

ASSESSING THE AWARENESS AND DISPOSAL PRACTICES OF UNUSED AND EXPIRED MEDICATIONS AMONG PATIENTS VISITING UBTH CONSULTANT OUTPATIENT DEPARTMENT (COPD).



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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF CLINICAL PHARMACY AND PHARMACY PRACTICE, FACULTY OF PHARMACY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DOCTOR OF PHARMACY (PHARM.D) DEGREE OF THE UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA.

FEBRUARY, 2025

CERTIFICATION

This is to certify that this work was done by **GABRIEL EBOSEREMHEN ELENBALULU** in the Department of Clinical Pharmacy and Pharmacy Practice, Faculty of Pharmacy, University of Benin, Benin City, Nigeria, in partial fulfillment for the award of the Pharm. D degree of the University.

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ANTI-PLAGIARISM CERTIFICATION

We, the undersigned, attest and declare that the research project of **GABRIEL EBOSEMHEN ELENBALULU** titled **ASSESSING THE AWARENESS AND DISPOSAL PRACTICES OF UNUSED AND EXPIRED MEDICATIONS AMONG PATIENTS VISITING UBTH CONSULTANT OUTPATIENT DEPARTMENT (COPD)** has successfully passed the anti-plagiarism test and does not violate any copyright regulations.

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DEDICATION

I dedicate this work to my beloved parents and siblings whose love, support and prayers have been unwavering over the years.

ACKNOWLEDGEMENT

First and foremost, I am deeply grateful to God Almighty for granting me the strength, wisdom, and perseverance to successfully complete this project.

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ABSTRACT

Background: Improper disposal of unused and expired medications poses public health and environmental risks. Medications discarded in household waste or flushed into water systems contribute to pollution, antimicrobial resistance, and accidental poisonings. This study assesses awareness and disposal practices among patients at the Consultant Outpatient Department (COPD) of the University of Benin Teaching Hospital (UBTH).

Objectives: To evaluate patients' awareness of proper medication disposal, identify common disposal practices, and assess associated environmental and public health risks.

Methods: A descriptive cross-sectional study was conducted using a structured questionnaire administered to 270 UBTH COPD outpatients. Data were analyzed using SPSS version 27, with descriptive and inferential statistics. Statistical significance was set at $p < 0.05$.

Results: Among respondents, 185 (68.5%) had unused or expired medications. The majority, 229 (84.8%) disposed of them in household waste bins, while only 8 (3.0%) used take-back programs. Additionally, 25 (9.3%) flushed medications down the toilet. Although 216 (80.0%) recognized the risk of accidental ingestion and 172 (63.7%) linked improper disposal to antimicrobial resistance, only 53 (19.6%) had received proper medicine disposal education. A significant relationship existed between educational background and awareness ($p < 0.05$), but awareness did not always translate to safe practices.

Conclusion: A gap exists between awareness and safe disposal practices. Unsafe disposal remains prevalent, highlighting the need for public awareness campaigns, regulatory enforcement, and accessible take-back programs.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Due to increased medication availability, the use of medicines throughout the world and in Nigeria for treating and managing various diseases has significantly increased in recent years. This rise often leads to the storage of medicines at home, which can result in medication waste and the accumulation of unused or expired drugs over time.

An unused drug is a medicine which remains after a patient has quit using it (Wang *et al.*, 2021). Patients may have leftover medications for a variety of reasons, some of which include, treatment failure, change of prescription by the prescriber, medicines reaching the expiry date, undesirable side effects, change in treatment plan, precautionary prescribing, failure to complete prescribed course (non-compliance with the treatment plan). Patients may also stop taking their medications once they feel better without completing the treatment plan, storing the medication with the plan to reuse the medicines soon.

These unused medications in some cases are given to friends or family members presenting with symptoms which they believe are similar to what they were earlier treated for, without encouraging these persons to visit their healthcare provider. This results in taking medication without appropriate diagnosis, not realising the uniqueness of each individual, and the need for an appropriate/differential diagnosis.

Some of these drugs are antibiotics, which can result in antibiotic resistance since these patients lack the required expertise and knowledge of the correct dose and treatment regimen for the condition.

Besides keeping unused medications at home, how these medications are disposed of, is also of great importance. Leftover drugs that patients may not see the need to keep in storage at home, probably because they are expired, may be discarded in a manner that is not in line with stipulated guidelines from appropriate bodies like World Health Organization (WHO) or National Agency for Food and Drug Administration Control (NAFDAC). Improper disposal methods can harm the environment, and by extension, our health.

Expired drugs are medications that have passed their expiration date, the date after which the manufacturer can no longer guarantee the drug's safety, potency, and effectiveness (FDA, 2024).

1.2 Literature Review

Improper disposal of unused and expired medications has been identified as a significant environmental and public health concern worldwide. Studies have shown that large quantities of unused drugs accumulate in households due to various reasons, including non-adherence to prescriptions, change in treatment plans, and over-prescription. The disposal methods employed by individuals are often unsafe, leading to environmental contamination, accidental poisoning, and the development of antimicrobial resistance (AMR) (Kale *et al.*, 2025). While awareness of safe disposal practices varies, there is a general consensus that more structured interventions, educational programs, and policy regulations are required to ensure proper medication disposal. This literature review presents studies on global guidelines for safe medication disposal of unused or expired medicines, medication disposal awareness and practices, highlighting factors influencing behaviour, consequences of improper disposal.

1.2.1 Guidelines for Disposal of Unused/Expired Medicines

World Health Organization (WHO) and other regulatory bodies, such as Federal Drug Administration (FDA) and National Agency for Food and Drug Administration Control (NAFDAC) have established comprehensive guidelines on how medicines (unused/expired) can be safely disposed of. These guidelines were designed to prevent environmental contamination, accidental poisoning, and drug misuse.

WHO Guideline for the safe disposal of unused/expired medicines:

These guidelines apply to not only patients but drug distributors and manufacturers alike;

1. Return to Pharmacy/Manufacturer: Unused or expired medications can be returned to participating pharmacies or manufacturers for safe disposal.

2. Landfill: Disposing waste directly into a land disposal site without prior treatment. Two types are recognized: Open uncontrolled non-engineered dumps and engineered landfills.
3. Waste Immobilization: This can be through encapsulation or inertization.
4. Sewer: Liquid pharmaceutical preparations like Syrups and Intravenous (IV) fluids can be diluted with water and flushed into the sewers in small quantities over some time.
5. Medium temperature incineration
6. Burning in containers
7. Chemical composition: If an appropriate incinerator is not available, the action of chemical decomposition can be used by the manufacturer's recommendation

FDA Guideline for the safe disposal of unused/expired medicines:

US Food and Drug Administration emphasizes that the best way to dispose of your expired, unwanted, or unused medicines is through a drug take-back program, The U.S. Drug Enforcement Administration (DEA) organizes National Prescription Drug Take Back Day across various communities. Additionally, many local areas run their drug take-back initiatives. Some pharmacies provide safe disposal options, such as on-site drop-off boxes, mail-back programs, and other convenient methods for discarding unused medications. (FDA, 2024).

Also, in areas where take-back is not an easy option, two options for disposing of medicines at home are recommended, they include;

1. Flushing Medications:

To determine whether a medication should be flushed, patients should consult the medication label or the accompanying patient information leaflet for specific disposal instructions.

Additionally, the U.S. Food and Drug Administration (FDA) provides a list of medicines recommended for flushing when take-back programs are unavailable. It is essential to avoid flushing medications unless explicitly instructed to do so, as improper disposal may pose environmental and public health risks.

Some medicines, such as fentanyl patches, oxycodone, hydromorphone and morphine are particularly dangerous if misused. Powerful opioids like buprenorphine, hydrocodone-containing medications, methadone, and oxymorphone also pose a high risk of overdose and fatal respiratory depression. Because of their potential harm, especially to children, pets, or individuals who might misuse them, these medications come with specific disposal instructions, including flushing them down the toilet or sink if a take-back option is unavailable. (FDA, 2024)

2. Disposing of Medicines in Household Trash

If a take-back program is unavailable, most medications, including prescription and over-the-counter (OTC) drugs in various forms like pills, liquids, patches, drops, and creams can be disposed of in household trash, except those on the FDA's flush list.

Steps for Safe Disposal:

1. Remove the medication from its original packaging and mix it with an unappealing substance such as used coffee grounds, dirt, or cat litter. This helps prevent accidental ingestion by children or pets and deters anyone from retrieving it from the trash.
2. Place the mixture in a secure, resealable container (such as a plastic bag or an empty can) to prevent spills.
3. Dispose of the sealed container in the garbage.

4. Remove or scratch out personal details from the empty medicine packaging to protect your privacy before discarding it. (FDA, 2024).

NAFDAC Guideline for the safe disposal of unused/expired medicines:

The National Agency for Food and Drug Administration Control (NAFDAC), a regulatory body in Nigeria, also have outlined guidelines that align with the aforementioned, they are;

1. Take-back programs: Consumers are encouraged to return expired or unused medicines to approved collection centres.
2. Environmental Protection: Ensuring that medications do not enter water sources or open landfills to avoid environmental damage.
3. Controlled Incineration: For hazardous and controlled substances, incineration is required.

These bodies stress the importance of avoiding unsafe disposal methods.

A study by Michael *et al.* (2019), using a mixed-method design to evaluate pharmacy compliance with NAFDAC guidelines, assessed the disposal practices of expired and unused medications among community pharmacies in Anambra State, southeast Nigeria. The various disposal methods were through NAFDAC 31.8%, drug distributors 23.9%, and rubbish bins 9.1%; this was mainly for solid dosage forms.

However, 7.1% reported that they used the sink to dispose of their liquid dosage forms and 29.6% noted they do not stock Class B controlled drugs. A lesser proportion of respondents 23.4% complied fully with the national guideline on disposal of expired medications, while 22.1% complied partially and 54.5% did not comply. Some of the respondents 22.1% reported that NAFDAC uses incineration or other forms of heat to dispose of expired drugs, but 24.7%

reported they do not know how NAFDAC dispose of their expired drugs. The majority of the respondents 71.4% suggested the state-run disposal system.

The study identified low compliance with NAFDAC-specified standards in the disposal of expired and unused medicines.

1.2.2 Awareness and Disposal Practice of Unused and Expired Medicines

Awareness of safe disposal methods among patients and caregivers plays a significant role in influencing methods employed by individuals to dispose of their unused/expired medicines and by extension mitigate the risk associated with unsafe disposal practices. Several studies have illustrated the disposal practice and awareness among patients in different parts of the world;

A study by Gidey *et al.*, 2020, assessed the knowledge, attitude, and practices related to disposing of unused and expired medications among 384 patients visiting Ayder Comprehensive Specialized Hospital outpatient pharmacy in Ethiopia.

