EXPLORING THE INPUT OF PHARMACEUTICAL WASTE MANAGEMENT DISPOSAL IN SANITATION SERVICE CHAIN: A CASE STUDY OF NKUBU TOWN, MERU, KENYA

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DECLARATION

This thesis is my original work and has not been presented submitted for an award of degree in any institution.

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DEDICATION

This work is dedicated to my dear lovely wife Fridah Makena, my lovely children Liam Mureti and Abigail Kendi, and My Parents Mr. and Mrs. Gitobu and Mr. and Mrs. Mbae.

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ACRONYMS AND ABBREVIATIONS

AAPCC	American Association of Poisons Control Centers
ANOVA	Analysis of Variance
API	Active Pharmaceutical Ingredients
APIs	Active Pharmaceutical Agents
CDC	Centre for Disease Control
CP	Community Pharmacies
CPM	Community Pharmacy Managers
EPA	Environmental Protection Agency
FEFO	First to Expire-First Out
GOK	Government of Kenya
HBM	Health Belief Model
HCF	Health Care Facilities
HCW	Health care waste
HCWM	Healthcare Waste Management
IAPHL	International Association of Public Health Logistician
ICRC	International Committee the Red Cross
KEMSA	Kenya Medical Supplies Agency
KNBS	Kenya National Bureau of Statistics
KPA	Kenya Pharmaceutical Association
MoH	Ministry of Health
NACOSTI	National Commission for Science Technology and Innovation
NAFDAC	National Agency for Food Administration and Control
NDCP	National Drug Control Policy
NEMA	National Environmental Management Authority

NIDA	National Institute on Drug Abuse
NSAIDs	Non- Steroidal Anti-Inflammatory Drugs
OTC	Over-The-Counter drugs
PPB	Pharmacy and Poisons Board
PSK	Pharmaceutical Society of Kenya
PVCs	Polyvinyl Chloride
PW	Pharmaceutical Waste
PWM	Pharmaceutical Waste Management
SDGs	Sustainable Development Goals
SOP	Standard Operating Procedures
SPSS	Statistical Package for Social Sciences
TFDA	Tanzania Food and Drugs Authority
UNEP	United Nations Environmental Program me
WHO	World Health Organization

OPERATIONAL DEFINATION OF TERMS

Community Pharmacy	Refers to all establishments privately owned whose function is to serve the community pharmaceutical and drug services and needs.
Diagnosis	Refers to identification of the disease/illness/disorder nature by examining the symptoms.
Expiry	The end of pharmaceutical/drug being valid. Cessation of a drug being effective.
Household head	A person in charge of the family.
Households	The smallest domestic unit consisting of one or more people who share living accommodation.
Improper disposal	Any disposal of pharmaceuticals which is not following the guidelines on safe disposal as stipulated by World Health Organization.
Non-target organisms	Any organism which is unintentionally affected by pharmaceuticals including aquatic life like microbes, fish, and even humans who are not intended to take these medications.
Pharmaceutical Waste	Refers to drugs which are no longer usable for the intended purpose and will never be used whether expired or not.
Pharmaceuticals	These are substances/drugs used to cure, diagnose, and treat/prevent diseases for pets and humans.

Pharmacy manager	A person in charge for daily management of pharmacies.
Take back programs	These are initiatives which entail collection of unwanted pharmaceuticals from households to hospitals where they are later disposed of in a safe way which cannot pollute the environment.
Practices	Behaviour/ habits during collection, transportation, procession and disposal of waste materials
Pharmaceutical waste management	Operational and administrative activities used in handling, storage, collection, treatment, packaging, reusing/recycling, and disposal of drug waste.

ABSTRACT

Pharmaceutical Waste Management (PWM) has emerged as a serious issue, with both health concerns and environmental damage. The study assessed the availability of infrastructures that supports sound pharmaceutical waste management, identified the commonly dispensed drugs among the community pharmacies and those found in households, determined the proportion of community pharmacy managers and households with knowledge of pharmaceutical waste management and also determined the common methods of pharmaceutical waste management in Nkubu town among community pharmacies and households in sanitation service chain.

The study was conducted in Nkubu Town, Imenti South, sub-county. A cross-sectional study design was utilized to achieve the specific objectives. Data was collected by use of questionnaires. The sample size was 19 community pharmacy managers and 380 households' heads located within the borders of Nkubu Town, Meru County. Descriptive data was analyzed using the Statistical package for social sciences (SPSS) version 22 and findings were presented using figures and tables. Antibiotics were the most commonly disposed of drugs along the sanitation service chain. Antimicrobials interfere with water treatment process depend on microbes for biodegradation. It was also evident that majority of households and community pharmacies are either connected to piped water or a sewerage system. Improperly disposed pharmaceuticals end up in garbage collection centers and water purification systems which are not sufficiently equipped to manage this form of waste. On the proportion of community pharmacy managers and household heads with knowledge on pharmaceutical waste disposal, there was lack of training on the same. The study recommends the need to establish public awareness, educational programs regarding management and handling of unwanted pharmaceuticals among households that would highlight their effects both on human beings and across the sanitation chain if poorly disposed. Sensitization of the public on the dangers of poor disposal of pharmaceuticals and provision of collection points for proper disposal are recommended especially at the local dispensing chemists. The study established study that pharmaceutical waste is evident in across the sanitation service chain. The pharmacy and poisons board, the regulatory authority for pharmacies should discourage the establishment of community pharmacies before verifying the pharmaceutical waste disposal sanitation infrastructure available to them. This requirement should be a prerequisite for pharmacy outlet licensing. Future studies can explore further the presence and concentration of active pharmaceutical ingredients/ agents in municipal waste, sewage and drinking water to build on the findings of this study.

