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KNOWLEDGE AND PRACTICE OF DIPOSAL OF UNUSED MEDICATION AMONG GENERAL PUBLIC

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Abstract

Background: *Improper disposal of unused and expired medications poses significant risks to public health and the environment. In Pakistan, safe disposal practices are poorly understood and rarely implemented due to limited awareness and lack of structured take-back programs.*

Objective: This study aimed to assess the knowledge, attitude, and practice (KAP) regarding safe disposal of unused medications among the general public in Bahawalpur, Punjab, and to identify associated demographic factors.

Methods: *A cross-sectional study was conducted from January to March 2025 among 417 adults aged 18 years and above in Bahawalpur. Data were collected using a validated, self-administered questionnaire covering demographics, knowledge, attitude, and practice related to medication disposal. Descriptive statistics, Chi-square tests, and logistic regression were used for analysis using SPSS v26.*

Results: *Of 417 participants, 58.5% had poor knowledge, 62.1% had a negative attitude, and 71.2% reported unsafe disposal practices. The most common disposal method was discarding medications in household trash (54.7%). Higher education level, employment in healthcare-related fields, and female gender were significantly associated with better knowledge and safer practices ($p < 0.05$). Lack of awareness about disposal guidelines and absence of disposal facilities were the main barriers reported.*

Conclusion: *The study reveals substantial gaps in knowledge, attitude, and practice regarding safe medication disposal in Bahawalpur. Targeted public education campaigns, pharmacist-led counseling, and establishment of medicine take-back programs are recommended to reduce environmental contamination and public health risks.*

Chapter #1:
INTRODUCTION:
An Assessment of the Storage and Disposal of Unused Medications in Bahawalpur:
Introduction:

As the population of world is growing, the consumption of medicine due to various reasons is also at its peaks. This substantial use of medicine has resulted in the excessive storage of unused medication at homes. Medicines that are not intended to be used in future or are considered to have no particular value to the consumer are called unused medicines. In other words, the medicines that are discontinued to use but remain with the patient population are called unused medicines [1].

In Pakistan, the regulation of pharmaceutical sales is often inadequate, leading to widespread

availability of medicines without prescription. This contributes significantly to self-medication practices and the accumulation of unused medicines in households.

Unused medications can be broadly classified into several categories. Expired medicines, partially used medicines, and medicines that remain unopened, all are included in the category of unused medicines. Expired medicines are those that have surpassed their labeled shelf life and may have reduced efficacy or potential safety concerns. Partially used medicines often result from incomplete treatment courses or early discontinuation of therapy, while unused medicines may accumulate due to changes in prescriptions or over-purchasing [2]. This classification is important as each category may require different considerations in terms of storage risks and disposal methods.

According to the WHO, a large amount of medicine is sold to public without any prescription which results in the collection of unused medication in homes [3]. Unused medicines are considered as waste and should be disposed of or destroyed very efficiently. In household settings, a wide range of medications are commonly stored. This includes antibiotics, analgesics, antipyretics, etc. The presence of such medications in homes reflects common prescribing patterns and self-medication practices.

However, improper handling of these medicines can lead to misuse, especially in the case of antibiotics, which may be used without proper medical guidance, contributing to inappropriate therapy and resistance development. One of the most critical global concerns associated with improper storage and disposal of medications is the rise of antimicrobial resistance [4] [5]. When antibiotics are discarded improperly, such as through wastewater systems, they can enter natural water bodies and create selective pressure on microorganisms. This promotes the development of resistant strains, making infections more difficult to treat and increasing the burden on healthcare systems. Addressing this issue is essential for safeguarding the effectiveness of existing antimicrobial therapies [5].

Medicine disposal is defined as proper, safe and environmentally responsible practice of discarding unwanted, unused, or related pharmaceutical products. Both the general public and healthcare professionals often lack the basic knowledge regarding the storage and effective disposal of unused medication. This lack of awareness can cause serious consequences including unintentional overdosing of medication, accumulation of dangerous chemicals or compounds from the medication in the environment around it or the possibility of prescription drug misuse [6] [7].

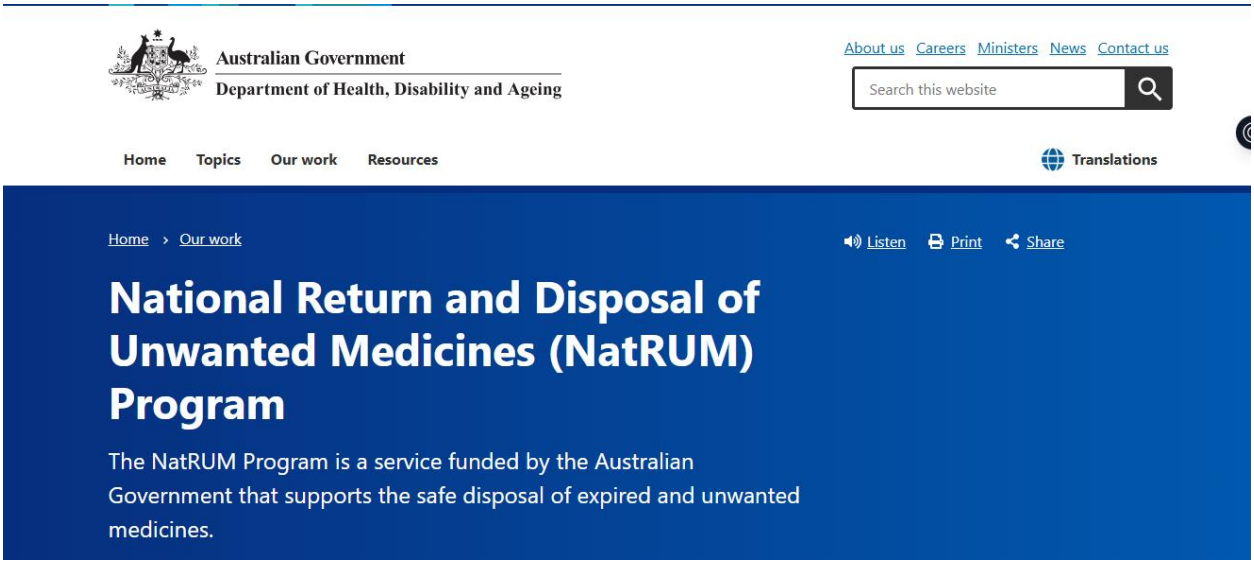
Pharmacists play a pivotal role in addressing the issue of medication storage and disposal. As accessible healthcare professionals, they are well-positioned to educate patients regarding proper medication use, storage conditions, and safe disposal practices [8]. Community pharmacists, in particular, can act as key facilitators in promoting awareness and potentially implementing medication take-back initiatives. Strengthening the role of pharmacists in public education can significantly improve safe medication practices at the household level [9].

Majority of people buy medicine in bulk and when they perceive them as no longer needed, they either place the leftover medicine in homes, while other throw them away in dust bins or flush in the sink. The improper disposal of medicine is seen globally but the ratio is greater in developing countries rather than developed countries [10]. People from developing countries especially the uneducated one do not feel that they have responsibility in proper disposal of unused medicines. For instance, in Pakistan, over 80% of population is unaware of proper disposal of medicine. Females use dust bins for disposing the unused medicine. On the other hand, male buried the unused medicines in the ground [11].

In contrast, in other countries, especially Dutch, studies showed that the residents pay proper attention to proper disposal of unused medication. Almost 80% participants of a poll expressed a high degree of information regarding proper disposal of medication among the total population. The 80% respondents have contacted the chemical waste facilities or pharmacies to

return unused medication [12]. According to data, self-medication, improper medication, alteration in prescriptions, not clear instructions, non-compliance and resolution of symptoms all contribute to the unwarranted storage of medicine. [13-16]. Unused medications can pose serious threats to both environment and health systems. Unused medication can contribute to environmental pollution, leading to a decrease in the population of vultures, feminization of male fishes and sterility in species of frogs. [17].

Besides having an impact on environment, unused medicines are also dangerous to humans, particularly children [18]. It is important that HCP aka, healthcare professionals should be aware of the proper storage and disposal of unused medicines. Doctors as well as pharmacists should educate the patient and general public regarding the efficient storage and disposal of unused medicines. According to reports and studies, the appropriate storage and disposal of unused medicine is a major challenge among the globe. Several developed countries including Australia, Sweden, Canada, and United Kingdom have developed various strategies and plans for safe disposal of medicines. For instance, NatRUM [19], Drug Take-back programs, [20] etc.



Behavioral factors also play an important role in the accumulation of unused medications [21]. Many individuals tend to store medicines for future use, often without considering expiry dates or changes in their medical condition. Additionally, there is a general lack of perceived risk associated with improper storage and disposal, which further discourages safe practices. Understanding these behavioral patterns is essential for designing effective educational interventions [12].

Although International guidelines exist for the proper storage and disposal of medication, but their implementation is often limited and the public remains largely unaware of, or has restricted access to these platforms [22].

In Contrast, Pakistan lacks a national initiative for the efficient disposal of unused medicine. Furthermore, no sufficient data on public awareness in Pakistan related to medication disposal can be found. Based on available data on Internet, no study is performed related to assessment of the storage and disposal of unused medications in Bahawalpur. It is essential to enhance awareness among the public and promote safe storage and disposal practices among public. This gap between policy and practice contributes significantly to the persistence of unsafe behaviors among the population.

The present study is conducted to evaluate the knowledge and practice of storage and proper disposal of unused medicine.

1.Rationale:

The rationale for this study arises from the widespread issue of improper storage and disposal of unused medications. This problem represents a significant yet under-addressed public health and environmental challenge in Pakistan. Self-medication is highly prevalent in the country due to easy over-the-counter access to pharmaceuticals, incomplete treatment courses, changes in prescriptions, over-prescription by healthcare providers, and patient non-adherence. As a result, households frequently accumulate unused medicines. This leads to risks such as accidental ingestion (especially by children), drug misuse, reduced efficacy due to improper storage, and the development of antimicrobial resistance.

Existing evidence from other regions of Pakistan demonstrates these problems clearly.

For instance:

Studies in Quetta have shown that nearly 87% of households keep unused medicines, often stored in refrigerators or bedrooms without checking expiry dates. And such medicines are then disposed of primarily through household trash or by flushing them down toilets/sinks [23].

Similarly, research in rural Punjab revealed that over 81% of households possess unused or expired medications, with more than 80% of respondents unaware of proper disposal methods [11].

Although the Drug Regulatory Authority of Pakistan (DRAP) and WHO have issued guidelines for the safe disposal of expired pharmaceuticals, implementation at the household and community level remains negligible due to various reasons. Some main reasons include the following:

1. Lack of awareness
2. Inadequate infrastructure for take-back programs
3. Limited public education.

Bahawalpur, a major urban center in southern Punjab with a mix of urban and peri-urban populations, has no prior published assessment specifically focused on household-level storage and disposal practices of unused medications.

This study is therefore justified as it will provide localized, context-specific data to bridge this research gap, identify region-specific risk factors, and lay the foundation for evidence-based interventions that are focusing on the socio-cultural and environmental realities of southern Punjab.

2. Significance of the Study:

This research holds substantial importance for public health, environmental protection, pharmacy practice, and policy development in Pakistan. First and foremost, it will generate the first baseline data on storage and disposal practices specific to Bahawalpur. This will enable local health authorities, pharmacies, and municipal bodies to design targeted awareness campaigns.

Also, medication take-back programs can be established at community pharmacies or hospitals. Such programs are currently almost non-existent at the household level in most parts of Pakistan.

By documenting the prevalence of unsafe practices and their potential consequences, the study will raise awareness among healthcare professionals, policymakers, and the general public.

Furthermore, the study will identify barriers and facilitators to safe storage and disposal practices. These barriers may include lack of knowledge, convenience, or inadequate infrastructure. The findings will offer practical and context-specific recommendations. These recommendations can inform future pharmacy education, community outreach programs by Pharm-D graduates, and necessary regulatory reforms.

3. Objectives

3.1 General Objective

To assess the storage practices and disposal methods of unused medications among households in Bahawalpur, Pakistan.

3.2 Specific Objectives

1. To determine the prevalence, types, and reasons for accumulation of unused medications in households of Bahawalpur.
2. To evaluate the storage conditions and practices for keeping medications in households.
3. To identify the most common methods used for the disposal of unused medications and the frequency of these practices.

4. To assess the level of knowledge regarding proper medication storage, expiry checking, and safe disposal among household respondents.
5. To explore the common disposal methods of unused medications and the frequency of disposal.
6. To identify the sources of information and the role of healthcare professionals (including pharmacists) in educating the public about proper medication storage and disposal.

Chapter#2:
Literature Review.
Introduction:

Medicines are an essential part of human life and modern healthcare. They are used to treat minor illnesses such as headaches and fever, as well as serious diseases like diabetes, hypertension, heart disease, and cancer. In many situations, medicines can save lives and improve overall quality of life. Because of these benefits, the use of pharmaceuticals has increased significantly worldwide. Millions of people depend on medicines daily for treatment, prevention, and diagnosis of diseases. However, along with increased usage, problems related to improper use, storage, and disposal of medicines have also increased. Many people do not complete their treatments or misuse medicines, which leads to leftover or unused medications in households (Maharana, Paul et al. 2017)

The presence of unused and expired medicines has become a growing concern globally. These medicines, if not handled properly, can pose risks to both human health and the environment. Therefore, it is important to understand how medicines are used, stored, and disposed of, and what attitudes people have toward these practices.(Maharana, Paul et al. 2017)

Pharmaceuticals:

Pharmaceuticals play a central role in healthcare systems. They are used for the prevention, diagnosis, and treatment of diseases. Over time, advancements in pharmaceutical research and medical technology have significantly improved health outcomes, especially in developing countries. Historically, improvements in health were mainly due to better nutrition, sanitation, and living conditions. However, modern pharmaceutical innovations have made it possible to achieve better health outcomes even in low-income settings (Fogel 1986)

Research shows that pharmaceutical innovation has contributed greatly to increased life expectancy and reduced mortality rates. For example, improvements in medicines have significantly reduced deaths from diseases such as cancer. It has been reported that pharmaceutical advancements between 1985 and 1996 reduced the years of life lost due to cancer considerably. This shows that medicines are not only essential for treatment but also for improving long-term public health.(Lichtenberg 2016)

Despite these benefits, the increasing use of medicines has also resulted in challenges such as overuse, misuse, and wastage. Large quantities of medicines are produced and consumed every year, and not all of them are used appropriately. This leads to the accumulation of unused medicines and creates the need for proper management and disposal.(Lichtenberg 2016).

