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Original Research

Public habits and attitudes toward disposal of unused medications and views on advanced medication take-back programs in UAE: A cross sectional study

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Abstract

Objective: This study aimed to assess the general population's habits and attitudes toward disposing of expired and unused medications and evaluate their awareness of advanced medication take-back programs using an application system in the UAE. **Methods:** Over three months, a descriptive cross-sectional study was conducted with a sample size of 411 participants from the seven emirates of the UAE. Data were collected via an online questionnaire and analyzed using SPSS (version 28.0). **Results:** Half of the participants were aged 18–24, and 58% were university graduates. A total of 78.4% reported having unused medications at home. While 69.6% were unaware of pharmacists' roles in pharmaceutical waste disposal, only 25% had received advice from healthcare professionals. The most common disposal method was throwing medications in the garbage (74%), while only 5.9% returned them to pharmacies. Notably, 77.6% expressed willingness to participate in a mail-back program for expired and unused medications. **Conclusion:** Implementing an online mail-back program could enhance community awareness of proper medication disposal, reduce risks associated with improper practices, and improve pharmaceutical waste management in the UAE, contributing to a healthier environment.

Keywords: Medications, expired, pharmacy, U.A.E, disposal, patient, public, awareness

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INTRODUCTION

Pharmaceutical drugs are chemicals introduced into the body to combat illnesses by suppressing pathological conditions or alleviating symptoms. Additionally, they are used prophylactically to prevent disorders and diagnose diseases[1,2]. Various factors contribute to medication wastage, but this issue escalated significantly after the COVID-19 pandemic. Many individuals began stockpiling medications, including antipyretics, cold and flu remedies, antitussives, expectorants, and vitamins like Vitamin C, as a precaution against the virus. This behavior, driven by fear and anxiety, led to substantial changes in attitudes toward drug use. Families accumulated excessive and often unnecessary medications in preparation for potential illnesses during lockdowns. As a result, many homes in the UAE now contain expired or unused medications. Common disposal methods include flushing them down toilets or discarding them in household garbage. Raising public awareness about proper pharmaceutical disposal methods is essential to address this issue[1,2]. Other reasons for unused medications include non-adherence to treatment plans, regimen changes during follow-ups, and the role of health insurance in facilitating medication stockpiling. With minimal out-of-pocket costs, patients may feel less concerned about over-purchasing pharmaceuticals.

Awareness of safe medication handling and disposal is crucial to prevent improper practices[3,4,5]. In the United States, the FDA recommends medication take-back programs, drug deactivation pouches, and proper disposal through law enforcement agencies. Controlled substances, in particular, require specialized disposal methods to prevent abuse[6]. Proper

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pharmaceutical waste management involves correct packaging, labeling, and storage before disposal. These measures ensure compliance with regulations, safeguard healthcare workers, and protect the environment. Government and non-governmental organizations in the UAE should collaborate to develop an efficient medical waste management system. This system could collect data on waste generation, allowing for safe disposal at designated locations.

Furthermore, providing occupational health and safety training for workers and waste handlers is critical, particularly for handling hazardous drugs like those used in cancer treatment. Public education on the risks of improper disposal and the correct methods for disposing of expired or unused medications is equally vital. Raising awareness within pharmaceutical companies and healthcare industries about environmentally responsible disposal practices is necessary to mitigate the risks posed by pharmaceutical waste [3–8].

This study assessed patients' habits regarding expired and unused medication disposal in the UAE. It explored factors contributing to improper practices, including educational attainment, awareness levels, and the influence of health insurance. The study examined whether participants had prior knowledge of pharmacists' roles in pharmaceutical waste disposal and if they had received guidance from healthcare professionals. It also evaluated the extent of stockpiling behaviors and reasons for unfinished medication courses to understand current disposal practices.

METHODS

Study setting

The study was conducted over three months, from 22 August to 22 November 2022, in the seven emirates of the United Arab Emirates. The United Arab Emirates public made up the study population for the online questionnaire.

Study Design

This study uses a cross-sectional observational survey.

Inclusion and exclusion criteria

Although the participants' ages varied, they were all over 18. We excluded participants who did not use medications, those who did not have unused or expired medications, participants under 18, and those who refused to participate in the questionnaire.

