Journal of Primary Care & Community Health
Volume 11: 1–8

DOI: 10.1177/2150132720920496
journals.sagepub.com/home/jpc
SAGE

Assessment of Pharmaceuticals Waste Practices Among Private Drug Retail Outlets in Ethiopia

Tadesse Gudeta[1] and Desta Assefa[1]

Abstract

Background: Pharmaceuticals waste is a public safety concern, resulting in a possible accidental poisoning, misuse, and environmental pollution. Thus, appropriate disposal of the damaged and expired medicines would save lives and protect the ecological system. **Objective:** The study was aimed to assess knowledge, attitudes, and disposal practices of pharmaceuticals waste among practitioners in private retail outlets. **Method:** A facility-based descriptive cross-sectional study was conducted among private practitioners in retail outlets of Jimma city from November 20 to December 19, 2018. All private drug retail outlets and the respective staffs that fulfilled the eligibility criteria were included in the study. The data were collected using self-administrated questionnaires. **Results:** Of 106 questionnaires distributed to practitioners, 87 completed questionnaires returned, making a response rate of 82.1%. Fifty-nine (67.8%) of the participants reported that at least one type of damaged or expired medicines was present in their store. The main reasons for the damage or expiration include inappropriate storage practices, 32 (29.1%), and receiving medicines with a near expiration date, 42 (38.2%). Concerning knowledge about disposal practices, 70 (41.7%) and 47 (38.2%) of the participants, respectively, reported that safe disposal of damaged or expired medicines would prevent environmental pollution and illegal use. Regarding disposal practice, 47 (38.2%) of the respondents reported burning separately, and 24 (19.5%) of them reported burying underground. Fifty-two (59.8%) of the total participants strongly agreed that they had a responsibility to protect environmental pollution. **Conclusions:** The majority of the participants knew that the appropriate disposal of pharmaceuticals waste could protect human beings and ecological systems. However, a majority of the respondents disposed of the pharmaceuticals waste at the retail pharmacy.

Keywords

pharmaceuticals waste, knowledge, attitudes, practices, retail outlets, Jimma city, Ethiopia

Dates received: 26 September 2020; revised 28 January 2020; accepted 4 February 2020.

Background

Undeniably, many pharmaceuticals save lives and relieve suffering. However, if these products get damaged, expired, and indecorously disposed, they may have a reverse action leading to adverse impacts on the environment as well as dangerous consequences like poisoning and death to humans.[1,2]

All living things are exposed to pharmaceuticals through the consumption of tainted food and water.[3,4] Pharmaceuticals may enter the environment through different means, such as excretion after ingestion and the elimination of topical medications during showering.[5] However, inappropriate disposal of unused and expired pharmaceuticals accounts for the largest share.[6]

Developing countries, with unknown quantities of (and capacity for) medicinal wastes, have recently significantly increased in pharmaceutical product consumption.[7,8] This leads to global apprehensions associated with the production of pharmaceuticals waste, which in turn necessitate the advancement of knowledge and awareness on safe disposal of the wastes for the general public.[9,10] These global concerns include inappropriate self-medication, accidental consumption by children, accumulation of active pharmaceutical ingredients in streams as environmental pollutants, a risk of antimicrobial resistance, and accidental poisoning

[1]Jimma University, Jimma, Ethiopia

Corresponding Author:
Tadesse Gudeta, School of Pharmacy, Faculty of Health Sciences, Jimma University, Jimma, ET, Ethiopia
Email: gudetatadesse@gmail.com

of wildlife.[10] For example, diclofenac, a nonsteroidal anti-inflammatory drug, has been shown to induce renal failure in vultures following the uptake of the flesh of oxen treated with this drug.[11] Expired tetracycline is also confirmed to cause renal tubular damage.[12]

Thus, any damaged or expired medicinal product ought to be processed directly into specialized waste bins following their removal from pharmacy stock or return from patients. If pharmaceuticals waste cannot undergo immediate processing, they should be separated from the other pharmaceutical products, and tags should be attached by specifying "medicines for destruction" and stored under the control of authorized personnel in a specified quarantine, pending timely processing for disposal. There should be no accumulation of such medicinal waste at the pharmacy.[13]