Rational Use of Pharmaceuticals:

Rational use of medicines is a key concept in healthcare. According to the World Health Organization (WHO), rational use means that patients receive medicines appropriate to their clinical needs, in the correct dose, for an adequate period, and at the lowest possible cost. Rational use ensures effective treatment, reduces side effects, and minimizes wastage of medicines.(Organization 2002)

However, irrational use of medicines remains a major issue worldwide. Many medicines are prescribed unnecessarily, and patients often do not follow proper instructions. According to WHO, more than half of all medicines are used inappropriately, and about 50% of patients do not take their medicines correctly. This leads to leftover medicines, which are either stored at home or disposed of improperly.(Organization 2002)

Various factors contribute to irrational use, including over-prescribing by doctors, lack of patient awareness, and promotional practices by pharmaceutical companies. Additionally, changes

in treatment, side effects, and non-compliance by patients also result in unused medicines. Tools such as ABC/VEN analysis have been recommended by WHO to improve medicine management and reduce wastage(Dutta 2019).

Introduction to Unused and Expired Medications:

Medicines are essential for the prevention, diagnosis, and treatment of diseases, and their use has increased significantly worldwide over the past few decades. However, along with the increased consumption of pharmaceuticals, the issue of unused and expired medications has become a growing concern for healthcare systems, communities, and the environment. Unused medications refer to drugs that are prescribed or purchased but not fully consumed by patients, while expired medications are those that have passed their recommended shelf life and may lose their effectiveness or safety. The accumulation of such medications in households and healthcare facilities has become a common phenomenon globally.(AlAzmi, AlHamdan et al. 2017)

There are several reasons why medications remain unused. One of the most common factors is improvement in the patient's health condition, which leads to discontinuation of therapy before completion. In other cases, medications may be stopped due to side effects, lack of effectiveness, or changes in treatment prescribed by healthcare professionals. Patient non-adherence is another significant factor, as many individuals do not follow prescribed dosing schedules or stop taking medicines once they feel better. Additionally, over-prescribing, dispensing larger quantities than required, and easy availability of over-the-counter medicines contribute to the accumulation of unused drugs. Studies have shown that a considerable proportion of patients do not use all the medicines provided to them, resulting in leftover medications stored at home (AlAzmi, AlHamdan et al. 2017).

Expired medications also contribute to this issue, as many people tend to store medicines for long periods without checking their expiry dates. Over time, these medicines may lose their potency, making them less effective in treating diseases. In some cases, expired medications can even become harmful due to chemical changes. Despite these risks, many individuals continue to keep expired medicines at home, either due to lack of awareness or the intention to use them in the future. This behavior increases the risk of accidental ingestion, especially among children and elderly individuals, which can lead to serious health complications.(AlAzmi, AlHamdan et al. 2017)

The presence of unused and expired medications in households poses significant risks to public health. One of the major concerns is accidental poisoning, which can occur when medications are mistakenly consumed by children or other family members. Another concern is the misuse and abuse of medications, particularly antibiotics and controlled substances. Keeping unused medicines at home increases the chances of self-medication and sharing drugs without proper medical advice, which can result in incorrect treatment, adverse drug reactions, and the development of antimicrobial resistance. The World Health Organization has reported that improper use of medicines is a major global issue, with more than half of all medicines being used inappropriately(Organization 2019).

In addition to health risks, unused and expired medications also have serious environmental implications. Improper disposal methods, such as throwing medicines in household garbage or flushing them into sinks and toilets, can lead to contamination of water and soil. Pharmaceutical residues can enter water systems and persist in the environment, affecting aquatic life and ecosystems. Research has shown that exposure to pharmaceutical compounds can cause harmful effects in wildlife, including reproductive abnormalities and organ damage. For example, studies have reported that certain drug residues have contributed to kidney failure in vultures and hormonal changes in fish species. These findings highlight the environmental impact of pharmaceutical waste and the need for proper disposal practices.(Kümmerer 2009)

Another important aspect of this issue is the economic burden associated with medication wastage. Unused medicines represent a loss of financial resources for both individuals and

healthcare systems. In many developing countries, where patients often pay for medicines out of pocket, the cost of unused medications can be significant. This not only affects individual households but also places additional pressure on healthcare systems that are already limited in resources. Reducing medication wastage through better prescribing practices, patient education, and proper disposal can help minimize these economic losses.(Kümmerer 2009)

The management of unused and expired medications requires a comprehensive approach involving healthcare professionals, policymakers, and the general public. Pharmacists and physicians play a key role in educating patients about proper medication use and disposal. Public awareness campaigns can help inform people about the risks associated with storing and improperly disposing of medicines. Additionally, the implementation of drug take-back programs and clear disposal guidelines can provide safe and convenient options for the public. Studies have shown that when proper systems are in place, people are more likely to adopt safe disposal practices(Tong, Peake et al. 2011).

Household Storage of Unused Medication:

The storage of unused medications in households is a common practice observed worldwide and has become an important public health concern. With the increasing use of pharmaceuticals for the treatment and prevention of diseases, a significant amount of medicines remains unused and is often kept at home for future use. These medications may include prescription drugs, over-the-counter products, and even herbal preparations. While storing medicines may seem convenient and economical for individuals, it can lead to several health, safety, and environmental risks if not managed properly. Studies have shown that a large proportion of households possess unused or leftover medications due to various factors related to prescribing practices, patient behavior, and healthcare systems(Maharana, Paul et al. 2017).

One of the main reasons for the storage of unused medications at home is non-adherence to prescribed treatment. Many patients do not complete their full course of medication once they start feeling better, leading to leftover drugs. In some cases, patients may stop taking medicines due to side effects, lack of perceived benefit, or forgetfulness. Changes in treatment plans by healthcare professionals can also result in previously prescribed medicines becoming unnecessary. Additionally, over-prescribing and dispensing medicines in quantities larger than required contribute to the accumulation of unused drugs. Easy access to over-the-counter medications further increases the likelihood of medicine storage in households(Kusturica, Tomas et al. 2016).

Another important factor contributing to the storage of medications is the perception that keeping medicines for future use can save time and money. Many individuals prefer to retain leftover medicines in case similar symptoms occur again, rather than visiting a healthcare provider. This practice is particularly common in low- and middle-income countries, where access to healthcare services may be limited and out-of-pocket expenses are high. However, this behavior encourages self-medication and increases the risk of inappropriate drug use. Using previously stored medicines without proper medical consultation can lead to incorrect diagnosis, ineffective treatment, and adverse drug reaction(Maharana, Paul et al. 2017).

Improper storage conditions in households further add to the risks associated with unused medications. Medicines are often kept in places such as kitchens, bathrooms, or bedrooms, where they may be exposed to heat, humidity, and light. These environmental factors can affect the stability and effectiveness of drugs, causing them to degrade over time. As a result, even if medicines have not expired, they may not work as intended. In some cases, degraded medicines can produce harmful effects. Lack of knowledge about proper storage conditions contributes to this problem, as many individuals are unaware of the importance of keeping medicines in cool and dry places(Dar, Maqbool et al. 2019).

The presence of unused medications in households also increases the risk of accidental poisoning, particularly among children and elderly individuals. Medicines that are not stored securely

can be easily accessed and consumed unintentionally. This can result in serious health emergencies, especially when the medications involved are strong or require careful dosing. Studies have reported that a significant number of poisoning cases are linked to medicines stored at home. In addition to accidental exposure, the availability of unused medicines increases the likelihood of intentional misuse or abuse, particularly in the case of antibiotics, sedatives, and painkillers(Tong, Peake et al. 2011).

Another major concern related to household storage of medications is the practice of sharing medicines among family members and friends. Individuals often give their leftover medicines to others who have similar symptoms, without considering differences in medical conditions, allergies, or drug interactions. This practice can lead to inappropriate treatment and serious health complications. It also contributes to the growing problem of antimicrobial resistance, as antibiotics are frequently used without proper medical guidance. The misuse of medicines due to household storage highlights the importance of educating the public about the risks associated with such practices(Yu, Hu et al. 2019).

Environmental risks are also associated with the storage and eventual disposal of unused medications. When stored medicines are no longer needed, they are often disposed of improperly, such as being thrown in household waste or flushed into water systems. This can lead to the release of pharmaceutical substances into the environment, affecting soil and water quality. Over time, these substances can accumulate and have harmful effects on aquatic organisms and ecosystems. The presence of pharmaceuticals in the environment has been linked to changes in behavior and reproduction in wildlife, raising concerns about long-term ecological impacts(Kusturica, Tomas et al. 2016).

The issue of household storage of unused medications is closely related to the efficiency of healthcare systems. High levels of medication storage may indicate problems such as over-prescribing, lack of patient counseling, and poor adherence to treatment. It also reflects gaps in public awareness regarding the safe use and disposal of medicines. Addressing these issues requires a coordinated approach involving healthcare professionals, policymakers, and the community. Pharmacists and physicians can play a key role in reducing medication storage by prescribing appropriate quantities and providing clear instructions to patients. Public education programs can also help increase awareness about the risks associated with storing unused medicines at home and encourage safer practices(Organization 2019).

Knowledge Regarding Medication Waste Disposal:

Knowledge about medication waste disposal is an important factor that influences how individuals handle unused and expired medicines. Proper understanding of safe disposal methods helps reduce risks to human health and the environment. However, studies conducted in different parts of the world have shown that public knowledge regarding medication disposal is generally limited and often inadequate. Many individuals are not aware of recommended guidelines and continue to follow unsafe practices such as throwing medicines in household garbage or flushing them into sinks and toilets. This lack of knowledge contributes significantly to improper disposal behaviors and increases the potential for harm(Yu, Hu et al. 2019).

One of the major gaps in knowledge is the lack of awareness about appropriate disposal methods. Ideally, unused and expired medications should be returned to authorized collection centers or drug take-back programs. However, in many countries, especially developing regions, such systems are either not available or not widely known to the public. As a result, people rely on convenient but unsafe disposal methods. Research indicates that a large percentage of individuals have never received proper instructions on how to dispose of medicines safely, which highlights the need for improved education and communication strategies(Kusturica, Tomas et al. 2016).

Healthcare professionals play a key role in providing information about medication disposal, yet this aspect is often overlooked in routine practice. Pharmacists and physicians usually focus

on prescribing and dispensing medicines but may not provide guidance on what to do with leftover or expired drugs. Studies have shown that only a small proportion of patients receive counseling about safe disposal practices. This lack of professional guidance leaves patients uncertain and increases the likelihood of inappropriate disposal methods. Strengthening the role of healthcare providers in patient education can significantly improve knowledge levels and promote safer practices(Tong, Peake et al. 2011).

Another important aspect of knowledge is understanding the environmental impact of improper medication disposal. Many people are unaware that pharmaceuticals can enter water systems and persist in the environment for long periods. When medicines are disposed of through sinks or toilets, they can pass through wastewater treatment systems and contaminate natural water sources. This can have harmful effects on aquatic life, including changes in growth, reproduction, and behavior. For example, exposure to certain pharmaceutical compounds has been linked to hormonal disruptions in fish and other aquatic organisms. Lack of awareness about these environmental risks reduces the motivation of individuals to adopt safe disposal practices (Kümmerer 2009).

Knowledge about the health risks associated with improper disposal is also limited among the general population. Unused medicines stored at home can be accidentally ingested by children or misused by adults, leading to serious health consequences. In addition, improper disposal may contribute to the misuse of medications, particularly antibiotics and controlled drugs. When individuals are not aware of these risks, they are less likely to prioritize safe disposal. Studies suggest that individuals with better knowledge about health risks are more likely to follow recommended disposal practices, indicating the importance of educational interventions (Citaristi 2022).

The concept of the Knowledge, Attitude, and Practice (KAP) model is often used to understand behavior related to medication disposal. According to this model, knowledge serves as the foundation for developing positive attitudes, which in turn influence behavior. However, research has shown that knowledge alone may not always lead to appropriate practices. Even when individuals are aware of safe disposal methods, they may not follow them due to lack of convenience or access to proper facilities. Therefore, while improving knowledge is essential, it should be combined with efforts to address other barriers such as availability of disposal systems and public awareness campaigns (Bashaar, Thawani et al. 2017).

Socio-demographic factors also influence the level of knowledge regarding medication waste disposal. Education level, age, and access to healthcare information play an important role in determining how much individuals know about proper disposal practices. Studies have found that individuals with higher education levels are more likely to have better knowledge and awareness. Similarly, people who frequently interact with healthcare providers tend to be more informed about medication use and disposal. However, even among educated populations, gaps in knowledge still exist, indicating the need for widespread educational initiatives (Kümmerer 2009).

Public awareness campaigns and community-based programs can help improve knowledge regarding medication waste disposal. Educational interventions such as seminars, media campaigns, and informational leaflets have been shown to increase awareness and encourage safer practices. In addition, incorporating medication disposal education into routine healthcare services can help ensure that patients receive consistent and reliable information. Governments and health organizations also have a responsibility to develop clear guidelines and promote public awareness about safe disposal methods (Organization 2020).

Attitude Towards Safe Disposal of Medication:

Attitude toward safe disposal of medication is an important factor that influences how individuals manage unused and expired medicines. Attitude refers to a person's beliefs, perceptions, and feelings about a particular issue, which ultimately shape their behavior. In the context of medication disposal, it includes how seriously individuals consider the risks associated with improper

disposal, their level of concern about environmental and health impacts, and their willingness to follow recommended disposal practices. Although awareness about medication safety has improved in recent years, studies indicate that people's attitudes toward safe disposal are often not strong enough to ensure proper behavior (AlAzmi, AlHamdan et al. 2017). Research shows that many individuals have a generally positive attitude toward safe medication disposal. They agree that improper disposal can lead to harmful consequences such as environmental pollution and accidental poisoning. However, this positive attitude does not always translate into correct practices. A large number of people continue to dispose of medicines through household garbage or by flushing them into water systems. This suggests that while people may understand the importance of safe disposal, their attitudes are often influenced by convenience and lack of access to proper disposal facilities (Yu, Hu et al. 2019).