Questionnaire development and Data collection method

A panel of four experts in pharmacy practice and medicine validated the questionnaire for content validity after it was produced based on a thorough literature study from numerous prior well-written research articles we located online. All suggestions, thoughts, and comments regarding the questions were considered before submitting the most recent version of the questionnaire. Ten laypeople unfamiliar with the study participated in a pilot test. A validated questionnaire with 28 questions, including open-ended questions on behaviors and attitudes toward leftover medications, was designed. Interviews were conducted regarding household disposal procedures for unneeded medicines. Medications maintained at respondents' homes were listed on the observation checklist. A total of 411 participants—representing 411 distinct UAE households—were surveyed for this study.

Literature search strategy

The researchers created a questionnaire based on their evaluation of the literature, the WHO recommendations, and other surveys and research carried out in various institutions by various organizations like Cytotoxic Drug Dispersal, Cytotoxic Safety, and Cytotoxic Waste Management: Practices and Proposed India-specific Guidelines"[3], and "Investigating the disposal of expired and unused medication in Riyadh, Saudi Arabia[10]. All information was meticulously gathered from various reputable, legally published papers and books from various sources, including PubMed, Google Scholar, and the online library of the University of Sharjah.

Sample size and power calculation

Slovin's Formula was used to estimate the sample size of at least 399 randomly selected people, with a margin of error of 5% and a confidence interval of 95%. Since we had the population size (N) and the margin of error (e), we used them to find the sample size through this formula:

$$n = \frac{N}{1 + Ne^2}$$

n = number of samples

N = total population

e = margin of error

n = 10,176,603 / 1+ (10,176,603 x 0.05^2) n = 399.984, we received 411 replies

Statistical analysis

All the survey responses were tabulated, and statistical analysis was conducted using IBM SPSS Statics (version 28.0). Data were descriptively evaluated to determine response frequency and percentage. We tested the relationship between patient awareness and knowledge and proper medication disposal. In the regression-hypothesis testing, we tested the hypothesis of the impact of medical insurance companies on the number of unused medications present in households, and it is a potential cause.

RESULTS

A total of 411 household surveys were completed. 18% of the respondents were men, while 82% were females. This stark difference in proportion was anticipated and sought after because most women are in charge of keeping track of numerous home items, including medications, and are more

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likely to dispose of them when they are no longer needed. In addition, more than half of the participants were between 18 and 24. 57.9%of the participants graduated from university (Table 1).

Moreover, our finding regarding the attitudes toward unused medicine meant to measure people's views on throwing away unused medications revealed that only (21%) of the respondents indicated they had no unused prescriptions at home. (70%) of the respondents reported that their health insurance was active. Most respondents (87.8%) said they always check the expiration date on their medications before taking them. Furthermore, 30.5% reported hearing about the pharmacist's role in dealing with expired and unused medications. Only (25%) of the participants reported receiving advice on proper medication disposal from a health professional. 55% reported that incorrect disposal of unwanted and expired medications impacted the environment, while (36%) thought it could. Finally, 80.8% of them reported that they stock pharmaceutical medicines like vitamins and analgesics. 38% of the participants reported that they have more than six types of unused medications at their home, while 25% of them reported that they have 3-6 medications. When asked about the type of unused medications found in the homes of respondents, at least 1144 unused drugs were discovered. Tablets made up the bulk of these (34.4%). Lotions and creams came next with (19.4%). Meanwhile, suppositories, inhalers, and injections were the least found and only covered (16.8%). Liquids (17.9%) and drops (14.1%) were also kept (Table 2).

Table 1. Socio-demographic characteristics of the participants (n=411)

Sociodemographic characteristics	**n (%)**
Gender	
Women	336 (81.75%)
Men	75 (18.25%)
Age	
18 to 24 years.	208 (50.61%)
25 to 39 years.	107 (26.03%)
40 to 60 years.	90 (21.9%)
60 years and more.	6 (1.46%)
Marital status	
Single	233 (56.69%)
Married	178 (43.31%)
Educational level	
Less than senior high school	14 (3.41%)
Pass senior high school	159 (38.69 %)
Graduated from university	238 (57.91%)
Insurance status	
Active	289 (70.32%)
Not Active	122 (29.68%)
Domestics	
Sharjah	246 (59.85%)
Dubai	79 (19.22%)
Abu Dhabi	44 (10.71%)
Ajman	32 (7.79%)
Ras Al-Khaimah	6 (1.46%)
Fujairah	2 (0.49%)
Umm Al Quwain	2 (0.49%)