A previous study showed that around 3% of pharmaceuticals and chemicals released along with other healthcare waste through health care activities. This can be sufficient to cause hazardous impact if disposed of improperly.[14] Of the total waste generated by health care activities, 10% to 25% are considered unsafe and threats to environmental and health.[15]

Health care system failures and factors associated with repeat prescribing and dispensing processes become the principal reasons for pharmaceuticals waste in service delivery points.[16] Besides, many health workers, especially in developing countries, have failed to manage damaged and expired medicines appropriately, primarily due to resource constraints, lack of knowledge, and awareness of safe disposal practices.[13,17]

The strength of policies regarding waste disposal systems, as well as the availability of national disposal guidelines, may influence how people dispose of waste medicinal products.[6] Moreover, in health care systems with weak regulatory and managerial support, most practitioners remain unaware of the best disposal practices of unused or expired medicines.[18] Previous related studies conducted in South Africa KwaZulu-Natal district hospital and Indian tertiary hospital showed that only 42.7% and 39% of participants, respectively, knew proper disposal of health care waste.[19,20] In the latter study, the health workers disposed of unused and damaged medicines through flushing in sewer and river, throwing in household trash, and burning at home.[20]

To date, in Ethiopia, no formal system has been established to recall back the damaged, expired, unused, and leftover medicines from the downstream supply chain system. Nonetheless, just a few months ago (before the current study), the Ethiopian government has officially declared to introduce reverse logistics. Hence, it is essential to investigate the level of awareness, practice, and knowledge of consumers and practitioners toward the safe disposal practices of pharmaceutical waste products, thereby designing strategies to inform the stakeholders on how to write off the harmful waste medicinal products.

In Ethiopia, studies in this field are limited in some parts of the country where most were conducted from a patient and public health practitioner perspective. Besides, the roles of private practitioners remain overlooked. Therefore, the study was aimed to assess knowledge, attitudes, and disposal practices of pharmaceuticals waste among practitioners in private retail outlets in Jimma city. It was intended to answer the following questions: (*a*) What level of knowledge do private practitioners have about disposal practices of damaged and expired pharmaceuticals? (*b*) What is the practitioners' attitude toward pharmaceuticals waste disposal practice? (*c*) How does the current pharmaceuticals waste disposal practice look like at private retail outlets?

Methods

Study Area

The study was conducted among practitioners in private drug retail outlets of Jimma city. Jimma is the largest city in southwestern Ethiopia. It is a special zone of the Oromia regional state and surrounded by Jimma Zone. It has a latitude and longitude of 7°40′N 36°50′E. The city has a total population of 207 573, comprising different ethnic groups, including Oromo (accounts for the largest portion), Yem, Amhara, Kafficho, and others (Central Statistical Agency 2012). Currently, Jimma city has 1 medical center, 1 general public hospital, 21 private pharmacies, and 35 drug shops (Jimma City Health Bureau 2019).

Study Design and Period

A facility-based descriptive cross-sectional study was conducted among practitioners engaged in dispensing and managing medicines in private drug retail outlets in Jimma city. The study was conducted from November 20 to December 19, 2018.

Source Population

We considered all drug retail outlets and practitioners in those retail outlets of the city as source populations.

Study Population and Sampling Procedures

All private drug retail outlets, that is, pharmacies and drug shops and practitioners involved in dispensing and managing medicines in those pharmacies, and drug shops were selected as a study population.

Inclusion and Exclusion Criteria

All open retailers on the day of the data collection and the practitioners agreed to take part in the study were included. The total number of data collection tools was determined based on the estimation of practitioners in each retailer. We

estimated based on previous experience. As a result, an average of 2 practitioners per retailer expected, which could make 112. However, 111 practitioners met during the actual practice, of whom 5 took part in the pretest.

Data Collection Procedures

We used self-administrated questionnaires to collect all the necessary data. It had 4 parts. The first part dealt with sociodemographic characteristics of the study participants; the second part consisted of questions addressing medicine disposal practice; the third part contained questions to assess the participant's knowledge about disposal practice of damaged or expired medicines. The final part contained questions about the practitioners' attitudes toward pharmaceuticals waste disposal practices.

Data Processing and Analysis

We used the Statistical Package for Social Sciences (SSPS) software version 20 to encode and analyze data. Descriptive statistical analysis, including frequency and percentages, were used, and the findings summarized using tables and figures.