One of the key factors affecting attitude is the level of education and awareness among individuals. People who have better knowledge about the risks of improper disposal tend to have a more responsible attitude. However, in many cases, individuals are not adequately informed about safe disposal methods or the potential consequences of unsafe practices. Lack of proper guidance from healthcare professionals further contributes to weak attitudes. Studies have shown that many patients do not receive instructions about how to dispose of unused medicines, which results in uncertainty and careless behavior (Tong, Peake et al. 2011).

Cultural beliefs and personal habits also play a significant role in shaping attitudes toward medication disposal. In many communities, people prefer to store leftover medicines for future use rather than disposing of them. This behavior is often driven by the desire to avoid waste or save money. Additionally, sharing medicines among family members and friends is a common practice, reflecting a casual attitude toward medication use and safety. Such behaviors indicate that individuals may not fully recognize the risks associated with improper storage and disposal of medicines (Kusturica, Tomas et al. 2016).

Environmental awareness is another important aspect influencing attitudes. Improper disposal of medicines can lead to contamination of water sources and harm aquatic life. However, many individuals are not aware of the environmental impact of pharmaceutical waste. Studies have shown that people who are more environmentally conscious are more likely to adopt safe disposal practices. Increasing awareness about the environmental consequences of improper disposal can help strengthen positive attitudes and encourage responsible behaviour (Kümmerer 2009).

The role of healthcare professionals is crucial in shaping public attitudes toward safe medication disposal. Pharmacists and physicians are in a position to educate patients and provide guidance on proper disposal methods. However, this responsibility is often overlooked in clinical practice. Patients are usually not given clear instructions regarding disposal, which affects their perception and behavior. Improving communication between healthcare providers and patients can help build a more positive attitude toward safe disposal practices (Bashaar, Thawani et al. 2017).

Another important factor influencing attitude is the availability of proper disposal systems. In areas where drug take-back programs and disposal facilities are available, individuals are more likely to develop a positive attitude and follow recommended practices. On the other hand, in places where such facilities are lacking, people tend to adopt convenient but unsafe methods. This highlights the importance of providing accessible and user-friendly disposal options to support positive attitudes and behaviors.

Attitudes toward medication disposal are also influenced by perceived risk. Individuals who believe that improper disposal can cause serious harm are more likely to adopt safe practices. However, if the perceived risk is low, people may not consider safe disposal important. Therefore, increasing awareness about the health and environmental risks associated with improper

disposal can help strengthen attitudes and promote safer practices.

Disposal Practice of Unused and Expired Medication:

The improper disposal of unused and expired medications has emerged as a pressing public health and environmental concern worldwide (Boxall, 2012). Pharmaceuticals, when discarded incorrectly, can enter water systems, soil, and landfills, leading to contamination of ecosystems and contributing to antimicrobial resistance (Tong, Peake, & Braund, 2011). Many individuals are unaware of the potential risks associated with improper disposal and often resort to convenient but unsafe methods such as throwing medications in household trash or flushing them down toilets and sinks (Leporatti, 2020). While throwing medications in household trash may appear harmless, studies indicate that chemical residues can leach into soil and groundwater over time, posing long-term environmental hazards (Kümmerer, 2018). Flushing medications, though sometimes recommended for high-risk drugs such as opioids, introduces active pharmaceutical ingredients into wastewater systems, where conventional treatment facilities are not equipped to remove all compounds, resulting in detectable residues in rivers, lakes, and even drinking water supplies (U.S. Environmental Protection Agency [EPA], 2019).

To address these challenges, pharmacy-based return programs and community drug take-back initiatives have been developed in several countries (Tong et al., 2011). These programs allow individuals to return unused medications to designated collection bins or participate in periodic collection events, ensuring that pharmaceuticals are safely destroyed or neutralized (Leporatti, 2020). Evidence demonstrates that participation in take-back programs significantly reduces the volume of medications entering household waste and prevents accidental ingestion or misuse (EPA, 2019). Despite their effectiveness, access to these programs varies widely by region, and public participation often depends on awareness, convenience, and regulatory support (Boxall, 2012). In countries where comprehensive pharmaceutical waste management policies exist, pharmacies are required to accept unused medications and guide patients on proper disposal practices, thereby enhancing safety and reducing environmental contamination (Kümmerer, 2018). Regulatory authorities and healthcare systems play a critical role in standardizing disposal practices (Boxall, 2012). Guidelines often recommend segregating pharmaceutical waste according to hazard classifications, ensuring that hazardous and non-hazardous drugs are treated differently to prevent environmental exposure and protect healthcare workers (EPA, 2019). In addition, many countries mandate that medication packaging include disposal instructions to inform patients about proper handling of expired or unused drugs (Tong et al., 2011). Despite these initiatives, several barriers hinder safe disposal, including lack of public awareness, limited availability of collection points, and economic constraints that affect program sustainability (Leporatti, 2020). Logistical challenges are particularly pronounced in rural and underserved areas, where individuals may need to travel long distances to access take-back services (Kümmerer, 2018). Furthermore, inconsistent disposal guidelines across regions create confusion, leaving many consumers uncertain about the safest methods to manage their medications (Boxall, 2012).

Educational interventions have proven to be effective in promoting responsible disposal behaviors (Leporatti, 2020). Pharmacists, as primary healthcare providers, are in an ideal position to educate patients at the point of dispensing, providing both verbal instructions and written materials about safe disposal methods (EPA, 2019). Research indicates that patients are more likely to comply with safe disposal practices when counseling is provided by healthcare professionals (Tong et al., 2011). Community-based campaigns, media outreach, and school programs further enhance awareness by highlighting the environmental and health consequences of improper disposal (Boxall, 2012). Multifaceted approaches that combine these strategies have been shown to be more effective than isolated interventions, as they reinforce

messaging across multiple channels and reach diverse populations (Kümmerer, 2018).

Technological innovations have also contributed to improving pharmaceutical disposal practices (EPA, 2019). On-site drug deactivation products, which allow individuals to neutralize medications at home before discarding them, have become increasingly popular (Leporatti, 2020). These products contain chemical agents that render active pharmaceutical ingredients less harmful, mitigating the risk of environmental contamination (Kümmerer, 2018). Policy-level interventions, such as extended producer responsibility frameworks, place the burden of proper disposal on pharmaceutical manufacturers (Boxall, 2012). By financing and managing take-back programs, manufacturers help ensure widespread access to safe disposal options and support environmentally sustainable systems (EPA, 2019).

Regional studies reveal significant disparities in disposal practices (Tong et al., 2011). In several European countries, national take-back systems and mandatory pharmacy collection programs have resulted in higher rates of proper disposal (Kümmerer, 2018). Conversely, in many low- and middle-income countries, formal disposal systems are limited or nonexistent, leading to unsafe practices such as burning medications in household fires, discarding them in open dumps, or releasing them into water bodies (Boxall, 2012). These practices not only increase the risk of environmental contamination but also contribute to accidental ingestion and medication misuse (Leporatti, 2020). Addressing these disparities requires tailored interventions that consider local infrastructure, cultural practices, and community engagement, ensuring that solutions are practical and widely adopted (EPA, 2019).

Monitoring and evaluation are essential to improving the effectiveness of pharmaceutical disposal programs (Kümmerer, 2018). Tracking the volume of collected medications, public participation rates, and environmental concentrations of pharmaceutical residues helps policymakers and program administrators assess the success of interventions and identify areas for improvement (Boxall, 2012). Data-driven approaches allow for the allocation of resources where they are most needed and inform the design of future programs (Tong et al., 2011). Incorporating feedback from communities and healthcare providers further enhances program responsiveness and sustainability, promoting long-term adherence to safe disposal practices (EPA, 2019).

The environmental and public health implications of improper medication disposal are significant (Leporatti, 2020). Pharmaceuticals detected in aquatic environments, including antibiotics, hormones, and antidepressants, have been shown to alter the behavior and physiology of aquatic organisms and contribute to the development of antibiotic-resistant bacteria (Boxall, 2012). Human health risks are also evident, as children and pets are particularly vulnerable to accidental ingestion, and the contamination of water sources can affect wider populations (Kümmerer, 2018). By implementing effective disposal strategies, including take-back programs, educational campaigns, technological solutions, and policy initiatives, the risk of environmental contamination and public health hazards can be substantially reduced (EPA, 2019).

Environment and Public Health Impact:

Environmental Impact: The improper disposal of unused and expired medications poses significant environmental risks. Pharmaceuticals are designed to be biologically active, and their presence in the environment can have unintended consequences.

- **Water Contamination:** Unused medications often end up in wastewater, contaminating water sources. Studies have detected pharmaceutical residues in rivers, lakes, and drinking water (Daughton, 2003).
- **Soil Pollution:** Pharmaceuticals can contaminate soil through landfill leachate or agricultural runoff, affecting plant growth and wildlife (Kümmerer, 2009).
- **Impact on Aquatic Life**: Pharmaceuticals in water bodies can harm aquatic organisms, disrupting ecosystems and potentially affecting human food chains.

Examples:
- Antibiotics in water contribute to antimicrobial resistance.
- Hormones from pharmaceuticals can disrupt endocrine systems in wildlife (Boxall, 2004).

Public Health Impact
Unused and expired medications pose risks to public health, particularly through misuse and accidental exposure.

- **Medication Misuse:** Unused medications can be diverted for recreational use or lead to self-medication, increasing risks of overdose or adverse reactions (Glassmeyer et al., 2017).
- **Accidental Poisoning:** Improperly stored medications can be accidentally ingested, especially by children or pets.

- **Antimicrobial Resistance:** Improper disposal of antibiotics contributes to antimicrobial resistance, a major global health threat (WHO, 2019).

Examples:
- Opioid misuse from leftover prescriptions contributes to the opioid crisis.
- Unused antibiotics can lead to inappropriate self-treatment.

Role of Healthcare professional in Rational prescribing:
Rational prescribing by healthcare professionals is a fundamental component of quality patient care, ensuring that medications are selected based on clinical evidence, patient needs, and safety considerations. At its core, rational prescribing requires that healthcare professionals demonstrate in-depth knowledge of pharmacology, disease pathology, and patient characteristics such as age, comorbidities, and concomitant medications. This process begins with an accurate diagnosis, which guides the selection of the most appropriate therapeutic agent. Evidence suggests that diagnostic accuracy significantly influences treatment outcomes, as misdiagnosis can lead to inappropriate drug selection, suboptimal therapeutic efficacy, and increased risk of adverse drug reactions (Wortmann & Schaefer, 2020). Healthcare professionals thus bear the responsibility of continuously updating their clinical knowledge and skills to match evolving treatment guidelines and emerging evidence from clinical research.
In addition to diagnosis, rational prescribing involves careful assessment of drug effectiveness and safety for individual patients. Doctors and pharmacists must integrate data from clinical trials, real-world studies, and formularies to select medications with the best risk–benefit profile. This is particularly important in populations that may be underrepresented in clinical trials, such as the elderly or patients with multiple chronic conditions. Through clinical judgment, prescribers weigh the therapeutic advantages of a medication against potential harms, including drug–drug interactions, side effects, and long-term toxicity. Such decision-making reflects principles of evidence-based medicine, underscoring the obligation of healthcare professionals to ground prescribing choices in scientifically validated information rather than habit, tradition, or pharmaceutical marketing pressures (Blenkinsopp, Paxton, & Blenkinsopp, 2012).
Healthcare professionals also play a pivotal role in reducing the inappropriate use of antibiotics—a key global health priority. The over prescription and misuse of antibiotics have accelerated the development of antimicrobial resistance, rendering common infections harder to treat and increasing morbidity and mortality worldwide. Rational antibiotic prescribing demands that prescribers differentiate between bacterial and viral infections, reserve broad-spectrum antibiotics for specific indications, and adhere to recommended treatment durations. Research demonstrates that educational programs targeting physicians' antibiotic prescribing behavior can significantly reduce unnecessary antibiotic use without compromising patient outcomes (Huttner et al., 2019). Active stewardship efforts by clinicians, including audit and feedback, guideline dissemination, and decision support tools, contribute to improved prescribing patterns and help preserve antibiotic effectiveness for future generations.

Pharmacists also serve a crucial function in promoting rational prescribing by intervening at points of medication selection and use. Through medication therapy management, pharmacists review prescriptions for appropriateness, dose optimization, potential interactions, and duplication of therapy. In many healthcare systems, pharmacist-led interventions have reduced medication errors and improved clinical outcomes, particularly among patients receiving multiple medications or those with complex therapeutic regimens. Pharmacists' expertise in pharmacokinetics and pharmacodynamics enables them to recommend dose adjustments based on renal or hepatic function, advise on therapeutic alternatives, and counsel patients on safe and effective medication use. Collaborative practices between pharmacists and prescribers have been shown to enhance rational drug use by combining clinical and pharmacological perspectives in patient care (Allemann, van Mil, & Botermann, 2014).

Communication between healthcare professionals and patients is another essential element of rational prescribing. Shared decision-making involves explaining treatment options, discussing benefits and risks, and considering patient preferences and values. When patients understand why a particular medication is prescribed, they are more likely to adhere to therapy and less likely to request unnecessary or inappropriate treatments. Poor communication has been linked to nonadherence, therapeutic failure, and increased healthcare costs. Effective patient education by prescribers and pharmacists fosters trust and empowers patients to participate actively in their treatment plans, ultimately improving therapeutic outcomes and reducing unwarranted medication use.

Furthermore, rational prescribing extends beyond individual patient encounters to encompass system-level responsibilities. Healthcare professionals contribute to formulary management, guideline development, and quality improvement initiatives aimed at standardizing prescribing practices. By participating in multidisciplinary teams, clinicians help design protocols that reduce variability in drug therapy and promote the use of cost-effective, evidence-based treatments. Such initiatives reduce unnecessary prescribing, minimize adverse events, and optimize resource utilization within healthcare systems. Research in health services has shown that standardized prescribing protocols, when developed and implemented collaboratively, lead to measurable improvements in medication use and patient safety (Vogler, 2018).

Education and ongoing professional development further reinforce the capacity of healthcare professionals to prescribe rationally. Medical, pharmacy, and nursing curricula increasingly emphasize pharmacology, therapeutics, and clinical reasoning skills. Postgraduate training programs and continuing education opportunities keep clinicians abreast of emerging therapies, updated guidelines, and safety alerts. Professional organizations and regulatory bodies often mandate continuing education in drug therapy and prescribing principles as a condition of licensure. By engaging in lifelong learning, healthcare professionals maintain competence in therapeutic decision-making and are better equipped to adapt prescribing practices in response to new evidence and changing patient populations.

