

# Disposal of Unused Antibiotics in Community Pharmacies in Saudi Arabia: A Mixed-Methods Study

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**Introduction:** Improper disposal of unused antibiotics poses a significant global challenge, drawing attention from various stakeholders. This discharge of antibiotics into the environment can occur through various means such as industrial production, consumption, and excretion by humans and animals, as well as improper disposal of unused or expired antibiotics. The aim of our study is to investigate the availability of proper disposal of antibiotics in community pharmacies and to explore obstacles and opportunities from pharmacist's point of view.

**Methods:** This study used a mixed-methods approach that consisted of two study arms: quantitative and qualitative. The quantitative arm used a mystery-shopper method for assessing the disposal of antibiotics in community pharmacies. The qualitative study arm consisted of several in-depth semi-structured focus groups with a sample of pharmacists working in community pharmacies in Riyadh.

**Results:** The mystery shopper arm showed that 85% (n=88) refused to take the return of antibiotics. Interviews with pharmacists have indicated a lack of knowledge on safe disposal methods for antibiotics and medications. Additionally, pharmacists have cited several factors contributed to accumulation of the antibiotics such as nonadherence or policies mandating the sale of whole medication packs instead of the required amounts as a contributing factor to this issue. Furthermore, there is a lack of dedicated facilities for the population to safely dispose of their medications and/antibiotics.

**Conclusion:** By acknowledging the factors contributing to improper disposal practices, recognizing the importance of proper antibiotic disposal, and advocating for multi-faceted initiatives, we can work towards mitigating this critical issue. Through collaborative efforts involving education, policy interventions, and community engagement, we can foster a culture of responsible medication disposal, ultimately safeguarding public health and environmental well-being.

**Keywords:** antibiotic disposal, antibiotic waste, Saudi Arabia, unused antibiotics, health care professionals, mixed methods, mystery shoppers, qualitative research, in-depth interviews

## Introduction

Improper disposal of unused antibiotics poses a significant global challenge, drawing attention from various stakeholders including policymakers, healthcare professionals, pharmaceutical companies, and communities.<sup>1</sup> Antibiotics, being crucial medicines in hospitals, can lead to substantial amounts being released into hospital wastewater due to excretion and improper disposal of unused compounds.<sup>2</sup> This discharge of antibiotics into the environment can occur through various means such as industrial production, consumption, and excretion by humans and animals, as well as improper disposal of unused or expired antibiotics.<sup>3</sup> Improper disposal practices of antibiotics have been linked to environmental health risks, including the presence of antibiotic residues in sewage and the emergence of antibiotic-resistant bacteria.<sup>4</sup>

Studies have highlighted the importance of appropriate disposal of unused and expired antibiotics to mitigate environmental hazards and public health risks.<sup>5</sup> The consequences of improper antibiotic disposal extend far beyond the development of antimicrobial resistance, posing significant threats to both human health and the environment.

Antibiotics, when improperly discarded, can contaminate water sources and ecosystems, potentially harming wildlife and affecting human health through the food chain. Moreover, the emergence of antibiotic-resistant infections leads to increased healthcare costs associated with treating these complex conditions, placing a significant strain on hospitals and healthcare systems. The rise of antibiotic resistance also poses a serious public health risk, as the spread of these resistant bacteria can lead to outbreaks and potentially overwhelm healthcare infrastructure.<sup>6</sup>

Improper disposal practices not only contribute to environmental pollution but also fuel antimicrobial resistance, leading to the mutation of microbes into resistant pathogens.<sup>6</sup> Efforts such as the National Return and Disposal of Unwanted Medicines scheme in Australia provide avenues for the safe disposal of unused antibiotics through local community pharmacies.<sup>7</sup> In contrast, studies have shown that a significant portion of the population is unaware of proper disposal methods, leading to antibiotics being thrown away with household waste.<sup>8</sup>

The aim of our study is to investigate the availability of proper disposal of antibiotics in community pharmacies and to explore obstacles and opportunities from pharmacist's point of view.

