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Management and safe disposal of unwanted medicines in community pharmacies in Sri Lanka

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Introduction: Pharmaceutical pollutants, such as antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs), have been detected in Sri Lankan waterways. These contaminants may arise from multiple sources, including community pharmacy disposal practices. This raises concerns that improper disposal of unwanted medicines poses an increasing risk to the environment and public health. Community pharmacies—both chain and independent pharmacies—serve as the final point in the pharmaceutical supply chain at the community level and play a crucial role in managing the disposal of unwanted medicines. This study aimed to explore the current practices, factors influencing these practices, and strategies for improving the management and safe disposal of unwanted medicines in community pharmacies in Sri Lanka.

Methods: A qualitative research design was adopted. Semi-structured interviews using the validated interview guide were conducted with the participants. The participants primarily comprised the community pharmacists representing both chain and independent pharmacies operating in the Western Province of Sri Lanka. Participants were selected through purposive sampling. Interviews were conducted until data saturation was achieved. Using the thematic analysis, emerging reporting patterns within the data were identified.

Results: The study identified four main themes: current disposal and waste management practices; factors influencing and limiting disposal practices; perceptions and attitudes toward disposal responsibility; and recommendations for improvement. Community pharmacies use various methods for medicine disposal and pharmaceutical waste management. Their practices are primarily influenced by the absence of proper medicine collection mechanisms, weak regulation, limited awareness, and inadequate disposal facilities. Pharmacists suggested implementing a well-structured medicine collection system, strengthening laws, and conducting awareness programs to minimize pharmaceutical waste.

Discussion: Although a regulatory framework exists for pharmaceutical waste management, implementation and monitoring within community pharmacies, particularly independent pharmacies, remain limited. Furthermore, these pharmacies have fewer facilities to carry out safe drug disposal practices. Research revealed the need for improved infrastructure, tighter regulatory supervision, and increased awareness programs to address these challenges. Implementing a well-coordinated national medicine collection program and improving awareness of safe medicine disposal are important measures for protecting the environment and public health.

KEYWORDS

community, community pharmacy, disposal, expired, medicines, pharmacies, safe medicine disposal, Sri Lanka

Introduction

The accumulation of unwanted medicines and their improper disposal are serious global issues, particularly in Sri Lanka. These issues result in economic losses and environmental and public health risks through water contamination and potential for accidental ingestion or misuse (Qing et al., 2025; Insani et al., 2020). Pharmaceuticals can enter the environment via human and animal excretion and through improper medicine disposal (Alghadeer and Al-arifi, 2021). Healthcare facilities and households are major sources of unwanted medicines (Nairat et al., 2023). In this study, “unwanted medicines” refers to pharmaceutical products that are not suitable for use or dispensing within the community pharmacy setting. Although several high-income countries have structured pharmaceutical waste disposal mechanisms, low- and middle-income countries have given limited attention to appropriate pharmaceutical waste disposal (Bataduwaarachchi et al., 2020).

Community pharmacies are the most accessible healthcare facilities, which typically focus on profitable business operations. However, their responsibilities have evolved to support the safe and effective use of medications within the primary healthcare system (Chong et al., 2022). In some countries, pharmacies are considered the key entities responsible for collecting pharmaceutical waste and are mandated to bear the disposal cost (Jonjić and Vitale, 2014).

Improper disposal practices, such as discarding medicines with household waste, flushing them down toilets, and improper burning, have been associated with consequences, including water pollution, antimicrobial resistance, accidental poisoning, and an increasing healthcare burden (Nyaga et al., 2020). These issues have worsened in countries with weak regulatory systems and enforcement. To address these issues, many countries have established drug take-back programs to limit the release of active pharmaceutical ingredients into the environment (Hiew and Low, 2025).

A Sri Lankan survey revealed that community pharmacists had an inadequate understanding of correct disposal protocols and that their knowledge levels were significantly affected by their educational background and training (Janarthanan et al., 2022). Another national survey revealed that most Sri Lankan pharmacists were unaware of safe medicine disposal guidelines (Bataduwaarachchi et al., 2020). A study reported the contamination of Sri Lankan surface waterways with pharmaceuticals, such as antibiotics and NSAIDs, confirming the contribution of improper pharmaceutical disposal to environmental hazards and the development of antibiotic-resistant microorganisms (Guruge et al., 2019).

