



A review on status of drug disposal practice of unused and expired drugs among different countries

Aakriti Aryal¹, Paulvarnan Anitha Anuba¹, Gopalan Ramalingam Arun¹, Sundararajan Sarumathy^{1*},
Ramachandran Nanda kumar²

¹Department of Pharmacy Practice, SRM College of Pharmacy, Faculty of Medicine and Health Sciences, SRM Institute of Science and Technology, SRM Nagar, Chengalpattu (DT), Tamil Nadu, Kattankulathur, 603203, India.

²Department of General Medicine, SRM Medical College Hospital And Research Centre, SRM Institute of Science and Technology, Chengalpattu (DT), Tamil Nadu, Kattankulathur, 603203, India.

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ABSTRACT

Medicines are crucial in treating various diseases, but when they are not needed, it is essential to dispose of them correctly. This review aims to study the status of the disposal of unused and expired drugs in different countries. The study objectives included reviewing procedures adopted by the general public for disposing of pharmaceuticals and public awareness about the problem of incorrect disposal methods. The literature search was done from PubMed and Elsevier databases, by entering the keywords “unused medications,” “expired drugs,” and “drug disposal.” Articles were excluded if they did not focus specifically on drug disposal practices. In many nations, disposing of unwanted drugs has become a burden since pharmaceutical waste permeates the ecosystem, posing a severe risk to human and environmental health. As a need of the hour, public education on proper medication disposal is required. Furthermore, the government should promote the reverse distribution practice. Residents are urged to return undesired prescriptions to pharmacies, which are collected and destroyed by approved agents or bodies.

INTRODUCTION

The side effects, dose changes, feeling well, medications approaching their expiration dates, promotional practices by manufacturers, physician prescribing procedures, or dispenser practices have made the consumers (patients) unable to use all the prescribed medications (Ruhoy and Daughton, 2008; Seehusen and Edwards, 2006). Excessive prescriptions by clinicians and poor patient compliance with recommended medicines are the most common causes of unused and expired medications (UEM) in homes (Ekedahl, 2006). It has been discovered that the general public lacks sufficient understanding of how to dispose of unutilized, unneeded, and expired pharmaceuticals (Medhi and Sewal, 2012). Many pharmaceutical contaminants have been found

in groundwaters, surface waters, seawater, soils, and sludges. When home medications are disposed of in the garbage, solid pharmaceuticals end up in landfills, and liquid pharmaceuticals end up in the environment via liquid drainage systems (Bound and Voulvoulis, 2005). Unwanted and expired pharmaceuticals pose a higher risk to people, the environment, and wildlife (Daughton and Ternes, 1999; Vollmer, 2010; Zuccato *et al.*, 2004). The non-steroidal anti-inflammatory drug (NSAID) diclofenac, has been demonstrated to cause renal failure in vultures after they consume carrion from cattle treated with it (Boehringer, 2004). In the United States, various medicines such as acetaminophen, verapamil, and estradiol are detected in rivers due to incorrect disposal of unused and expired drugs (Oaks *et al.*, 2004). Unused drug build-up results in medication waste and ensuing losses of financial resources. Unused pharmaceuticals include drugs, vaccinations, and sera that are no longer needed and need a proper disposal procedure. They also include pharmaceutical goods that have expired, spilled, and been contaminated (Makki *et al.*, 2019). Different parts of the world’s healthcare systems are struggling

*Corresponding Author
S. Sarumathy, SRM College of Pharmacy, SRM
Institute of Science and Technology, Chennai, India.
E-mail: sarumats@srmist.edu.in

financially as a result of drug waste (Davidová *et al.*, 2008). This narrative review concerns the methods adopted by different groups of people from different countries and helps us to implicate proper practices for drug disposal.

METHODS

Search terms and strategies

This is a non-systematic narrative review that examines the knowledge on the concern of drug disposal procedures to provide better public awareness of the problem of incorrect disposal practices. The literature search was done through public databases such as Elsevier, PubMed, and Google Scholar by using the keywords “unused medications,” “expired drugs,” and “drug disposal.” The search strategy included the application of Boolean operators such as “AND,” “OR,” and “NOT,” which can either limit or widen the scope of the search records.