Reasons for stopping to take medications and way to dispose of unused medicine

Regarding the reasons for not taking medications; (37%) of the participants reported that disease or symptoms improved. (18%) reported that the doctor replaced the medication with a better alternative. (15.5%) said that they did not feel any progress on it, while 20.5% reported that they experienced undesired side effects. 9% of them forgot to use them **(**Table

Table 2. Attitudes and Habits of the respondents toward unused medicine

Items		**N (%)**
Do you have any unused medicine at your home?	Yes	322 (78.4%)
	No	89(21.6)
Insurance status	Active	289(70%)
	Inactive	122(30%)
Does your insurance cover all the costs of your medication? N=289	No	36(12.5)
	Partially >80% of its cost	151(52.1)
	Yes	102(35.3)
Do you check the expiry date of your medication?	Yes	361 (87.8%)
	No	50(12.2%)
Have you heard about the pharmacist's role in dealing with expired and unused medications?	Yes	125(30.4)
	No	286(69.6)
Did you receive advice on proper medication disposal from a health professional?	Yes	103 (25.06%)
	No	308(74.9)
Do you think improper disposal of unused medicines affects the environment?	Yes	228 (55.4%)
	May be	*149 (36.3%)*
	No	34(8.3)
Do you stock any pharmaceutical medications (vitamins, analgesics, etc)?	Yes	332 (80.8%)
	No	79(19.2%)
The number of unused medications at home by the respondents	None	30(7%)
	01-Mar	123(30%)
	04-Jun	101(25%)
	More than 6	157(38%)
Type of pharmaceutical medicines used in 411 households (n=1144)	Liquid.	205 (17.92%)
	Tablet.	393 (34.35%)
	Lotions & creams.	222 (19.41%)
	Suppositories.	59 (5.16%)
	Drops.	161 (14.07%)
	Inhalers.	78 (6.82%)
	Injections.	56 (4.9%)

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3**).** Regarding disposal procedures for medications, about three fourth of all respondents (74%) reported throwing medications in household waste, (13.9%) reported keeping the medication, (6.2%) flushed them in the sink or toilet, while only (5.9%) reported returning medication to a pharmacy (Table 3).

Table 3. Reasons for stopping to take medications and Way to dispose unused medicine (n=411)

Reasons for unused medicines	**N(%)**
Doctor it with a better alternative	118 (18%)
I felt better, so I didn't complete it	244 (37%)
I experienced undesired side effects	135 (20.5%)
I didn't notice any progress on it	102 (15.5%)
I forget to take them	56 (8.5%)
Others (I avoid taking medications)	4 (0.6%)
Ways to dispose unused medicine	**N (%)**
I throw it in the garbage.	337 (74%)
I flush it down a sink or toilet.	28 (6.2%)
I give it back to the pharmacy	27 (5.9%)
I keep the medication.	63 (13.9%)
*Each participant chose more than one option.	

Thoughts and awareness about medication take-back programs and the inclusion of a web application

77.6% of the participants are willing to participate in a mail-back program for unused, unwanted, or expired (UUE) medications. (47%) said they were willing to pay a symbolic fee for medication pickup (< 6 Dirhams), while (74.7%) of those who were not willing to pay said they were willing to visit a collection point and hand them for free instead. When asked if receiving a discount on their next purchase from a pharmacy will encourage them to use the UUE mail-back program, nearly (62.3%) said yes, while (31.4%) said it might, and only (6.3%) answered no. Finally, when asked if they think the inclusion of a web application for unused and expired drug disposal would be an easy method to share awareness and encourage good disposal practices, almost (75.4%) thought it is a good idea, while (19.2%) said it could be a good idea and only (5.4%) said it is not a good idea. (89%) agreed that they would support the idea of a web application for controlling unused or expired drug disposal, and finally, 79.5% of them agreed that there are difficulties that might software elderlies and people who are not very familiar with using online services software (Table 4).

When the chi-square test was done to determine the association between receiving advice from medical professionals and other factors, we found that receiving advice from medical professional has a statistically significant association with the population's awareness of the pharmacist's role in medication disposal, disposing of medication in the garbage and disposing medication through returning to the pharmacy (P values =0.0001. In addition, received, advice from medical professionals revealed statistically significant results with the participants willingness to join in the UUE program (p-value =0.01) (Table 5).