Data Quality Assurance

The principal investigator (PI) provided a half-hour training for the data collectors on how to gather relevant data by describing the objectives and significance of the study. All investigators oversaw the data collectors and reviewed the completeness of the questionnaires at the end of each data collection day. We discarded the incomplete questionnaires and redirected the data collectors to support respondents in need of clarification. Before leaving for the actual data collection, a pretest was conducted on 5% of the estimated sample size (112) to check the clarity of the tools and the length of time to complete the questionnaires. The participants for the pretest were selected from three retail outlets and excluded from the actual study.

Operational Definitions

Pharmaceuticals. The term pharmaceuticals is interchangeably used with drugs or medicines. These may include chemical products, supplies, reagents, or packages.

Private Drug Retail Outlets. These include private pharmacies and drug shops providing service to communities. According to the Ethiopian regulatory body, only licensed pharmacy practitioners are allowed to open a pharmacy or drug shop. Nevertheless, other health care professionals may also provide pharmacy services under compelling circumstances.[21] Pharmacies are retail outlets where prescription drugs dispensed to patients. Drug shops are also retail outlets but less than pharmacies in the scope of services and types of drugs it manages.

Private Practitioners. Private practitioners include any health professionals involved in the sale and administration of medicines in private pharmacies or drug shops.

Pharmaceuticals Waste. Pharmaceuticals waste refers to damaged, expired, or leftover pharmaceutical products.

Antibiotics. As per the Food and Drug Authority of Ethiopia, antibiotics are medicines used to treat infections caused by bacteria and other microorganisms.

Results

Sociodemographic Characteristics

All drug shops, 35 (62.5%) and pharmacies, 21 (37.5%) in Jimma city were visited, 3 of which were used for pretesting. A total of 106 questionnaires were distributed to practitioners in 53 retail outlets, of which 87 returned the completed questionnaires, making a response rate of 82.1%. The majority of the practitioners, 44 (50.6%) were within the age range of 25 to 31 years. More than half, 56 (64.4%) of them were males. Regarding their profession, the majority of them were pharmacy professionals, 73 (83.9%). Nearly half of the practitioners, 44 (50.6%), were degree holders. Of the total respondents, only 16 (18.4%) received training on pharmaceuticals waste management (Table 1).

The Drug Retail Outlet–Related Characteristics

Sixty-six (51.5%) of the participants reported that the sources of medicines for private retail outlets were wholesales. Sixty-eight (78.2%) of them specified that they had received an inspection from regulatory bodies. The majority of them, 46 (52.9%), replied that their retail outlets received inspection once per year, but 19 (21.8%) of the retailers did not receive yet (Table 2).

Practitioners' Knowledge About Pharmaceuticals Waste Disposal Practices

The majority of participants, 53 (60.9%), had awareness regarding appropriate disposal practices and safe disposal sites. Specifically, pharmacy professionals had better awareness, 44 (50.6%) (Figure 1).

As shown in Table 3, the main reasons for the damage or expiration of medicines in retail outlets were receiving products with a near expiration date, 42 (38.2%), and "inappropriate storage practice, 32 (29.1%). Seventy (41.7%) of the participants knew that the safe disposal of damaged or expired pharmaceuticals would prevent

Table 1. Sociodemographic Characteristics of Private Practitioners in Retail Outlets of Jimma City, Jimma, Ethiopia: November 20 to December 19, 2018 (N = 87).

Variables	Drug Shop, n (%)	Pharmacy, n (%)	Total, n (%)
Gender			
Male	21 (75)	35 (59.3)	56 (64.4)
Female	7 (25)	24 (40.7)	31 (35.6)
Total	28 (100)	59 (100)	87 (100)
Age (years)			
18-24	4 (14.3)	10 (16.9)	14 (16.1)
25-31	14 (50.0)	30 (50.8)	44 (50.6)
≥32	10 (35.7)	19 (32.2)	29 (33.3)
Total	28 (100)	59 (100)	87 (100)
Profession			
Pharmacy	23 (82.1)	50 (84.7)	73 (83.9)
Nurse	3 (10.7)	6 (10.2)	9 (10.3)
Others[a]	2 (7.14)	3 (5.08)	5 (5.75)
Total	28 (100)	59 (100)	87 (100)
Educational qualification			
Diploma	15 (53.6)	28 (47.5)	43 (49.4)
Degree	13 (46.4)	31(52.5)	44 (50.6)
Total	28 (100)	59 (100)	87 (100)
Training on PWM			
Received	5 (17.9)	11 (18.6)	16 (18.4)
Not received	23 (82.1)	48 (81.4)	71 (81.6)
Total	28 (100)	59 (100)	87 (100)

Abbreviation: PWM, pharmaceutical waste management.
[a]Health officer, midwife, medical laboratory.