Their findings showed that more than half of the respondents (199 (51.8%)) were not correctly informed about medicine waste and 233 (60.7%) of these participants had no prior information on the correct guidelines for the disposal of medicine waste. However, a significant portion of the participants (351 (91.4%)) acknowledged that inappropriate disposal of unused and expired medicine can cause environmental harm.

56.8% of the respondents “agreed” with the potential risks linked to having unused/expired medicines at home, and 53.6% of them "strongly agreed" that children are more likely to be at risk. 41.41% of the respondents had unused/expired medicines in their homes. The study also showed that the commonly used disposal practice for unused medicines was throwing them in household trash as reported by 297 (77.3%) followed by flushing unused medications in the toilet/sink 152 (39.6%). These two methods were also the most commonly preferred disposal practices for expired medicines.

This study confirmed that the method mostly employed by individuals in disposing of their pharmaceutical waste (disposal in household garbage and toilet/sink) is not in line with the recommendations of both national and international policies and guidelines, and a majority of People are not aware that these guidelines exist.

A similar study by Sonowal *et al.*, (2016) was conducted at a tertiary care hospital in India, that evaluated consumers' knowledge, attitudes, and practices regarding disposal of unused medicines. From the result of the study, most of the respondents (136, 68%) stored unused medicines at home, with analgesics (drugs for pain) being the most common.

Although most participants (160, 80%) recognized the importance of safe medicine disposal to prevent drug misuse and abuse (84, 42%), environmental pollution (32, 16%), and adverse drug reactions (54, 27%), only 78 (39%) were aware of appropriate disposal methods. The most common disposal practice was throwing medicines in household trash (30.5%). Moreover, 76% of respondents supported establishing a program for collecting unused medications, and 77% felt that increased awareness about the hazards and proper disposal methods was necessary.

This study highlights the gap between awareness and actual disposal practices, reinforcing the need for educational campaigns and proper disposal facilities.

Similarly, a cross-sectional population-based survey by Okoro & Peter, 2020 was carried out on residents conveniently selected from the 22 units or wards of Maiduguri's metropolis.

Approximately 35% of people who participated in the research, stored unused or unwanted medications at home for future use or until expiration, while 30.2% chose to give them to friends or relatives. Over half (59.7%) of the respondents disposed of expired medications in household garbage, whereas a small percentage (1.3%) gave them to friends or relatives or buried them.

Analysis of respondents' responses, showed significant agreement between participants' gender, age, marital status, and educational level with their disposal practices for both unused/unwanted and expired medications.

From this study, keeping unused/expired medicines for future use or until expiration and throwing them in household garbage/trash cans was the most common method of disposal.

Additionally, 80% of the study population knew of the harmful effects of improper disposal of expired and unused/unwanted medicines on public health and the environment and yet did not practice appropriate disposal behaviour, which should make this a priority for concerned authorities to formulate and implement guidelines to protect public health and environment.

A descriptive cross-sectional questionnaire-based study by Adedeji-Adenola *et al.*, 2022, assessed the knowledge, perception and practice of pharmaceutical waste disposal among the public (534 respondents) in Lagos State, Nigeria.

A total of 250 respondents (46.8%) were currently taking one or more medications. The majority of participants (413, 78.3%) had not received guidance from health professionals on pharmaceutical waste disposal. Knowledge of pharmaceutical waste was moderate among respondents, with 234 (43.8%) demonstrating fair awareness. Many participants (500, 93.6%) believed that there was not enough information on proper disposal methods, and 475 (88.9%) were in support of the implementation of a program to collect unused, leftover, or expired medications. A significant number of respondents (391, 73.2%) disposed of unused medicines in household garbage.

Another study by Alnahas *et al.*, 2021 conducted in Mwanza, Tanzania, examined household pharmaceutical disposal practices. The study found that 70.19% of surveyed households stored medications at home, with 96.0% of them retaining unused medications intended for disposal. The primary reason for medication retention was the uncompleted course of treatment due to

perceived recovery. The most common disposal methods included discarding medications in household trash (75.5%) and pit latrines (15.5%). Alarming, while 76% of respondents were aware of the dangers of improper medication disposal, unsafe practices persisted (Mwanza Study, 2022). These findings underscore the urgent need for targeted interventions by regulatory agencies such as the Food and Drugs Authority (FDA) and local stakeholders to promote safer disposal methods.

1.2.2.1 Practice Discrepancies

Although healthcare professionals play a critical role in promoting proper medication disposal, studies suggest that many do not adhere to recommended guidelines. Research shows that 29.2% of doctors dispose of unused medications in household garbage, highlighting a concerning lack of compliance with safe disposal practices (Gangopadhyay *et al.*, 2024). Additionally, the absence of well-established disposal services and clear guidelines further complicates adherence to proper disposal methods (Lam *et al.*, 2024).

Conversely, some argue that the responsibility for proper disposal should not rest solely on healthcare professionals but should extend to the general public. Many individuals are also unaware of safe disposal methods (Lam *et al.*, 2024), making it necessary to implement widespread educational initiatives that emphasize the importance of responsible medication disposal at all levels.

1.2.2.2 Bridging the Gap Between Awareness and Practice

While many studies highlight the importance of safe medication disposal, the persistent gap between awareness and actual practice suggests that knowledge alone is not enough to drive behavioural change. The findings from this study will help bridge this gap by identifying the specific barriers that prevent patients from following recommended disposal practices. These barriers may include:

- Limited access to proper disposal facilities, such as drug take-back programs or designated collection points.
- Lack of clear disposal guidelines for patients at the point of medication dispensation.
- Cultural and habitual practices, where patients dispose of medications based on convenience rather than safety.
- Insufficient enforcement of disposal policies, leading to inconsistent or ineffective implementation.

By understanding these challenges, healthcare providers, policymakers, and environmental agencies can develop targeted interventions that go beyond awareness campaigns to include practical, accessible, and sustainable solutions.

1.2.3 Factors Influencing Medication Disposal Behaviours

The disposal of medications is influenced by various factors, including awareness, attitudes, and access to proper disposal methods. These factors play a crucial role in shaping behaviours that can mitigate the environmental and health impacts of pharmaceutical waste. Understanding these influences is essential in guiding the development of effective interventions and policies to promote responsible medication disposal practices.

1. Awareness and Education

Awareness of pharmaceutical-related environmental contamination significantly influences disposal behaviours. In Malaysia, 73% of respondents were aware of such contamination, which correlated with participation in the Medicine Return Program (MRP) (Ling *et al.*, 2024). Similarly, in Thailand, while commendable knowledge about proper disposal was observed, this awareness did not always translate into practice, highlighting a gap between knowledge and behaviour (Srijuntrapun & Maluangnon, 2024).

2. Attitudes and Perceptions

Attitudes towards environmental protection and moral obligations have been found to significantly influence medication disposal behaviours. In Algeria, individuals with strong environmental concerns demonstrated greater intentions to reduce medication waste (Mouloudj *et al.*, 2023). Likewise, in the United Kingdom (UK), attitudes and risk perceptions were key predictors of correct disposal behaviour, with increased awareness reducing disposal in household bins and encouraging returns to pharmacies (Watkins *et al.*, 2022).

3. Access to Proper Disposal Infrastructure

The availability of collection points and structured take-back programs significantly impacts medication disposal practices. In Thailand, the absence of such systems was identified as a major barrier to proper disposal (Srijuntrapun & Maluangnon, 2024). Conversely, in Brazil, the presence of designated collection points and supportive public policies played a crucial role in encouraging responsible disposal practices (Silva *et al.*, 2023).

4. Demographic Factors

Demographic characteristics such as age and education level also influence disposal behaviours. Studies indicate that younger individuals and those with higher education levels are more likely to engage in appropriate medication disposal methods (Srijuntrapun & Maluangnon, 2024; Watkins *et al.*, 2022). This suggests that targeted educational interventions may be necessary to bridge gaps in disposal practices across different population groups.

1.2.4 Consequences of Improper Medication Disposal

Improper disposal of medications poses significant risks to public health and the environment. When expired or unused drugs are discarded in household trash, flushed down the drain, or

poured into water bodies, they can contaminate soil and water sources, leading to harmful ecological effects.

Additionally, improper disposal increases the risk of accidental poisoning, drug misuse, and antibiotic resistance. Understanding these consequences highlights the urgent need for effective disposal strategies and public awareness initiatives to mitigate these risks.

1.2.4.1 Environmental Impact

Disposal of unused/expired medicines poses significant environmental challenges, primarily due to improper disposal practices that lead to contamination of water and soil. This issue is exacerbated by the lack of awareness and inadequate disposal guidelines.

Improper disposal methods, such as flushing medications or discarding them in household trash, can lead to contamination of water supplies and ecosystems (Lam *et al.*, 2024). Pharmaceutical residues have been detected in surface water, groundwater, and even drinking water, raising concerns about long-term environmental and health consequences.

However, studies show that a majority of individuals remain unaware of these environmental risks. Without proper interventions, the continued presence of pharmaceutical pollutants could disrupt aquatic life and contribute to the growing issue of drug resistance.

An observational cross-sectional conducted by Mahara *et al.*, 2021 assessed the impact of improper disposal practices of expired drugs on the environment, water and soil in China.

This study was carried out, using a self-structured questionnaire, with a total of 613 community residents with a 99.4% response rate enrolled for the study. More than half (60.2%) of the residents who participated in the study, acknowledged that expired medications can harm the environment, including soil and water sources. Additionally, 81.2% were aware that improper disposal could lead to side effects or toxic effects.

Despite this awareness, 71.6% still discarded expired drugs in the trash or sink. Only 24.8% followed proper disposal practices by using designated recycling bins, while just 8.3% disposed of expired medications at collection points three to five times a year. Alarming, 65.1% had never used a collection point, highlighting poor disposal habits.

Traces of pharmaceutical products used for humans, animals, and birds have been found in water bodies. Wastewater treatment plants are not equipped to effectively remove these pharmaceutical residues, which enter the water through human consumption and excretion. Additionally, improper disposal and inadequate wastewater treatment contribute to freshwater contamination, ultimately harming the environment.

A study by Patneedi *et al.*, (2015) examined how pharmaceutical effluents contribute to pollution in water bodies, affecting both human and aquatic life. The study highlighted that pharmaceutical residues originate from various sources, including industrial effluents, hospital and domestic waste, veterinary pharmaceuticals, and incomplete sewage treatment processes. These contaminants persist in water sources, leading to potential bioaccumulation and toxicity risks.

