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Assessment on disposal practices of unused and expired medications

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ABSTRACT

Pharmaceutical disposal practices have become a global issue that has caught the concern of health authorities, pharmaceutical firms, healthcare practitioners, and the general public. The current study aimed to assess the disposal practices of unused and expired medications among the households Namakkal district, Tamil Nadu, India. The qualitative, cross-sectional study was conducted using a well-structured questionnaire form. A total of 400 responses were obtained from each member of the family. Participants under the age of 18 were excluded from the study. Respondents who refused to participate were not included in the study. More than 50% of the study population reported that they stored unused and expired medications at home. Most of the participants revealed that the unused medications they stored costs approximately ≤₹300. Majority of participants dispose unused/expired medications by means of trash can (53.1%). A significant population (71.2%) was unaware of novel disposal practices like drug take-back system. The study concluded that there is an inappropriate disposal practice among households which has to be rectified by providing awareness among the public. Further studies should be conducted for the development of well formalized protocol regardingproper disposal practices.

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1. INTRODUCTION

Pharmaceutical products have been in great demand in recent years. However, improper disposal of unwanted medications leads to the piling up of medication waste. The World Health Organization (WHO) defines medication waste as unwanted medications which include expired, unused, spilt and contaminated pharmaceutical products, drugs, vaccines and sera that are no longer required and need to be disposed of appropriately [1]. As per recent data, worldwide prescription and over-the-counter drug use has surged and is anticipated to reach 4.5 trillion doses by 2020, rising 24% from 2015 [2]. Also, statistics claim that 5 million people (including 4 million children) have to suffer death due to waste-related problems every year. Improper disposal practices pose a risk to public health; it can also affect a country's economy [3].

In the United States of America, it was recorded that every 2 out of 3 prescription drugs were stored as unused, with a total estimated cost ranging from 59,264.20 USD to 152,014.89 USD [4]. Similar pharmacoeconomic studies based on unused and expired medications are lacking in India. Piling of medications may be due to non-compliance, lack of knowledge, medication discontinuation due to changes in dose, drug expiration, forgetfulness, improved health condition and death [5]. Unused medications are commonly disposed in trash cans, sinks, flushed in toilets or burned. However, these methods are not advisable as they may negatively impact human health and the environment [6].

Pharmaceuticals and their metabolites end up in landfills and the sea via garbage and sewage canals [7]. Sometimes expired drugs can be misused by scroungers or children if the dumping ground is not secure. Also, these drugs may be used for illegal marketing and resale purposes [8]. Most expired medications are found to lose their efficacy, and this may result in various adverse effects [9]. Recent studies conductedby the researchers from Doon University, Dehra Dun, have reported the accumulation of 15 categories of pharmaceutical and hygiene products in the Ganges River near two pilgrimages cities. Many countries recognize over the counter (OTC) medicines as a separate category and have established regulations for these medicines. However, India has no proper guidelines for licensing over the counter medicines [10]. This leads to the piling up of unused and expired medications and the exploitation of drugs. According to WHO, incineration is the most environmentally friendly method of disposing of pharmaceutical waste, and it is only possible if the pharmaceuticals are returned to the pharmacy [11]. A drug take-back programme is an effective strategy to address this issue. Unfortunately, due to financial constraints, this has not yet begun or become effective in many world regions. Hence, there is an urgent need to create awareness among the Indian population regarding safe disposal practices. Therefore, the study aimed to assess the disposal practices of unusedand expired medications among the households in Namakkal district, Tamil Nadu.

2. RESEARCH METHOD

A community-based cross-sectional study was conducted in Namakkal District, Tamil Nadu, India, from April to September 2020. The study focused on rural households as similar studies were not conducted previously. The responses were obtained from each member of the family. Respondents >18 years and not willing to participate in the study were excluded from the study. The minimum samplesize was 375 and it was calculated using Rao soft sample size calculator with population size 15,270 (households) approximately, the margin of error 5% and confidence level 95%. Institutional ethics committee permission was taken before the beginning of the study. Data were collected through direct interviews using a structured questionnaire which was prepared on the context of previous research articles and validated. The questionnaire comprised three sections; the first section included socio-demographic data (name, age and marital status), 2nd section consisted of 21 questions regarding disease and medications procured, while the third section had 20 questions to assess the disposal practices unused and expired medications.