## Materials and Methods

This study used a mixed-methods approach that consisted of two study arms: quantitative and qualitative. The quantitative arm used a mystery-shopper method for assessing the disposal of antibiotics in community pharmacies that were randomly selected from the all five regions of Saudi Arabia. The mystery shoppers acted as patients that have two bottles of unused antibiotics. The qualitative study arm consisted of several in-depth semi-structured interviews with a sample of pharmacists working in community pharmacies in Riyadh.

## Ethical Approval

Our research project submitted to the Institutional Review Board (IRB) was reviewed and approved on 14 February 2021 and granted permission to conduct this study, given that our study does not disclose participant's identity and poses no risk to the patients.

The number of ethical approval is 23.02.2021 (11.07.1442), Ref. No. 21/0202/IRB, and the approval was from the Chairman, IRB for Health Sciences Colleges Research on Human Subjects, King Saud University College of Medicine.

## The Mystery-Shopper Method

Four researchers acted as mystery shoppers and used a predesigned scenario when calling the pharmacies. The scenario is presented in [Appendix 1](#). Mystery shoppers received two training sessions. The first one was before the pilot study and included a role playing and working through possible pharmacy scenarios according to what might happen. Mystery shoppers was given explicit instructions on how to conduct the call, especially in regards to not providing information unless requested by the pharmacist. The second session was after the pilot study and it include a thorough discussion about what happened and the issues emerged. Each researcher was assigned to call a specific number of pharmacies from a list obtained from the Saudi Ministry of Health.

## Data Collection

The scenarios and the mystery-shopper approach were piloted with eight community pharmacies to ensure consistency. The mystery shopper fills a checklist after each call. The disposal of unused antibiotics post call checklist is presented in [Appendix 2](#).

## Sample Size

The estimated sample size for the mystery-shopper method was calculated after conducting the pilot study. The target population was drawn from pharmacies in all five provinces of Saudi Arabia: Central Region, Southern Region, Northern Region, Western Region, Eastern Region. Saudi Arabia has 10,347 pharmacies in the private sector,<sup>9</sup> which include community pharmacies and those incorporated in private hospitals. The sample size was determined using the followed formula:

$$n = \frac{z^2 P(1 - P)}{d^2}$$

In this formula,  $Z$  is the statistic corresponding to a 95% confidence level, which was 1.96.  $P$  is the prevalence (it was obtained after the pilot study as the prevalence is unknown currently), and  $d$  is the accuracy level of the precision, which was 5%. Therefore, a sample size of 230 pharmacies would be required.

## Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences version 21.<sup>10</sup> Descriptive statistics were used to analyze the data, presenting frequencies and percentages for the following variables:

Pharmacy Type: Independent vs Chain pharmacies.

Province: Central, Southern, Northern, Western, and Eastern regions.

Response: Refuse, Accept, and No Answer.

## The Semi-Structure in-Depth Interviews

### Sampling and Recruitment

Purposeful sampling of health care providers working in community was recruited for the interviews using the following criteria: holding a valid practice licence and English speaking.

### Interview Guide

A topic guide presented in [Appendix 3](#) was created using the experience of the research team and a literature search on the topic. The questions were open ended questions, changing the order of the questions was undertaken if needed, in addition, probing questions and variation from interview to interview might happen. The guide was piloted before using it for relevancy and understanding.

### Data Collection

The interviews were conducted in English through the Zoom Video Communications<sup>11</sup> due to covid 19 crises by the primary researcher (NA) using the topic guide described above. Consent was obtained before each interview. Interview participants provided informed consent, including consent for the publication of their anonymized responses. The interviews were recorded and transcribed verbatim using ATLAS.ti software (Scientific Software Development GmbH, 2020). Moderators were taking notes during the interview and write a summary following each interview.