In addition to formal education, healthcare professionals must remain vigilant regarding pharmaceutical industry influences that can skew prescribing practices. Marketing efforts such as sponsored educational events, promotional materials, and direct sales representative interactions can bias clinician preferences toward newer or more expensive medications without clear therapeutic advantages. Rational prescribing requires that clinicians critically evaluate promotional claims and rely on independent evidence from peer-reviewed research. Ethical standards and conflict-of-interest policies within healthcare institutions serve to shield prescribing decisions from undue commercial influence, thereby supporting patient-centered and evidence-driven care.

Healthcare professionals also play an important role in monitoring and reporting adverse drug reactions (ADRs), which feeds back into rational prescribing practices. Timely reporting of ADRs contributes to pharmacovigilance systems that

detect safety signals and inform regulatory actions, such as label changes or drug withdrawals. Clinicians who report and analyze ADRs enhance collective knowledge about medication safety, leading to more informed prescribing decisions in the future. Encouraging a culture of safety reporting within healthcare settings fosters awareness of potential medication hazards and prompts careful consideration of drug risks when initiating therapy.

Finally, the ethical imperative of rational prescribing aligns with broader healthcare goals of equity, safety, and quality. Healthcare professionals who prescribe rationally uphold the principle of beneficence by selecting treatments that are most likely to benefit patients while minimizing harm. They uphold justice by considering cost-effectiveness and fair allocation of limited healthcare resources. Rational prescribing embodies professional accountability, clinical competence, and patient-centeredness, reinforcing the trust placed in clinicians as stewards of safe and effective medication use.

Awareness and Take Back Program of Unused and Expired Medication:

Awareness regarding the safe handling and disposal of unused and expired medications has become an essential component of public health strategies worldwide. Many households accumulate medications due to overprescribing, non-adherence, or changes in therapy, yet a large proportion of the population remains unaware of appropriate disposal practices. Studies conducted by organizations such as the World Health Organization indicate that improper disposal methods, including throwing medicines in household waste or flushing them down sinks and toilets, contribute to environmental contamination and potential health risks. Pharmaceutical residues have been detected in water systems, posing threats to aquatic life and possibly affecting human health through long-term exposure. Public awareness campaigns are therefore critical in educating communities about the environmental and safety implications of improper medication disposal and promoting responsible behaviors (World Health Organization, 2012; Glassmeyer et al., 2009).

In many countries, structured medication take-back programs have been introduced as an effective intervention to address this issue. These programs provide designated collection points, often located in pharmacies, hospitals, or community centers, where individuals can return unused or expired medications safely. The U.S. Food and Drug Administration has actively supported such initiatives, emphasizing their role in preventing accidental poisoning, misuse, and environmental harm. Public participation in take-back programs is largely influenced by awareness levels, convenience, and trust in the system. Research suggests that when individuals are informed about the availability and purpose of these programs, participation rates significantly increase, highlighting the importance of continuous education and outreach (U.S. Food and Drug Administration, 2020; Tong et al., 2011).

Community pharmacists play a vital role in enhancing awareness and facilitating take-back programs. As accessible healthcare professionals, pharmacists are in a unique position to counsel patients on medication use, storage, and disposal. Programs implemented in collaboration with pharmacies have demonstrated higher engagement, as pharmacists can directly inform patients at the point of dispensing. The involvement of organizations such as the International Pharmaceutical Federation further strengthens these initiatives by promoting global standards and encouraging professional responsibility among pharmacists. Educational interventions led by pharmacists, including verbal counseling and informational leaflets, have been shown to significantly improve patient knowledge and attitudes toward safe medication disposal (Kusturica et al., 2017; International Pharmaceutical Federation, 2019).

Mass media and digital platforms also contribute significantly to raising awareness about medication take-back programs. Campaigns utilizing television, radio, and social media can reach a broad audience and reinforce key messages about the risks associated with improper disposal.

Governments and health organizations often collaborate to launch nationwide campaigns, particularly during designated take-back events. For example, initiatives supported by the Drug Enforcement Administration in the United States have successfully collected substantial quantities of unused medications, demonstrating the effectiveness of well-publicized programs. These campaigns not only provide information but also encourage behavioral change by making disposal options more visible and accessible to the public (Drug Enforcement Administration, 2021; Seehusen & Edwards, 2006).

Despite the proven benefits of take-back programs, several challenges hinder their widespread implementation, particularly in developing countries. Limited infrastructure, lack of regulatory frameworks, and insufficient funding often restrict the establishment of permanent collection systems. In regions like Pakistan, awareness remains low, and formal take-back programs are scarce, leading to reliance on unsafe disposal methods. Efforts by national regulatory bodies such as the Drug Regulatory Authority of Pakistan are essential to develop policies and guidelines that support safe medication disposal practices. Integrating awareness campaigns into existing healthcare services and educational curricula can further enhance public understanding and participation. Studies indicate that even simple interventions, such as labeling medications with disposal instructions, can improve awareness and encourage safer practices among consumers (Khan et al., 2022; Kusturica et al., 2017).

Educational institutions and healthcare facilities also play a significant role in promoting awareness and supporting take-back initiatives. Incorporating topics related to pharmaceutical waste management into medical and pharmacy education can prepare future healthcare professionals to address this issue effectively. Additionally, hospitals can establish internal take-back systems to manage unused medications from patients and staff. Collaborative efforts between healthcare providers, regulatory authorities, and community organizations are crucial to creating a sustainable system for medication disposal. By strengthening awareness and expanding take-back programs, societies can reduce environmental pollution, prevent drug misuse, and promote overall public health safety (World Health Organization, 2012; International Pharmaceutical Federation, 2019).

Challenges in Developing Countries for Disposal of Unused and Expired Medication:

The management of unused and expired medications presents significant challenges in developing countries due to weak healthcare infrastructure, limited regulatory enforcement, and low public awareness. One of the primary issues is the absence of well-established systems for pharmaceutical waste collection and disposal. In many low- and middle-income countries, formal take-back programs are either unavailable or poorly implemented, leaving individuals with no safe or convenient options for disposing of medications. As a result, people often resort to unsafe practices such as discarding medicines in household waste, flushing them into sewage systems, or storing them indefinitely at home. According to the World Health Organization, inadequate systems for managing pharmaceutical waste contribute to environmental contamination and increase the risk of accidental exposure and misuse (World Health Organization, 2012).

Another major challenge is the lack of public awareness and education regarding the risks associated with improper medication disposal. In many developing countries, individuals are unaware of the environmental and health consequences of discarding pharmaceuticals improperly. Cultural beliefs and economic factors also influence behavior, as people tend to retain unused medications for future use or share them with others to avoid wastage. This practice can lead to self-medication, incorrect dosing, and increased antimicrobial resistance. Studies have shown that insufficient knowledge about proper disposal methods is a key factor contributing to unsafe practices. Efforts by organizations such as the International Pharmaceutical Federation highlight the importance of educating communities to improve attitudes and behaviors toward

medication disposal (Kusturica et al., 2017; International Pharmaceutical Federation, 2019).

Regulatory and policy-related barriers further complicate the control of unused and expired medications in developing regions. Many countries lack comprehensive legislation or clear guidelines for pharmaceutical waste management. Even where policies exist, enforcement is often weak due to limited resources, lack of coordination among regulatory bodies, and insufficient monitoring mechanisms. National authorities, including agencies like the Drug Regulatory Authority of Pakistan, face challenges in implementing and overseeing proper disposal systems. Additionally, there is often no clear assignment of responsibility among stakeholders, such as manufacturers, pharmacies, and healthcare institutions, leading to gaps in accountability. Without strong regulatory frameworks, it becomes difficult to establish standardized practices for medication disposal (Khan et al., 2022; World Health Organization, 2012).

Financial constraints also play a significant role in limiting the development and sustainability of pharmaceutical waste management systems. Establishing and maintaining take-back programs, incineration facilities, and waste treatment infrastructure require substantial investment, which may not be prioritized in resource-limited settings. Governments in developing countries often allocate limited budgets to more immediate healthcare needs, such as infectious disease control and basic medical services. Consequently, pharmaceutical waste management is overlooked despite its long-term implications for public health and the environment. Support from international organizations such as the United Nations Environment Programme can help address these financial challenges by providing technical assistance and funding opportunities for sustainable waste management initiatives (UNEP, 2019; Glassmeyer et al., 2009).

Inadequate healthcare practices and irrational prescribing further contribute to the accumulation of unused medications. Overprescribing, polypharmacy, and lack of patient adherence often result in surplus medicines that eventually expire. In many developing countries, the absence of electronic prescribing systems and limited patient follow-up exacerbate this issue. Healthcare professionals may not always provide adequate counseling on medication use, leading to improper consumption and leftover drugs. Additionally, easy access to over-the-counter medications without proper regulation encourages excessive purchasing and storage of drugs at home. These factors collectively increase the volume of pharmaceutical waste and complicate efforts to manage it effectively (Seehusen & Edwards, 2006; Kusturica et al., 2017).

Environmental and infrastructural limitations also hinder the safe disposal of medications in developing regions. Many areas lack proper waste segregation systems, and pharmaceutical waste is often mixed with general household or medical waste. This increases the likelihood of contamination of soil and water resources, particularly in regions with inadequate sanitation systems. Informal waste disposal practices, such as open dumping and burning, are common and can release harmful substances into the environment. The lack of advanced treatment technologies, such as high-temperature incineration, further limits the ability to safely destroy pharmaceutical compounds. Addressing these infrastructural gaps requires coordinated efforts from governments, healthcare systems, and environmental agencies to develop sustainable and context-appropriate solutions (World Health Organization, 2012; UNEP, 2019).

Strategies for Improving Safe Disposal of Unused and Expired Medication:

Improving the safe disposal of unused and expired medications requires a comprehensive and multi-sectoral approach that integrates public awareness, regulatory enforcement, healthcare involvement, and infrastructure development. One of the most effective strategies is the implementation of widespread educational and awareness campaigns. Many individuals are unaware of the environmental and health risks associated with improper medication disposal, such as water contamination and accidental poisoning. Educational initiatives led by healthcare

institutions, community pharmacies, and public health agencies can significantly improve knowledge and practices. The World Health Organization emphasizes that public education should include clear instructions on identifying expired medications, understanding disposal methods, and recognizing the importance of not sharing or reusing leftover drugs. Utilizing media platforms, including social media, television, and print materials, can enhance outreach and ensure that key messages reach diverse populations (World Health Organization, 2012; Kusturica et al., 2017).

Another important strategy is the establishment and expansion of medication take-back programs. These programs provide safe, accessible, and environmentally sound options for the public to dispose of unused medicines. Permanent collection sites in pharmacies and hospitals, as well as periodic take-back events, have proven to be highly effective in reducing household pharmaceutical waste. The U.S. Food and Drug Administration supports such programs and recommends them as the preferred method for medication disposal. In addition, mail-back services and secure drop boxes can increase accessibility, particularly in rural or underserved areas. Ensuring that these programs are convenient and well-publicized can significantly improve participation rates and reduce unsafe disposal practices (U.S. Food and Drug Administration, 2020; Tong et al., 2011).

Strengthening regulatory frameworks and policy implementation is another key strategy for improving safe medication disposal. Governments need to develop clear guidelines and enforce regulations related to pharmaceutical waste management. Policies that assign responsibility to manufacturers, distributors, and pharmacies—often referred to as extended producer responsibility—can help ensure that proper disposal systems are established and maintained. Regulatory authorities such as the Drug Regulatory Authority of Pakistan can play a critical role in formulating and enforcing such policies. Additionally, integrating medication disposal guidelines into national healthcare policies can standardize practices and promote accountability among stakeholders. Effective monitoring and evaluation mechanisms are also necessary to assess compliance and identify areas for improvement (Khan et al., 2022; World Health Organization, 2012).

Healthcare professionals, particularly pharmacists, are central to promoting safe disposal practices. As the most accessible healthcare providers, pharmacists can educate patients during dispensing about proper medication use, storage, and disposal. Counseling sessions can include practical advice, such as removing personal information from packaging and returning unused medicines to designated collection points. Organizations like the International Pharmaceutical Federation advocate for the active involvement of pharmacists in public health initiatives, including medication waste management. Training programs and continuing education for healthcare workers can further enhance their ability to communicate effectively with patients and encourage responsible behaviors (International Pharmaceutical Federation, 2019; Kusturica et al., 2017).

Improving infrastructure for pharmaceutical waste management is also essential for ensuring safe disposal. Developing countries, in particular, need investment in waste treatment facilities, such as high-temperature incinerators, which can safely destroy pharmaceutical compounds without releasing harmful pollutants. Collaboration with environmental agencies and international organizations like the United Nations Environment Programme can support the development of sustainable waste management systems. Proper segregation of pharmaceutical waste from general waste streams is another important aspect, as it reduces the risk of contamination and facilitates appropriate treatment. Establishing clear protocols for waste handling within healthcare facilities can further improve overall disposal practices (UNEP, 2019; Glassmeyer et al., 2009).

Technological innovations can also play a supportive role in enhancing safe medication disposal. Digital tools, such as mobile applications and online platforms, can provide information about nearby take-back locations, disposal

guidelines, and awareness campaigns. These tools can improve accessibility and encourage public participation by making information readily available. Additionally, electronic prescribing systems can help reduce the over-dispensing of medications, thereby minimizing the accumulation of unused drugs. Data collected through such systems can also be used to monitor medication usage patterns and identify areas where interventions are needed. Integrating technology into healthcare and waste management systems can thus contribute to more efficient and sustainable disposal practices (Tong et al., 2011; Kusturica et al., 2017).

Literature Review:

This study investigated the knowledge, attitudes, and practices related to the disposal of unwanted household medicines among university students in the Western Region of Saudi Arabia. Using a cross-sectional design and a convenience sampling method, data were collected from 1,446 students enrolled at Taif University, King Abdul-Aziz University, and Umm Al-Qura University through a validated, structured questionnaire. The study aimed to assess awareness of environmental risks, disposal behaviors, and sources of information regarding proper medicine disposal.