Inclusion and exclusion criteria

Inclusion criteria

Studies that involve questionnaire-based surveys related to drug disposal methods and procedures adopted by the general public for disposing of pharmaceuticals and public awareness of the problem of incorrect disposing of methods were included.

Exclusion criteria

Articles were excluded if they did not focus specifically on drug disposal practices. Articles written in languages other than English, as well as duplicate articles and citations, were also excluded.

At first, 52 articles were found using the above-mentioned search strategy. These articles were screened based on the inclusion and exclusion criteria. Fifteen articles that did not focus on drug disposal practice, 5 articles with language other than English, 7 articles that did not involve survey-based studies, and 8 duplicated articles were removed to bring the total number excluded to 35. The resultant 17 text records were screened for full-text eligibility, these records were found to be published from 2006 to 2018. These 17 records were included in the qualitative synthesis. The selected records involve the qualitative assessment of the set of opinions answered by different groups of people (households, general public, and healthcare professionals) in different countries. These 17 survey-based studies compile the participation of 3,062 general public, 1,034 household participants, 1,389 students, 521 healthcare professionals, and 884 patients. The Preferred Reporting Items for Systematic Review and Meta-Analysis flowchart is formulated for the whole selection process (Fig. 1).

RESULTS

This section deals with the disposal practice of unutilized and expired medicines among different populations. It analyzes the studies conducted among various nations for proper drug disposal management and risk minimization regarding human health, aquatic health, and the environment. The maximum number of articles was explored, and the literature review was done accordingly to study the global practice in drug disposal management. This section discusses people’s knowledge, attitudes,

and methods for disposing of unwanted and expired medications used in households and healthcare institutions (Table 1).

Disposal of unused and expired medicines in the African region

A study was conducted in Ghana about the disposal of unused and expired drugs at home and in hospitals. This study involved a questionnaire-based survey conducted by interview and personal observation. It included five healthcare institutions, and the sample size for the study conducted on the general public involved 83 participants. The outcome of this study conveyed that among the five hospitals involved in the study, one quasi-governmental hospital has implemented a drug disposal program called the Disposal of Unused Medicines Program, and there are no separate drug disposal programs provided by the other hospitals. The general public polled that they admitted keeping unwanted or expired drugs at houses, and more than 75% said that they disposed of medicinal waste in regular trash cans, which ended up in landfills or disposal sites (Sasu *et al.*, 2012).

A cross-sectional survey was conducted among students of the pharmacy department at the University of Jos in Nigeria. This study showed the reasons for having pharmaceuticals in their homes were for emergency usage or comparable illnesses. The survey report emphasized that none of the survey participants returned unused medications to pharmacies. The majority of responses revealed that they threw away unwanted and expired prescriptions in garbage cans or dustbins. About 72.2% of respondents reported that they threw away their unneeded pills in the garbage (Auta *et al.*, 2012).

A survey conducted in Gondar, Ethiopia, regarding the unwanted drug disposal process showed that 89.1% had unused medications of which 57.3% of participants conveyed the reason for having unused drugs was due to a chronic disease condition. Also, the disposal methods preferred by the respondents were to keep the unutilized medications in their homes or throw them into the garbage or flush them into the toilet. The survey results also convey that about 75.3% of participants favored appropriate household World Health Organization (WHO) and U.S. Food and Drug Administration (FDA) drug disposal methods (Atinafu *et al.*, 2015).

In the Tigray Region of Northern Ethiopia, a study about household drug storage and related issues disclosed that 29% of household participants had stored drugs and were not adequately identified. In contrast, according to 36% of respondents, the central place of drug storage was the drawer base cabinet. It also reported that most medications retained at home are not appropriately labeled or stored in a secure location. The presence of health professionals at home and in the residence area (rural versus urban) would help and influence improving household drug storage (Wondimu *et al.*, 2015).