3. RESULTS AND DISCUSSION

The proper management and disposal of medical waste is currently a debatable issue. It has been proven that inappropriate disposal can contaminate the environment, posing serious hazards to water, air, agriculture, the food chain, and even animals. Because of the negative consequences of improperly dumped pharmaceuticals, research is being performed worldwide to develop a policy for correct disposal [11], [12]. In a recent report published in United States, it was estimated that around $213 billion was wasted in 2012 on prescribed medications [13]. These medications have been discarded into the environment, which may deteriorate both environment and people's health. Combustion of pharmaceutical products poses a threat to the environment. This may release toxic substances into the atmosphere, causing environmental pollution, which may indirectly cause resistance to drugs in microbes [14]. Additionally, excess amounts of antiseptics should not be disposed into waterways as it may cause sterility in female fishes due to phytoestrogen chemicals including infertility drugs. Medications like narcotic painkillers and sleeping pills that are found in landfills can be exploited [15]. As a result, many developed countries have introduced legislation for the safe disposal of unused and expired pharmaceuticals to address this challenge [16]. For instance, Australia and Canada's government and pharmaceutical industries have implemented the national return and disposal of unwanted medicines project. A drug take-back programme is an effective strategy to address this issue. Red disposal bags must be offered to consumers in a drug take-back programme for disposing of unneeded pharmaceuticals; these pharmaceuticals must be delivered to or collected by nearby pharmacies. This service must be offered free of charge [17]. Table 1 describes respondent's socio-demographic characteristics and reveals that majority of them were males, 273 (70.3%). 166 (41.9%) belong to 25- 40 years of age which indicates that most of participants were middle aged.

Our study noted that 108 (58%) participants stored unused medications at their homes as represented in Table 2. In a study conducted by A Tong *et al.* (13), out of 452 participants, 62% of respondents stored unwanted medications in their house. The underlying reason could be the lack of implementation of awareness by the governmental officials, doctors, and paramedical staff to create awareness about the use of unusedand expired medications stored at home [12].

Table 1. Socio-demographic details of the respondents (n=400)

Characteristics	n (%)
Sex	
Male	273 (70.3%)
Female	127 (29.7%)
Age	
18-25 years	128 (31.4%)
25-40 years	166 (41.9%)
40-60 years	101 (25.3%)
Above 60 years	5 (1.4%)
Educational status	
Primary	20 (2.8%)
High school	41 (10.8%)
Degree	248 (63.6%)
Post graduate	91 (22.5%)

Table 2. Respondent's practices of disposing of unused/expired medications

Categories		n (%)
Do you have any unused medicationsat home presently?	Yes	237 (57.5%)
	No	163 (42.5%)
Do you have any expired medicationsat home presently?	Yes	280 (70%)
	No	120 (30%)
Approximate cost of unusedmedications	Below Rs.300	170 (53.9%)
	Rs.300-500	103 (31.3%)
	Rs.500-800	24 (8.1%)
	Above Rs.800	20 (6.7%)
Dosage form	Tablets	199 (44.6%)
	Capsules	61 (15.9%)
	Injections	10 (2.2%)
	Creams/Ointments	81 (21.7%)
	Syrup/Suspensions	49 (15.5%)
Why do you keep medicines at home?	For later use	195 (48.7%)
	I don't keep them	81 (20.2%)
	Not sure how to dispose them	58 (14.5%)
	Others	34 (8.5%)
	I don't want to waste them	32 (8%)
Reason for the discontinuation ofmedications	Doctor advised me to discontinue	126 (31.5%)
	Self-discontinuation	66 (16.3%)
	It caused side effects	24 (6.2%)
	Change of treatment regimen	52 (13.2%)
	Condition got improved	132 (32.9%)
Do you know the consequences of storing expired/unused medications?	Yes	275 (70.8%)
	No	125 (29.2%)