Pharmaceutical waste primarily enters the environment through the discharge of untreated or partially treated wastewater from manufacturing plants, improper disposal of expired medications, and agricultural runoff containing veterinary drugs. Traditional wastewater treatment methods, such as activated sludge, have proven ineffective in completely removing pharmaceutical residues. As a result, active pharmaceutical ingredients (APIs) have been detected in surface water, groundwater, and even drinking water, sometimes in concentrations ranging from micrograms per liter ($\mu\text{g/L}$) to milligrams per liter (mg/L) (Patneedi *et al.*, 2015).

One of the key concerns highlighted in the study is the toxicity of pharmaceutical pollutants. Antibiotics, for instance, can alter microbial communities, potentially leading to antibiotic

resistance. Non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, naproxen, and diclofenac have also been frequently detected in municipal effluents. These compounds pose risks to aquatic ecosystems, as seen in the decline of vulture populations due to diclofenac toxicity. Additionally, prolonged exposure to low concentrations of pharmaceutical pollutants has been linked to reproductive damage in aquatic species, hormonal disruptions, and alterations in food chains. (Patneedi *et al.*, 2015)

The study also underscored the lack of stringent regulations regarding pharmaceutical waste disposal. In many regions, there are no established limits for pharmaceutical contaminants in wastewater or drinking water. Patneedi *et al.*, (2015) emphasized the need for enhanced monitoring and the adoption of advanced wastewater treatment technologies to mitigate these risks. Effective strategies such as improved pharmaceutical take-back programs, stricter industrial waste disposal regulations, and the implementation of advanced oxidation processes in wastewater treatment plants could help reduce pharmaceutical contamination in the environment.

A more recent study by Karungamye *et al.*, (2022) reviewed pharmaceutical disposal practices and their environmental contamination risks in East African countries. The study highlighted that improper pharmaceutical waste disposal is a significant concern, as pharmaceuticals enter the environment through municipal wastewater, hospital waste, and direct disposal into landfills or water sources. Despite the existence of regulations, non-compliance and lack of enforcement remain key challenges. The review also emphasized that pharmaceutical pollutants contribute to antibiotic resistance and ecological toxicity, affecting both aquatic organisms and human health. The study called for increased awareness, policy revisions, and stricter enforcement of disposal regulations to mitigate environmental risks (Karungamye *et al.*, 2022).

The study also underscored the lack of stringent regulations regarding pharmaceutical waste disposal. In many regions, there are no established limits for pharmaceutical contaminants in wastewater or drinking water.

1.2.4.2 Health Threats

Evidence has shown that the presence of antibiotics in waterways may lead to antibiotic resistance due to bacterial exposure to these drugs (Costanzo *et al.*, 2005), expired and unused medicines in households may increase the likelihood of accidental child poisonings (Beirens *et al.*, 2006) and risk of possible reuse for conditions that the medication may not be indicated for.

A study carried out by Oaks *et al.* (2004), links the decline of Oriental White Backed Vultures (OWBV) with exposure to Diclofenac residues in Pakistan. Moa (2011) showed that Early-life progesterin exposure causes arrested oocyte development, oviductal agenesis and sterility in adult *Xenopus tropicalis* frogs.

A study by Maharana *et al.*, 2017, on the storage, reuse, and disposal of unused medications to find out the proportion of unused medicines present in the households of a village in Singur, West Bengal, and the reasons why medications were left unused was conducted. The result of the survey showed that 67.1% of the households surveyed had unused medicines, of which 34.4% were antacids followed by antipyretics (31.25%) and antibiotics (28.1%). The most common reason highlighted for discontinuation of their medication was due to recovery from illness and stored for subsequent use.

This results in self-medication, since the condition they intend to treat may not require the drugs they were earlier prescribed and as such, subsequent failure in therapy.

1.2.5 Interventions and Strategies for Improving Medication Disposal

Improving medication disposal is essential for protecting both environmental safety and public health. Various strategies have been identified to enhance proper disposal practices, with a strong focus on education, community-based programs, and healthcare provider involvement. The following sections outline key approaches aimed at promoting responsible medication disposal.

1. Educational Interventions

Public Awareness Campaigns: Educational programs such as Safe DUMP have demonstrated significant improvements in public knowledge about medication disposal. Participants' understanding increased from 60% to 80% following targeted educational sessions (Lai *et al.*, 2021).

Pharmacist-Led Initiatives: Pharmacists play a crucial role in educating the public on proper disposal methods. Their engagement helps address common improper disposal practices, such as discarding medications in household trash or flushing them down the drain (Alfian *et al.*, 2024).

2. Community Take-Back Programs

Drug Take-Back Events: Organized events encourage the return of unused medications; however, studies indicate mixed effectiveness in increasing overall disposal rates (Schäfer *et al.*, 2021).

Access to Disposal Bins: The availability of community take-back bins has been shown to significantly influence disposal Behaviours. Higher disposal rates are observed in areas with multiple accessible collection points (Roberts *et al.*, 2022).

3. Healthcare Provider Engagement

Patient Education: Healthcare providers play a critical role in medication disposal by distributing disposal packets and providing guidance on safe practices. This is particularly important for high-risk medications, such as opioids, which require careful handling to prevent misuse and environmental contamination (Roberts *et al.*, 2022).

While these strategies have shown promising results, challenges remain in ensuring that knowledge translates into consistent disposal practices. Continued research and tailored interventions are necessary to effectively enhance medication disposal Behaviours and minimize associated risks.

1.3 Justification of Study

Assessing the knowledge and practices regarding disposing of unused and expired medicines is crucial due to the significant environmental and health risks associated with improper disposal.

Medications discarded incorrectly, whether by flushing down the toilet, throwing them in household trash, or pouring them into drains, can contaminate water sources, pollute soil, and contribute to antimicrobial resistance (AMR), posing serious public health and ecological threats. While healthcare professionals and students generally demonstrate a positive attitude towards safe disposal, research indicates that their actual practices often fall short, revealing a gap between awareness and action. This discrepancy underscores the need for targeted educational initiatives and stronger policy enforcement to promote safe disposal practices.

1.3.1 Knowledge Gaps

Despite a general awareness of the need for safe medication disposal, significant gaps exist in knowledge regarding correct disposal methods and available services (*Lam et al.*, 2024; *Gangopadhyay et al.*, 2024). For example, 70% of the general public and 60% of doctors reported being unaware of proper disposal methods (*Lam et al.*, 2024).

Many individuals are unfamiliar with drug take-back programs, recycling bins, and other safe disposal options, leading them to adopt unsafe practices. Addressing these knowledge gaps is essential for improving disposal behaviours and preventing medication-related environmental and health risks.

1.4 Objectives of The Study

The primary objective of this study is to assess the disposal practices and level of awareness regarding unused and expired medications among outpatients at the University of Benin Teaching Hospital (UBTH).

1.4.1 Specific Objective

1. Assess Current Disposal Practices:

- To identify the common methods used by out-patients at UBTH to dispose of unused and expired medications.
- To examine the factors influencing the disposal practices of outpatients regarding unused and expired medications.

2. Evaluate Awareness Levels:

- To determine the level of awareness of UBTH outpatients about the environmental and health risks associated with improper disposal of medications.

CHAPTER TWO

METHODS

2.1 Study Design

This study adopted a cross-sectional design to assess the awareness and disposal practices of unused/expired medications among patients visiting the Consultant Out-patient Department (COPD) pharmacy unit at the University of Benin Teaching Hospital (UBTH).

This approach enabled data collection at a single point in time, offering valuable insights into the awareness and disposal practices of unused and expired medications among patients at the UBTH Consultant Outpatient Department (COPD).

2.2 Study Setting

This study was conducted at the Consultant Outpatient Department (COPD) Pharmacy of the University of Benin Teaching Hospital (UBTH) in Benin City, Edo State. As a prominent urban centre and the capital of Edo State, Benin City hosts a diverse population with varying levels of healthcare awareness and access.

The COPD Pharmacy Department serves as a critical point of pharmaceutical care for patients attending the Consultant Outpatient Department (COPD), providing medication counselling, prescription dispensing, and pharmaceutical care services. This unit serves approximately 400 patients weekly, providing care for individuals undergoing treatment for chronic conditions, infectious diseases, and specialized outpatient services, including cardiology, endocrinology, and nephrology. Patients visit the unit either for prescription refills or to obtain their prescribed medications from the COPD Pharmacy Department.

For this study, the COPD Pharmacy Department was selected as the study site because it is a key access point for medication dispensing and patient interactions regarding medication use

and disposal. By focusing on outpatients at this pharmacy unit, the study provides valuable insights into their awareness and practices regarding the disposal of unused and expired medications.

2.3 Data Collection

The questionnaire used as the main data collection tool in this study was developed based on previously validated surveys from Gidey *et al.*, (2020), Adedeji-Adenola *et al.*, (2022), and Sonowal *et al.*, (2016), with modifications to fit the study population at UBTH. It was distributed to participants at the University of Benin Teaching Hospital (UBTH) Consultant Outpatient Department (COPD) to assess their knowledge and practices related to the disposal of unused and expired medications.

The questionnaire included sociodemographic information, types of medications used, specific disposal methods (e.g., throwing in the trash, flushing, take-back programs) and specific questions addressing various aspects of medication disposal habits, awareness of environmental effects, and availability of proper disposal options.

2.4 Study Population

The participants in this study consisted of patients visiting the University of Benin Teaching Hospital (UBTH) Consultant Outpatient Department (COPD).

2.4.1 Inclusion Criteria:

- Participants aged 18 years and above.
- Should be currently seeking healthcare or receiving treatment at the outpatient department to ensure they have relevant experience with medications.
- Participants must voluntarily agree to take part in the study by providing informed consent.

- Participants (patients and caregivers) must be able to understand and respond to the questionnaire. Caregivers can assist in answering on behalf of elderly patients when needed.

2.5 Sample Size

A sample size of 270 patients was targeted to ensure sufficient data for statistical analysis. Participants was selected using a random sampling technique from patients visiting the COPD pharmacy department.

To determine the sample size using Slovin's formula ($n = N / (1+Ne^2)$), we need to establish the total population size (N) and the margin of error (e). Here's how we can calculate it based on the study context:

2.5.1 Step-by-Step Calculation

1. Define Parameters:

- The total patient population in the Consultant Outpatient Department (COPD) at UBTH over a two-week period is estimated at **N = 800**, based on records from the COPD Pharmacy Unit.
- Margin of error (e): Typically set at 5% or 0.05 for most studies, which indicates a 95% confidence interval.