Disposal of unused and expired medicines in Asia

A cross-sectional survey study conducted in Kabul, Afghanistan, aimed to demonstrate the disposal practices of the general public for unused drugs in Kabul. It involved 301 respondents directly interviewed for questionnaires regarding disposal practices among the general public. The study results

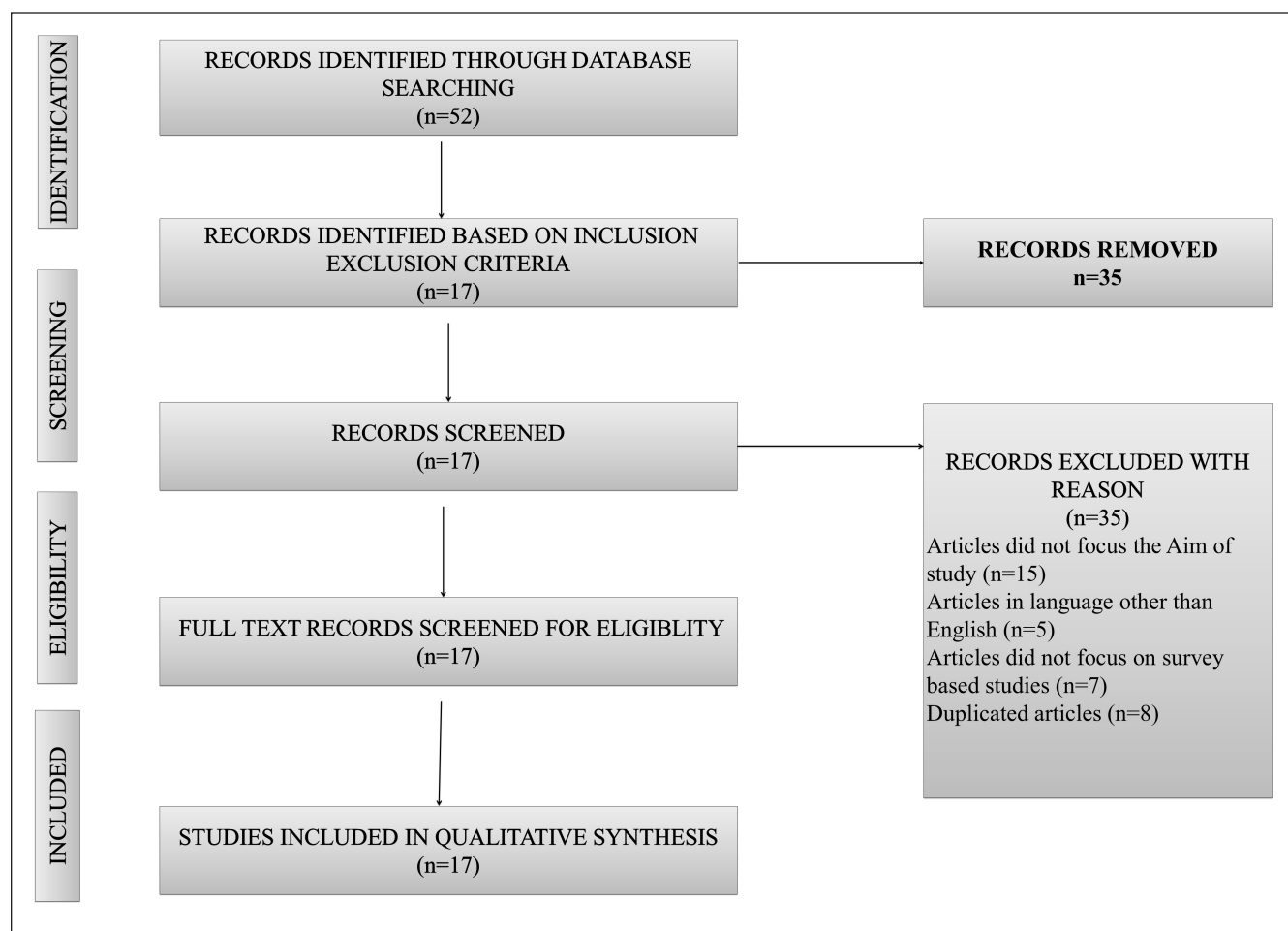


Figure 1. Prisma Flow Chart.

conveyed that about 95.3% kept their medications at home, and 77.7% of participants responded that expired medications were disposed of in trash cans at home. A proportion of participants claimed that the government should be responsible for increasing public awareness about proper medicine disposal. Most respondents agreed that improper management of unoccupied and expired medications might influence human health and the environment (Bashaar *et al.*, 2017).