Table 4. Thoughts and awareness about medication take-back programs and the inclusion of a web application

Items (n=411)		***n (%)***
In general, are you aware of medication take-back programs?	Yes	77 (19%)
	No	333(81%)
Are you willing to participate in a mail-back program for UUE medications?	Yes	319 (77.6%)
	No	92(22.4)%
Are you willing to pay a symbolic fee to be a part of a UUE mail-back program?	Yes	140 (34.1%)
	May be	53 (12.9%)
	No	218(53)
If not, can you visit a collection point for the UUE mail-back program and hand them for free? (N=218)	Yes	163(74.7%)
	No	55(25.3%)
Will receiving a discount on your next purchase from a pharmacy encourage you to use UUE mail-back program?	Yes	256 (62.3)
	May be	129(31.4)
	No	26(6.3)
Do you think the inclusion of a web application for UUE medication disposal would be an easy method of sharing awareness and encouraging good disposal practices?	Yes	310 (75.4%)
	May be	79(19.2)
	No	22(5.4)
I would support the idea of a web application for controlling unused or expired drug disposal.	Strongly agree,	206(50.1%)
	Agree	160 (38.9%)
	Neutral	39(9.5%)
	Disagree	2(0.4)
	Strongly disagree	4(0.9)
Difficulties in using the web application might encounter elderlies and people who are not very familiar with using online services software.	Strongly agree,	140 (34%)
	Agree	187 (45.5%)
	Neutral	73(17.8)
	Disagree	7(1.7)
	Strongly disagree	4(0.9)

When multiple linear regression was done to determine the predictors of the number of unused medications present at home, we found that the presence of active medical insurance and whether the insurance covers the cost of the medication are predictors for high numbers of unused medication present at home (P values 0.016, 0.038). A negative coefficient (-0.127) suggests that having active medical insurance is associated with fewer unused medications at home. Since the *p*-value is 0.016 (< 0.05), this result is statistically significant. However, a positive coefficient (0.103) suggests that when insurance covers the cost of medications, the number of unused medications at home increases (*p*-value = 0.038). People with active medical insurance tend to have fewer unused medications at home. However, if insurance covers the cost of medications, the number of unused medications at home increases. This suggests that full coverage might lead to medication over-prescription or over-purchasing, possibly because patients are less concerned about cost (Table 6).

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Table 5. Crosstabulation between Receiving advice on proper medication disposal from a health professional and other factors (n=411)

No		Receiving advice on proper medication disposal from a health professional		P value
		Yes		
Do you think improper disposal of unused medicines affects the environment?	Maybe	38.50%	29.40%	0.154
	No	8.70%	6.90%	
	Yes	52.80%	63.70%	
Stock any pharmaceutical medication (vitamins, analgesics, etc.)	No	17.80%	23.50%	0.13
	Yes	82.20%	76.50%	
Willing to participate in a mail-back program for unused, unwanted, or expired (UUE) medications	No	19.40%	31.40%	**0.01**
	Yes	80.60%	68.60%	
Have you heard about the pharmacist's role in dealing with expired and unused medications?	No	81.60%	33.30%	**0.001**
	Yes	18.40%	66.70%	
Throw in garbage	yes	86.40%	68.60%	**0.001**
	no	13.60%	31.40%	
Give back to the pharmacy	yes	3.20%	16.70%	**0.001**
	no	96.80%	83.30%	

Table 6. Regression analysis to predict the number of unused medications present at home

Model	Unstandardized B	Coefficients S. E	Standardized Coefficients Beta	P value
(constant)	0.566	0.151	-	<0.001
Insurance status	-0.127	0.052	-0.194	**0.016**
Insurance covers the cost of medications	0.103	0.049	0.168	**0.038**

DISCUSSION

This is the first study in the United Arab Emirates (UAE) to assess the patterns and factors influencing the disposal of unused medications across various households in the Emirates. Despite respondents' young age and high educational attainment, misconceptions about proper disposal methods were prevalent. Reasons for not taking medications, such as improved symptoms or side effects, aligned with findings from similar studies in other countries[9-13]. Our study revealed that over 78% of respondents reported unused medications at home, with 74% disposing of them in household trash. This aligns with findings from a study in Illinois, USA, where 45% of respondents admitted to storing unused or expired medications at home. Similarly, in India, 68% of participants kept unneeded medications, while in Riyadh, Saudi Arabia, 55.3% were unaware of the risks of expired medications at home[14]. The significant volume of wasted prescriptions may stem from poor medication adherence, overuse, misuse of prescription drugs, and insufficient communication between prescribers, pharmacists, and patients[15,16]. Although 87.8% of respondents consistently checked expiration dates before using medications, many neglected proper disposal methods, indicating a gap between awareness and action. Only 25% of respondents had received guidance from healthcare professionals on medication disposal, consistent with findings from other studies[17,18].