The findings revealed that improper disposal of medicines is highly prevalent among university students. More than three-quarters of respondents (76.9%) reported having discarded medicines, with disposal via household waste baskets being the most common method for both solid and liquid dosage forms. Disposal through sinks or toilets was also frequently practiced, while returning unused medicines to pharmacies or physicians was rare. Expiry of medicines was identified as the primary reason for disposal, and most respondents did not consult medication leaflets or healthcare professionals before discarding medicines.

Although approximately 60% of respondents recognized that improper disposal could harm the environment, only about one-quarter had received prior information from healthcare professionals on correct disposal methods. Despite this gap, the majority of students believed that public education on safe medicine disposal is necessary. Key factors influencing disposal decisions included the dosage form and quantity of medication, whereas cost was considered least important.

The study highlights a clear discrepancy between awareness of environmental risks and actual disposal practices. This gap is largely attributed to low levels of formal guidance and the absence of medicine take-back programs in Saudi Arabia. The authors conclude that implementing structured drug return systems, alongside targeted awareness campaigns, is essential to promote rational disposal practices and reduce potential environmental and public health risks.

This study assessed the knowledge, attitudes, and practices related to the disposal of unused and expired pharmaceuticals among households in Harar City, Eastern Ethiopia. A descriptive cross-sectional design was employed between February and April 2018, involving 695 household residents selected through a multi-stage sampling technique. Data were collected using face-to-face interviews with a structured questionnaire covering socio-demographic characteristics, knowledge, attitudes, and disposal practices. Descriptive statistical analysis was conducted using SPSS version 20.

The results indicated that while general awareness of medication waste was relatively high, significant gaps existed in safe disposal practices. Approximately 72.9% of respondents were aware of medication waste, and 86% recognized that improper disposal could harm the environment and public health. However, nearly two-thirds of participants (66.9%) were unaware of drug take-back programs. Most respondents emphasized the need for proper guidance to consumers as a key strategy for minimizing environmental contamination caused by pharmaceuticals. Electronic media and physicians were identified as the primary sources for awareness creation, while pharmacists were less frequently recognized.

In terms of attitudes, a majority of respondents strongly agreed that unused and expired medicines pose risks within households, particularly to children, and acknowledged a lack of adequate information on safe disposal practices. Regarding actual practices, approximately 66% of households

reported storing unused medicines at home, with analgesics and antibiotics being the most commonly retained drugs. The predominant disposal method for both unused and expired medicines was discarding them in household garbage (53.2%), followed by flushing them into sinks or toilets. Only a very small proportion of participants reported returning medicines to pharmacies.

The study concludes that although awareness of the risks associated with improper pharmaceutical disposal is relatively high, disposal practices remain largely inappropriate. The absence of structured disposal guidelines and drug take-back systems contributes significantly to unsafe practices. The authors recommend the development of national guidelines, public education initiatives, and organized pharmaceutical take-back programs to promote safe disposal and reduce environmental and public health risks.

This study by Seehusen and Edwards examined patient practices and beliefs regarding the disposal of unused and expired medications, highlighting the role of patient education in promoting environmentally safe disposal behaviors. Improper medication disposal is a growing public health and environmental concern, as pharmaceuticals discarded into sewage systems or household waste may contaminate groundwater, surface water, and drinking water. Despite incineration being the most appropriate disposal method, clear guidance for patients remains limited.

A cross-sectional survey was conducted among 301 patients attending an outpatient pharmacy at Madigan Army Medical Center in the United States. Participants completed an anonymous questionnaire assessing their medication disposal practices, beliefs about acceptable disposal methods, and whether they had received prior counseling from healthcare providers. Descriptive statistics and comparative analyses were performed to identify associations between patient education and disposal behaviors.

The findings revealed widespread inappropriate disposal practices. More than half of respondents reported storing unused or expired medications at home, and 53.8% indicated that they had flushed medications down the toilet. Only 22.9% returned medications to a pharmacy, while 14% returned them to a healthcare provider. Fewer than 20% of participants had ever received advice from a healthcare professional regarding proper medication disposal. Notably, prior counseling was strongly associated with safer disposal practices. Patients who had received education were significantly more likely to return medications to pharmacies or providers and were more likely to believe that these methods were appropriate. Counseling was also associated with reduced acceptance of storing medications at home.

The study concludes that patient education is a key determinant of appropriate medication disposal behaviors. Incorporating disposal counseling into routine healthcare and pharmacy interactions may significantly improve patient practices and reduce environmental contamination. The authors emphasize the need for increased provider involvement and structured education to promote safe disposal of unused and expired medications

This cross-sectional study investigated public awareness, attitudes, and practices regarding the disposal of expired and unused medications in Riyadh, Saudi Arabia, where formal medication disposal systems are limited. The study was conducted between February and April 2015 at King Khalid University Hospital and King Saud University. A total of 1,200 individuals were randomly approached, and 1,057 completed self-administered questionnaires were included in the analysis. The questionnaire collected data on demographic characteristics, types of medications stored at home, disposal methods, and preferred approaches for public education.

The findings revealed that inappropriate medication disposal practices were widespread. The majority of respondents (79.1%) disposed of unused or expired medications in household waste, while 7% flushed medications down sinks or toilets. Only 1.7% returned medications to pharmacies, reflecting the absence of medication take-back programs in Saudi Arabia. In addition, 21.4% of respondents reported storing expired medications at home, and more than half (51.9%)

kept leftover antibiotics, suggesting potential misuse and a risk of antibiotic resistance.

Awareness of the consequences of improper medication disposal was low, with over half of respondents unaware of the risks associated with storing expired medications. Despite this limited awareness, 70.2% of participants believed that proper medication disposal was their personal responsibility, and 78.6% expressed interest in receiving information on safe disposal practices. Demographic factors such as age, gender, and educational level influenced awareness and attitudes, with older individuals and females demonstrating greater responsibility and willingness to use disposal facilities.

The study concludes that unsafe medication disposal practices are common in Riyadh and pose risks to public health and the environment. The authors recommend the development of national disposal guidelines, implementation of pharmacy-based take-back programs, and targeted public education campaigns to promote safe medication disposal practices.

A study conducted by Seehusen and Edwards (2006) examined patient practices and beliefs regarding the disposal of unused and expired medications. The study was carried out using a survey-based approach, involving 301 patients at an outpatient pharmacy in a military medical center in the United States. The primary objective was to assess how patients dispose of medications and to explore their understanding and attitudes toward appropriate disposal methods.

The study highlighted that improper disposal of medications is a significant environmental and public health concern. Pharmaceuticals can enter water systems through inappropriate disposal methods such as flushing or rinsing medications down sinks and toilets. These substances have been detected in groundwater, surface water, and even drinking water, posing potential long-term risks to human health and the environment. Furthermore, storing unused or expired medications at home increases the risk of accidental ingestion, misuse, and sharing among family members.

The findings revealed that improper disposal practices were highly prevalent among patients. More than half of the respondents reported storing unused or expired medications in their homes, while a similarly large proportion admitted to flushing medications down the toilet. Disposal through household trash and sinks was also common. In contrast, only 22.9% of participants reported returning medications to pharmacies, and an even smaller proportion returned them to healthcare providers. These findings indicate that safe disposal methods are not widely practiced.

In terms of knowledge and awareness, the study found that patient education on proper medication disposal was limited. Less than 20% of respondents had ever received advice from healthcare professionals regarding appropriate disposal practices. However, those who had received prior counseling demonstrated significantly better behaviors and attitudes. For instance, patients who were educated were more likely to return medications to pharmacies (45.8% compared to 17.1%) and healthcare providers. They were also more likely to believe that returning medications to authorized facilities was the correct method of disposal.

The study also explored patient beliefs about acceptable disposal practices. While a majority considered returning medications to pharmacies or healthcare providers as appropriate, a considerable number still believed that flushing medications or disposing of them in sinks was acceptable. This discrepancy highlights a gap between knowledge and actual behavior, as well as confusion regarding proper disposal guidelines.

Importantly, the study identified patient education as a key factor influencing safe disposal practices. Counseling by healthcare providers was strongly associated with improved knowledge, positive attitudes, and safer disposal behaviors. The authors suggested that pharmacies and healthcare professionals play a crucial role in educating patients, as frequent interactions with patients provide opportunities to deliver guidance on proper disposal methods.

In conclusion, the study demonstrated that improper medication disposal is common due to lack of awareness and insufficient patient education. The findings emphasize the need for structured educational interventions and clearer

guidelines to promote safe disposal practices. Enhancing patient awareness through healthcare providers and incorporating disposal instructions into routine care could significantly improve behaviors and reduce the environmental and health risks associated with pharmaceutical waste.

A cross-sectional study conducted by Al-Shareef et al. (2016) investigated the disposal practices of expired and unused medications among the general population in Riyadh, Saudi Arabia. The study aimed to evaluate public behavior, awareness, and preferred educational methods regarding safe medication disposal. A total of 1,200 participants were randomly selected from King Khalid University Hospital and King Saud University, with 1,057 completed responses included in the final analysis.

The study emphasized that improper disposal of medications poses significant risks, including environmental pollution, antibiotic resistance, and accidental poisoning, particularly among children and pets. Pharmaceuticals can enter water systems and negatively affect both human health and wildlife, making safe disposal practices a critical public health concern.

The findings revealed that awareness regarding proper medication disposal was generally low among participants. More than half of the respondents (55.3%) were unaware of the consequences of storing expired medications at home, and only 9.1% had ever received information about appropriate disposal methods. Despite this lack of awareness, a large proportion of participants (78.6%) expressed interest in receiving education on safe disposal practices, indicating a willingness to improve their knowledge.

In terms of household practices, the study found that medication storage was common, with 75.8% of respondents reporting the presence of medicines at home. Additionally, 21.4% had expired medications in their households. Notably, more than half of the participants (51.9%) reported storing antibiotics, which raises concerns about misuse and the potential development of antibiotic resistance.

Regarding disposal practices, the majority of respondents (79.1%) reported discarding unused or expired medications in household waste, making it the most common method. A smaller proportion (7%) disposed of medications by flushing them down toilets or sinks. Only a very small percentage (1.7%) returned medications to pharmacies, highlighting the absence or underutilization of formal drug take-back systems in Saudi Arabia.

The study also examined attitudes toward responsibility and disposal behavior. Approximately 70.2% of participants believed that it is their responsibility to find safe ways to dispose of medications, and over 80% expressed willingness to use drug collection facilities if available. These findings suggest that while awareness is low, there is a positive attitude toward adopting safer practices if appropriate systems are implemented.

Furthermore, the study explored preferred methods for receiving information about safe disposal. Participants favored modern communication channels such as social media, smartphone applications, and healthcare professionals, particularly hospital pharmacists. This highlights the importance of using accessible and engaging platforms for public health education.

In conclusion, the study demonstrated a significant gap between current practices and recommended guidelines for medication disposal in Riyadh. The widespread use of improper disposal methods, combined with low awareness and lack of structured programs, underscores the need for urgent intervention. The authors recommended the implementation of national drug take-back programs, increased public education campaigns, and stronger policy frameworks to promote safe and environmentally responsible disposal practices.

Overall, this study highlights the critical need for improving awareness and infrastructure to address pharmaceutical waste management effects.

A study conducted by Ayele and Mamu (2018) assessed the knowledge, attitude, and practices (KAP) regarding the disposal of unused and expired pharmaceuticals among households in Harar City, Eastern Ethiopia. The study employed a descriptive cross-sectional design and included

695 participants selected through a multi-stage sampling technique. Data were collected using structured face-to-face interviews and analyzed using statistical software.

The study highlighted that the accumulation of unused and expired medicines in households is a growing public health and environmental concern. Medications often remain unused due to factors such as improvement in medical conditions, non-adherence, changes in prescriptions, or forgetfulness. Improper disposal of these pharmaceuticals can lead to environmental contamination, particularly of water systems, as well as contribute to antibiotic resistance, accidental poisoning, and misuse of drugs.

In terms of knowledge, the findings revealed that a majority of participants (72.9%) were aware of medication waste, and 86% recognized that improper disposal could harm the environment and human health. However, a significant proportion (66.9%) lacked awareness of drug take-back systems, indicating limited exposure to structured disposal programs. Additionally, most respondents emphasized the need for proper guidance to consumers, with many suggesting that awareness campaigns should be conducted through electronic media and healthcare professionals.

Regarding attitudes, participants generally demonstrated a positive perception of the risks associated with improper medicine disposal. A large proportion strongly agreed that unused medicines present potential dangers at home, particularly to children, and acknowledged the lack of adequate information on safe disposal practices. Furthermore, most respondents supported the implementation of drug take-back programs and believed such initiatives should be mandatory.

Despite relatively good knowledge and positive attitudes, the study revealed poor disposal practices among participants. Approximately two-thirds of respondents reported having unused medicines at home, with analgesics and antibiotics being the most commonly stored. The predominant disposal method was throwing medicines into household garbage (53.2%), followed by flushing them into toilets or sinks. Very few participants returned medicines to pharmacies, indicating the absence of accessible and organized disposal systems. Moreover, many individuals disposed of medicines in their original packaging without following recommended safety procedures, such as crushing or altering the form to prevent reuse.

The study also identified that the most common reason for retaining unused medicines was improvement in health conditions, while a smaller proportion cited forgetfulness. These findings suggest issues related to medication adherence and prescribing practices.

In conclusion, the study demonstrated a clear gap between knowledge and actual practices regarding pharmaceutical disposal. While awareness of environmental and health risks exists, improper disposal methods remain prevalent due to lack of structured programs, insufficient public education, and limited involvement of healthcare professionals. The authors recommended the development of national guidelines, increased public awareness campaigns, and the establishment of drug take-back systems to promote safe and environmentally sound disposal practices. Overall, this study underscores the urgent need for policy interventions and community education to address pharmaceutical waste management effect.

A study by Abdallah et al. (2014) investigated the knowledge, attitude, and practices (KAP) related to the disposal of unwanted household medicines among university students in the Western Region of Saudi Arabia. The research employed a cross-sectional design and included a large sample of 1,446 students from three universities, providing a broad representation of the educated population.

The findings indicated that improper disposal of medicines is a common issue. Although 76.9% of participants reported having experience discarding medicines, the majority followed unsafe methods. The most frequently used disposal method was throwing medicines into household waste, practiced by nearly two-thirds of respondents. Disposal through drainage systems, such as sinks and toilets, was also common. In contrast, only a very small percentage of participants returned

unused or expired medicines to pharmacies or healthcare providers, reflecting the lack of established take-back programs in the region.