A cross-sectional survey-based study was conducted with a set of questionnaires among 481 female university students at Universiti Sains Malaysia to assess the presence, perceptions, and behaviors of the female students regarding the storage of medicines and self-medication. The results conveyed that about 93.1% of the total students claimed that they store pharmaceuticals in their rooms, 70.7% stopped using prescription medications without a doctor's consultation, and also self-medication was high among the study population (Ali *et al.*, 2010).

According to a study on the environmental impact of drug disposal practices in Thailand, the most typical disposal method was discarding medicines in a trash bin. It involved the participation of 331 people in the survey with questions about how medications are stored, the storage procedure, and their management of leftover medications. The study showed that

about 89.4% of people retained leftover medications at home and threw away the medicines when no longer needed. Trashing into a garbage bin was the most common practice for disposing of medicine. Disposed drugs were 81.4% of solid dosage form, 64.6% of liquid dosage form, and 66.6% of drugs used for external application. About 7.4% of respondents conveyed that drugs belonging to liquid formulations were disposed of into the drainage system (Arkaravichien *et al.*, 2014).

A cross-sectional survey was performed to ascertain the prevalence, attitude, and behavior toward the storage of medication and self-medication practices among young people in Karnataka, India. Out of 150 respondents, 84.62% kept medications in their rooms. Self-medication was observed in 88.6% of people. The reasons for self-medication were a lack of knowledge about the disease condition and its treatment, the desire to save time, and the prescriber's ineffective medications (Sharma *et al.*, 2012).

An observational, prospective self-administered cross-sectional study with a sample size of 372 participants was conducted to study the storage and disposal practice of medicines at home among pharmacy, nursing, and arts and science students in Gandhinagar, India. The survey was conducted in pre- and post-education sessions using a predefined questionnaire. According to the findings of this study, respondents threw their

Table 1. Medication disposal practice in different countries.

Reference	Study design/sample size	Region	Findings
African region			
Sasu <i>et al.</i> (2012)	Questionnaire-based survey N = 5 healthcare institutions N = 83 general public	Ghana, Africa	More than half of the participants polled keep unwanted or expired drugs at home, and more than 75% disposed of unused medications in regular trash cans, which ended up in landfills or disposal sites.
Auta <i>et al.</i> (2012)	Cross-sectional study N = 240 pharmacy students	Nigeria, Africa	None of the survey participants made a point of returning unused medications to pharmacies. The majority of respondents said they throw away unwanted and expired prescriptions in trash cans or dustbins.
Atinafu <i>et al.</i> (2015)	Cross-sectional study N = 384 patients	Ethiopia, Africa	This survey emphasizes that the majority of the participants preferred disposal methods such as throwing into the trash and flushing into the toilet. About 75.3% of participants implemented appropriate household FDA and WHO disposal methods.
Wondimu <i>et al.</i> (2015)	Cross-sectional study N = 1,034 household participants	Ethiopia, Africa	This study aims at investigating factors linked with the storage of medicines at home and it reported that the majority of medications kept at home were not properly labeled or stored in a secure location. The presence of health professionals in the household favored proper disposal methods.
Asian countries			
Bashaar <i>et al.</i> (2017)	Cross-sectional study N = 301	Kabul	The results of the study conveyed that majority of about 95.3% kept their medications at home and expired medications were discarded in household trash by 77.7% of respondents. Almost the entire sample (98%) agreed that improper disposal of UEM can harm the environment and human health.
Ali <i>et al.</i> (2010)	Cross-sectional study N = 481	Malaysia	The results conveyed that about 93.1% (n = 448) of the 481 students claimed they stored pharmaceuticals in their rooms, while 70.7% (n = 340) said they stopped using prescription medications without seeing a doctor.
Arkaravichien <i>et al.</i> (2014)	Survey study N = 331	Thailand	According to the study, 89.4% of people kept drugs in their homes. The study found that the leftover medicines were trashed into garbage bins when they were no longer needed. Trashing into a garbage can was the most common method of disposal. In addition, liquid dosage forms were disposed of into the drainage system.
Sharma <i>et al.</i> (2012)	Pre-cross-sectional survey N = 150	Karnataka, India	This survey reported that the most common reasons for self-medication were respondents' lack of knowledge about the illness and its treatment, the desire to save time, and the prescriber's ineffective medications.
Pankajkumar <i>et al.</i> (2016)	Observational, prospective self-administered cross-sectional study N = 372	Gujarat, India	According to the findings of this study, respondents threw their unwanted or expired medications in the trash cans and concluded that students' knowledge of home storage and disposal was insufficient. Drug-use assessments are required to raise awareness about safe and proper drug storage and disposal methods.
Labu and Harun-or-Rashid (2016)	Questionnaire survey N = 310	Bangladesh	The study was conducted among 310 pharmacy students, 290 students completed the survey, and liquid medical waste was reported to be disposed of in residential water systems via the sink and toilet by 58% of the participants. Almost 73% of them said that the solid dose form was thrown away in the trash.
Middle East countries			
Bungau <i>et al.</i> (2018)	Questionnaire survey N = 521	Romania	Of the surveyed pharmacists, 16% work in pharmacies that do not collect unused/expired drugs from the public, and nearly 33% have refused to take unused medicines from the public at least once. According to the findings, pharmacies in Romania have several deficiencies in pharmaceutical waste collection services.