Table 2. Frequency of Inspection and Sources of Medicines for Retail Outlets in Jimma City: November 20 to December 19, 2018 (N = 87).

Variables	Drug Shop, n (%)	Pharmacy, n (%)	Total, n (%)
Source of medicines for the retail outlets			
Wholesales	19 (52.8)	47 (50.5)	66 (51.5)
EPSA	16 (45.7)	40 (43)	56 (43.8)
Local manufacturers	0 (0.0)	6 (6.45)	6 (4.7)
Total	35 (100)	93 (100)	128 (100)
Received inspection			
Yes	18 (64.3)	50 (84.7)	68 (78.2)
No	10 (35.7)	9 (15.3)	19 (21.8)
Total	28 (100)	59 (100)	87 (100)
Frequency of inspection per year			
Once	13 (46.4)	33 (55.9)	46 (52.9)
Twice	3 (10.7)	10 (16.9)	13 (14.9)
Thrice	2 (7.1)	7 (11.9)	9 (10.3)
None	10 (35.7)	9 (15.3)	19 (21.8)
Total	28 (100)	59 (100)	87 (100)

Abbreviation: EPSA, Ethiopian Pharmaceutical Supply Agency.

environmental pollution. Sixty-one (46.9%) and 50 (38.5%) of the participants respectively held the Ethiopian Pharmaceutical Supply Agency and Ethiopian Food and Drug Authority accountable to take the largest share in creating awareness for the drug retail outlets (Table 3).

Practitioners' Disposal Practices of Pharmaceuticals Waste

The majority of participants, 67 (77 %), had an experience of checking the expiration date of medicines during the