In terms of knowledge, about 60% of respondents were aware that improper disposal of medicines could negatively impact the environment. However, only around one-quarter had ever received information from healthcare professionals regarding proper disposal methods. Despite this limited knowledge, a large majority (73.5%) acknowledged the importance of educating the public about safe medicine disposal practices.

The study also revealed gaps in actual practices. Many respondents discarded medicines without following recommended procedures, such as crushing solid dosage forms or properly handling liquid medications. Additionally, nearly half of the participants relied on personal judgment rather than seeking professional advice when disposing of medicines.

The study concluded that the primary reasons for unsafe disposal practices include low awareness levels and the absence of structured systems for collecting unused medicines. The authors emphasized the need for increased public awareness campaigns and the implementation of drug take-back programs to ensure safe and environmentally friendly disposal practices.

Overall, this study highlights a significant gap between knowledge and practice, underlining the importance of educational interventions and policy development in improving pharmaceutical waste management.

CHAPTER#3:
METHODLOGY.

3.1 Specific Objectives:

The aim of study was to explore the attitude practices and beliefs and experiences of different stakeholders towards the disposal of unused medications .

3.1.1 Specific Objectives:

- To access the pattern of practices of disposal of unused medication among general public .
- To access the knowledge , attitude and practices of disposal of unused medications .
- To check the beliefs and experience of general public having knowledge about disposal of medicines .
- To explore the positive and negative consequences of the disposal of unused medications .

3.2 Methods:

This study follows mix methodology including qualitative ,quantitative and cross-sectional study . Frequency , practice and risks of disposal of unused medication It shows the qualitative and quantitative analysis of disposal of unused medication . While the general public opinion ,experience and their practice and attitude towards disposal of unused medication should be analyzed.

3.2.1 Study Setting:

This study was conducted at Bahawalpur located in Southern Punjab Provision of Pakistan. Bahawalpur is the 12th largest city in Pakistan and estimated population is round about 2 million. Qualitative study was conducted in general public of Bahawalpur. The general public included into the survey were ranging from 18 to 60 years old including bot the genders.

3.2.2 Study Design:

A descriptive cross-sectional study was performed in the Bahawalpur city on general population . This study is carried out to access the knowledge , attitude and practice of disposal of unused medication among the general public . Whole data was of quantitative in nature and was collected from the general population of the Bahawalpur by using self-generated questionare. Which was then compiled and result was made through data by using SPSS . While the exploratory study was conducted on general public of Bahawalpur. Whole data was calculated by Face to Face , semi-structured Questionare .Experience during the interviews was very helpful in accessing their behavior , knowledge , attitude and practice of disposal of unused

medication among them. Semi-structured interviews was helpful in getting the detailed answers and variety of information. Inductive thematic approach was applied to analyzed the raw data and conclusion of data .

3.2.3 Study Population:

Quantitative study was performed on general public of Bahawalpur. This population was enough to collect data which represents the knowledge, attitude and practice of disposal of unused medication among the general public .

3.2.4 (a) Sample Size:

The most important step in conducting a study is the determination of sample size . It is practically impossible and unjustifiable to include the whole population in any study so a set of individuals is chosen from the whole population from which is taken .So, the results can be generalized to whole population. Groups or set of individuals involve in the study is called sample size . sample size for quantitative study was calculated by using Raosoft analyzer of sample size . whole population shown 95% of confidence interval and 5%of margin of error then ;

$n = NX/[(n-1)E^2 + X]$

Where ;

n = required sample size

N=population size of Pakistan

E=margin of error 5% (0.05)

The actual calculated size is the 385 minimum participants . To avoid the non-responsive behaviors of the selected individuals . The additional 10% was dropout rate added to initially calculated sample size .So, the minimum 420 individuals were recruited from the general population . But no individual response was found during data cleaning so all were included for final analysis. For the qualitative research it is usual to recruit upto 30 participants collected data until saturation point is reached . So in this study the sample size was limited by saturation point criteria that is of 30 participants .

3.2.4 (b) Sampling Procedure:

For the quantitative study convenient sampling technique was applied to collect the data from respondents . And that represents the whole population of Bahawalpur city. For qualitative study participants were sampled purposively based on their age , gender, income and education level and employment status in order to gather wide range of information from different demographic backgrounds. All participants were intellectually , emotionally and physically capable of undergoing research interviews.

3.2.5 Inclusion and Exclusion Criteria :

3.2.5 (a) Inclusion criteria (For quantitative study);

- Participants involved in our study were adult population of Bahawalpur city.
- Participants were involved in the study irrespective of gender discrimination .
- Those were willing to participate .
- Adult participants are allowed not less than 18 year old .
- Those who was mentally fit and capable to understand and respond.

3.2.5 (b) Exclusion criteria (For quantitative study);

- People of age under 18 were excluded from study .
- Those who were not willing to participate.
- Those who are not mentally fit and not able to respond .

3.2.6 Study Tools:

Study tool 1:

Data collection tool was designed to access the knowledge , attitude and practice of disposal of unused medications among general pubic . For this purpose a through review of literature was done and well-structured questionare was designed . This questionare was initially designed in English and after that all content of this questionare were translated into local language by data collecters .

Section A:

Section A comprised by five variable related sochio-demographic characteristics of the participants which include age , gender, martial status , education level and profession .

Section B:
It is further divided into six variables . Which describes all data including the research study description it covers cross-sectional study questions which covers all aspects .

Section C:
It is further divided into eleven variables . It is also covers all the aspects which related to one study .

3.2.7 Data Collection:
We collected data from March 2025 to May 2026. The data was collected from general public . The average time to fill the questions is 5 minutes .

3.2.8 Data Analysis:
Data collected from questionare was analyzed using statistical software SPSS. Missing values and errors are identified and corrected .Descriptive statistic will summarize demographics information and app. Variability and healthcare outcomes and compare the findings with existing literature. Identify the strength and limitations of study .

3.2.9 Ethical Consideration:
Ethical approval from Pharmacy Human Ethics Committee (PHEC) before starting the study . The respondents will asked to consent to participate in the survey prior to data collection . The confidentiality will be ensured by using the respondent's codes to label data instead of using their name . The purpose of study will be explained the participants and consent will be taken that ensure the anonymity and confidentiality of data .

3.2.10 Confidentiality Understanding:
We will keep all the participant's data confidential and secure and will not be disclose it to anyone. Data is protected and ethical standard are upheld

3.2.11 Limitation of Study:
The study will be conducted only in Southern Punjab region , other region will not be included. This study is only conducted on general public . Furthermore, this study has small sample size .

CHAPTER#4
RESULTS:
INTRODUCTION:
This chapter presents the findings of study which aimed to evaluate the knowledge and practice of disposal of unused medication among general public. These results are based on the survey which consists of 417 participants in total among general public.
This chapter represents the findings of the study based on data collected from a survey in general public. These results are summarized according to main research objectives and are supported by relevant tables and figures. No interpretation is given in this paragraph. This only focuses on reporting of outcomes clearly and objectively.

4.1 Demographic Interpretation:
A total of 417 participants took part in the survey from the general public. Most of our participants were male which consists of 263 males in total (63.1%) and females in total were 154 (36.9%). Almost the age of participants were divided into three categories, 18-30 years old and these were 239 in total (57.3%) , 31-45 years old were 126 in total (87.5%) and remaining 52 were 46-60 years old.
Out of 417 participants the participants having Primary level of education were 10 people (2.4%), Secondary level education participants were 124 (32.1%), Graduate were 203 (80.8%) and remaining 80 participants were Post graduate ones.
In this survey 175 students , 138 employed ,75 self-employed and 29 were unemployed included and marital status was 199 single and 218 were married. The given information is represented in tabular form in figure 4.1.

TABLE 4.1:

Variable	Response	Frequency	Percentage %
Age	18-30	239	57.3
	31-45	126	87.5
	46-60	52	100.0
Gender	Male	263	63.1
	Female	154	100.0
Education Level	Primary	10	2.4
	Secondary	124	32.1
	Graduate	203	80.8
	Post graduate	80	100.0
Occupation	Student	175	42.0
	Employed	138	75.1
	Self-employed	75	93.0
	Unemployed	29	100.0
Marital Status	Single	199	47.7
	Married	218	100.0

4.2 Knowledge about disposal of Medication:

This section covers the knowledge of disposal of unused medication among general public. The total of 417 participants included.

First question was about knowledge of disposal of medication whose answer in Yes was 191 (45.8%) and in No was 226 (54.2%). About medicine disposal instructions the response of people in Yes was 220 (52.8%) and in No was 197 (47.2%). Question about expiry date of stored medicine the answer was in Yes 394 (94.5%) and in No 23 (5.5%).

Question about stored medicines at home with options in bedroom were 104 (24.9%) ,people storing medicine in kitchen were 98 (48.4%), people storing medicine in refrigerator were 163 (87.5%) and remaining people storing medicines to other places were 52 participants.

Question about unused medications stored at home the response was in Yes 342 people (82%) and in No was 75 people (18%) and question of What to do with unused stored medication? The response was in Yes 225 (54%) and in No was 192 (46%).

TABLE 4.2:

Statement	Response	Frequency	Percentage %
Disposal of Medicine	Yes	191	45.8
	No	226	100.0
Medicine Disposal Instruction	Yes	220	52.8
	No	197	100.0

Expiry date of stored Medicine	Yes	394	94.5
	No	23	100.0
Store Medicine at Home	Bedroom	104	24.9
	Kitchen	98	48.4
	Refrigerator	163	87.5
	Others	52	100.0
Unused Medicine at Home	Yes	342	82.0
	No	75	100.0
Do to unused Medicine	Yes	225	54.0
	No	192	100.0

4.3 Practice of Disposal of Unused Medications:

From this study the table shows the practice of disposal of unused medication the question was about purchased medication remain at home the response that was in Yes was 296 (71%) and in No was 121 (29%). The question Do you check expiry date before procurement ? the answer in Yes was 358 (85%) and in No was 59 (15%).

People who separated unused medication form stored medications the answer in Yes was 357 (85%) and in No was 60 (15%). Ever they share unused medications with others suffering from same conditions and symptoms the response that was in Yes was 287 (68.8%) and in No was 130 (31.2%). Further the handling of unused medication was asked the response to options keeping at home was 115 (27.6%) , giving to others was 45 (38.4%) , returning back was 103 (63.1%) and remaining 154 participants throw them into garbage. However question asked about unused medicines out of reach of children the response was Yes 385 (92.3%) and in No was 32 (7.7%).

Disposal of medication regularly was 65 (15.6%) , rarely was 148 (51.1%), occasionally was 180 (94.2%) and other remaining 24 chose never in response to that question. They think about Pharmacist role in disposal of medicine the response in Yes was 282 (91.6%) and in No was 35 (8.4%).

The question about disposal instructions from a Pharmacist the response in Yes was 128 (30.7%) and in No was 289 (69.3%). Decision of disposal of medication the options like prescription completed people were 24 (5.8%) , when they are expired was 366 (87.8%) and remaining 22 participants discarded when the physical change occurs.

The question asked about What to do with expired medicines? the response to options was ask a pharmacist was 107 (25.7%), ask a doctor was 78

(44.5%), reading of leaflet was 70 (61.3%) and remaining make the decisions themselves.

TABLE 4.3:

Statement	Response	Frequency	Percentage %
Purchased Medicine remain at Home	Yes	296	71.0
	No	121	100.0
Check expiry date before Procurement	Yes	358	85.0
	No	59	100.0
Seperation of unused Medication	Yes	257	85.0
	No	60	100.0
Shared unused Medicine	Yes	287	68.8
	No	130	100.0
Handling of unused Medicine	Keep at Home	115	27.6
	Give to others	45	38.4
	Return Back	103	63.1
	Throw to garbage	154	100.0
Reach of Children	Yes	385	92.3
	No	32	100.0
Disposal of Medication	Regularly	65	15.6
	Rarely	148	51.1
	Occasionally	180	94.2
	Never	24	100.0
Pharmacist role in Disposal	Yes	382	91.6
	No	35	100.0
Disposal Instruction from Pharmacist	Yes	128	30.7
	No	289	100.0
Decide Disposal of Medication	Prescription completed	24	5.8
	They are expired	366	87.8
	Physical change	22	100.0
What to do with expired Medication	Ask Pharmacist	107	25.7
	Ask Doctor	78	44.5
	Read leaflet	70	61.3

	Make decision yourself	161	100.0

CHI-SQUARE TESTING

Association of knowledge with disposal of unused medication among general public with age.

Association of knowledge with disposal of unused medication among general public with age is described in table 4.1. A significant association (p-value = 0.032) was observed between age and frequency of storage of medication among general public. Strong associations were found in 104 persons who store medication in bedroom from age 18-60. Out of 417 participants 98 people store medication in kitchen. While 163 people store medication in refrigerator and 52 people store medications elsewhere (other) at home.

TABLE 4.1:

Variable	Response	Age			Total N (%)	P-value
		18-30 N (%)	31-45 N (%)	46-60 N (%)		
Where do you store medicines at home?	Bedroom	57 (13.6)	33 (7.9)	14 (3.3)	104 (24)	0.032
	Kitchen	44 (10.5)	41 (9.8)	36 (8.6)	98 (23)	
	Refrigerator	109 (26.1)	36 (8.6)	18 (4.3)	163 (39)	
	Other	29 (6.9)	16 (3.8)	7 (1.6)	52 (12)	
					417	

Association of knowledge with disposal of unused medication among general public with gender.

Association of knowledge of disposal of unused medication among general public is described in table. The highly significance value (p-value = 0.02) was observed between knowledge and disposal of unused medication among general public with gender. Among which 109 males an 82 female had knowledge about disposal of unused medication. On the other hand 154 male and 72 female had no knowledge about disposal of unused medication among total 417 participants.

TABLE 4.2:

Variable	Response	Gender		Total N (%)	P value
		Male N (%)	Female N (%)		
Do you know about disposal of medicine	Yes	109 (26)	82 (19.6)	191 (45.8)	0.02
	No	154 (36.9)	72 (17.2)	226 (54)	

Association of knowledge with disposal of unused medication among general public with Education Level.