The interview transcripts were checked against the audio recordings and anonymized it. All transcripts and audio-recordings were securely kept in password-protected computers. Thematic content analysis was undertaken to analyze the data. This process involved systematically analyzing the transcripts, assigning codes to ideas, and gathering examples of those codes from the text.<sup>12</sup>

### Evaluation

In this study, we employed the Mixed Methods Appraisal Tool (MMAT)<sup>13</sup> to rigorously assess the methodological quality of both qualitative and quantitative components of our mixed methods research. It is provided in [Appendix 4](#).

By utilizing the MMAT, we aimed to enhance the transparency, credibility, and methodological rigor of our mixed methods study, ultimately contributing to the validity and reliability of our research findings.

## Results

### The Mystery Shopper

235 pharmacies were selected to cover all district of Saudi Arabia and contacted. Each pharmacy was called through the phone number by one of the researchers (RS, AB, AA, RA) and asked if they can take the antibiotic returned using the scenario described above ([Appendix 1](#)). Only 103 out of 235 pharmacies answered the phone calls (43.8% response rate). This suggests a potential challenge in reaching pharmacies for this type of inquiry. Among the responding pharmacies, 88 (85.4%) refused to accept the returned antibiotics. This highlights a significant reluctance among pharmacies to

**Table I** Pharmacies Characteristics and Pharmacists' Responses to Return an Antibiotic

Variables	N (235)	(%)
<b>Pharmacy type</b>		
Independent	110	47
Chain	126	53
<b>Provinces</b>		
Central Region	61	26
Southern Region	17	7
Northern Region	34	14
Western Region	98	42
Eastern Region	26	11
<b>Responses: only 103 (56%) answered the call</b>		
Refuse to return an antibiotic	88	37
Accept to return an antibiotic	15	7

participate in antibiotic return programs. The study found no significant difference in refusal rates between independent and chain pharmacies. The refusal rate varied across provinces, with the highest refusal rate observed in the Western Region (42%) and the lowest in the Eastern Region (11%). However, the sample size for each province was relatively small, making comparisons difficult. Detailed of the pharmacy characteristics and the results are presented in Table 1.

## The Interview

Four focus groups were undertaken with 19 community pharmacists. Most of the participants were male (n=13) who identified several contributing factors for improper disposal of antibiotics from their perspective. Below is a description of each factor and the related quotation.

The interviews revealed that pharmacists seldom encounter requests for the return of antibiotics:

...it is very rare to ask for a return of antibiotics in our pharmacies, especially in community pharmacies, as most of the antibiotics come in suitable doses or quantities in their packaging. FG 5

Furthermore, the interviews showed that pharmacist do not know how the proper method to get rid of antibiotics and the risk associated with it:

...I am a pharmacist and my wife is a doctor, but most of the time we still throw it in the trash, hahaha. FG 5

I mean, we need to know what harm there is if it's significant. We definitely need awareness on this issue, but the awareness is limited, even for us as pharmacists, honestly. What will happen if we dispose of them in any way, what will happen and where is the harm in this matter? We ourselves do not know, it has not come to us either through study or work, how this could potentially affect things in the future. FG 4

## The Factors That Contributed to the Return of Antibiotics?

The pharmacists discussed that it is crucial to consider the adherence of patients when they return medication, and to view this as an opportunity to examine it:

Now, if the patient returns his medications ... we do consider if the patient is adherent in taking his medication or not, whether he takes it daily or not? FG 2

Next, the interviewee mentioned that certain regulations, such as the policy of selling the entire box of antibiotics instead of the precise number of pills needed by the patients, might have contributed to such returns:

The most wastage of antibiotics comes from dentists because the dosage is less than the full package. FG 2

## The Solutions

The pharmacist discussed the importance of raising awareness among people about the proper disposal of antibiotics.:

... but I think the issue needs to be directed at the community, not just the pharmacist. People need to know that they have to dispose of medication properly. It should be a general message to the people, with the pharmacist being a part of it. FG 3

Suggestions, such as placing collection boxes at local pharmacies, were discussed:

Most people come to the pharmacy and say, 'Keep it for me, give it to someone in need.' Of course, this policy is completely rejected at [...] primarily due to privacy and liability concerns, and secondly due to storage conditions and accountability but considering other solutions such as have a service like a medication collection box or charitable organizations. FG 4

## Conclusion

Our research has revealed that the majority of community pharmacies in Saudi Arabia do not accept returned medication. Interviews with pharmacists have indicated a lack of knowledge on safe disposal methods for antibiotics and medications. Pharmacists have cited policies mandating the sale of whole medication packs instead of specific amounts as a contributing factor to this issue. Furthermore, there is a lack of dedicated facilities for the population to safely dispose of their medications and/antibiotics.

The lack of awareness and policies for returning unused medications has been identified as a key factor contributing to improper disposal practices elsewhere.<sup>14</sup> Community pharmacies' reluctance to accept returned medications, as highlighted in previous research, reinforces the challenge of safe disposal. Moreover, the interviews conducted with pharmacists have revealed a lack of knowledge on safe disposal methods, particularly for antibiotics, further exacerbating the issue.

Proper disposal of unused antibiotics is crucial for several reasons. Firstly, inappropriate use of antibiotics can lead to adverse health effects, including the development of antimicrobial resistance.<sup>15</sup> Additionally, improper disposal of antibiotics contributes to environmental pollution, further exacerbating the global concern of antimicrobial resistance. The improper disposal of antibiotics, particularly those that persist in the environment, poses a significant threat to human health and ecosystems. Aminoglycosides and cephalosporins, commonly used antibiotics, are of particular concern due to their potential for environmental contamination and contribution to the development of antimicrobial resistance. Aminoglycosides, for instance, have been shown to persist in soil and water, potentially affecting aquatic life and entering the food chain. Similarly, cephalosporins can contaminate water sources and promote the selection of antibiotic-resistant bacteria in the environment.<sup>16</sup> This underlines the urgent need to address the inadequate disposal of antibiotics to ensure public health and environmental sustainability.

Initiatives such as take-back programs have been proposed to facilitate the safe disposal of household antibiotics and reduce unsupervised use.<sup>2,17</sup> These programs provide a structured mechanism for individuals to return unused medications, including antibiotics, to designated collection points, thereby preventing improper disposal and reducing the risk of environmental contamination.

Addressing the lack of awareness surrounding proper medication disposal is crucial.<sup>18</sup> Educational campaigns targeted at both healthcare professionals and the general public can raise awareness about the potential risks associated with improper antibiotic disposal. By imparting knowledge on safe disposal methods and the importance of returning unused medications, these campaigns can contribute to fostering responsible medication disposal practices.

Policy interventions play a vital role in promoting proper antibiotic disposal.<sup>19</sup> Implementing regulations that mandate the acceptance of returned medications by community pharmacies and establishing guidelines for safe disposal practices

can significantly mitigate the current challenges. Moreover, policies advocating for the implementation of take-back programs can further facilitate the safe disposal of antibiotics and other unused medications.

Overall, addressing the issue of improper disposal of antibiotics necessitates a multi-faceted approach. Education and awareness campaigns can enhance public understanding of the risks associated with improper disposal and encourage responsible practices. Policy interventions are essential to create a supportive regulatory framework that promotes safe medication disposal. Community engagement initiatives can further reinforce responsible disposal behaviors and increase participation in take-back programs, ultimately safeguarding public health and the environment.

In conclusion, the improper disposal of antibiotics presents a pressing challenge with far-reaching implications for public health and the environment. By acknowledging the factors contributing to improper disposal practices, recognizing the importance of proper antibiotic disposal, and advocating for multi-faceted initiatives, we can work towards mitigating this critical issue. Through collaborative efforts involving education, policy interventions, and community engagement, we can foster a culture of responsible medication disposal, ultimately safeguarding public health and environmental well-being.

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## Disclosure

The authors declare that there are no conflicts of interest regarding the publication of this research paper.

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