Continued

Reference	Study design/sample size	Region	Findings
Developed countries			
Vatovec <i>et al.</i> (2017)	Questionnaire survey N = 358	USA	This survey examined the disposal behavior of students regarding pharmaceuticals and the findings convey that 18% of students have disposed of the drugs. Disposal of drugs via municipal trash was 25% and 1% via flushing. The survey indicates that the students are storing large amounts of unused drugs at home.
Vellinga <i>et al.</i> (2014)	Questionnaire survey N = 398	Ireland	Findings of this survey reveal that the most common reason for storing unused medications was "in case they are needed later." The sewage system and general waste disposal were both environmentally unsound methods of disposal.
Kozak <i>et al.</i> (2016)	Questionnaire survey N = 200	Indiana	The findings from a survey conducted among 15 community pharmacies in Indiana conveyed that, to return UEM, 77% of patients were willing to drive to a take-back location, and only vulnerable populations lacked knowledge about UEM and access to proper disposal.
Coma <i>et al.</i> (2008)	Questionnaire survey N = 227	Spain	This study emphasizes the significance of analyzing the return of unwanted medicines in order to reduce unnecessary health expenditures. It also highlights the shortcomings of the Spanish healthcare system in terms of prescription, dispensing, and medication use. It is necessary to develop strategies to reduce the waste of unused medicines.
Arabian countries			
Abahussain <i>et al.</i> (2006)	Questionnaire survey N = 300	Kuwait	This survey aimed at determining Kuwaiti patients' attitudes and practices about the safe disposal of unused medicines, the most prevalent methods of disposal were throwing unwanted medicines in the bin (76.5%) or flushing them (11.2%).
Al-Shareef <i>et al.</i> (2016)	Cross-sectional survey N = 1,200	Saudi Arabia	The results of this survey emphasize that a significant proportion of respondents (79.15%) disposed of unwanted medication through household waste, while a small proportion (1.70%) returned unwanted medication to a pharmacy.

unwanted or expired medications in the trash bins. The study also concluded that students' knowledge of drug storage and disposal was insufficient and drug-use assessments were required to raise awareness about drug storage and disposal methods (Pankajkumar *et al.*, 2016).

According to research conducted in Bangladesh to assess safe disposal practices, 36.3% of the 290 students surveyed were aware of the term "medication trash." The majority of participants reported that drugs belonging to liquid and solid dosage forms were disposed of and ended up in a landfill. About 73% of them said that solid dosage form is disposed of in landfills. According to the findings of this survey, there seems to be an urgent need to raise public awareness and develop dispensing guidelines that reduce the volume of medication waste (Labu and Harun-or-Rashid, 2016).