2. Apply Slovin's Formula:

$$n = N / (1+Ne^2)$$

Where:

n = required sample size

N = total population size

e = margin of error

3. Substitute the Values:

$$n = 800 / (1 + 800 * 0.05^2)$$

$$n = 267$$

2.6 Ethical Consideration

Ethical approval was obtained from the UBTH Health Research Ethics Committee (HREC) with protocol number: **ADM/E 22/A/VOL. VII/14865432048** before the commencement of the study.

All participants will provide informed consent, ensuring their participation is voluntary and confidential.

2.7 Data Analysis

Descriptive and inferential analyses were carried out using an appropriate statistical software package. Data analysis was performed with SPSS version 27, with discrete variables expressed as percentages and proportions. Statistical significance was set at a p-value of less than 0.05, which corresponds to a 95% confidence interval.

CHAPTER THREE

RESULTS

3.1 Socio-demographics factor

A total of 270 respondents participated in the study. The largest age group was 45 years and older, comprising 90 participants (33.3%), followed by 66 participants (24.4%) aged 25–34. The gender distribution was nearly equal, with 136 males (50.4%) and 134 females (49.6%). In terms of educational attainment, 178 respondents (65.9%) had completed tertiary education, while 62 (23.0%) had attained secondary education. Regarding employment status, 108 respondents (40.0%) were employed, whereas 62 (23.0%) were students. Additionally, 142 respondents (56.6%) were married (Table 3.1).

3.2 Types of Medications Used and Storage Among Respondents

Among the respondents, 185 reported having unused or expired medications, accounting for 68.5% of the sample. The most commonly stored medications were analgesics, reported by 135 participants (50.0%), followed by antibiotics with 80 participants (29.6%) and medicated creams with 66 participants (24.4%). A significant number of participants, 151 (55.9%), reported always checking expiration dates before use, while 20 (7.4%) never checked (Table 3.2).

TABLE 3.1: Socio-demographics Factor of Respondents (N= 270)

Variable	Frequency	Percentage (%)
Age (Years)		
18-24	56	20.7
25-34	66	24.4
35-44	58	21.1
45+	90	33.3
Gender		
Male	136	50.4
Female	134	49.6
Educational Background		
No Formal Education	9	3.3
Primary Education	21	7.8
Secondary Education	62	23.0
Tertiary Education	178	65.9
Employment Status		
Employed	108	40.0
Unemployed	23	8.5
Retired	20	7.4
Student	62	23.0
Other	57	21.1
Marital status		
Married	142	56.6
Single	107	39.6
Separated	5	1.9
Divorced	6	2.2
Widowed	10	3.7

TABLE 3.2: Types of Medications Used and Storage Among Respondents (N= 270)

Variable	Frequency	Percentage (%)
Analgesics		
Yes	135	50.0
No	135	50.0
Antibiotics		
Yes	80	29.6
No	190	70.4
Medicated Creams		
Yes	66	24.4
No	204	75.4
Inhalers		
Yes	24	8.9
No	246	91.1
Ear/Eye Drops		
Yes	48	17.8
No	222	82.2
Antacids		
Yes	39	14.4
No	231	85.6
Supplements		
Yes	53	19.6
No	217	80.4
Cough and Cold Meds		
Yes	62	23.0
No	208	77.0
Diarrhea/Constipation		
Yes	45	16.7
No	225	63.3
Antihypertensive Meds		
Yes	56	20.7
No	214	79.3
Diabetes Mellitus Meds		
Yes	31	11.5
No	239	88.1
Others		
Yes	32	11.5
No	238	88.1

3.3 Perception of the Environmental and Public Health Impact of Unused and Expired Drugs

A total of 145 respondents agreed that improper disposal contaminates water sources, representing 53.7% of the sample, while 172 respondents (63.7%) linked improper disposal to antibiotic resistance. Additionally, 216 respondents acknowledged that improper disposal increases the risk of accidental ingestion by children, accounting for 80.0%, while 196 respondents (72.6%) believed it could encourage drug abuse (Table 3.3).

3.4 Medication Disposal Practices Among Respondents

The most common disposal method was throwing medications in household waste bins, reported by 229 respondents, accounting for 84.8% of the sample, followed by 25 respondents (9.3%) who flushed them down the toilet. Participation in drug take-back programs was low, with only 8 respondents (3.0%) reporting involvement. Additionally, 78 respondents (28.9%) stored unused medications, while 39 (14.4%) gave them to others. Among those who disposed of medications in waste bins, 165 respondents (61.1%) sealed them in a bag, whereas 105 (38.9%) discarded them exposed (Table 3.4, Fig 3.1).

3.5 Attitude and Perception

Among these participants, only 53 (19.6%) had received education on proper medication disposal, while the majority 217 (80.4) had not. Additionally, 126 (46.7%) expressed willingness to participate in take-back programs, whereas 144 (53.3%) were unwilling.

TABLE 3.3 Perception on the Environmental and Public Impact of Unused/Expired Medicines (N= 270)

Variable	Frequency	Percentage (%)
Contaminate Water		
Agree	145	53.7
Disagree	125	46.3
Accumulate in Soil		
Agree	112	41.5
Disagree	158	58.5
Antibiotic Resistance		
Agree	172	63.7
Disagree	98	36.3
Accidental Ingestion by Children		
Agree	216	80.0
Disagree	54	20.0
Encourage Drug Abuse		
Agree	196	72.6
Disagree	74	27.4

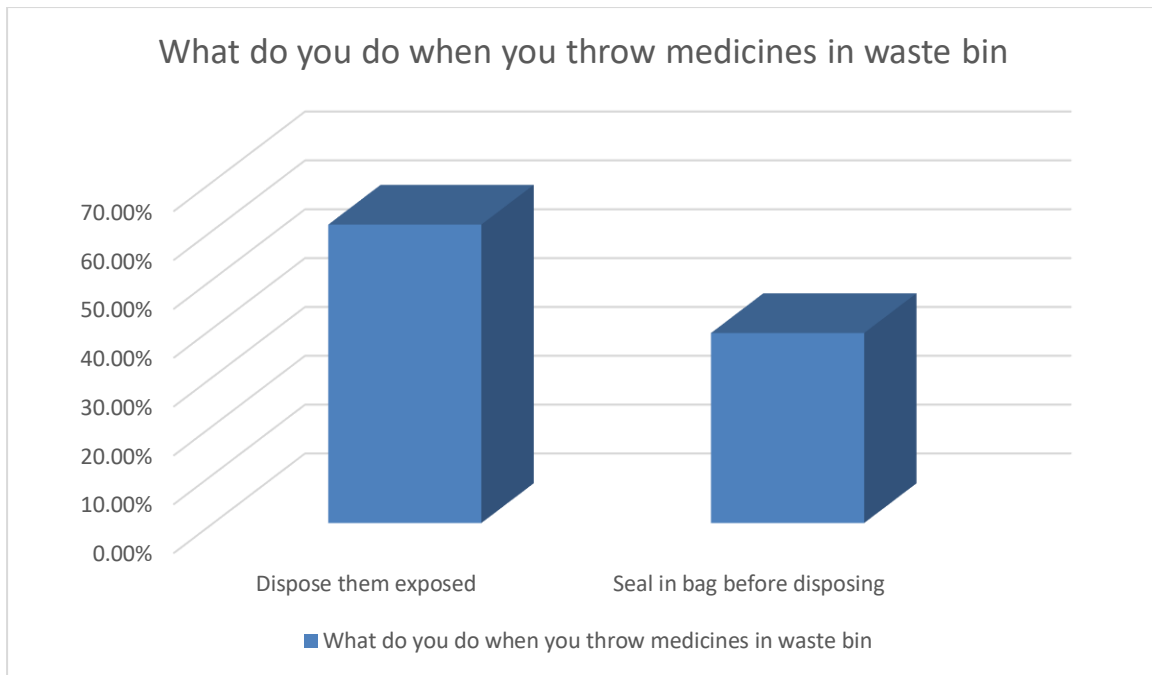


Fig 3.1: Bar chart showing disposal practices of participants.

TABLE 3.4: Medication Disposal Practices Among Respondents (N= 270)

Variable	Frequency	Percentage (%)
Throw In Waste Bin		
Yes	229	84.8
No	41	15.2
Flush Down the Toilet		
Yes	25	9.3
No	245	90.7
Take-back program		
Yes	8	3.0
No	262	97.0
Keep In storage		
Yes	78	28.9
No	192	71.1
Give to Someone Else		
Yes	39	14.4
No	231	85.6
Keep for Later Use		
Yes	73	27.0
No	197	73.0
Other		
Yes	20	7.4
No	250	92.6

3.6 Relationship Between Gender and Type of Medications Stored

There was no statistically significant association between gender and the type of medications stored across all categories ($p > 0.05$). However, some trends were observed:

- Storage of medicated creams was slightly higher among females (59.1%) compared to males (40.9%), though the difference was not statistically significant ($p = 0.077$).
- Males were more likely to store supplements (62.3%) compared to females (37.7%), but this also did not reach statistical significance ($p = 0.053$).
- Similarly, storage of blood pressure medications was slightly higher among females (57.1%) compared to males (42.9%), though this difference was not significant ($p = 0.207$).

Overall, the findings suggest that both genders exhibit similar medication storage behaviours without strong statistical differences. (Refer to Table 3.5 for detailed results.)

Table 3.5: Relationship between Gender and type of medications stored. N (270)

Variable	Yes (%)	No (%)	P-value
Analgesics			
Male	69 (50.74)	67 (49.26)	0.808
Female	66 (49.25)	68 (50.75)	
Antibiotics			
Male	41 (30.15)	95 (69.85)	0.851
Female	39 (29.10)	95 (70.90)	
Medicated Creams			
Male	27 (19.85)	109 (80.15)	0.077
Female	39 (29.10)	95 (70.90)	
Inhalers			
Male	13 (9.56)	123 (90.44)	0.679
Female	11 (8.21)	123 (91.79)	
Ear/Eye Drops			
Male	22 (16.18)	114 (83.82)	0.488
Female	26 (19.40)	108 (80.60)	
Antacids			
Male	15 (11.03)	121 (88.97)	0.108
Female	24 (17.91)	110 (82.09)	
Supplements			
Male	33 (24.26)	103 (75.74)	0.053
Female	20 (14.93)	114 (85.07)	
Cough and Cold Meds			
Male	32 (23.53)	104 (76.47)	0.824
Female	30 (22.39)	104 (77.61)	
Diarrhea/Constipation			
Male	21 (15.44)	115 (84.56)	0.586
Female	24 (17.91)	110 (82.09)	
Antihypertensive Meds			
Male	24 (17.65)	112 (82.35)	0.207
Female	32 (23.88)	102 (76.12)	
Diabetes mellitus Meds			
Male	16 (11.76)	120 (88.24)	0.883
Female	15 (11.19)	119 (88.81)	
Others			
Male	19 (13.97)	117 (86.03)	0.278
Female	13 (9.70)	121 (90.30)	

For analysis with educational background, respondents were grouped into two educational categories:

- Basic Education: Includes those with no formal education, primary education, or secondary education.
- Tertiary Education: Includes those who attained education beyond secondary school (e.g., university, polytechnic, or other higher institutions).