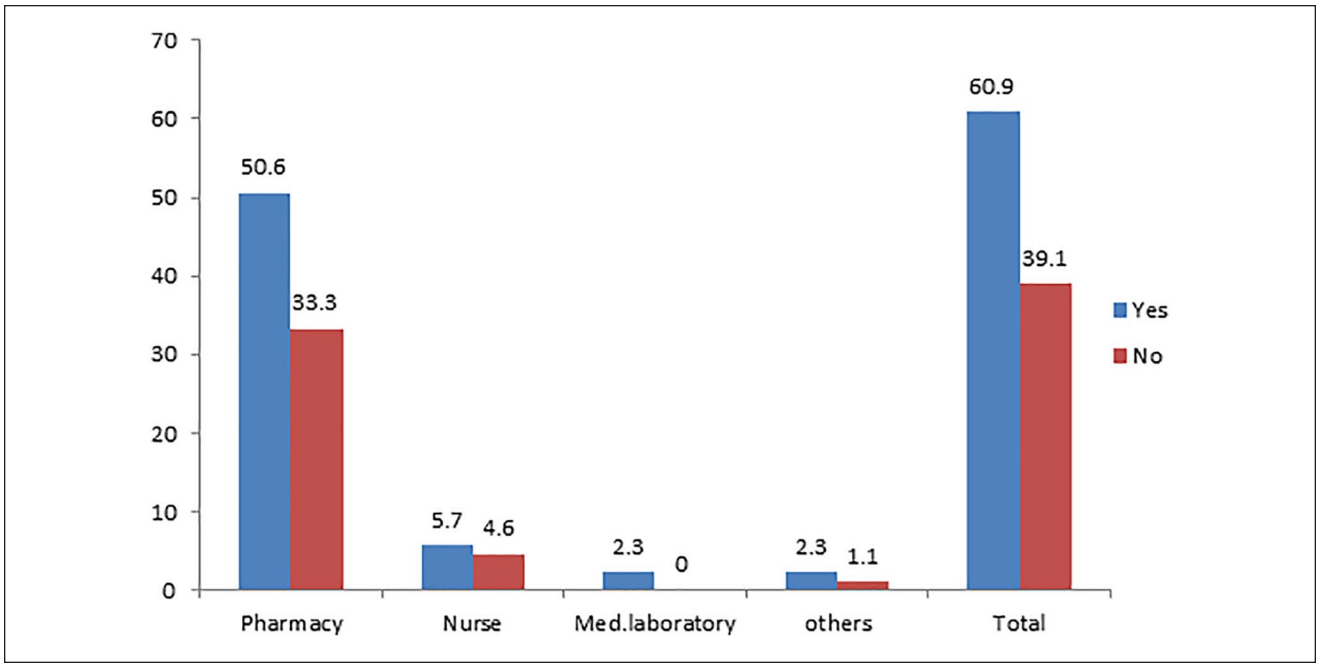

Figure 1. Awareness of safe disposal practices and disposal sites for pharmaceuticals waste among practitioners in retail outlets in Jimma city, Jimma, Ethiopia: November 20 to December 19, 2018, (N = 87).

Table 3. Knowledge of the Participants on the Causes of Medicines Damage or Expiry, Reasons for Safe Disposal, and Awareness Creation for Practitioners in Retail Outlets in Jimma City, Jimma, Ethiopia: November 20 to December 19, 2018 (N = 87).

Variables	Drug Shop, n (%)	Pharmacy, n (%)	Total, n (%)
Causes of damage or expiration of medicines in drug retail outlets			
Receiving products with a near expiration date	13 (28.3)	29 (45.3)	42 (38.2)
Weak storage practice	18 (39.1)	14 (21.9)	32 (29.1)
Improper handling during distribution	14 (30.4)	8 (12.5)	22 (20)
Poor sales	0 (0.0)	12 (18.8)	12 (10.9)
Others[a]	1 (2.2)	1 (1.6)	2 (1.8)
Total	46 (100)	64 (100)	110 (100)
The reasons for the safe disposal of pharmaceuticals waste			
To prevent environmental pollution	22 (40.7)	48 (42.1)	70 (41.7)
To prevent illegal use	16 (29.6)	39 (34.2)	55 (32.7)
To prevent adverse consequences	15 (27.8)	27 (23.7)	42 (25)
Others[b]	1 (1.9)	0 (0.0)	1 (0.6)
Total	54 (100)	114 (100)	168 (100)
Responsible body to create awareness on drugs waste management			
EPSA	16 (38.1)	45 (51.1)	61 (46.9)
EFDA	20 (47.6)	30 (34.1)	50 (38.5)
FMOH	4 (9.5)	13 (14.8)	17 (13.1)
Others[c]	2 (4.8)	0	2 (1.5)
Total	42 (100)	88 (100)	130 (100)

Abbreviations: EPSA, Ethiopian Pharmaceutical Supply Agency; EFDA, Ethiopian Food and Drug Authority; FMOH, Federal Ministry of Health.
[a]Change in prescribing pattern.
[b]To prevent antimicrobial resistance.
[c]Universities.

reception from suppliers. Fifty-nine (67.8%) of the participants reported that at least one type of damaged or expired medicines was available in their store because of the reasons mentioned in Table 3. Antibiotics, 31 (35.6%), and antihypertensive, 21 (24.1%), constituted the highest proportion of the waste. Regarding the actions taken to remove

Table 4. Private Practitioners' Disposal Practices of Pharmaceuticals Wastes in Retail Outlets in Jimma City, Jimma, Ethiopia: November 20 to December 19, 2018 (N = 87).

Statements/Variables	Frequency (%)
Check the expiration date of medicines during receiving	
Yes	67 (77.0)
No	20 (23.0)
Damaged or expired medicines present in the premise	
Yes	59 (67.8)
No	28 (32.2)
Types of damaged/expired medicines found in the premise	
Antibiotics	31 (35.6)
Antihypertensives	21 (24.1)
Antidiabetics	16 (18.4)
Over-the-counter medicines	15 (17.2)
Antifungals	1 (1.1)
Medicinal waste disposal practice	
Burning separately at retail outlets	47 (38.2)
Burying underground	24 (19.5)
Store in quarantine until received by district health bureau	18 (14.6)
Flushing in toilet or rivers	17 (13.8)
Throwing in household trash	11 (8.9)
Return to suppliers	5 (4.1)
Transferring them to other retail outlets	3 (2.4)
Total	123 (100)

the waste, 47 (38.2%) of the respondents reported burning separately, and 24 (19.5%) of them reported burying underground (Table 4).