This highlights the need for strategies promoting rational prescribing practices, improving adherence, and increasing pharmacist involvement in education about proper disposal. To address this issue, we developed a mobile application named USMC (Unused and Expired Medicine Collectors)**.** This app provides instructions for medication disposal and facilitates the collection of unused and expired medications from any location. While installation is free, a small fee may apply for pickup services. Our study found that 47% of respondents were willing to pay for pickups, while 77% of those unwilling to pay preferred dropping off medications at collection points for free. Additionally, 62.3% indicated that a discount on pharmacy purchases would motivate participation, suggesting that a 15% voucher could encourage program use[19,20]. Most participants (75.4%) viewed the app as a simple way to promote awareness and proper disposal practices. However, concerns were raised about challenges older individuals or those unfamiliar with online services might face. To address this, we propose user-friendly tutorials, incorporating proper disposal practices into healthcare consultations, and promoting public education initiatives, programs, and campaigns to enhance community consciousness[21-23].

Suggestions from participants included adding a call center

for elderly users, establishing accessible pickup locations like malls and co-ops, and creating secure drop-off containers to prevent theft or misuse. Our research demonstrated limited public awareness of appropriate medication disposal in the UAE. This issue can be mitigated with sufficient incentives, guidance, and collaboration, reducing environmental risks and preventing harm to animals and the pharmaceutical industry. Following collection, medications would be sorted, sterilized, and processed using steam treatment before being safely disposed of in sanitary landfills.

The study underscores the critical need for reform in pharmaceutical waste management in the UAE, stressing the implementation of mandatory take-back systems, standardized disposal methods, and more strict regulations by the Ministry of Health and Prevention. Emphasis is placed on modifying insurance policies to prevent overprescribing, launching public education campaigns, and establishing a national take-back system with pharmacy return locations and online monitoring. Sustainable waste management methods involving green disposal sites and WHO regulations are also necessary. In addition, the research provides policymakers in the UAE with strong evidence to impose stricter laws regarding the disposal of medications, incorporate waste management into the sustainability objectives of the UAE, create public incentive schemes, and implement the UAE-specific regulatory framework based on international standards. With these changes, the UAE would improve pharmaceutical waste management, ensuring public health and spearheading sustainability on the regional level.

CONCLUSION

This study highlights the recent knowledge among UAE residents regarding proper medication disposal and its associated risks to the environment, animals, and the pharmaceutical market. Based on our findings, we recommend developing a medical waste management system to collect expired and unused medications from households, ensuring safe and environmentally friendly disposal practices.

AUTHOR'S CONTRIBUTION

All authors shared equally in the conceptualization, methodology, validation, data curation, writing the original draft, approval of the manuscript, and the name's order.