Disposal of drugs in Middle East countries

A survey of Romanian pharmacists about unused and expired medicines analyzed the factors that may affect the efficiency of pharmacies in collecting and disposing of the medications used by the population. This survey included 521 pharmacists of which 16% of them worked in pharmacies that did not allow the process of collecting unutilized or expired drugs from the community, and 33% of pharmacies refused to take unutilized medicines from the general public at least once. The most common reasons given by pharmacists for refusing to collect back the unutilized medications

included the lack of procedure, insufficient legislation, exceeding the amount contracted with the operators, and high costs. As per the findings, pharmacies operating in Romania had many drawbacks regarding pharmaceutical waste collection services (Bungau *et al.*, 2018).

Disposal of drugs in developed countries

According to a survey conducted at the University of Vermont to investigate the buying, usage, and disposal procedures among youths, the findings conveyed that 94% of the students had bought medicines in the early 12 months, 61% had 10 drugs leftover, and 18% of students had disposed of the drugs. The most common method of drug disposal was municipal trash (25%) and flushing (1%). Only 4% of the students used the drug take-back service and only 24% were conscious of drug take-back programs (Vatovec *et al.*, 2017).

A questionnaire survey was completed by 398 randomly selected people in Ireland to analyze baseline knowledge on medicine storage and disposal among the general public. About 88% of respondents reported that they retain unutilized medications at home, and the common reason conveyed by 68% of respondents for storing unutilized medications was to keep them for later use. The sewage system and general waste disposal used by the study respondents were both environmentally unsound methods. Surprisingly, 75% of people who had received advice on

proper disposal practices from a healthcare professional disposed of their medicine correctly (Vellinga *et al.*, 2014).

Issues on UEM were carried out among 200 patients drawn from 15 different community pharmacies in Indiana that were part of a practice-based research network. Although 40% of patients were conscious of the UEM take-back location in their community, only 15% adhered to it. About 77% of patients were willing to adapt to a take-back location to return UEM. It was noted that the vulnerable populations lacked knowledge about UEM and access to proper disposal (Kozak *et al.*, 2016).

A questionnaire survey was carried out in community pharmacies in Barcelona, Spain, to investigate the number of unutilized drugs and their cost to the public health system. According to the findings, approximately 52.4% handed back their prescription in person, while 32.2% handed back by their relative. The reason behind returning medications was the expiry date. About 24.9% of patients conveyed that the drugs were no longer required as their health conditions improved. This study emphasized the significance of returning unutilized medicines that would reduce unnecessary health expenditure. It also marked the shortcomings of the Spanish healthcare system in terms of prescription, dispensing procedures, and the use of medications. It is necessary to develop strategies to minimize the waste of unused medicines (Coma *et al.*, 2008).

Unused and expired drugs in Arabian countries

A questionnaire survey was conducted on 300 Kuwaiti patients to assess their attitudes and practices regarding the safe disposal of unutilized and unneeded medications. Almost half of the respondents obtained prescription medicines, and nearly all had unutilized and unnecessary medication at their homes. The most common reasons for having unutilized medications were found to be a change of prescription drugs by the physician and self-discontinuation. The standard disposal method adopted by the majority of respondents was throwing unutilized medicines in the garbage cans or flushing them into the toilet. About 54% of patients polled for the procedure, which included transporting drugs to pharmacies for safe disposal and beneficial effect (Abahussain *et al.*, 2006).

A cross-sectional study investigated participants' attitudes toward disposing of unutilized and expired medications conducted in Riyadh, Saudi Arabia. About 1,200 patients were randomly chosen from King Khalid University Hospital and King Saud University. Participants were asked to fill out a paper-based questionnaire that included self-enumeration. A significant proportion of respondents disposed of unutilized medications through household waste, while a small proportion of about 1.7% returned those medications to a pharmacy (Al-Shareef *et al.*, 2016).