In this context, the present study aims to explore the current practices for managing and disposing of unwanted medicines by

community pharmacists and to identify appropriate strategies for improving these practices and minimizing the health and environmental risks. By obtaining in-depth insights from pharmacists, this study specifically seeks to provide explanatory evidence on the factors influencing pharmaceutical waste management practices in community pharmacies.

Materials and methods

Research design

A case study design was adopted for this inductive qualitative research. According to Yin, a case study is suitable for researching a contemporary phenomenon, which is known as a “case” when the boundaries between the phenomenon and the context are not clearly defined (Yin, 2018). Pharmaceutical disposal practices in community pharmacies are inseparable from the organizational structure, resource limitations, supply chain interactions, and regulatory environment. In addition, the case study research approach was chosen because the main research questions are associated with “how” and “why” these practices occur. In this research, each community pharmacy represents a “bounded case,” thus making it a suitable case study to enable an in-depth analysis of a “case” (Creswell, 2018).

Study population and sampling

Non-probability, purposive sampling was used to select participants who are registered pharmacists in Sri Lanka with at least 1 year of experience in independent and chain pharmacies. Participation was voluntary. The criterion-based sampling approach was used to select participants with the relevant operational knowledge. Convenience sampling was applied to ensure geographical accessibility, particularly within the Western Province. Fourteen pharmacists representing independent and chain pharmacies were interviewed, with each participant representing a separate community pharmacy. Data collection continued until data saturation was reached (Merriam and Tisdell, 2016).

Data collection

Data were collected through semi-structured interviews conducted face-to-face or via telephone from September to October 2025. An interview guide was developed based on a literature review on pharmaceutical wastage and disposal practices. It included open-ended questions focusing on current disposal practices and influencing factors. Two preliminary interviews were conducted during the preliminary screening stage with pharmacists to refine the interview guide. Accordingly, these interviews were not included in the results. Interviews were conducted in either Sinhalese or English, and each interview lasted 30–45 min. All interviews were audio-recorded and then transcribed verbatim with the prior consent of participants, in accordance with research ethics. Sinhala transcripts were translated

Abbreviations: WHO, World Health Organization; API, Active Pharmaceutical Ingredient; NMRA, National Medicines Regulation Authority; FDI, Food and Drug Inspector; EPR, Extended Producer Responsibility; UAE, United Arab Emirates; NSAIDs, Non-steroidal Anti-inflammatory Drugs.

into English, followed by cross-checking to ensure accuracy and context. Interview transcripts were assigned identification codes (P01–P14) to ensure anonymity. All transcripts and recordings were stored in a password-protected folder.

Data analysis procedure

First, a within-case analysis was conducted to understand the unique characteristics of each pharmacy, and a cross-case analysis was used to identify differences between independent and chain pharmacies. Data were analyzed manually using inductive thematic analysis, following the approach of [Braun and Clarke \(2006\)](#). After familiarizing oneself with the data, each transcript was coded with *in vivo* coding. Then, the codes were grouped into broader categories, which were further developed into themes and sub-themes. Each pharmacy was examined as an individual case to understand its contextual practices. Thereafter, a cross-case comparison was conducted to identify patterns across independent and chain pharmacies.

Ethics statement

Ethical approval was granted for the study by the Ethics Review Committee, Sri Lanka Institute of Information Technology Business School (Reference no. SLIIT/REC/SBS/2025/38). Verbal consent was obtained from the participants before conducting the interviews.

Data trustworthiness

In this study, credibility was ensured through the familiarity of the researcher with the community pharmacy environment. For this, the rapport built with participants during interviews and the onsite observations in face-to-face interviews was largely responsible. Maintaining an audit trail documentation supported dependability, and conformability was assured by providing all interpretations verbatim and maintaining a clear chain of evidence. Providing detailed descriptions

of pharmacy types, settings, and participant characteristics supported the transferability in qualitative research for reliability and generalizability.