Practitioners' Attitudes Toward Pharmaceuticals Waste Management

More than half of the participants, 65 (74.7%) strongly agreed that improper disposal of damaged and expired medicines would negatively affect health and ecological systems. Fifty-two (59.8%) of the respondents strongly agreed that environmental protection is their responsibility. Concerning means of creating awareness on safe disposal of pharmaceuticals waste, the majority of the participants strongly agreed that training, 53 (60.9%), and provision of information by health professionals, 49 (56.3%) would improve the practitioners' awareness (Table 5).

Discussion

Improper disposal of medicinal waste would be hazardous if it contaminates the water supplies or local sources used by communities or wildlife. Moreover, pharmaceuticals waste may be diverted to the market for illegal resale and also used by scavengers or children if a landfill is insecure.[2] In the present study, 47 (38.2%) of the participants burned the damaged, expired, or unused medicines separately, 24 (19.5%) buried underground, and 17 (13.8%) flushed in the toilet or river. It is a suggestion of improper disposal practices, which are likely to lead to undesirable effects. The possible reason could be the infrequent inspection of retail outlets by the regulatory body, where most of them received once a year. These findings are in line with other studies conducted among health care professionals in Kuwait,[22] Kabul, Afghanistan,[23] and in Kwazulu-Natal, South Africa,[19] yet deviate from the Ethiopian medicinal waste management and disposal directive. The directive requires that unfit drugs, except for recyclable materials, cartons, and leaflets, be returned to the respective suppliers for disposal.[24]

In the current study, the participants reported that they knew safe disposal of pharmaceuticals waste would prevent environmental pollution, 70 (41.7%), and illegal use by the communities, 55 (32.7%). It is an indication of a good understanding of the safe disposal of pharmaceuticals waste, and it is also consistent with the findings of previous studies in Harar City and South India.[25,26]

Regarding attitude toward medicinal waste disposal practices, 65 (74.7%) participants strongly agreed that improper disposal of damaged and expired medicines could affect the environment and health. Nevertheless, the finding is not consistent with the study in Kabul, where around 98% stated that inappropriate disposal practices could harm the environment and human beings.[23] The reason might be the difference in the readiness of the practitioners to learn and cultural differences. Moreover, the commitment and actions the governments take in creating awareness might also matter. On the other hand, 52 (59.8%) participants strongly agreed that environmental protection is their responsibility, which is also in agreement with a study conducted in New Delhi, India.[27] Fifty-three (60.9%) and 49 (56.3%) of the participants respectively strongly agreed that training on pharmaceuticals waste management and a provision of information by health professionals could be the best means of raising practitioners' awareness about safe disposal of pharmaceuticals waste. These findings are in line with the study conducted in Gujarat, India.[20] However, in Ethiopia, apart from the curricular programs, it is not common for the government to provide short-term training for private practitioners.

As limitations, because of budget constraints, the study was conducted in retail outlets of one city. Thus, we recommend that other researchers extend the study to include broader geographic areas. Summative findings may, therefore, allow the Ethiopian Federal Ministry of Health and the regulatory body to enforce the reverse logistics already underway effectively. The current study was conducted among private practitioners. Thus, prospective researchers

Table 5. Private Practitioners' Attitudes Toward Pharmaceuticals Waste Management in Retail Outlets in Jimma City, Jimma, Ethiopia: November 20 to December 19, 2018 (N = 87).

Statements	Strongly Disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Agree, n (%)	Strongly Agree, n (%)	Average Response
Improper disposal of damaged and expired medicines can affect the environment and health	1 (1.1)	1 (1.1)	2 (2.3)	18 (20.7)	65 (74.7)	4.67
It is my responsibility to protect the environment even if others are irresponsible	1 (1.1)	1 (1.1)	8 (9.2)	25 (28.7)	52 (59.8)	4.44
Provision of information in the newspaper would create awareness on safe disposal of damaged and expired medicines	0	6 (6.9)	10 (11.5)	24 (27.6)	47 (54)	4.29
Provision of information through television or posters would create awareness on safe disposal of damaged and expired medicines	3 (3.4)	3 (3.4)	9 (10.3)	27 (31)	45 (51.7)	4.24
It is the responsibility of the government to create awareness on safe disposal of damaged and expired medicines	0 (0.0)	2 (2.3)	12 (13.8)	27 (31)	46 (52.9)	4.34
Health professionals are responsible to create awareness on safe disposal of damaged and expired medicines	3 (3.4)	1 (1.1)	9 (10.3)	25 (28.7)	49 (56.3)	4.33
Written instructions attached to the package of the medicines would create awareness on safe disposal of damaged and expired medicines	2 (2.3)	1 (1.1)	7 (8)	33 (37.9)	44 (50.6)	4.33
Provision of training on pharmaceuticals waste management would create awareness on safe disposal of damaged and expired medicines	3 (3.4)	1 (1.1)	5 (5.7)	25 (28.7)	53 (60.9)	4.42