3.7 Relationship Between Educational Background and Perception of Environmental/Public Health Impact

A significant relationship was observed between educational background and awareness of key environmental and public health risks associated with improper medication disposal:

- The risk of accidental ingestion by children and pets was more widely recognized among respondents with tertiary education ($p < 0.001$).
- A strong association was found between tertiary education and awareness that improper disposal contributes to antibiotic resistance ($p = 0.002$).
- Tertiary-educated respondents were also more likely to acknowledge that improper disposal contaminates water supplies and affects aquatic organisms ($p = 0.015$).

However, awareness of soil contamination due to pharmaceutical waste did not show a strong statistical association with educational background ($p = 0.033$). Similarly, recognition of medication disposal as a potential contributor to drug abuse showed a weaker but notable association ($p = 0.011$). (Refer to Table 3.6 for detailed results.)

Table 3.6: Relationship Between Educational Background and Perception of the Environmental/Public Health Impact. N (270)

Variable	Agreed (%)	Disagreed (%)	P-value
Contaminate Water Supplies and Aquatic Organisms			
Basic Education	40 (43.49)	52 (56.51)	0.015*
Tertiary Education	105 (58.98)	73(41.02)	
Accumulate in Soil and Affect Crops			
Basic Education	30 (32.60)	62 (67.4)	0.033*
Tertiary Education	82 (46.07)	96 (53.93)	
Results in Resistance to Antibiotics			
Basic Education	47 (51.09)	45 (48.91)	0.002*
Tertiary Education	125 (70.22)	53 (29.78)	
Increase Risk of Accidental Ingestion in Children and Pets			
Basic Education	63 (68.48)	29 (31.52)	<0.001*
Tertiary Education	153 (85.95)	25 (14.05)	
Encourage Drug Abuse or Misuse			
Basic Education	58 (63.04)	34 (36.96)	0.011*
Tertiary Education	138 (77.52)	40 (22.48)	

*** - Statistical Significance**

3.8 Relationship Between Educational Background and Disposal Practice

No significant difference was observed in the practice of disposing of medications in waste bins or flushing them down the toilet ($p > 0.05$). However, those with basic education were more likely to store unused medications ($p < 0.001$), give them to others ($p = 0.037$), or keep them for later use ($p = 0.003$) (Table 3.7).

A higher proportion of tertiary-educated respondents (129 vs. 56) reported having unused medications, but this was not statistically significant ($p = 0.052$)

3.9 Relationship Between Educational Background and Frequency of Checking Expiry Dates

A strong association was found between educational background and the frequency of checking expiration dates ($p = 0.001$). Tertiary-educated respondents were more likely to always check expiration dates, while those with basic education were more likely to never check (Table 3.8).

Table 3.7: Relationship Between Educational Background and Disposal Practice. N (270)

Variable	Yes (%)	No (%)	P-value
Throw in Waste Bin			
Basic Education	76 (82.60)	16 (17.39)	0.468
Tertiary Education	153 (85.96)	25 (14.04)	
Flush Down the Toilet or Sink			
Basic Education	8 (8.69)	84 (91.30)	0.818
Tertiary Education	17 (9.55)	161 (90.44)	
Take-back Program			
Basic Education	0 (0)	92 (100)	0.054
Tertiary Education	7 (3.93)	171 (96.07)	
Keep in Storage at Home			
Basic Education	39 (42.39)	53 (57.61)	<0.001*
Tertiary Education	39 (21.91)	139 (78.09)	
Give them to Someone else.			
Basic Education	19 (20.65)	73 (79.35)	0.037*
Tertiary Education	20 (11.24)	158 (88.76)	
Keep for Later Use			
Basic Education	35 (38.04)	57 (61.96)	0.003*
Tertiary Education	38 (21.35)	140 (78.65)	
What do you do when you dispose of Medicine?			
	Dispose Exposed	Seal in Bag	
Basic Education	30 (32.61)	62 (67.39)	0.128
Tertiary Education	75 (42.13)	103 (57.87)	

* - Statistical Significance

Table 3.8: Relationship Between Educational Background and Frequency of Checking for Expiry Date.

Variable	Basic Education (%)	Tertiary Education (%)	P-value
Do You Check Medicines for Expiry Dates?			
Always	43 (46.74)	108 (60.67)	0.001*
Often	8 (8.69)	31 (17.42)	
Sometimes	18 (19.57)	19 (10.67)	
Rarely	10 (10.87)	13 (7.30)	
Never	13 (14.13)	7 (3.93)	

*** - Statistical Significance**

CHAPTER FOUR

DISCUSSION

4.1 Overview of Findings

The study assessed the awareness and disposal practices of unused and expired medications among patients visiting the Consultant Outpatient Department (COPD) at the University of Benin Teaching Hospital (UBTH). Findings revealed that a significant proportion of respondents (68.5%) had unused or expired medications at home, with analgesics (50%) being the most commonly stored medication. This trend can be attributed to the widespread use of analgesics for managing pain-related conditions such as headaches, musculoskeletal pain, and post-surgical recovery, leading to frequent prescriptions and purchases.

Additionally, the availability of analgesics as over-the-counter (OTC) medications contributes to their accumulation, as patients often purchase them without completing previous supplies (Auta *et al.*, 2011; Sonowal *et al.*, 2016). Similar trends have been reported in other studies, where analgesics are consistently identified as one of the most commonly stored and improperly disposed of medications (Adedeji-Adenola *et al.*, 2022; Gidey *et al.*, 2020).

Regarding disposal practices, 84.8% of respondents disposed of their medications in household waste bins, while only 3.0% participated in drug take-back programs, also 105 of these respondents disposed of their unused/expired medications without the precaution of disguising them, while 165 sealed them in a bag before disposal. Additionally, 9.3% flushed medications down the toilet, contributing to potential environmental contamination. Awareness of proper disposal methods was low, with only 19.6% of respondents having received prior education on safe medication disposal from their healthcare provider (Physician/Pharmacist). Despite recognizing the environmental and public health risks associated with improper disposal, a gap between awareness and practice was evident.

The study also found a significant relationship between educational background and awareness levels, but this did not translate into adherence to proper disposal guidelines. This suggests that awareness alone is insufficient to drive behavioural change, highlighting the need for systemic interventions, regulatory enforcement, and increased accessibility to proper disposal facilities.

4.2 Comparison with Previous Studies

The findings of this study are consistent with previous research conducted in Nigeria and other countries regarding medication disposal practices, perception of environmental and public health impact of unused and expired medicines, disposal practices, and attitude and perception.

4.2.1 Medication Usage

The study found that 68.5% of respondents had unused or expired medications at home, with analgesics (50%) being the most commonly stored medication. This is consistent with findings from Sonowal *et al.* (2016), where 68% of respondents reported storing unused medications, with analgesics being the most retained. The high prevalence of unused medications can be attributed to factors such as changes in prescriptions, self-medication, and the common practice of keeping medications "just in case" (Adedeji-Adenola *et al.*, 2022).

Similarly, Okoro & Peter (2020) reported that 35% of respondents stored unused or unwanted medications at home, with many doing so for future use. In Ethiopia, Gidey *et al.* (2020) observed that 41.41% of participants had unused or expired medications in their households, primarily due to incomplete treatment courses and changes in medical prescriptions.

The frequent storage of analgesics aligns with global trends, as these medications are widely used for pain management and are often purchased without prescriptions (Auta *et al.*, 2011). The easy accessibility of analgesics as over-the-counter (OTC) medications contributes to their

accumulation, with patients sometimes failing to finish a previously purchased supply before acquiring new ones (Adedeji-Adenola *et al.*, 2022).

4.2.2 Perception of Environmental and Public Health Impact of Unused and Expired Medicines

The study revealed that 53.7% of respondents agreed that improper disposal contaminates water sources, and 63.7% linked it to antimicrobial resistance. This aligns with findings from Maharana *et al.* (2021), who reported that 60.2% of community residents in China acknowledged that expired medications harm the environment, yet 71.6% still discarded medications improperly.

Globally, improper disposal of pharmaceuticals has been associated with water and soil contamination, with studies detecting traces of pharmaceuticals in water sources due to unsafe disposal methods (Patneedi *et al.*, 2015). Similarly, Costanzo *et al.* (2005) highlighted the role of pharmaceuticals in antimicrobial resistance (AMR), as drug residues in waterways create an environment for bacterial resistance to develop.

Despite widespread awareness of environmental risks, knowledge does not always translate to action. In Thailand, Srijuntrapun & Maluangnon (2024) found that while awareness of improper disposal was commendable, actual disposal practices remained poor. In Algeria, Mouloudj *et al.* (2023) demonstrated that individuals with strong environmental concerns showed greater intentions to reduce medication waste. This suggests that public education, reinforced by regulatory enforcement, is necessary to bridge the gap between awareness and safe disposal practices.

4.2.3 Disposal Practice

The most common disposal method among respondents was throwing medications in household waste bins (84.8%), followed by flushing them down the toilet (9.3%). Only 3.0%

participated in take-back programs. These findings mirror results from previous studies. In Nigeria, Halimat *et al.* (2021) found that 73.2% of respondents disposed of unused medications in household garbage, while only 6.1% returned them to pharmacies. A similar study in Ethiopia by Gidey *et al.* (2020) reported that 77.3% of participants disposed of medications in household trash, and 39.6% flushed them down the toilet. Likewise, Okoro & Peter (2020) found that 59.7% of respondents discarded expired medications in household garbage, with only 1.3% returning them to healthcare facilities.

While disposal of medications in household waste bins and flushing down the toilet are commonly practiced, regulatory guidelines recognize these methods as acceptable under specific conditions. However, improper disposal, such as discarding medications in trash bins without sealing or segregating them, poses risks of accidental exposure, drug misuse, and environmental contamination. Segregating medicinal waste and ensuring proper disposal techniques, such as sealing medications in bags before discarding can mitigate these risks.