DISCUSSION

This narrative review elaborates on the public knowledge of drug disposal practices. All survey-based studies regarding the drug disposal practice were identified through the above-mentioned search strategy. The results of the survey illustrated the opinion of different groups of people from different countries. The principle region involves the African region, Asian countries, Middle East countries, developed

countries, and Arabian countries. The survey records involve the participation of the population such as healthcare professionals, general public, pharmacy students, household participants, and patients. The practice of disposing of medications in trash cans, garbage, or flushing medications into the toilet was found to be the major improper drug disposal method reported by the participants involved in the survey and was mostly adopted by the general public. Some developed countries adopted the FDA or WHO procedures for drug disposal. The well-known proper drug disposal practice is "Drug Take Back Programs." Prescription drug take-back programs offer a mechanism for consumers to safely and legally return unused drugs to the proper authorities (Barlas, 2009). Healthcare professionals and healthcare institutions are mostly aware of this policy. However, there are no measures for disposing of medications from each residence, and proper disposal is not widely known. Therefore, in order to address the problems brought on by inappropriate drug disposal, a robust awareness campaign is urgently required. Lack of correct awareness has led to bias in medicine disposal practices, therefore there is an urgent need to educate the public on how to properly dispose of unneeded and expired drugs at home and in hospitals (Drug Disposal: Drug Take Back Locations|FDA Available at: <https://www.fda.gov/drugs/disposal-unused-medicines-what-you-should-know/drug-disposal-drug-take-back-locations>). Additionally, for effective pharmaceutical waste management, a national policy, legal framework, and staff training are necessary.

Medication wastage and improper drug disposal practices

The use of pharmaceuticals has grown significantly over the world. Unused pharmaceutical goods should not be stored or disposed of improperly because they could have negative effects. Improperly handled medications may present a chance for abuse and unintentional poisoning, both of which pose major health risks (Makki *et al.*, 2019). Additionally, it was discovered that several nations had a significant prevalence of unutilized drugs. The majority of people simply throw away their unused prescriptions in the garbage or toilet, and NSAID were most common among them (Gracia-Vásquez *et al.*, 2014). The incorrect disposal of unused pharmaceuticals can have detrimental effects on the economy and the environment. This can be due to a lack of return procedures for unwanted medications, and in some countries, public ignorance, negligence, or illiteracy remains to be a major cause for incorrect drug disposal practices (Makki *et al.*, 2019).

Safety disposal of unused drugs or prescriptions

Medicine take-back programs are the most secure way to dispose of unused or expired prescription and non-prescription (over-the-counter) medications (Where and How to Dispose of Unused Medicines|FDA Available at: <https://www.fda.gov/consumers/consumer-updates/where-and-how-dispose-unused-medicines>). Some facilities and businesses are registered with the United States Drug Enforcement Administration (DEA) to collect unused or expired medications. These collection stations collect and dispose of your unused or expired medicines, including those containing prohibited

substances, in a safe and secure manner (Drug Disposal: Drug Take Back Locations | FDA Available at: <https://www.fda.gov/drugs/disposal-unused-medicines-what-you-should-know/drug-disposal-drug-take-back-locations>). The DEA holds National Prescription Drug Take Back activities on a regular basis. Temporary drug collection locations are put up in communities across the country during these drug take-back days to ensure the safe disposal of prescription medicines. It is necessary to adhere to the disposal instructions provided by healthcare professionals (e.g., doctors and pharmacists) for the specific unused or expired medications prescribed by them. Identifying a drug take-back location is the right approach for drug disposal. It can be found in pharmacies, whether they are retail and hospital, clinic, or law enforcement centers.

IMPLICATIONS

As a need of the hour, public education on proper medication disposal is required. Furthermore, the government should promote the reverse distribution practice. Residents are urged to return undesired prescriptions to pharmacies, which are then collected and destroyed by approved agents or bodies.

CONCLUSION

In many nations, disposing of unwanted drugs has been a source of concern, as pharmaceutical waste permeates the ecosystem, impacting human health and the environment. As a necessity, public education on proper medication disposal is required. Furthermore, the government should promote the reverse distribution network. Residents have to be educated about returning undesired prescriptions to pharmacies, subsequently adopting a procedure for the medications to be collected and destroyed by approved agents or bodies.

LIMITATIONS

This review potentiates certain limitations as it compiles a literature search of articles only in the English language. This review involves survey-based studies and there was no segregation of national and international literature. This review mainly concerns the knowledge of different groups of people in different regions regarding drug disposal practices.

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AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

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