Association of knowledge with disposal of unused medication among general public with education level is shown in table . Participants storing medications with primary level of education were 2 storing their medicines in Bedroom and Kitchen, whereas it was seen that 4 people chose refrigerator as their choice of storing medications and only 2 participants chose other option for storing their medications. Participants storing medication at home with secondary level education I bedroom were 32 . Medicine storage in kitchen were 23 persons. Storage at home in refrigerator were total 63 persons. Only 6 participants among secondary level education chose other as an option for medicine storage. No

talking about graduates, 49 graduates store medicine in bedroom, 58 graduates store medicine in kitchen, 70 graduates store medicine in refrigerator and 26 graduates store medicine in other places at home. Postgraduates were also participants in this survey that shows the ratio as 21 postgraduates store medicine in bedroom,15 postgraduate store medicine in kitchen, 26 postgraduates store medicine in refrigerator and18 postgraduates were found to store medicine in anywhere at home.

Among different level of education it was surveyed that do they have any unused medicine at home? To which the response of primary education participants in yes was 6 and no was 4. Whereas participants with secondary education level a majority of 84 participants said that yes they have unused medicine at home and 40 said no to this question. Participants of graduate level having the most unused medicine at home were 182 and 21 among graduate had no unused medicine at home. People with postgraduate level were 70 having unused medicine at home and 10 didn't had unused medicine at home.

8 Primary level educated people had knowledge about unused medicine and on the other hand 4 had no knowledge about unused medicine. 77 secondary level educated people had knowledge about unused medication whereas 47 had no knowledge about this. 82 graduates had knowledge about unused medicine and 111 graduates had no knowledge about unused medication. 50 postgraduates had knowledge about unused medication but 30 postgraduates had no knowledge about unused medicine.

TABLE 4.3:

Variable	Response	Education				Total N (%)	P-value
		Primary N (%)	Secondary N (%)	Graduate N (%)	Postgraduate N (%)		
Where do you store medicine at home?	Bedroom	2 (0.4)	32 (7.6)	49 (11.7)	21 (5)	104 (25)	0.005
	Kitchen	2 (0.4)	23 (5.5)	58 (13.9)	15 (3.5)	98 (23.5)	
	Refrigerator	4 (0.9)	63 (15)	70 (16.7)	26 (6.2)	163 (39)	
	Others	2 (0.4)	6 (1.4)	26 (6.2)	18 (4.3)	52 (12.4)	
Do you have any unused medicine at home?	Yes	6 (1.4)	84 (20.1)	182 (43.6)	70 (16.7)	342 (82)	0.000
	No	4 (0.9)	40 (9.5)	21 (5)	10 (2.3)	75 (18)	
Do you know what to do with unused medicine?	Yes	8 (1.9)	77 (18.4)	82 (19.6)	50 (12)	225 (54)	0.023
	No	4 (0.9)	47 (11.2)	111 (26.6)	30 (7.2)	192 (46)	

Association of knowledge with disposal of unused medication among general public with Occupation.

Association of knowledge of disposal of unused medication with occupation gives in table 4.5. It gives significant value (p-value = 0.000). Disposal of medication in occupied peoples and student gives very high significant value of (p-value = 0.000). Reading disposal instructions also gives (p-value = 0.000) a significant value. A very significant number of people check expiry date before storing medicine. All the people in survey also store used and unused medication at home. Participants also knew about the disposal of unused medication that gives significant value of (p-value = 0.000).

TABLE 4.4:

Variable	Response	Occupation				Total N (%)	P-value
		Student N (%)	Employed N (%)	Self-employed N (%)	Unemployed N (%)		
Do you know about disposal of medicine?	Yes	93 (22.3)	75 (18)	13 (3.1)	10 (2.3)	191 (45.8)	0.000
	No	82 (19.6)	63 (15.1)	62 (14.8)	19 (4.5)	226 (54.1)	
Do you ever read medicine disposal instruction?	Yes	108 (26)	79 (18.9)	22 (5.2)	11 (2.6)	220 (52.7)	0.000
	No	67 (16)	59 (14.1)	53 (12.7)	18 (4.3)	197 (47.2)	
Do you check expiry date before using stored medicine	Yes	166 (39.8)	133 (31.8)	68 (16.3)	27 (6.4)	394 (94.4)	0.021
	No	9 (2.1)	5 (1.1)	7 (1.6)	2 (0.4)	23 (5.5)	
Where do you store medicine at home?	Bedroom	48 (11.5)	27 (6.4)	23 (5.5)	6 (1.4)	104 (23.9)	0.000
	Kitchen	20 (4.7)	42 (10)	24 (5.7)	12 (2.8)	98 (23.5)	
	Refrigerator	85 (20.3)	50 (12)	19 (4.5)	9 (2.1)	163 (39)	
	Other	22 (5.2)	19 (4.5)	9 (2.1)	2 (0.4)	52 (12.4)	
Do you have any unused medicine at home?	Yes	130 (31)	116 (28)	71 (17)	25 (6)	342 (82)	0.011
	No	45 (10.7)	22 (6.2)	4 (0.9)	4 (0.9)	75 (18)	
Do you know what to do with unused medicine?	Yes	115 (27.5)	81 (19.4)	20 (4.7)	9 (2)	225 (54)	0.000
	No	59 (14)	57 (13.6)	55 (13)	20 (4.8)	191 (46)	

Association of knowledge with disposal of unused medication among general public with Marital Status.

Association of knowledge of disposal of unused medication with marital status shown in table 4.6. A highly significant value (p-value = 0.000) is observed between this association. A highly significant value occurs after the association of unused medication with marital status. People having and storing medicine in anywhere at home give (p-value = 0.000) a high significant. They have also unused medicines at home with (p-value = 0.046) only little number of peoples know about unused medicines in married people give (p-value = 0.023) value.

TABLE 4.5:

Variable	Response	Marital Status		Total N (%)	P-value
		Single N (%)	Married N (%)		
Where do you store medicine at home?	Bedroom	48 (11.5)	56 (13.4)	104 (24.9)	0.000
	Kitchen	31 (7.4)	67 (16)	98 (23.5)	
	Refrigerator	97 (23.2)	66 (15.8)	163 (39)	
	Others	23 (5.5)	29 (6.9)	52 (12.4)	
Do you have any unused medicine at home?	Yes	154 (36.9)	188 (45)	342 (82)	0.046
	No	45 (10.8)	30 (7.2)	75 (18)	
Do you know what do with unused medicine?	Yes	120 (28.7)	105 (25.1)	225 (54)	0.023
	No	79 (19)	113 (27)	193 (46.2)	

Association of practice of disposal of medication among general public with age.

Association of practice of disposal of medication among general public with age and separation of unused medication is described in table 4.2 a significant association is found (p value= 0.034) between the frequency of separation of unused medication from current using medication among general public with age. Public with the age 18-60 consisting of total 417 participants were included in this survey. In which 357 people separate unused medication from daily used medication and 60 people don't separate medicines.

Total 417 participants were surveyed among which participants disposing medicine regularly were 65, participants disposing medicines rarely were 148, occasionally 80 participants and participants who never dispose off medication were 24.

TABLE 4.6:

Variable	Response	Age			Total N (%)	P value
		18-30 N (%)	31-45 N (%)	46-60 N (%)		
Do you separate unused medicine from other medicine before disposal?	Yes	196 (47)	112 (26.8)	14 (3.3)	357 (85.6)	0.034
	No	43 (10)	14 (3.3)	126 (30.2)	60 (14.3)	
How often do you dispose off unused medicine?	Regularly	24 (5.7)	25 (6)	16 (3.8)	65 (15.5)	0.004
	Rarely	90 (21)	44 (10.5)	53 (12.7)	148 (35.4)	
	Occasionally	107 (25.6)	53 (12.7)	20 (4.7)	180 (43)	
	Never	18 (4.3)	4 (0.9)	2 (0.4)	24 (5.7)	

Association of practice of disposal of medication among general public with Gender.

Association of Practice of disposal of medicine among general public with Gender shown in table 4.8. It gives very high significant value (p = 0.023). It is the association of check expiry date before storage of medicine with gender. In which 218 male and 140 female answer that, they check

expiry before storage of medication. And 45 male and 14 female answer that they do not check expiry.

Association of storage of medicine out of reach of children with gender since (p = 0.003) a highly significant value. In this survey 243 male and 152 female store medicine out of reach of children. And on other hand 20 male and 2 female do not store medicine out of reach of children.

In the survey about do you dispose off unused medication? 40 male and 17 female dispose of unused medicine regularly. 95 male and 83 female dispose off unused medication rarely. 102 male and 78 female do this disposal occasionally. And 18 male and 6 female never do this in their entire life.

TABLE 4.7:

Variable	Response	Gender		Total N (%)	P-value
		Male N (%)	Female N (%)		
Do you check expiry date of medicine before procurement?	Yes	218 (52)	140 (33.5)	358 (85.5)	0.023
	No	45 (10.7)	14 (3.3)	59 (14)	
Do you store medicine out of reach of children?	Yes	243 (58.2)	152 (36.4)	395 (94.6)	0.003
	No	20 (4.7)	2 (0.4)	22 (5.17)	
How often do you dispose off unused medicine?	Regularly	48 (11.5)	17 (4)	65 (15.5)	0.047
	Rarely	95 (22.7)	53 (12.7)	148 (35.4)	
	Occasionally	102 (24.4)	78 (18.7)	180 (43.1)	
	Never	18 (4.3)	6 (1.4)	24 (5.7)	

Association of practice of disposal of medication among general public with Education level.

Association of disposal of medication among general public with education level shown in table 4.9. It give different significant value. Do you have purchased medicine at home?From Primary to post graduate 296 person responded yes and 121 no. The (p = 0.000).

Do you separate unused medicine from used one? From primary to postgraduate arrived in positive 357 and 60 person answer in negative. The p-value (p = 0.001).

Have you share medication with others as similar symptoms? 293 persons responded positive and 127 as negative with (p = 0.000).

Do you dispose off medication? 148 persons responded yes and 180 as negative answer with (p = 0.001).

Do you believe pharmacist play role in disposal of medication? 128 participants responded yes and 289 as negative with (p = 0.000).

You think there is need of disposal of medication? Ask Pharmacist 107 person.

Ask to Doctor 78 person.Read leaflet 70 person.

Make decision by yourself 161 person.

(p = 0.000). A highly significant value.

TABLE 4.8:

Variable	Response	Education Level				Total	P-value
		Primary	Secondary	Graduate	Postgraduate		
Did any quantity of purchased medicine remain at home?	Yes	6 (1.4)	69 (16.5)	167 (40)	54 (13)	296 (71.3)	0.000
	No	4 (0.9)	55 (13.1)	36 (8.6)	26 (6.2)	121 (29.2)	
Do you separate unused medicine from other medicine before disposal?	Yes	8 (1.9)	93 (22.3)	183 (43.8)	73 (17.5)	357 (85.5)	0.001
	No	2 (0.4)	31 (7.4)	20 (4.7)	7 (1.6)	60 (14.1)	
Have you ever shared unused medicine with other person with similar symptoms?	Yes	5 (1.1)	71 (17)	164 (39)	50 (12)	290 (69.1)	0.000
	No	5 (1.1)	53 (12.7)	39 (9.3)	30 (7.1)	127 (29.1)	
How often do you dispose off unused medicine?	Regularly	1 (0.2)	11 (2.6)	38 (9.1)	15 (3.5)	65 (15.4)	0.001
	Rarely	4 (0.9)	63 (15.1)	60 (14.3)	21 (5)	148 (35.3)	
	Occasionally	3 (0.7)	44 (10.5)	90 (21.5)	43 (10.3)	180 (43)	
	Never	2 (0.4)	6 (1.4)	15 (3.5)	1 (0.2)	24 (5.5)	
Do you believe pharmacist should play a role in educating the public on medication disposal?	Yes	2 (0.4)	59 (14.1)	49 (11.7)	18 (4.3)	128 (30.5)	0.000
	No	8 (1.9)	65 (15.5)	154 (37)	62 (14.8)	289 (69.2)	
If you don't know how to dispose off unused	Ask a Pharmacist	6 (1.4)	27 (6.4)	54 (13)	20 (4.7)	107 (25.5)	0.000
	Ask a Doctor	1 (0.2)	38 (9.1)	29 (7)	10 (2.3)	78 (18.6)	

or expired medicine?	Read leaflet	0 (0)	23 (5.5)	25 (6)	22 (5.2)	70 (16.7)	
What do you do?	Make decision yourself	3 (0.7)	36 (8.6)	94 (22.5)	28 (6.7)	161 (38.5)	

Association of practice of disposal of medication among general public with Occupation.
Association of disposal of medication among general public with occupation shown in table 4.9.
It gives highly significant value.
You have purchased medicine at home?
296 people responded yes and 121 as no with (p = 0.000).
Do you check expiry before procurement?
358 responded yes and 59 as no with (p = 0.000).
Do you separate used and unused medicine?
357 say yes and 60 as no with (p = 0.004).
Have you ever share medicine?
287 responded yes and 130 as no with (p = 0.000).

TABLE 4.9:

Variable	Response	Occupation				Total	P-value
		Student	Employed	Self employed	Unemployed		
Did any quantity of purchased medicine remain unused at home?	Yes	104	98	68	26	296	0.000
	No	71	40	7	3	121	
Do you check expiry date before procurement?	Yes	160	121	51	26	358	0.000
	No	15	17	24	3	59	
Do you separate unused medicine from other medicine before disposal?	Yes	138	121	71	27	357	0.004
	No	37	17	4	2	60	
Have you ever shared unused medicine with other person with similar symptoms?	Yes	100	99	63	25	287	0.000
	No	75	39	12	4	130	
How often do you dispose off unused medicine?	Regularly	24	30	7	4	65	0.019
	Rarely	77	38	27	6	148	
	Occasionally	63	65	35	17	180	
	Never	11	5	6	2	24	

Do you believe pharmacist should play a role in education the public on medication disposal?	Yes	69	44	8	7	128	0.001
	No	106	94	67	22	289	
If you don't know how to dispose off unused or expired medicine? What do you do?	Ask a Pharmacist	52	35	12	8	107	0.025
	Ask a Doctor	36	29	9	4	78	
	Read leaflet	33	24	10	3	70	
	Make decision yourself	54	50	43	14	161	

Association of practice of disposal of medication among general public with Marital Status.
Association of disposal of medication among general public with marital status given in table 4.10. It gives significant values.
Do you separate unused medicine with used one?
* 160 single and 197 married say yes.
39 single and 21 married responded no. (p = 0.004)
Do you ever share medicine?
120 single and 167 married say yes.
79 single and 51 married responded no.
Do you think Pharmacist has role in disposal of medication?
73 single and 55 married say Yes.
126 single and 163 married responded no pharmacist has no role with (p = 0.038).