CONFLICTS OF INTEREST

The authors have no interests to disclose

References

1. Kamal KM, Chiumente M, Nakagawa S, Giannetti V, Marlin T. Disposal practices for unused and expired medications: pilot data from three cities in three countries. GMS Health Innov Technol. 2022;16: Doc01. Published 2022 Mar 7. doi:10.3205/hta000133.
2. Bashaar M, Thawani V, Hassali MA, Saleem F. Disposal practices of unused and expired pharmaceuticals among general public in Kabul [published correction appears in BMC Public Health. 2017 Mar 6;17 (1):231]. BMC Public Health. 2017;17(1):45. doi:10.1186/s12889-016-3975-z.
3. Capoor MR, Bhowmik KT. Cytotoxic Drug Dispersal, Cytotoxic Safety, and Cytotoxic Waste Management: Practices and Proposed India-specific Guidelines. Indian J Med Paediatr Oncol. 2017;38(2):190-197. doi: 10.4103/ijmpo.ijmpo_174_16
4. E. M. Smale, T. C. G. Egberts, E. R. Heerdink, B. J. F. van den Bemt, and C. L. Bekker, "Waste-minimising measures to achieve sustainable supply and use of medication," Sustainable Chemistry and Pharmacy, 2021;20.
5. A. Al-Khatib, A.-S. Khalaf, M. I. Al-Sari, and F. Anayah, "Medical waste management at three hospitals in Jenin district, Palestine," Environmental Monitoring and Assessment. 2020; 192(1).
6. Center for Drug Evaluation and Research, Disposal of Unused Medicines: What You Should Know [online]. U.S. Food and Drug Administration . FDA; 2020. Available from: https://www.fda.gov/drugs/safe-disposal-medicines/disposal-unused-medicines-what-you-should-know .
7. Simegn W, Dagnew B, Dagne H. Knowledge, and associated factors towards cytotoxic drug handling among University of Gondar Comprehensive Specialized Hospital health professionals, institutional-based cross-sectional study. Environ Health Prev Med. 3,25(1):11. doi: 10.1186/s12199-020-00850-z.
8. Algethami AA, Alshamrani MA, AlHarbi AM, AlAzmi AA, Khan MA, AlHadidi RA. Evaluation of handling, storage, and disposal practices of oral anticancer medications among cancer patients and their caregivers at home setting in the Princess Noorah Oncology Center. J Oncol Pharm Pract. 2021;27(1):20-25. doi:10.1177/1078155220908937
9. Seehusen DA, Edwards J. Patient practices and beliefs concerning disposal of medications. J Am Board Fam Med 2006;19:542-7.
10. Baryakova TH, Pogostin BH, Langer R, McHugh KJ. Overcoming barriers to patient adherence: the case for developing innovative drug delivery systems. Nat Rev Drug Discov. 2023;22(5):387–409.
11. Kvarnstrom K, Airaksinen M, Liira H. Barriers and facilitators to medication adherence: A qualitative study with general practitioners. BMJ Open. 2018;8(1):6–13.
12. Chan AHY, Cooper V, Lycett H, Horne R. Practical Barriers to Medication Adherence: What Do Current Self- or Observer-

Reported Instruments Assess? Front Pharmacol. 2020;11(May):1–11.
13. Badi S, Abdalla A, Altayeb L, Noma M, Ahmed MH. Adherence to Antidiabetic Medications Among Sudanese Individuals With Type 2 Diabetes Mellitus: A Cross-Sectional Survey. J Patient Exp. 2020;7(2):163–8.
14. Al-Shareef F, El-Asrar SA, Al-Bakr L, Al-Amro M, Alqahtani F, Aleanizy F, et al. Investigating the disposal of expired and unused medication in Riyadh, Saudi Arabia: A cross-sectional study. Int J Clin Pharm 2016;38:822-8.
15. National Institute for Health and Clinical Excellence. Medicines adherence: Involving patients in decisions about prescribed medicines and supporting adherence. NICE Guidel [Internet]. 2009;(January):1–31. Available from: https://www.nice.org.uk/guidance/cg76
16. Insani WN, Qonita NA, Jannah SS, Nuraliyah NM, Supadmi W, Gatera VA, et al. Improper disposal practice of unused and expired pharmaceutical products in Indonesian households. Heliyon. 2020;6(7):6–10.
17. Raund R, Peake BM, Shieffelbien L. Disposal practices for unused medications in New Zealand. Environ Int 2009;35:952-5.
18. Ikeda Y. Importance of patient education on home medical care waste disposal in Japan. Waste Manag 2014;34:1330-4.
19. Richard H. Thaler, Cass R. Sunstein. Nudge: Improving Decisions About Health, Wealth, and Happiness. New Haven & London: Yale University Press; 2008.
20. Myftaraj E, Trebicka B. Analyzing the impact of loyalty card programs on customer behavior: insights from the Albanian market. F1000Research. 2023;12:1028.
21. Woldamicael Bekele D, Dadebo E, Tilahun G, Gebremariam Z. Awareness and Disposal Practices of Medicines among the Community in Hawassa City, Ethiopia. J Toxicol. 2023.
22. Ling JY, Ng PY, Shamsuddin AS, Zulkifli A, Lee KE. Medication Disposal Patterns and Practices with Awareness of Environmental Contamination Caused by Pharmaceuticals among the General Public in Malaysia. Asian Pacific J Cancer Prev. 2024;25(8):2723–34.
23. Egan KL, Wolfson M, Lukacena KM, Zelaya CM, McLeary MS, Helme DW. Developing a health communication campaign for disposal of unused opioid medications. Addict Behav Reports [Internet]. 2020;12(April):100291. Available from: https://doi.org/10.1016/j.abrep.2020.100291.