In our study, 219 (44.6%) participants stored tablets as a common dosage form at their homes. 107 (21.7%) and 81 (15.9%) of respondents kept cream and capsules. while only 10% of respondents stored injection as unused medication as given in Table 2. A similar study was conducted by Samuel [17] and concluded that 64% ofrespondents had tablets as unused medications at their homes. Procuring medicines at home for longer durations may lead to many consequences such as adverse reaction, health hazards, medicine resistance, patient lack of compliance, and overall lowers population quality healthcare and increases death rates, as well as excessive pharmaceutical expenditure and waste of financial resources by both patients and the healthcare system [18]. According to our study, 170 (53.9%) participants stored an approximate cost of below Rs.300 of unused and expired medications at their homes. The total cost of unused medications collected during study period was > ₹60000 as shown in Table 2. Similar studies were conducted by Schuh and Hewuse [19], in which they have concluded that the total cost of > $63,000 worth unused medications were found in people's homes between the period December 2012 to April 2013. This could negatively impact a country's economic status, especially for a developing country like India, the economic needs are crucial for those living in rural areas. According to our study, 48.7% of respondents keep unused medications at home for lateruse, 20.2% of respondents don't keep them 14.5% of respondents are not sure how to dispose of them as shown in Table 2. A similarstudy was conducted by Azad *et al.* [20] where they found that most participants are not sure how to dispose of them. As a result, they suggest that this matter should be essential to develop public awareness regarding disposal practices through the campaigns.

In our study, respondents were asked about the reason for their discontinuation of medications, it was found that around 132 (32.9%) of participants stated that their condition got improved, 126 (31.5%) said that doctor advised them to discontinue, 66 (16.3%) participants self-discontinued medicines, while 52

(13.2%) had a change in their treatment regimen and 24 (6.2%) respondents discontinued because medications caused side effects as presented in Table 2. This was similar to the study conducted by Sivasankaran *et al.* [21] their study, they found that the grounds for storing unwanted and expired medicines at home were (39.2%)further usage, (22.8%) drug expiry and (20.3%) non-compliance and modified therapy (5.9%). The lodgment of unused and expired medicines results from non-compliance to the recommendations. In our study, the majority of respondents 212 (53.1%) threw the unused medications into the trash, and 77 (18.6%) of respondents burned them, 97 (24.2%) disposed of by other means, 8 (2.2%) disposed of medications in the sink and 7 (1.1%) participants disposed of unused medicines in the toilet as shown in Figure 1. A similar study was conducted by Gupta *et al.* [22] and concluded that 57.1% of respondents choose trash cans as disposal methods of unused medication. According to one study, conducted in Korea, housewives disposed of expired and unused medicines in standard garbage bags [23].

Dropping off expired and unused drugs at a medical take-back facility or organization is the right way to dispose of them [24]. If this is not practicable, flush the medicines as fast as possible down the toilet or sink; this is the correct approach for liquid medications [25]. If the pills aren't unsafe, they can be thrown in the trash. Expired medicines should be combined with anything indigestible like sand or used compost [26]. Place the solution in a jar such as a sealed plastic bag and throw it in the household garbage after erasing all private information from the label of the empty medication box or pill bottles [27].

Our study observed that the majority of the participants did not receive appropriate education on safe disposal practices. Hence, it is the medical team's primary duty, especially the pharmacists, to equip and enlighten the public regarding proper disposal of expired and unwanted medications. From our study, most of the respondents disposed via unsafe methods. The most preferred method of disposing of unused medications is by incinerating at high temperature. However, this can be put to practice only when the unused and expired medications are returned back to the pharmacies [28].