Results

[Table 1](#) summarizes the demographic characteristics of the 14 participants representing both independent and chain pharmacies. Nine participants were female, and five participants were male. Their professional experience ranged from 2 years to 25 years. The cross-case analysis followed on from the findings from the initial within-case analysis. Four main themes were developed from the thematic analysis. [Table 2](#) presents the developed themes and sub-themes.

Theme 1—current disposal and waste management practices

Sub-theme 1.1—disposal methods used by pharmacies

All participants stated that they attempt to return short-expiry and slow-moving medicines to the suppliers within the timeframe stipulated by the supplier. However, suppliers rarely accept expired medicines. Typically, independent pharmacies and small chains dispose of unwanted medicines through municipal waste (P1, P5, P6, P7). Participants also discussed their disposal experience of flushing, burial, and burning in the garden. Two pharmacists reported that water-soluble medicines were diluted in water and poured into the drainage system (P5, P9). P8 mentioned handing over waste to third-party contractors. Additionally, P9 and P14 reported incineration through a cement factory. Five participants (P10, P11, P13, P2, P4) mentioned that unwanted medicines were stored in separate

TABLE 1 Demographic profile of the participants.

Participant	Pharmacy type	No. of outlets	Location	Age (years)	Gender	Experience	Designation
P01	Independent	1	Colombo	33	Female	7 years	Pharmacist
P02	Independent	1	Colombo	30	Female	4 years	Owner Pharmacist
P03	Independent	1	Kalutara	31	Female	3.5 years	Pharmacist
P04	Independent	1	Colombo	30	Male	3 years	Owner Pharmacist
P05	Independent	1	Colombo	38	Male	12 years	Pharmacist
P06	Independent	1	Colombo	34	Male	7 years	Owner Pharmacist
P07	Chain	2	Gampaha	32	Male	4 years	Owner Pharmacist
P08	Chain	16	Colombo	30	Female	4 years	Pharmacist
P09	Chain	495	All Island	49	Female	25 years	Group Head of Pharmaceuticals
P10	Chain	55	Western Province	28	Female	3 years	Pharmacist
P11	Chain	9	Colombo	28	Female	2 years	Pharmacist
P12	Chain	17	Western Province	35	Female	15 years	Pharmacy Manager
P13	Chain	4	Colombo	37	Male	10 years	Pharmacist Manager
P14	Chain	60	All Island	37	Female	16 years	Pharmacist

TABLE 2 Identified themes and subthemes of the study.

S. No	Themes	Sub-themes
1	Current disposal and waste management practices	1.1 Disposal methods used by pharmacies 1.2 Inventory and record management practices 1.3 Causes of unwanted medicine accumulation
2	Factors influencing and limiting disposal practices	2.1 Supplier and return mechanisms 2.2 Regulatory and policy environment 2.3 Pharmacy level resources and limitations 2.4 Human and motivational factors 2.5 Awareness and knowledge gaps 2.6 Systemic and coordination gaps
3	Perceptions and attitudes toward disposal responsibility	3.1 Awareness of risks 3.2 Attitudes toward responsibility 3.3 Perceptions of the public's role
4	Recommendations for improvement	4.1 Strengthening the regulatory framework 4.2 Building infrastructure and supply chain connections 4.3 Education and awareness

cupboards until a safe disposal option became available. As such, their responses are indicated accordingly.

“Some items we can return to the suppliers. They take those as returns and exchange with new ones” (P10).

“We pour the liquids into a can, which will be diluted and removed” (P9).

Sub-theme 1.2—inventory and record management practices

Pharmacists described many inventory and record management practices to minimize medicine wastage and reduce the accumulation of expired products. Three participants stated that they order medicines based on demand and stock movement. A few participants emphasized purchasing medicines in smaller quantities. Four participants used a color-coding system to identify short-expiry dates. The majority of independent pharmacies performed manual expiry checks either monthly or quarterly, whereas chain pharmacies followed fixed schedules, updated expiry dates in the pharmacy system, and transferred stock between branches to prevent the accumulation of expired medicines.

