. Last but not least, a proactive approach should be taken to include more respondents from different ethnicities in a way to enhance the diversity and representativeness of the sample[27-31].

CONCLUSION

The educational intervention demonstrated a positive impact in enhancing the knowledge, attitude, and practice (KAP) regarding the safe disposal of unused and expired medications. By improving both knowledge and attitude, the pharmacist-led educational intervention ultimately influenced the actual disposal practices of an individual, as well as encouraging them to actively engage in the safe disposal of unused and expired medications. Further studies can be conducted to develop a longitudinal study with the aim to provide a long-term follow-up in evaluating the sustainability of the improved KAP towards the safe disposal of medications. This would help to determine if the positive effects of the educational intervention persist over an extended period of time.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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