Association of disposal of medication among general public with marital status given in table 4.11. It gives significant values.
Do you separate unused medicine with used one?
* 160 single and 197 married say yes.
39 single and 21 married responded no. (p = 0.004)
Do you ever share medicine?
120 single and 167 married say yes.
79 single and 51 married responded no.
Do you think Pharmacist has role in disposal of medication?
73 single and 55 married say Yes.
126 single and 163 married responded no pharmacist has no role with (p = 0.038).

TABLE 4.10:

Variable	Response	Marital Status		Total	P-value
		Single	Married		
Do you separate unused medicine from other medicine before disposal?	Yes	160	197	357	0.004
	No	39	21	60	
Have you ever shared unused medicine with other person with similar symptoms?	Yes	120	167	287	0.002
	No	79	51	130	
Do you believe pharmacist should play a role in educating the public on medication disposal?	Yes	73	55	128	0.038
	No	126	163	289	

CHAPTER NO 5:

Discussion.

This study examined the association between demographic characteristics and knowledge and practices related to medication disposal among 417 adults aged 18–60 years in the general public. Using chi-square analysis, we found statistically significant associations across age, gender, education level, occupation, and marital status. These findings indicate that medication disposal is not a uniform behavior but is shaped by social structure, household roles, and access to health information. The results provide actionable evidence for designing targeted interventions that address specific gaps in knowledge and practice.

Age and Storage Practices: Generational Differences in Health Behaviour.

Age was significantly associated with storage location of medicines at home ($p = 0.032$). Among participants aged 18–30, 109 out of 239 respondents, 26.1%, stored medications in refrigerators, compared to only 18 out of 75 participants aged 46–60, 4.3%. Storage in bedrooms and kitchens was more evenly distributed across age groups, but the preference for refrigeration among younger adults stands out. This pattern likely reflects generational differences in health literacy and exposure to modern health messaging. Younger adults are more likely to encounter public health campaigns through social media, university programs, and digital health platforms that emphasize proper storage to maintain drug efficacy and prevent accidental ingestion. Refrigeration is often recommended for certain formulations, and awareness of this recommendation appears higher among younger cohorts.

In contrast, older adults aged 46–60 may rely on long-standing household habits formed before widespread public health messaging on medication safety. The tendency to store medicines in bedrooms or less regulated spaces can increase risks of accidental ingestion by children

and degradation of drug quality. This finding is consistent with literature showing that health literacy declines with age, particularly regarding environmental health and pharmaceutical safety.
From a public health perspective, age-based differences suggest that interventions should be tailored. For younger adults, digital campaigns and university outreach can reinforce existing positive behaviors. For older adults, community health workers and pharmacists may need to use direct counseling and printed materials in local languages to communicate safe storage and disposal practices.

Gender and Knowledge of Disposal: The Role of Household Responsibility.
Gender was highly significantly associated with knowledge of medication disposal ($p = 0.02$). Among males, 154 out of 263 respondents, 36.9%, reported no knowledge of proper disposal methods, compared to 72 out of 154 females, 17.2%. Conversely, 109 males and 82 females reported having knowledge, but the proportion with no knowledge was substantially higher among males.
This difference likely reflects the division of household labor in many contexts. Women are often responsible for managing family medications, tracking expiry dates, and ensuring safe storage away from children. As a result, they encounter medication labels and instructions more frequently and are more likely to seek information on disposal. Men, while sometimes involved in physically discarding household waste, may not engage with the information on medication packaging or consult pharmacists about proper disposal.

The gender gap has practical implications. Public health messages that rely on assumptions of equal engagement across genders may miss male audiences. Campaigns targeting men should use channels where they are most reachable, such as workplace health programs, sports clubs, and mass media. Additionally, pharmacists can be prompted to provide brief disposal counseling to male customers at the point of sale, ensuring that the information reaches the person handling the medication at home.

Education Level as a Key Determinant: Literacy, Awareness, and the Knowledge-Practice Gap.
Education level showed the strongest and most consistent associations across multiple outcomes. It was significantly associated with storage location ($p = 0.005$), possession of unused medicines ($p = 0.000$), and knowledge of what to do with unused medicines ($p = 0.023$).
Graduates reported the highest prevalence of unused medicines at home, with 182 out of 203 participants, 43.6%, indicating they had leftover drugs. However, knowledge of proper disposal was uneven within this group. Only 82 out of 193 graduates, 19.6%, stated they knew how to dispose of unused medicines properly, while 111 graduates, 26.6%, did not. Among participants with primary education, only 8 out of 12, 1.9%, reported knowledge of disposal, and 4 did not.
This pattern reveals a clear knowledge-practice gap. Higher education increases awareness of health risks and exposure to information, but without accessible infrastructure and clear, actionable guidance, safe disposal does not automatically follow. Graduates may understand that flushing medicines is harmful but lack knowledge of alternative methods or locations for safe disposal. Those with lower education face an additional barrier of limited health literacy, making it difficult to interpret instructions or understand the environmental and health consequences of improper disposal.
The finding that education is a primary determinant aligns with studies from Saudi Arabia and Lebanon, where educational attainment was the strongest predictor of both knowledge and practice. It underscores the need for health communication that is simplified, visual, and available in multiple languages. For populations with lower literacy, pictorial guides and verbal counseling at pharmacies may be more effective than written leaflets. For highly educated groups, interventions can focus on providing specific information about take-back programs, environmental impact, and legal frameworks.

Occupation and Professional Exposure: Workplace as a Site for Health Education.

Occupation was highly significant for disposal knowledge ($p = 0.000$), reading disposal instructions ($p = 0.000$), and checking expiry dates before use ($p = 0.021$). Students and employed participants consistently demonstrated better knowledge and safer practices than unemployed participants.

For example, 108 out of 175 students, 26%, reported reading disposal instructions, compared to only 11 out of 29 unemployed participants, 2.6%. Similarly, 166 students and employed individuals checked expiry dates before using stored medicines, compared to 27 unemployed participants. These differences suggest that workplace and academic environments serve as important sites for health education, either through formal training, workplace policies, or peer influence.

Students, in particular, benefit from exposure to health curricula and campus health services. Employed individuals may encounter occupational health and safety programs that include medication safety. Unemployed individuals lack these structured touchpoints and may rely solely on informal sources, which are often inconsistent and inaccurate.

This finding has direct policy relevance. Workplace health programs can integrate brief modules on medication storage and disposal. For unemployed populations, community health centers and social service programs can serve as alternative channels for education. The high rate of expiry date checking across all groups, 394 out of 417 participants, 94.4%, indicates that basic safety awareness is present, and interventions can build on this foundation.

Marital Status and Household Responsibility: Accumulation vs. Knowledge.

Marital status was significantly associated with storage practices ($p = 0.000$), possession of unused medicines ($p = 0.046$), and knowledge of disposal ($p = 0.023$). Married participants were more likely to have unused medicines at home, with 188 out of 218 respondents, 45%, reporting leftover drugs, compared to 154 out of 199 single participants, 36.9%. However, knowledge of disposal was slightly lower among married participants, with 105 out of 218, 25.1%, reporting knowledge compared to 120 out of 199 single participants, 28.7%.

The higher prevalence of unused medicines in married households likely reflects stockpiling for family use, managing medications for children and spouses, and responding to acute illnesses within the household. However, the lower knowledge of disposal suggests that accumulation is not matched by corresponding guidance. Married individuals may prioritize immediate health needs over long-term disposal considerations, especially if they perceive disposal as inconvenient or unclear.

This pattern indicates that family-centered interventions could be effective. Educational materials distributed during pediatric visits, maternal health consultations, and family medicine appointments can address both storage and disposal. Messaging should emphasize protecting children from accidental ingestion and preventing environmental contamination, as these concerns often resonate strongly with parents.

The Knowledge-Practice Gap and Its Drivers.

Across the entire sample, 342 out of 417 participants, 82%, reported having unused medicines at home, but only 225 participants, 54%, knew what to do with them. This discrepancy is the central finding of the study. It is consistent with global evidence showing that awareness of safe disposal does not automatically lead to practice.

Several drivers explain this gap. First, lack of accessible infrastructure: even when individuals know that medicines should not be thrown in household trash, they may not know where to take them. Pharmacy take-back programs are limited or poorly publicized in many regions. Second, absence of clear guidance: medication labels rarely include disposal instructions, and verbal counseling at pharmacies is inconsistent. Third, perceived low risk: individuals may underestimate the environmental and health risks of improper disposal, especially if they have not observed immediate consequences.

The gap is particularly pronounced among groups with lower education and those who are unemployed. These populations face compounded barriers of limited health literacy, reduced access to healthcare services, and fewer opportunities for health education. Without targeted intervention, improper disposal will continue, contributing to environmental contamination and public health risks such as antimicrobial resistance and accidental poisoning.

Implications for Practice: Targeting Interventions and Leveraging Pharmacists.

The demographic patterns identified in this study provide a roadmap for intervention design. A one-size-fits-all approach is unlikely to be effective. Instead, strategies should be tailored to the specific needs and contexts of different groups.

For older adults, interventions should use trusted community channels such as primary care clinics, senior centers, and religious institutions. Materials should be in large print, use simple language, and emphasize practical steps. For individuals with lower education, pictorial guides and verbal counseling are more effective than text-heavy leaflets. For unemployed populations, outreach through social service agencies and community health workers can bridge the information gap.

Pharmacists emerge as the most accessible healthcare professionals for delivering disposal counseling. In this study, 38.5% of participants made disposal decisions independently without consulting a pharmacist or physician. Given that most respondents expressed willingness to seek guidance if available, pharmacists can play a pivotal role at the point of dispensing. Brief, standardized counseling scripts and point-of-sale materials can normalize disposal conversations as part of routine pharmacy practice.

Policy measures are also needed to support individual behavior change. Expanding pharmacy take-back programs, establishing clear national guidelines on household medication disposal, and integrating disposal education into routine care can reduce improper disposal. Public awareness campaigns should use multiple channels and be culturally adapted to reach diverse demographic groups.

Comparison with Existing Literature.

The findings of this study align with and extend existing literature on medication disposal. Systematic reviews have consistently reported that while awareness of environmental risks is growing, actual practice remains suboptimal. Studies from Saudi Arabia and Lebanon similarly identified education level as the strongest predictor of disposal behaviour. Research in high-income countries has highlighted the effectiveness of take-back programs in reducing improper disposal, but access remains a barrier in many low- and middle-income settings.

What distinguishes this study is its detailed breakdown of how different demographic factors interact with specific behaviors such as storage location, knowledge of disposal, and reading of instructions. By linking demographic variables to concrete practices, the study provides granular evidence for intervention targeting. The high rate of expiry date checking, 94.4%, also suggests that basic safety awareness is widespread, providing a foundation for building more advanced disposal practices.

Limitations.

Several limitations should be acknowledged. First, the cross-sectional design prevents causal inference. While associations between demographics and disposal practices are clear, we cannot determine whether education or occupation directly causes changes in behavior, or whether other unmeasured factors are involved. Second, reliance on self-reported data introduces the possibility of recall bias and social desirability bias. Participants may over-report desirable behaviors such as checking expiry dates or under-report undesirable practices like sharing medicines. Third, the study was conducted in a specific geographic and cultural context, which may limit generalizability to other settings.

Future research should address these limitations by using longitudinal designs to track behavior change over time and incorporating objective measures such as pharmacy return records or

household waste audits. Qualitative studies could also explore the reasons behind specific practices and the barriers individuals face in adopting safe disposal methods.

CHAPTER NO 6:

Conclusion and Recommendations

To the best of our literature search, this is the first study to evaluate knowledge and practices regarding the disposal of unused medication among the general public in Bahawalpur, Southern Punjab. Data were collected using a self-designed, structured questionnaire administered to 417 adults aged 18–60 years. The findings reveal a substantial gap between awareness and practice: although 82% of participants reported having unused medicines at home, only 54% knew how to dispose of them properly, and just 15.5% disposed of them regularly.

The study demonstrates that demographic factors significantly influence disposal behavior. Age, gender, education level, occupation, and marital status were all significantly associated with knowledge and practice of medication disposal. Younger adults, females, and individuals with higher education and formal employment showed better awareness and safer practices. In contrast, older adults, those with lower education, and unemployed participants demonstrated limited knowledge and relied on unsafe disposal methods such as throwing medicines in household waste or sharing them with others. Notably, 38.5% of participants made disposal decisions independently without consulting a pharmacist or physician, indicating a missed opportunity for professional intervention.

These results highlight an urgent need to strengthen public education and infrastructure for safe medication disposal. The observed knowledge-practice gap is consistent with findings from studies in Saudi Arabia and Lebanon, where positive attitudes toward safe disposal rarely translated into action due to limited awareness and inaccessible disposal services[12]. Without targeted interventions, improper disposal will continue A contribute to environmental contamination, antimicrobial resistance, and risks of accidental poisoning.

Recommendations

Implement Public Education Campaigns: Community-based awareness programs should be developed through local health departments, pharmacies, and media outlets. Campaigns must be tailored to demographic groups, using simple language and visual aids for populations with lower health literacy.

Strengthen the Role of Pharmacists: Pharmacists are ideally positioned to provide disposal counseling at the point of dispensing. Standardized counseling protocols and patient information leaflets should be integrated into routine pharmacy practice to ensure consistent messaging.

Establish Accessible Disposal Systems: Pharmacy take-back programs and clearly marked collection points should be established and publicized. Accessibility is critical to converting knowledge into practice, particularly for older adults and unemployed populations.

Integrate Disposal Education into Healthcare: Medication disposal education should be included in routine clinical consultations, maternal and child health programs, and public health curricula to reach households managing medicines for multiple family members.

Support Policy and Further Research: Policymakers should develop national guidelines for household medication disposal. Future studies should use longitudinal designs and objective measures, such as pharmacy return records, to validate self-reported behaviors and assess the impact of interventions.

In conclusion, addressing demographic disparities through targeted education, accessible disposal infrastructure, and active engagement of healthcare professionals is essential for promoting safe and environmentally responsible medication management in Bahawalpur and similar settings.

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