“If we have medicines that are not currently being moved in one branch, we transfer them to another branch and make that sale” (P11).

Sub-theme 1.3—causes of unwanted medicines accumulation

Short expiry and expired medicines due to non-moving stocks are the primary source of unwanted medicines. These accumulate due to larger pack sizes, low demands, and infrequent prescribing patterns. Customer-returned medicines become unwanted. Moreover, due to uncertain storage conditions, these medicines cannot be resold. Hence, all pharmacists generally avoid accepting customer returns. Due to various supplier conditions, pharmacists struggle to return the

short-expiry medicines, leading to the accumulation of unwanted medicines.

“There are some packs which are large, like 100 tablets. When a patient takes a small amount like 2 or 3 tablets, the rest of the pack actually remains with us” (P2).

“Most reputed companies take returns, but the lesser-known companies do not do so” (P4).

Theme 2—factors influencing and limiting disposal practices

Sub-theme 2.1—suppliers and return mechanisms

Seven participants explained that accepting items within a defined timeframe before expiry is the main condition set out by the suppliers and that they rarely accept expired medicines. Three participants stated that the main suppliers only accept take-back products when they are directly purchased from them, which are identified through their coding system, and refuse items supplied by sub-distributors. Five participants noted that suppliers do not accept partial packs as returns and require medicines to be in full packs.

“Some suppliers accept returns within 6 months or 3 months, and there are even some who take them back after expiry” (P5).

“What we have left are the cut pieces, because suppliers only accept full packs as returns” (P5).

Sub-theme 2.2—regulatory and policy environment

Several pharmacists pointed out that there are no specific legal criteria mandating the suppliers to take responsibility for the expired products. Nine participants emphasized that, although Food and Drug Inspectors (FDI) conduct pharmacy inspections, they pay limited attention to issues related to medicine disposal. A participant

representing a large pharmacy chain voiced that the National Medicines Regulatory Authority (NMRA) conducts regular inspections in warehouses.

“FDIs just come and inspect us. They do not tell us what to do with these unwanted medicines” (P13).

“There should be a law for companies to take back their own products once expired. As far as I know, there’s no such law” (P3).

Sub-theme 2.3—pharmacy level resources and limitations

The majority of independent pharmacies have limited space and struggle to allocate a separate area for expired medicines. Chain pharmacies usually experience fewer difficulties in transferring unwanted products between outlets, warehouses, or even for destruction, as they have their own licensed vehicles for medicine transportation. Moreover, chain pharmacies (P9, P10, P12) used tech-based systems that track and notify expiry dates, while most independent pharmacies rely on basic or manual inventory methods. Five participants emphasized that disposal through incineration or third-party contractors is expensive. P9 noted that cement companies accept only one ton of waste for incineration, making this option impractical for small quantities of medicine waste.

“Cement factory does not destroy waste in small batches. What they destroy is one ton at a time. No matter how long it takes, independent pharmacies will never collect a ton of pharmaceutical waste” (P9).

Sub-theme 2.4—human and motivational factors

Several participants highlighted that owner pharmacists are keen on waste management because it directly affects them, whereas staff in chain pharmacies feel less responsible, as mentioned by P4. However, some participants from chain pharmacies reported that their chain pharmacy has increased supervision and staff awareness to address the issue, as explained by P12. In addition, P9, from a large chain, emphasized how the fear of reputational damage and concern for professional integrity motivate them toward safe disposal practices. Financial motivation is another key factor that influences waste management practices. After recovering the costs from returning short-expiry medicines to suppliers, pharmacists are encouraged to record and return rather than dispose of pharmaceutical waste themselves.

“We have an annual goal that expiry should be 0%. Since this target affects incentives and bonuses, everyone fully participates” (P12).

“We cannot act unethically. If you look carefully, it’s possible. But we work with a brand that has been built for 175 years. We cannot play with it” (P9).

Sub-theme 2.5—awareness and knowledge gaps

Four participants mentioned that they had not received adequate training on medicine disposal since their undergraduate studies and

that even the knowledge gained was not practical. Six participants highlighted that the limited guidance provided by the FDI is rather inadequate and appears to be more focused on documentation rather than addressing practical issues. All respondents from independent pharmacies and small chains were generally unaware of proper disposal procedures.