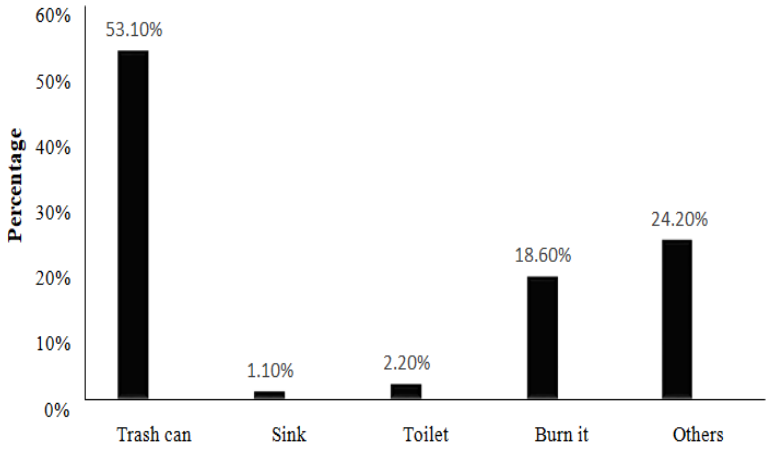

Figure 1. Disposal methods

Table 3 describes respondent's opinions on disposal practices. The majority of the 30% (120) participants stored expired medications at their homes. A similar study was conducted by Shivaraju and Gangadhar [29] in which the majority of the respondents stored expired medications at home. Recently a similar study was conducted in Saudi Arabia by Wajid *et al.* [30] related to the prevalence of unused medication, which shows that most of the respondents store unused medications till expiry. In our study, the majority of participants, 70.8% (275) were aware of the consequences of keeping unused/expired medications; still, most of them stored unused/expired medications at home. In a study conducted by Gupta *et al.* [22] most participants mentioned that they did not know the consequence of storing unused/expired medications. In a similar study conducted by Monga *et al.* [28] majority of the participants knew the consequences of storing unused and expired medications at homes due to lack of awareness regarding disposal guidelines, they continued following such unsafe methods. These expired drugs may break down to form hazardous compounds and have inappropriate therapeutic outcomes. When expired drugs are disposed of in septic tanks, it can lead to antibiotic resistance in microbes, Michael *et al.* [31]. It may also be noted that on keeping drugs at homes for a longer duration, there is a chance of neglecting proper storage conditions, as a result the lose their efficacy and may not give the beneficial therapeutic response. In our

study, 85.5% (307) of respondents would like to implement the drug take back system, but most of the respondents are unaware of this policy. The results of our study correlatedwith a similar study conducted by Ayele and Mamu [32] in terms of drug take back programs, majority of the participants (46.8%) strongly agreed for the implementation of drug take back system. The "Nebraska Medication Education Disposal Strategies (MEDS) program" advises that pharmacies install tamper-proof containers so that consumers can send off their unused and expired medications to pharmacists, Persson *et al.* [33]. In our study, the majority of the respondentssuggested that the unused medicines should be returned to the pharmacy 140 (36.6%), some of them said thatspecial force should be assigned to collect the unused medicines from home 109 (27.9%), while few were interested to keep special collection box in their village or town 106 (27%), minority participants didn't have any suggestion 40 (8.5%). Similar study was conducted by Raja *et al.* [34] in which majority of the participants 341 (87%) suggested that leftover medications should be disposed via drug take back system. However, in India, there is no evidence of provision for collecting drugs from homes and lack of awareness remains an unseen issue. In our study, 53% (212) of participants mentioned that the government is liable for providing public awareness regarding safe disposal practices, while 25.1% (100) of participants polled for pharmacists. A similar study was conducted in Kabul by Bashaar *et al.* [12]. The result correlated to our study as six out of ten respondents strongly stated that awareness campaigns organized by the government concerning disposal practices have to be awareness campaigns. In another study by Manocha *et al.* [35] majority of the participants (100%) insisted that there is an urgent need for awareness regarding the hazards of unsafe disposal and proper disposal practices. Relating both studies, it is evident that there has to be a well-formalized protocol for unused medication disposal and the urgent need to create awareness among the public to save both environment and human health from possible consequences in the future [36]. The limitations of the study were: The sample size calculated was less, the study population was selected from residents of Namakkal district and not from other regions.