may consider both private and public professionals for their comparative study.

Conclusions

To conclude, the majority of the participants knew that the appropriate disposal of pharmaceuticals waste could protect human beings and ecological systems. Most of the respondents also had a positive attitude toward environmental protection. However, on the contrary, a large share of them had disposed of unused or expired medicines inappropriately. It could be due to negligence and nonpharmacy professionals engaged in the management of medicinal products in the outlet. The authors, therefore, recommend that the Ethiopian Food and Drug Authority should increase the frequency of inspections and also raise practitioners' awareness of safe disposal practices of expired or damaged medicines. Additionally, Ethiopian Pharmaceutical Supply Agency and partners should consider private practitioners during the provision of training on health care waste management for public health professionals.

Acknowledgments

The authors would like to thank Jimma University for creating an opportunity to conduct this study. We express our deep gratitude to the owners of retail outlets and participants for their cooperation in providing us with all the necessary data. Last, but not least, our acknowledgment goes to Dereje Kebebe (PhD), the staff of Jimma University School of pharmacy, for reviewing the final manuscript.

Author Contributions

TG reviewed the article, was involved in the data collection process, analyzed data, interpreted data, participated in the sequence alignment, drafted the manuscript, and communicated for publication. DA reviewed the article, participated in the design of the study, and was involved in data analysis, interpretation, and drafting of the manuscript. Both authors read and approved the final manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Approval

Ethical approval was granted by the institutional review board of Jimma University. The owners of the retail outlets were communicated using a support letter written from Jimma University School of Pharmacy.

Informed Consent

The participants were asked to sign a consent form before the start of data collection.