“In the Bachelor of Pharmacy degree, they taught us disposal methods like the incineration tower, but in reality, there’s no proper way to actually do it” (P7).

“FDIs just come and inspect us. They do not instruct us what to do with these unwanted medicines” (P13).

Sub-theme 2.6—systemic and coordination gaps

Three participants identified the absence of designated contractors as an issue and also saw this as a potential business opportunity. Seven participants mentioned that, since they lack formal collection procedures, it compels them to store unwanted medicines for a long period or discard them unsafely. Seven respondents recognized that regulatory expectations do not align with the ground-level reality and the absence of clear guidelines for medicine disposal. Two participants highlighted that the absence of a national data system has hindered the regulatory authority from tracing and monitoring expired stocks, leading to potential misuse.

“The reality is there’s no proper system to collect these medicines” (P5).

“The NMRA has provided many guidelines, but I think there are no guidelines specifically on disposal practices. If these were indicated on the website, we could refer it and become aware” (P1).

Theme 3—perceptions and attitudes toward disposal responsibility

Sub-theme 3.1—awareness of risks

All respondents recognized the environmental and health risks of improper medicine disposal. Participants noted that the risk of developing resistance to antibiotics occurs as a consequence of improper disposal, demonstrating their understanding of risks relating to their ethical and professional responsibility.

“The real risk comes with antibiotics, cytotoxic drugs, and radioactive drugs. Discarding those into the environment is highly dangerous” (P5).

“If we do not handle this properly, it will not have a big impact on us right now. The real effect will fall on our children and even their children.”(P3).

Sub-theme 3.2—attitudes toward responsibility

Interestingly, all participants had a sense of professional responsibility for the safe disposal of medicines. Seven pharmacists identified pharmaceutical waste management as a key role of

pharmacists. Two pharmacists emphasized that, without proper infrastructure, the responsibility cannot be fulfilled. Three participants highlighted the shared responsibility among healthcare professionals, pharmacy owners, and the public. Nine participants stated that suppliers and importers should accept the responsibility to take back their products. Four participants highlighted the absence of a collection mechanism for household pharmaceutical waste. Three participants mentioned they would willingly follow the proper procedures if a streamlined disposal system were established.

“It’s mainly the pharmacists’ responsibility, but the other healthcare professionals are also responsible” (P5).

“At least the suppliers need to be forced to collect back what they have supplied” (P5).

Sub-theme 3.3—perceptions of the public’s role

Three participants noted a lower understanding of the environmental and health risks of improper medicine disposal by the general public. Eight participants admitted that they avoid patient counseling on medicine disposal due to the absence of proper formal guidelines.

“People do not really understand how to properly discard these medicine waste” (P6).

“Without proper guidelines, I do not prefer to comment on anything either. We usually do not advise on these kinds of matters unless it’s absolutely necessary” (P7).

Theme 4—recommendations for improvement

Sub-theme 4.1—strengthening the regulatory framework

Five participants believed that the absence of a legal framework has led to improper practices and reduced accountability throughout the supply chain. Nine participants highlighted the need for a law mandating the collection of medicines by manufacturers and importers, supporting the registration of medicines at the NMRA. In addition, two participants suggested regular inspections by the regulatory body on the disposal of unwanted medicines.

“NMRA can also check if such expired medicines have been accumulated when renewing the pharmacy license. But there should be a method to dispose” (P11).

“It would be great if there was a law that every company that registers a medicine must take it back when it expires” (P4).

Sub-theme 4.2—building infrastructure and supply chain connections

Two participants mentioned the need for a more interconnected supply chain between suppliers and pharmacies. Another two emphasized the importance of having authorized and regulated pharmaceutical waste management companies. Five participants suggested a government-mandated collection and disposal program to be in effect,

either through accredited contractors, municipal councils, or dedicated hospitals.

“There should be a clear mechanism in place for the company. They should go to the pharmacies and collect the medicines using baskets. Pharmacy owners have to pay a fee to get the service. (P9).