Table 3. Respondent's opinion on disposal practices

Categories		n (%)
Where do you gather information about your medications?	Doctors	306 (80.6%)
	Nurses	22 (3.3%)
	Pharmacists	50 (11.1%)
	Others	22 (5%)
According to your opinion, who is more responsible for creating awareness about proper disposal practices?	Government	212 (53%)
	Nurses	33 (8.4%)
	Pharmacist	100 (25.1%)
	Physician	55 (13.5%)
Have you heard about drug take back system?	No	285 (71.2%)
	Yes	115 (28.7%)
Are you willing to follow drug take back system	Yes	313 (78.2%)
	No	87 (21.7%)
What is your suggestion about proper disposal of unused/expired medicines?	Assign special force	109 (27.9%)
	Return to pharmacy	145 (36.6%)
	Keep a special collection box	106 (27%)
	I do not have any suggestion	40 (8.5%)

4. CONCLUSION

The study revealed that most of the participants had a practice of piling up expired/unused medications. This was due to the lack of awareness about safe disposal practices. We also found that the piling up of unused/expired medication impacts pharmacoeconomics. At the end of our study, the residents were willing to follow novel approaches to proper disposal practices. The majority of them opted for the drug take-back system. Unfortunately, in India, Drug take-back programme are not functional, and other methods such as mail drop and medicine dropbox are also not efficient. Further studies should be conducted for the regulation of proper disposal guidelines.

REFERENCES

[1] S. Vogler, C. Leopold, C. Zuidberg, and C. Habl, "Medicines discarded in household garbage: analysis of a pharmaceutical waste sample in Vienna," *Journal of Pharmaceutical Policy and Practice*, vol. 7, no. 1, Dec. 2014, doi: 10.1186/2052-3211-7-6.
[2] M. Aitken and M. Kleinrock, *Global medicines use in 2020: outlook and implications informatics: IMS institute for healthcare*. NJ, USA: Parsippany, 2015.
[3] Q. M. A. Abdallah *et al.*, "Knowledge, attitude and practice towards discarding unwanted household medicines among univerisity students in Western Region, KSA," *International Journal of Pharmacy*, vol. 4, no. 4, 2014.
[4] A. V. Law *et al.*, "Taking stock of medication wastage: Unused medications in US households," *Research in Social and Administrative Pharmacy*, vol. 11, no. 4, pp. 571–578, Jul. 2015, doi: 10.1016/j.sapharm.2014.10.003.
[5] S. L. Gracia-Vásquez *et al.*, "An analysis of unused and expired medications in Mexican households," *International Journal of*