The low participation in take-back programs is a global challenge. Sonowal *et al.*, (2016) observed that 76% of respondents in India supported drug collection programs, yet participation remained low. In the United States, despite well-established programs, accessibility and awareness still limit participation (FDA, 2024). These findings highlight the need for better public engagement, policy implementation, and expanded access to take-back programs, as well as improved education on proper disposal practices to ensure both safety and environmental protection.

4.2.4 Attitude and Perception

The study found that only 19.6% of respondents had received formal education on proper medication disposal, while 46.7% were willing to participate in take-back programs. Despite

recognizing risks such as accidental ingestion by children (80.0%) and drug misuse (72.6%), unsafe disposal practices persisted.

This aligns with findings by Adedeji-Adenola *et al.*, (2022), where 93.6% of respondents believed there was insufficient information on proper disposal methods. In Tanzania, Alnahas *et al.* (2021) found that while 76% of respondents were aware of the dangers of improper medication disposal, unsafe practices persisted due to a lack of education and disposal facilities.

The gap between awareness and practice is well-documented. Studies show that while healthcare professionals play a role in medication disposal education, many do not consistently provide guidance to patients (Lam *et al.*, 2024). Research also indicates that demographics such as education level significantly impact attitudes, with higher education correlating with greater awareness but not necessarily safer disposal behaviours (Srijuntrapun & Maluangnon, 2024).

Overall, these findings emphasize the importance of patient education, increased accessibility to disposal facilities, and strengthened regulatory frameworks to ensure that awareness translates into action.

4.3 Relationship Between Gender and Type of Medications Stored

The findings indicate no statistically significant association between gender and the type of medications stored among respondents ($p > 0.05$ across all medication categories). Both males and females reported similar storage patterns for medications, including analgesics, antibiotics, medicated creams, and chronic disease medications (e.g., antihypertensives and antidiabetics).

These results suggest that gender does not play a major role in medication storage Behaviours.

However, minor variations were observed, with slightly higher proportions of females storing medicated creams and ear/eye drops, while males were more likely to store supplements and cough/cold medications. These differences may be attributed to differences in healthcare-

seeking Behaviours, where females might prioritize dermatological and ophthalmic care, while males may be more inclined toward self-medication with supplements. Despite these variations, the overall lack of statistical significance suggests that both genders exhibit similar tendencies in retaining unused medications.

4.4 Relationship Between Educational Background and Perception of Environmental/Public Health Impact

The study found a significant relationship between educational background and awareness of the environmental and public health impact of improper medication disposal. Respondents with tertiary education demonstrated a higher level of awareness regarding:

- The contamination of water supplies and harm to aquatic organisms.
- The accumulation of pharmaceutical residues in soil affecting crops.
- The role of improper disposal in antimicrobial resistance (AMR).
- The increased risk of accidental ingestion by children and pets.
- The potential for drug misuse and abuse.

These findings align with previous studies that show higher education levels correlate with better awareness of environmental and health risks associated with pharmaceutical waste. However, despite increased awareness, improper disposal methods remain prevalent, indicating that awareness alone does not necessarily translate into proper disposal behavior. This highlights the need for behavioral interventions and structured disposal programs to bridge the awareness-practice gap.

4.5 Relationship Between Educational Background and Disposal Practice

Educational background was not significantly associated with the most common disposal methods, such as throwing medications in household waste bins or flushing them down the toilet. However, significant differences were observed in other disposal Behaviours:

- Storage of unused medications at home was more common among respondents with basic education compared to those with tertiary education.
- Giving medications to someone else was more frequently reported among those with basic education.
- Keeping medications for later use was significantly more common in respondents with basic education.
- Use of alternative disposal methods also showed a significant difference.

These findings suggest that individuals with lower educational levels are more likely to engage in risky disposal Behaviours, such as retaining medications for future use or sharing them with others. This may be due to misconceptions about medication reuse, financial constraints, or a lack of knowledge about the risks associated with medication sharing. Consequently, targeted educational interventions are needed for individuals with lower educational levels to promote safe disposal Behaviours.

4.6 Relationship Between Educational Background and Having Unused/Expired Medications

While a higher proportion of respondents with tertiary education reported having unused or expired medications, the difference was not statistically significant. This suggests that medication accumulation is a widespread issue across all educational levels and is likely influenced by factors such as prescription changes, non-adherence, or overprescription rather than education alone.

Despite a lack of significant association, the slightly higher proportion of tertiary-educated respondents with unused medications may indicate that more educated individuals are more likely to monitor and identify expired medications, leading to their classification as "unused" rather than continuous storage. However, given that possession of unused medications does not

necessarily lead to proper disposal, there is still a need for improved patient counseling on medication adherence and disposal guidelines.

4.7 Relationship Between Educational Background and Frequency of Checking Expiry Dates

A strong association was found between educational background and the frequency of checking medication expiration dates:

- Respondents with tertiary education were significantly more likely to always check expiration dates.
- Those with basic education were more likely to report that they never check expiration dates.

This finding suggests that education plays a crucial role in medication safety awareness, as individuals with higher education levels are more diligent in monitoring expiration dates. The fact that some respondents, particularly those with lower education levels, never check expiry dates raises concerns about the potential risks of accidental consumption of expired medications, reduced drug efficacy, and increased chances of adverse drug reactions.

4.8 Factors Influencing Awareness and Disposal Practices

Several factors were found to influence medication disposal behavior, including educational background, healthcare guidance, and accessibility to proper disposal facilities.

4.3.1 Educational Background

A high proportion of respondents with tertiary education recognized the risks associated with accidental ingestion of medications by children and pets and the potential for drug abuse or misuse. These findings align with previous studies highlighting the role of education in fostering responsible medication management and disposal practices.

4.3.2 Healthcare Guidance

Only 19.6% of respondents had received formal education on proper disposal methods, indicating a lack of guidance from healthcare professionals. This aligns with studies indicating that pharmacists and doctors rarely discuss disposal methods with patients, missing a crucial opportunity to educate the public.

4.3.3 Accessibility to Disposal Facilities

The accessibility of proper disposal facilities, particularly drug take-back programs, plays a crucial role in shaping medication disposal behaviour. Take-back programs are structured initiatives that allow the public to return unused or expired medications to designated collection points for proper disposal. These programs aim to reduce pharmaceutical waste in the environment, prevent accidental ingestion, and curb medication misuse. They are typically organized by government agencies, healthcare institutions, or pharmacies.

However, participation in take-back programs in this study was only 3.0%, suggesting that such facilities are either limited, inaccessible, or poorly publicized.

4.3.3.1 Take-Back Programs in Other Countries

In the United States, the Drug Enforcement Administration (DEA) organizes National Prescription Drug Take Back Days, during which designated collection points are set up at pharmacies, hospitals, and law enforcement agencies (FDA, 2024). Additionally, some pharmacies provide permanent drug disposal kiosks and mail-back programs that allow individuals to safely return their unused medications. Despite these efforts, a study by Roberts *et al.*, 2022, found that only 30% of participants had ever used take-back programs, citing lack of awareness and convenience as major barriers.

In Canada, take-back programs are more structured, with many provinces implementing year-round drug return initiatives through community pharmacies. The Health Products Stewardship Association (HPSA) oversees medication disposal efforts, ensuring safe collection and disposal. Yet, a study by Schäfer *et al.* (2021) found that many Canadians still dispose of medications in household trash due to a lack of knowledge about available disposal sites.

In Europe, take-back programs vary by country. France and Germany have well-established systems where pharmacies are legally required to collect expired medications. A study by Silva *et al.* (2023) in Brazil found that even though take-back programs were available in urban centres, rural communities lacked access, leading to continued improper disposal practices such as flushing and landfill dumping.

4.3.3.2 Challenges in Nigeria and Other Low-Resource Settings

In Nigeria, take-back programs are not widely available, and there is no nationwide structured system for medication returns. A study by Michael *et al.* (2019) found that only 31.8% of community pharmacies in Anambra State complied with NAFDAC disposal guidelines, while 54.5% did not engage in any structured disposal process. Additionally, many Nigerians are unaware of take-back initiatives, making household waste disposal the default method.

Similarly, in Ethiopia, Gidey *et al.* (2020) found that drug take-back programs were virtually non-existent, with over 77.3% of respondents disposing of medications in household trash due to lack of alternatives. This trend is consistent across many low- and middle-income countries, where weak infrastructure and limited regulatory enforcement make proper disposal difficult.

4.4 Impact on Public Health and the Environment

The improper disposal of medications has severe implications for public health, environmental sustainability, and antimicrobial resistance (AMR).

4.4.1 Contamination of Water and Soil

Improper disposal of medications contributes significantly to water and soil contamination, posing severe environmental and public health risks. When pharmaceuticals are flushed down toilets, discarded in sinks, or thrown into household waste, they eventually leach into water bodies and soil through landfill seepage and wastewater effluents.

Studies have shown that wastewater treatment plants (WWTPs) are often unable to completely remove pharmaceutical residues, leading to their persistence in surface water, groundwater, and even drinking water supplies (Patneedi *et al.*, 2015). A study by Mahara *et al.* (2021) in China found that over 60.2% of community residents acknowledged that expired medications harm soil and water sources. However, 71.6% of participants still discarded expired drugs improperly, contributing to contamination.

Pharmaceutical pollutants such as antibiotics, analgesics, and hormones have been detected in rivers, lakes, and even municipal drinking water. A study by Karungamye *et al.* (2022) in East Africa found that pharmaceutical waste from households, hospitals, and industries contributes to significant ecological toxicity, affecting aquatic life and disrupting ecosystems. Traces of ibuprofen, antibiotics, and hormonal medications have been found in surface water, leading to bioaccumulation in fish and other aquatic organisms.

Additionally, soil contamination occurs when medications are disposed of in open landfills or buried. Research by Patneedi *et al.* (2015) demonstrated that antibiotics and analgesics alter soil microbial composition, reducing fertility and harming plant growth. This can have long-term consequences on agriculture and food security, as pharmaceutical residues disrupt the natural microbial balance essential for soil health.

These findings emphasize the urgent need for proper pharmaceutical waste disposal policies and improved public awareness to mitigate environmental contamination.

4.4.2 Risk of Antimicrobial Resistance (AMR)

One of the most alarming consequences of improper medication disposal is the promotion of antimicrobial resistance (AMR). When antibiotics are flushed into water systems or discarded in landfills, they create selective pressure on bacteria, encouraging the survival and proliferation of resistant strains (Costanzo *et al.*, 2005).