“It would be really good if the government could have stepped in and set up a proper system to collect expired medicines from pharmacies” (P7).

Sub-theme 4.3—education and awareness

Three participants emphasized the need to strengthen awareness of proper pharmaceutical waste management among pharmacists and the public. They also noted that such strategies should initially begin with pharmacists. Participants suggested the importance of executing educational programs for the public using mass media, community police services, and FDIs.

“If pharmacists are made aware of, at least the medicines that are removed from pharmacies can be managed properly” (P1).

“Community pharmacists should be made aware first, and then the general public. I think this can be done quite easily through the media” (P7).

Discussion

The first objective of assessing the current management and disposal practices of unwanted medicines in community pharmacies has been addressed through theme 1. Findings revealed a clear difference between large chain pharmacies and smaller chain or independent pharmacies. Large chains follow more organized practices, such as centralized inventory management, inter-branch stock transfers, and disposal through incineration. All pharmacies conducted regular expiry checking, and some used color coding to manage inventory. Independent pharmacies primarily rely on unsafe methods such as disposal via municipal waste, flushing in toilets, improper burial, and burning. This finding aligns with previous research in developing countries, such as Sri Lanka, emphasizing the lack of formal guidelines, which leads to convenience-based and environmentally hazardous disposal practices (Bataduwaarachchi et al., 2020; Janarthanan et al., 2022). When pharmaceuticals are discarded via municipal waste, their final consequence is unknown, raising concerns about soil and water contamination. Similar challenges have been reported in Pakistan and Nigeria, where community pharmacies lack access to regulated waste mechanisms (Khan et al., 2020; Michael et al., 2019). The landfill method is globally practiced but recommended as the option of last resort, which should be conducted with proper sealing to avoid leaking into the soil (Ingale et al., 2023).

Only one large pharmacy chain was found to follow incineration. Another chain pharmacy provided its waste to a third-party waste collector, which was unknown to independent pharmacies. Moreover, the said chain pharmacy was not aware of the disposal method of the waste-collecting company. A similar awareness gap was observed in the United Arab Emirates (UAE). However, in the UAE, the most common disposal method used was to outsource it to a contractor licensed by the health authority, and fewer medicines were returned to the suppliers (Kharaba et al., 2022), unlike in Sri Lanka.

Returning short-expiry stocks to suppliers was observed as the most common proactive medicine management strategy. However, inconsistent supplier policies, such as rejecting partial packs and refusing products supplied through sub-distributors, led to the accumulation of unwanted medicines. These findings highlight a critical weakness in the supply chain, whereby the financial and environmental responsibility is shifted from the manufacturer or importer to the community pharmacist (Nyaga et al., 2020). Large chain pharmacies benefit from bulk purchases and mutual contracts, while small chains and independent pharmacies struggle due to weak bargaining power, as they receive no assurance from suppliers for the acceptance of unwanted medicine returns.

Theme 2 addressed the second objective and revealed that systemic limitations have affected the current practices rather than professional negligence. Independent pharmacies face resource constraints, such as inadequate storage space, lack of transport facilities, limited staff, and the lack of advanced inventory management systems. High cost and large volume requirements for incineration have further discouraged proper disposal. Hence, a centralized national-level collection mechanism, accessible and affordable to all pharmacy types, is essential. A similar situation is reported in the Middle East and South-East Asia (Nairat et al., 2023; Ingale et al., 2023).

A study conducted in Pakistan found that safe disposal techniques were not covered in diploma and degree programs, leading pharmacists to rely entirely on pharmaceutical sales representatives, workshops, textbooks, and research journals, unlike in India, where workshops were a major source for updating their knowledge (Khan et al., 2020). In contrast, this study showed that, although Sri Lankan pharmacists have received some knowledge in their degree or diploma courses, their level of awareness can be neither up to date nor practically feasible, highlighting the lack of training after becoming a practicing pharmacist.