Clinical Pharmacy, vol. 37, no. 1, pp. 121–126, Feb. 2015, doi: 10.1007/s11096-014-0048-1.
[6] C. G. Daughton and I. S. Ruhoy, "Green pharmacy and pharmEcovigilance: prescribing and the planet," *Expert Review of Clinical Pharmacology*, vol. 4, no. 2, pp. 211–232, Mar. 2011, doi: 10.1586/ecp.11.6.
[7] A. K. Azad, M. Hossain, M. K. Rahman, Robuiul, M. M. Abdullahi, and M. A. Islam, "Medication wastage and its impact on environment: Evidence from Malaysia," *Pharmacologyonline*, vol. 3, 2016.
[8] S. Sasu, K. Kümmerer, and M. Kranert, "Assessment of pharmaceutical waste management at selected hospitals and homes in Ghana," *Waste Management & Research: The Journal for a Sustainable Circular Economy*, vol. 30, no. 6, pp. 625–630, Jun. 2012, doi: 10.1177/0734242X11423286.
[9] M. Makki, M. A. Hassali, A. Awaisu, and F. Hashmi, "The prevalence of unused medications in homes," *Pharmacy*, vol. 7, no. 2, p. 61, Jun. 2019, doi: 10.3390/pharmacy7020061.
[10] P. Marathe, S. Kamat, R. Tripathi, S. Raut, and N. Khatri, "Over-the-counter medicines: Global perspective and Indian scenario," *Journal of Postgraduate Medicine*, vol. 66, no. 1, p. 28, 2020, doi: 10.4103/jpgm.JPGM_381_19.
[11] T. G. Bean *et al.*, "Evaluation of a novel approach for reducing emissions of pharmaceuticals to the environment," *Environmental Management*, vol. 58, no. 4, pp. 707–720, Oct. 2016, doi: 10.1007/s00267-016-0728-9.
[12] M. Bashaar, V. Thawani, M. A. Hassali, and F. Saleem, "Erratum to: Disposal practices of unused and expired pharmaceuticals among general public in Kabul," *BMC Public Health*, vol. 17, no. 1, p. 231, Dec. 2017, doi: 10.1186/s12889-017-4139-5.
[13] A. Tong, B. Peake, and R. Braund, "Disposal practices for unused medications in New Zealand community pharmacies," *Journal of Primary Health Care*, vol. 3, no. 3, p. 197, 2011, doi: 10.1071/HC11197.
[14] B. Hazell and R. Robson, "Pharmaceutical waste reduction in the NHS." 2015, [Online]. Available: https://www.england.nhs.uk/wp-content/uploads/2015/06/pharmaceutical-waste-reduction.pdf.
[15] P. J. Bergen, S. Y. Hussainy, J. George, D. C. Kong, and C. M. Kirkpatrick, "Safe disposal of prescribed medicines," *Australian Prescriber*, vol. 38, no. 3, pp. 90–92, Jun. 2015, doi: 10.18773/austprescr.2015.031.
[16] J. P. Laurenson, R. A. Bloom, S. Page, and N. Sadrieh, "Ethinyl estradiol and other human pharmaceutical estrogens in the aquatic environment: A review of recent risk assessment data," *The AAPS Journal*, vol. 16, no. 2, pp. 299–310, Mar. 2014, doi: 10.1208/s12248-014-9561-3.
[17] S. B. Banwat, A. Auta, D. W. Dayom, and Z. Buba, "Assessment of the storage and disposal of medicines in some homes in Jos north local government area of Plateau State, Nigeria," *Tropical Journal of Pharmaceutical Research*, vol. 15, no. 5, p. 989, May 2016, doi: 10.4314/tjpr.v15i5.13.
[18] L. M. Bexfield, P. L. Toccalino, K. Belitz, W. T. Foreman, and E. T. Furlong, "Hormones and pharmaceuticals in groundwater used as a source of drinking water across the United States," *Environmental Science & Technology*, vol. 53, no. 6, pp. 2950–2960, Mar. 2019, doi: 10.1021/acs.est.8b05592.
[19] J. L. Schuh and A. J. Hewuse, "The cost of unused medications," *Federal Practitioner*, vol. 32, no. 4, pp. 14–18, 2015.
[20] M. A. K. Azad, "Disposal practice for unused medications among the students of the international islamic university Malaysia," *Journal of Applied Pharmaceutical Science*, vol. 2, no. 7, Jul. 2012, doi: 10.7324/JAPS.2012.2712.
[21] P. Sivasankaran, E. B. Mohammed, N. Ganesan, and R. Durai, "Storage and safe disposal of unwanted/unused and expired medicines: a descriptive cross-sectional survey among indian rural population," *Journal of Young Pharmacists*, vol. 11, no. 1, pp. 97–100, Jan. 2018, doi: 10.5530/jyp.2019.11.20.
[22] D. Gupta, A. Gupta, N. A. Ansari, and Q. S. Ahmed, "Patient's opinion and practice toward unused medication disposal: a qualitative study," *Journal of Pharmaceutical and Scientific Innovation*, vol. 2, no. 5, pp. 47–50, Oct. 2013, doi: 10.7897/2277-4572.02574.