A study by Cisar *et al.* (2014) investigated water sources upstream and downstream of a wastewater treatment plant and found significantly higher concentrations of antibiotic-resistant bacteria downstream, indicating that pharmaceutical waste contributes directly to AMR. These resistant bacteria can spread through water supplies, enter the food chain, and reduce the effectiveness of antibiotics in treating infections.

Similarly, a study by Gangopadhyay *et al.* (2024) found that persistent exposure to sub-lethal doses of antibiotics in the environment accelerates the development of resistant bacterial strains, which can then infect humans and animals. This is particularly concerning in hospitals and communities where infections caused by multidrug-resistant organisms (MDROs) are becoming increasingly difficult to treat.

In Nigeria, where AMR is an emerging public health crisis, improper medication disposal worsens the spread of resistant pathogens. A study by Okoro & Peter (2020) found that 63.7% of respondents linked improper medication disposal to antibiotic resistance, yet disposal practices remained unsafe.

To combat AMR, it is crucial to enforce proper pharmaceutical waste management, regulate antibiotic sales, and implement robust take-back programs to prevent these drugs from entering the environment.

4.4.3 Accidental Ingestion and Poisoning

The improper disposal of medications, especially discarding them in open trash, within reach of children, or in easily accessible locations, increases the risk of accidental ingestion and poisoning.

Children and pets are particularly vulnerable to poisoning from analgesics, sedatives, antihypertensives, and antibiotics. A study by Beirens *et al.* (2006) found that households with improperly stored or disposed-of medications had significantly higher rates of accidental poisoning incidents among children.

Additionally, the reuse of expired medications can cause toxicity due to chemical degradation and loss of potency. Parand *et al.* (2017) found that expired medications may develop toxic metabolites, leading to severe adverse effects when consumed unknowingly.

In Nigeria, Auta *et al.* (2011) reported that 80% of respondents recognized the risks of accidental ingestion, yet a majority still disposed of medicines in ways that could lead to unintentional exposure.

Ingestion of expired or improperly stored medications can result in:

- Liver and kidney toxicity (e.g., expired paracetamol)
- Respiratory depression (e.g., opioids and sedatives)
- Neurological effects (e.g., accidental overdose of antihypertensives)

Public health strategies such as child-proof disposal containers, public education, and stricter disposal regulations are necessary to reduce the incidence of accidental poisonings due to unsafe medication disposal practices.

4.5 Regulatory Framework and Compliance

The proper disposal of unused and expired medications is a global concern, prompting various health organizations to establish guidelines to mitigate environmental contamination, prevent accidental poisoning, and curb medication misuse. Regulatory frameworks from the World Health Organization (WHO), the U.S. Food and Drug Administration (FDA), and the National Agency for Food and Drug Administration and Control (NAFDAC) provide structured approaches to medication disposal. However, compliance with these guidelines remains a challenge due to limited awareness, lack of enforcement, and inadequate disposal facilities.

The WHO provides comprehensive recommendations for medication disposal, applicable to households, healthcare facilities, and pharmaceutical industries. The guidelines emphasize returning unused medications to pharmacies, incineration, chemical decomposition, and controlled landfill disposal (WHO, 2012). According to WHO, certain medications, such as cytotoxic drugs and controlled substances, require special handling to prevent environmental contamination and public health risks. However, many countries, including Nigeria, lack the infrastructure to implement WHO's stringent disposal recommendations, resulting in improper disposal practices such as landfill dumping and open burning (Michael *et al.*, 2019).

The FDA promotes medication disposal primarily through drug take-back programs, which provide safe, convenient, and responsible methods for discarding unused medications. The U.S. Drug Enforcement Administration (DEA) organizes National Prescription Drug Take-Back Days, offering temporary collection sites at pharmacies, law enforcement agencies, and hospitals (FDA, 2023). Additionally, the FDA supports permanent drug disposal kiosks and mail-back programs, enabling consumers to return medications year-round (Schäfer *et al.*, 2021). Despite these efforts, public participation remains inconsistent, with studies indicating that only 30% of surveyed individuals have used take-back services, citing lack of awareness

and accessibility as barriers (Roberts *et al.*, 2022). To address these challenges, the FDA provides an alternative disposal method—a "flush list" for specific high-risk medications such as opioids and controlled substances, which should be flushed only when take-back options are unavailable (FDA, 2023). However, this recommendation remains controversial due to concerns about water contamination and antimicrobial resistance (Costanzo *et al.*, 2005).

In Nigeria, NAFDAC has established guidelines for the disposal of pharmaceutical waste, aligning with WHO and FDA principles. According to NAFDAC (2023), pharmacies, healthcare institutions, and drug manufacturers are required to participate in disposal programs that involve incineration, secure landfill disposal, or controlled drug return programs. The agency prohibits the disposal of pharmaceuticals in open landfills, waterways, or household trash, emphasizing the importance of preventing contamination and drug diversion (NAFDAC, 2023). However, a study by Michael *et al.* (2019) found that only 31.8% of community pharmacies in Nigeria complied with NAFDAC disposal regulations, while 54.5% did not engage in structured medication disposal practices. The lack of enforcement mechanisms, limited take-back infrastructure, and inadequate public awareness continue to hinder compliance with these regulations.

Despite these established regulatory frameworks, non-compliance remains a significant issue worldwide. In low- and middle-income countries, such as Nigeria, Ethiopia, and Brazil, limited access to disposal programs forces individuals to discard medications in ways that pose environmental and health risks (Gidey *et al.*, 2020; Silva *et al.*, 2023). Even in high-income countries, where structured take-back programs exist, public engagement remains suboptimal due to lack of awareness, convenience, and regulatory enforcement (Schäfer *et al.*, 2021). Addressing these challenges requires strengthening regulatory oversight, expanding take-back initiatives, and increasing public education to promote responsible medication disposal practices on a global scale.

4.6 Challenges and Barriers to Safe Disposal

Despite the existence of guidelines and regulatory frameworks for medication disposal, several barriers hinder proper disposal practices, leading to environmental contamination, antimicrobial resistance, and accidental poisonings. The major challenges include lack of public awareness, limited availability of take-back programs, cultural and behavioral practices, financial constraints, and weak enforcement of regulations.

4.6.1 Lack of Public Awareness and Education

One of the most significant barriers to safe medication disposal is the low level of awareness among the general public. Many individuals are unaware of proper disposal methods and the environmental and health risks associated with improper disposal (Adedeji-Adenola *et al.*, 2022). In this study, only 19.6% of respondents had received prior education on safe medication disposal, highlighting a critical knowledge gap.

A study by Gidey *et al.* (2020) in Ethiopia found that 60.7% of respondents had no prior information on correct disposal methods, leading to unsafe practices such as throwing medications in household trash or flushing them down the toilet. Similarly, in India, Sonowal *et al.* (2016) found that only 39% of participants were aware of appropriate disposal methods, despite recognizing the risks of improper disposal. Limited education campaigns, inadequate pharmacist-patient communication, and the absence of disposal instructions on medication packaging contribute to this widespread lack of awareness.

4.6.2 Limited Availability and Accessibility of Take-Back Programs

The lack of easily accessible take-back programs is another major barrier to proper medication disposal. In this study, only 3.0% of respondents reported using take-back programs, suggesting that these facilities are either unavailable, inconveniently located, or poorly publicized.

In contrast, countries like Canada and Germany have well-established take-back programs, where pharmacies legally collect expired medications year-round (Schäfer *et al.*, 2021). However, even in high-income countries, participation remains low due to a lack of awareness and accessibility (Roberts *et al.*, 2022). In low- and middle-income countries (LMICs) like Nigeria, Ethiopia, and Brazil, take-back programs are virtually non-existent, leaving individuals with no alternative but to dispose of medications in unsafe ways (Gidey *et al.*, 2020; Silva *et al.*, 2023). Expanding take-back initiatives in pharmacies and hospitals, along with public education, could significantly improve participation rates.

4.6.3 Cultural and Behavioural Practices

Cultural beliefs and habitual Behaviours also influence medication disposal practices. Many people store unused medications for future use or give them to friends and family members instead of properly discarding them. In this study, 28.9% of respondents kept unused medications, while 14.4% gave them to others.

Okoro & Peter (2020) found that 30.2% of Nigerians preferred giving unused medications to friends or family rather than disposing of them. Similarly, a study in Tanzania (Alnahas *et al.*, 2021) found that 96.0% of respondents stored unused medications at home, citing financial constraints and the belief that medicines should not be wasted. These findings emphasize the need for behavioral interventions and public education campaigns to change perceptions about medication reuse and safe disposal.

4.6.4 Financial Constraints and Lack of Incentives

Economic factors also contribute to unsafe disposal practices. Many individuals, especially in low-income settings, hesitate to discard medications due to the financial burden of repurchasing them in the future. This results in self-medication, stockpiling, and the retention of expired drugs.

A study by Mouloudj *et al.* (2023) in Algeria found that individuals with financial difficulties were more likely to keep expired medications, fearing the cost of replacement. Additionally, in Nigeria, Michael *et al.* (2019) reported that 54.5% of community pharmacies did not comply with NAFDAC disposal guidelines because of the costs associated with proper disposal methods. Subsidizing take-back programs or offering incentives (such as pharmacy discounts for returned medications) could encourage safe disposal behaviours.

4.6.5 Weak Regulatory Enforcement and Policy Gaps

Although international organizations such as WHO, FDA, and NAFDAC have established guidelines for safe medication disposal, enforcement remains weak, particularly in developing countries. In this study, despite existing regulations, the majority of respondents continued to dispose of medications improperly.

In Nigeria, Michael *et al.* (2019) found that only 31.8% of pharmacies complied with NAFDAC disposal regulations, while 54.5% did not engage in any structured disposal process. A similar study in Ethiopia (Gidey *et al.*, 2020) found that the absence of strict policies contributed to widespread unsafe disposal. Without stronger policy enforcement, structured disposal programs, and government oversight, compliance with safe disposal practices will remain low.

4.6.6 Environmental and Infrastructure Challenges

A lack of proper disposal infrastructure further complicates medication disposal. Many developing countries lack incineration facilities, dedicated disposal sites, and specialized pharmaceutical waste management systems. Consequently, expired and unused medications end up in open dumps, rivers, and landfills, contaminating the environment (Karunganye *et al.*, 2022).

A study by Patneedi *et al.* (2015) found that pharmaceutical residues persist in soil and water due to the absence of adequate disposal infrastructure, particularly in LMICs. Additionally, in

China, Mahara *et al.* (2021) found that despite 60.2% of residents acknowledging the risks of medication contamination, inadequate infrastructure led to continued unsafe disposal. Developing centralized medication disposal centers and integrating pharmaceutical waste management into national policies would help mitigate this issue.