The absence of a clear, mandatory regulatory framework for pharmaceutical waste disposal was identified as a key limiting factor. Pharmacists reported minimal concern and supervision by the NMRA and FDIs on disposal procedures, reflecting weak enforcement common in low- and middle-income countries (Chong et al., 2022). Participants strongly believed in the need for a law mandating the suppliers to accept expired medicines from pharmacies, in contrast to high-income countries with medicine take-back policies where producer responsibility is legally mandated. (Wang et al., 2024; Egan et al., 2022). Although the NMRA has published disposal guidelines, participants were not aware of these guidelines (NMRA, 2024), indicating limited awareness and poor coordination between the regulatory body and community pharmacies.

Theme 3 demonstrates pharmacists' perceptions of their professional role in medicines disposal. Remarkably, all participants showed high awareness of the environmental and public health risks and admitted their responsibility toward safe disposal. They expressed willingness to follow proper disposal procedures if a streamlined system were established. However, pharmacists were reluctant to counsel patients on safe disposal due to the absence of formal guidelines and disposal mechanisms. These findings align with international findings showing low counseling rates where clear protocols and take-back programs are absent (Alfian et al., 2024), particularly among developing nations such as Sri Lanka. Furthermore, these findings indicate that the public health educator role of a pharmacist is currently underdeveloped in Sri Lanka due to insufficient education (Sakeena et al., 2019).

Theme 4 demonstrates the participants' recommendations for addressing the identified systemic gaps. Their main suggestion was

mandating the supplier take-back system, which aligns with the principle of Extended Producer Responsibility (EPR), where producers are liable for disposal or recycling (Wang et al., 2024). In Sri Lanka, supplier return acceptance is mostly voluntary and inconsistent, putting the disposal burden on community pharmacies.

Overall, pharmacists suggested a government-led collection program involving authorized waste management contractors, municipal councils, or hospital waste management systems, along with practical guidelines and awareness programs targeting both pharmacists and the general public.

Conclusion

The study revealed various unsafe disposal practices among Sri Lankan community pharmacies due to infrastructural and regulatory limitations. Large-scale chain pharmacies follow safer methods like incineration, while a few use contract collectors, which is still not a popular method nor widely used in Sri Lanka. In contrast, small chains and independent pharmacies use informal methods, such as municipal waste disposal, flushing, improper burial, and burning, due to the absence of accessible proper disposal mechanisms. In addition, the abovementioned small-scale operators cannot be directly involved in incineration due to high cost, inability to meet the high volume of waste, limited storage, transport, and staff limitations, leading to prolonged storage of unwanted medicines. However, pharmacists were aware of the environmental and health risks of improper disposal, highlighting the absence of a standardized disposal procedure as the main issue. The most common proactive method adopted was returning short-expiry medicines to the suppliers, although this approach is also limited due to inconsistent and restrictive supplier policies.

Participants primarily suggested the need for a legal framework mandating the medicine suppliers to take back the expired products, a centralized government-based collection system through municipal councils, and authorized contractors or designated facilities. Publishing clear guidelines, strengthening awareness, and enforcing these were also highlighted. Pharmacists expressed a positive attitude toward complying with the formal procedures if a structured system is established. A top-down policy-driven approach supported by infrastructure and legislation is mandatory to improve the safe disposal of pharmaceutical waste in Sri Lanka.

Limitations

In this study, non-probability purposive sampling was used, and the participants were primarily selected from the Western Province of Sri Lanka. This might have introduced a sampling bias. Similarly, the sampling method for selecting the participants would have caused selection bias with a tendency to limit generalizability. The focus of the study was confined to community pharmacists, excluding medicine suppliers and regulators, which might have limited the comprehensive understanding of systemic barriers to medicine disposal practices in Sri Lanka.

Recommendations

Future studies, which span a national survey using mixed methods, can be conducted to quantify the disposal volumes.

Identifying the perspectives of regulators and suppliers, as well as the effectiveness of pilot testing on take-back or medicine collection programs through interventional studies, calls for further research.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethics Review Committee of Sri Lanka Institute of Information Technology Business School (Reference no. SLIIT/REC/SBS/2025/38). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

MP: Writing – original draft, Data curation, Formal analysis, Investigation. RH: Conceptualization, Methodology, Supervision, Writing – review & editing. CP: Writing – original draft, Data curation, Formal analysis, Investigation.

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