[23] B.-D. Hwang, "Storage and disposal of unused medications for housewives in the Busan Metropolitan City," *The Korean Journal of Health Service Management*, vol. 7, no. 2, pp. 69–79, Jun. 2013, doi: 10.12811/kshsm.2013.7.2.069.
[24] L. M. West, D. Stewart, and M. Cordina, "Mixed-methods approach to determine adherence, knowledge and behavioral determinants associated with medication wastage," *Research in Social and Administrative Pharmacy*, vol. 16, no. 5, pp. 654–662, May 2020, doi: 10.1016/j.sapharm.2019.08.003.
[25] S. L. Yang, S. L. Tan, Q. L. Goh, and S. Y. Liau, "Utilization of ministry of health medication return programme, knowledge and disposal practice of unused medication in Malaysia," *Journal of Pharmacy Practice and Community Medicine*, vol. 4, no. 1, pp. 07–11, Feb. 2018, doi: 10.5530/jppcm.2018.1.3.
[26] S. Comber, M. Gardner, P. Sörme, D. Leverett, and B. Ellor, "Active pharmaceutical ingredients entering the aquatic environment from wastewater treatment works: A cause for concern?," *Science of The Total Environment*, vol. 613–614, pp. 538–547, Feb. 2018, doi: 10.1016/j.scitotenv.2017.09.101.
[27] M. Paut Kusturica *et al.*, "Analysis of expired medications in Serbian households," *Slovenian Journal of Public Health*, vol. 55, no. 3, pp. 195–201, Sep. 2016, doi: 10.1515/sjph-2016-0025.
[28] P. Monga, Rubi, T. Pruthi, S. Gupta, and B. K. Agrawal, "Current disposal practice of unused and expired medicines amongst patients visiting a tertiary care hospital in North India," *Medical Science*, vol. 24, no. 106, pp. 4303–4310, 2020.
[29] P. Shivaraju and M. Gangadhar, "Knowledge and awareness of disposal of unused and expired medications among medical undergraduates of a tertiary care teaching hospital at B G Nagar: A cross-sectional observational study," *National Journal of Physiology, Pharmacy and Pharmacology*, vol. 7, no. 12, p. 1, 2017, doi: 10.5455/njppp.2018.8.0727006072017.
[30] S. Wajid, N. A. Siddiqui, R. A. Mothana, and S. Samreen, "Prevalence and practice of unused and expired medicine - a community-based study among Saudi Adults in Riyadh, Saudi Arabia," *BioMed Research International*, vol. 2020, pp. 1–5, Jul. 2020, doi: 10.1155/2020/6539251.
[31] I. Michael, B. Ogbonna, N. Sunday, M. Anetoh, and O. Matthew, "Assessment of disposal practices of expired and unused medications among community pharmacies in Anambra State southeast Nigeria: a mixed study design," *Journal of Pharmaceutical Policy and Practice*, vol. 12, no. 1, p. 12, Dec. 2019, doi: 10.1186/s40545-019-0174-1.
[32] Y. Ayele and M. Mamu, "Assessment of knowledge, attitude and practice towards disposal of unused and expired pharmaceuticals among community in Harar city, Eastern Ethiopia," *Journal of Pharmaceutical Policy and Practice*, vol. 11, no. 1, p. 27, Dec. 2018, doi: 10.1186/s40545-018-0155-9.
[33] M. Persson, E. Sabelström, and B. Gunnarsson, "Handling of unused prescription drugs — knowledge, behaviour and attitude among Swedish people," *Environment International*, vol. 35, no. 5, pp. 771–774, Jul. 2009, doi: 10.1016/j.envint.2008.10.002.
[34] S. Raja, S. Mohapatra, A. Kalaiselvi, and R. Jamuna Rani, "Awareness and disposal practices of unused and expired medication among health care professionals and students in a tertiary care teaching hospital," *Biomedical and Pharmacology Journal*, vol. 11, no. 4, pp. 2073–2078, Dec. 2018, doi: 10.13005/bpj/1585.
[35] S. Manocha *et al.*, "Current disposal practices of unused and expired medicines among general public in Delhi and National Capital Region, India," *Current Drug Safety*, vol. 15, no. 1, pp. 13–19, Feb. 2020, doi: 10.2174/1574886314666191008095344.

[36] H. Kahsay, M. Ahmedin, B. Kebede, K. Gebrezihar, H. Araya, and D. Tesfay, "Assessment of knowledge, attitude, and disposal practice of unused and expired pharmaceuticals in community of Adigrat City, Northern Ethiopia," *Journal of Environmental and Public Health*, vol. 2020, pp. 1–11, Apr. 2020, doi: 10.1155/2020/6725423.

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