4.7 Strength and Limitation of the Study

4.7.1 Strengths of the Study

This study provides valuable insights into the awareness and disposal practices of unused and expired medications among patients at the Consultant Outpatient Department (COPD) of the University of Benin Teaching Hospital (UBTH). The following strengths highlight its significance:

1. **Novelty and Relevance:** This study addresses an important but often overlooked public health issue—the improper disposal of medications and its implications for environmental and public health. By focusing on a Nigerian healthcare setting, the study contributes to the limited body of research on medication disposal practices in low- and middle-income countries (LMICs).
2. **Structured Methodology:** The study utilized a well-structured, validated questionnaire to collect data, ensuring that responses were systematically gathered and analyzed. The inclusion of 270 participants provides a robust sample size for statistical analysis.
3. **Assessment of Key Factors:** This study not only examined disposal practices but also explored the influence of education, awareness, and regulatory compliance on patient behavior. The inclusion of perception, attitudes, and challenges adds depth to the findings, allowing for a comprehensive understanding of the issue.

4. Contribution to Policy and Public Health: The findings of this study can serve as a baseline for policymakers, regulatory agencies (e.g., NAFDAC), and healthcare professionals to develop interventions, awareness campaigns, and regulatory frameworks aimed at improving safe medication disposal practices.

4.7.2 Limitations of the Study

Despite its strengths, the study has certain limitations that should be considered:

1. Self-Reported Data and Recall Bias: The study relied on self-reported responses, which may introduce recall bias or social desirability bias. Participants may have over-reported positive Behaviours (e.g., stating they disposed of medications safely) or under-reported unsafe disposal practices due to perceived judgment.
2. Single-Center Study: Data collection was limited to UBTH's Consultant Outpatient Department, which may restrict the generalizability of findings to other hospitals, states, or rural areas in Nigeria. A multi-center study across different regions would provide broader insights into national disposal practices.
3. Cross-Sectional Design: The study used a cross-sectional approach, capturing data at a single point in time. This prevents the assessment of long-term trends or changes in disposal Behaviours over time. A longitudinal study would be needed to track changes in awareness and compliance.
4. Limited Exploration of Underlying Factors: While the study identified key factors influencing medication disposal (e.g., education, awareness, regulatory compliance), it did not extensively explore cultural, economic, or systemic healthcare barriers that might shape disposal Behaviours. Qualitative research methods (e.g., interviews, focus groups) could provide deeper insights into these factors.

5. **Absence of Direct Observation:** The study relied on survey responses rather than direct observation of disposal practices. Future studies could incorporate observational methods to validate self-reported Behaviours.

CHAPTER FIVE

CONCLUSION

This study highlights significant gaps in awareness and disposal practices related to unused and expired medications among outpatients at the University of Benin Teaching Hospital (UBTH). While 68.5% of respondents reported having unused or expired medications, disposal practices remain largely inappropriate, with 84.8% discarding medications in household waste bins and only 3.0% utilizing take-back programs, a method considered appropriate by regulatory guidelines.

Despite awareness of potential environmental and public health risks, such as antimicrobial resistance, accidental ingestion, and drug abuse, many individuals continue to engage in unsafe disposal methods, including flushing medications down the toilet (9.3%) or discarding them in open waste bins without proper containment. These practices contrast with recommended disposal guidelines, which include returning unused medications to pharmacies, using designated drug take-back programs, or following manufacturer-recommended disposal instructions (WHO, FDA, NAFDAC).

Educational background was found to influence awareness, with individuals having tertiary education demonstrating higher levels of understanding regarding proper disposal guidelines. However, awareness alone did not translate into correct disposal behaviours, emphasizing the need for structured interventions to bridge the gap between knowledge and practice.

Furthermore, the lack of formal guidance from healthcare professionals (reported by 80.4% of respondents) and the absence of accessible take-back programs contribute significantly to inappropriate disposal habits. In contrast, structured take-back programs, widely implemented in some high-income countries, provide safe and effective means for medication disposal but remain largely unavailable in Nigeria.

The consequences of improper medication disposal are far-reaching, including environmental pollution, contamination of water sources, and the rise of antimicrobial resistance. Addressing these issues requires a multi-stakeholder approach involving healthcare professionals, policymakers, regulatory agencies, and the general public. Expanding public awareness, increasing access to appropriate disposal programs, and enforcing proper regulatory compliance will be essential in ensuring safe medication disposal practices to protect both human health and the environment.

5.1 Recommendations

Based on the findings of this study, the following recommendations are proposed to improve awareness and promote safe disposal practices of unused and expired medications:

1. Implementation of Public Awareness Campaigns: There is a need for sustained public education campaigns to improve awareness of proper medication disposal methods. Government agencies, healthcare institutions, and environmental organizations should collaborate to disseminate information through social media, community outreach programs, and mass media platforms.

2. Strengthening Medication Disposal Policies and Regulations: Regulatory bodies such as the National Agency for Food and Drug Administration and Control (NAFDAC) should enforce stricter guidelines on medication disposal and ensure their effective implementation. Policies should mandate the inclusion of disposal instructions on medication packaging and enhance oversight of pharmaceutical waste management practices.

3. Expansion of Drug Take-Back Programs: Pharmacies, hospitals, and healthcare facilities should establish accessible medication take-back programs where patients can return unused or expired medications for proper disposal. The government should incentivize pharmacies to participate in these programs by providing regulatory support and logistical assistance.

4. Integration of Medication Disposal Education into Healthcare Services: Healthcare professionals, particularly pharmacists and physicians, should take an active role in educating patients on safe disposal practices during prescription counselling sessions. Hospitals should incorporate medication disposal guidance into routine patient care to reinforce responsible disposal behaviours.

5. Development of Environmentally Safe Disposal Methods: Innovative and environmentally friendly disposal strategies should be explored, such as biodegradable medication disposal bags and pharmaceutical waste treatment facilities. Research institutions and environmental agencies should collaborate on developing sustainable disposal technologies to minimize environmental contamination.

6. Inclusion of Medication Disposal Education in School Curricula: To foster long-term behavioural change, safe medication disposal should be integrated into school health education programs. This will ensure that future generations develop a strong awareness of proper pharmaceutical waste management from an early age.

7. Further Research on Medication Disposal Practices: Future studies should adopt a multi-centre approach to assess disposal behaviours across different regions and demographic groups. Additionally, qualitative research exploring cultural and behavioural factors influencing disposal practices can provide deeper insights into patient attitudes and barriers to proper disposal.

By implementing these recommendations, stakeholders, including healthcare providers, policymakers, environmental agencies, and the public, can work collectively to reduce the risks associated with improper medication disposal, thereby protecting public health and the environment.

5.1.1 Implications for Public Health and Policy and Future Research

To address the challenges identified, several policy and healthcare interventions are necessary:

1. **Stronger Policy Enforcement:** Government agencies should mandate proper disposal regulations and provide designated disposal facilities in hospitals and pharmacies.
2. **Integration into Healthcare Services:** Pharmacists and doctors should educate patients on proper disposal during consultations.
3. **Expansion of Take-Back Programs:** Establishing accessible collection points will facilitate proper disposal.
4. **Educational Campaigns:** Public awareness campaigns should be widespread to emphasize the environmental and health impacts of improper disposal.
5. **Further Research:** More studies should explore long-term disposal trends and assess the effectiveness of implemented interventions.

This study highlights a significant gap between awareness and practice regarding medication disposal. Despite recognizing the risks of improper disposal, many respondents continue to discard medications in unsafe ways, contributing to environmental contamination, antimicrobial resistance, and accidental poisonings.

To mitigate these risks, multi-sectoral collaboration is essential, involving government agencies, healthcare professionals, and the general public. Implementing policy reforms, expanding take-back programs, and increasing awareness campaigns will promote sustainable and responsible medication disposal practices, ultimately protecting public health and the environment.

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APPENDIX

DEPARTMENT OF CLINICAL PHARMACY, UNIVERSITY OF BENIN

QUESTIONNAIRE

I am conducting a study to Assess The awareness And Disposal Practices of Unused and Expired Medications Among Patients Visiting UBTH Consultant Outpatient Department (COPD). Your response will be kept confidential and used solely for research purposes.

SECTION A: DEMOGRAPHICS

1. **Age:** 18-24 years[] 25-34 years [] 35-44 years[] 45 and above[]
2. **Gender:** Male[] Female[]
3. **Educational Background:** No formal education[] Primary education[] Secondary education[] Tertiary education[]
4. **Employment Status:** Employed[] Unemployed[] Retired[] Student[] Other (Please specify)
5. **Marital status:** Married[] Single[] Separated[] Divorced[] Widowed[]

SECTION B: MEDICATION USAGE

1. **Do you currently have any unused or expired medications at home?** Yes[] No[]
2. **Do you check medicines for expiry dates?** Always[] Often[] Sometimes[] Rarely[] Never[]
3. **Which of the following medicines do you have that you no longer use or that are expired (click all that apply)**

CLASS OF DRUG	YES	NO
Drugs For Pain		
Antibiotics		
Medicated Creams		
Inhalers		
Eye/Ear drops		
Antacids		

Supplements		
Cough and Cold Medicines		
Drugs to relieve Diarrhoea and/or Constipation		
Blood pressure medicines		
Diabetes medicines		
Others		

SECTION C: ENVIRONMENTAL AND PUBLIC HEALTH IMPACT OF UNUSED AND EXPIRED MEDICINES

UNUSED AND EXPIRED MEDICINES CAN?	AGREE	DISAGREE
Contaminate water supplies and aquatics organism		
Accumulate in the soil and affect crops		
Result in resistance to antibiotics		
Increase risk of accidental ingestion by children or pets		
Encourage drug abuse or misuse		

SECTION D: DISPOSAL PRACTICE

- How do you usually dispose of unused or expired medications?** (Check all that apply).
 Throw them in the waste bin[] Flush them down the toilet or sink[] Return them to a pharmacy or take-back program[] Keep them in storage at home[] Give them to someone else[] Keep for later use[] Other (please specify): _____
- Which of the following do you do when you throw medicines in the waste bin?** Dispose them exposed[] I seal them in a bag before disposing[]

SECTION E: ATTITUDE AND PERCEPTION

- Does your Pharmacist or Physician educate you on how to properly dispose of medicines?** Yes[] No[]
- If there is a program to take back unused or expired medicines, would you participate?** Yes[] No[]

Thank You for Filling This Questionnaire.