ORCID iD

Tadesse Gudeta https://orcid.org/0000-0002-5109-0953

References

1. Kummerer K. The presence of pharmaceuticals in the environment due to human use—present knowledge and future challenges. *J Environ Manage*. 2009;90:2354-2366.
2. World Health Organization. Guidelines for safe disposal of unwanted pharmaceuticals in and after emergencies. https://apps.who.int/iris/bitstream/handle/10665/42238/WHO_EDM_PAR_99.2.pdf? Accessed January 8, 2019.
3. Ahmed A, Mushtaq N, Tariq M, Durrani M, Arif M, Yasmeen G. Disposal practices of unused and expired pharmaceuticals in Karachi and their impact on health and environment. *J Univ Med Dent Coll*. 2013;4:1-7.
4. Stackelberg PE, Furlong ET, Meyer MT, Zaugg SD, Henderson AK, Reissman DB. Persistence of pharmaceutical compounds and other organic wastewater contaminants in a conventional drinking-water-treatment plant. *Sci Total Environ*. 2004;329:99-113.
5. Sue I, Daughton CG. Types and quantities of leftover drugs entering the environment via disposal to sewage—revealed by coroner records. *Sci Total Environ*. 2007;388:137-148.
6. Tong AYC, Peake BM, Braund R. Disposal practices for unused medications in New Zealand community pharmacies. *J Prim Health Care*. 2011;3:197-203.
7. Teelavath M, Teelavath V, Teelavath K. Pharmaceutical waste and public health—a review. *Int J Pharm Educ Res*. 2014;1:22-27.
8. Windfeld ES, Brooks MS. Medical waste management—a review. *J Environ Manage*. 2015;163:98-108.
9. Nipa NY, Ahmed S, Shahriar M, Rahman M, Haider B, Uddin MB. Improper management of pharmaceutical waste in South and South-East Asian regions. *J Environ Stud*. 2017;3:1-7.
10. Ruhoy IS, Daughton CG. Beyond the medicine cabinet: an analysis of where and why medications accumulate. *Environ Int*. 2008;34:1157-1169.
11. Vinasan N. Diclofenac in Gyps vultures: a molecular mechanism of toxicity. https://repository.up.ac.za/bitstream/handle/2263/26027/Complete.pdf?sequence=7. Accessed October 11, 2019.
12. Anastasios K, Paridis D, Kozyrakis D, et al. Fanconi syndrome in adulthood. The role of early diagnosis treatment. *J Musculoskeletal Neuronal Interact*. 2017;17:303-306.
13. Pharmaceutical Society of Ireland. Guidelines on the disposal of medicinal products for a retail pharmacy business. https://www.thepsi.ie/Libraries/Folder_Pharmacy_Practice_Guidance/01_5_Disposal_of_Medicinal_Products_for_Retail.sflb.ashx. Accessed December 10, 2018.
14. Nwachukwu NC, Orji FA. Health care waste management—public health benefits, and the need for effective environmental regulatory surveillance in the Federal Republic of Nigeria. https://www.researchgate.net/profile/Ositadinma_Ugbogu/publication/236842418_Health_Care_Waste_Management. Accessed January 15, 2019.
15. World Health Organization. *Protecting Health Through Health Care Waste Management*. Geneva, Switzerland: World Health Organization; 2016.
16. National Health Service. Polypharmacy and deprescribing—medicines adherence. https://www.prescqipp.info/media/1566/b187-polypharmacy-improving-medicines-adherence-20.pdf. Accessed January 25, 2019.
17. Kozak MA, Melton JR, Gernant SA, Snyder ME. A needs assessment of unused and expired medication disposal practices: a study from the medication safety research network of Indiana. *Res Soc Adm Pharm*. 2016;12:336-340.
18. Franzoso G. An effective tool to manage the distribution of medicines and monitor the treatment in hospital pharmacies. *Online J Public Health Inform*. 2014;6:e183.
19. Olaifa A, Govender RD, Ross AJ. Knowledge, attitudes and practices of healthcare workers about healthcare waste management at a district hospital in KwaZulu-Natal Knowledge, attitudes and practices of healthcare workers about healthcare waste management at a district hospital in KwaZulu. *South Afr Fam Pract*. 2018;60:137-145. doi:10.1080/20786190.2018.1432137
20. Sonowal S, Desai C, Kapadia JD, Desai MK. A survey of knowledge, attitude, and practice of consumers at a tertiary care hospital regarding the disposal of unused medicines. *J Basic Clin Pharm*. 2017;8:4-7.
21. Ethiopian Food and Drug Authority. Food and medicine administration proclamation. http://www.fmhaca.gov.et/wp-content/uploads/2019/03/Proclamation-Final-draft-2018.docx. Accessed January 16, 2020.
22. Abahussain E, Waheedi M, Koshy S. Practice, awareness and opinion of pharmacists toward disposal of unwanted medications in Kuwait. *Saudi Pharm J*. 2012;20:195-201.
23. Bashaar M, Thawani V, Hassali MA, Saleem F. Disposal practices of unused and expired pharmaceuticals among the general public in Kabul. *BMC Public Health*. 2017;17:45.
24. Food, Medicine and Healthcare Administration and Control Authority of Ethiopia. Medicines waste management and disposal directive. http://forsslund.org/StandardHealthFaclitiy/Medicines%20Waste%20Management%20&%20Disposal%20Directive%20-%20Final%20prin.pdf. Accessed April 14, 2020.
25. Ayele Y, Mamu M. Assessment of knowledge, attitude and practice towards disposal of unused and expired pharmaceuticals among the community in Harar city, Eastern Ethiopia. *J Pharm Policy Pract*. 2018;11:27.
26. Radhakrishna L, Nagarajan P, Vijayanandhan SS. Knowledge, attitude and practice (KAP) towards disposal of medicines: a qualitative study among health care professionals in south India. *World J Pharm Res*. 2014;3:1955-1963.
27. Bhayana K, Rehan HS, Arora T. Comparison of the knowledge, attitude, and practices of doctors, nurses, and pharmacists regarding the use of expired and disposal of unused medicines in Delhi. *Indian J Pharmacol*. 2016;48:725-728.