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background Information

Ghosh (2020), denotes that management of pharmaceutical waste from households and community pharmacies poses a serious challenge because of the environmental damage it causes and the health concerns. Managing pharmaceutical waste is fundamental and critical to prevent the ecosystem and public health dangers posed. Furthermore, Pharmaceutical waste remains a serious issue in most Low and Middle-income Countries (LMIC) due to the economic, social, technological difficulties and insufficient training on waste management (Ghosh, 2020). Proper pharmaceutical waste handling should be done to promote safe sanitation systems as a goal to achieve the Sustainable Development Goal (SDG) 6.

Pharmaceutical waste contributes approximately 3% of total waste generated by health facilities. Nearly 85% of the pharmaceutical waste generated at community pharmacies is non-hazardous while 15% is hazardous, radioactive, toxic and infectious (Iosue, 2020). For instance, Batterman, (2004) recorded that around 16 billion injections are used but not all are properly disposed as some undergo incineration or open dumping. Additionally, Glassmeyer (2010), In the United States of America (USA), community pharmacies purchase over four billion pharmaceuticals per year, generating around 84,000 tons of the pharmaceutical waste from households and pharmacies. Glassmeyer (2010) and Hinchey (2017), indicate that the Geology survey of USA records that 80% of the pharmaceutical waste is found in water consequently contaminating drinking water. India generates around 60 metric

tons of pharmaceutical waste from pharmacies and households, making their disposal and sorting a great challenge (Hinchey, 2017). Pharmaceutical waste is usually discarded into landfills or drains except for the chemotherapy agents which are incinerated (Hinchey, 2017).

Battermnan (2004), indicates that Pharmaceutical waste management need to be recognized in order to prevent environmental pollution caused by unsafe disposal of pharmaceutical products from households and community pharmacies. The pharmaceutical wastes from households vary in different ways, but they have great potential of contaminating sanitation service chain especially in children (Arukwe, 2012). The American Association of Poison Control Centers (AAPCC) report recorded that nearly 18.6% of poisoning in children was as a result of acute pharmaceutical products poisoning (APCC, 2008). Improper disposal and handling of unused pharmaceutical products has become a growing problem worldwide as cited by Cormican et al., (2010)

Cormican et al. (2010), goes on to explain that pharmaceutical waste has become a potential poisoning source, with manifold impacts on public health, health care and the environment. A cross-sectional study conducted in the Republic of Serbia on management of pharmaceutical waste in pharmacies revealed that 76.5% of the assessed pharmacies collect and dispose expired medicines brought by the community people, while the other 23.5% of pharmacies do not collect expired drugs from households (Manojlović et al., 2014). Additionally, Manojlovic (2014), concludes that community pharmacies need to instill obligations of pharmaceutical waste collection and

disposal legally.

Pharmaceutical waste contains hazardous metabolites that are not environment friendly if handled improperly (Manojlović et al., 2014). Michael et al. (2019), cites that animals and human can be exposed to toxicities from pharmaceutical products in the environment through consumption of contaminated water, this is mainly because many community pharmacies and households keep unused, unwanted and expired drugs which they frequently discard through sinks, toilets, and the municipal or garbage waste bins. For example, narcotic and sleep aid drugs were found in garbage's of most Nigerian households (Awodele *et a*l., 2016). A mixed design study in Anambra State of Nigeria on assessment of unused medication disposal practices among community pharmacies revealed that community pharmacies relied on 9.1 % rubbish bins, 23.9% drug distributors, 31.8 % National Agency for Food administration and control (NAFDAC) for disposal of drugs. However, 7.1% relied on sinks for disposal and 29.6% reported not to have stocked expired drugs. Further, regarding compliance to the National guidelines of expired drugs disposal, only 23.4% of the respondents were reported to be complying to the regulations, while 22.1% partially complied and 54.5% did not comply (Michael et al., 2019). Furthermore, 22.1% of the people assessed confirmed that NAFDAC depends on incineration and other heat forms for management of expired medication while 71.4% relies on state-run programs for disposal. The finding of this study led to conclusion that poor compliance to national guidelines for disposal of expired medication increases the risks of environment contamination and possibilities of toxic

pharmaceutical waste ingestion by animals and humans (Michael et al., 2019).

A systematic review by Isoue (2020), on comparing the disposal of pharmaceutical waste at industry, household and community levels in Kenya, Ethiopia, Sudan and Uganda revealed that Kenya has a comprehensive and Standard Operating Procedure (SOP) for management of pharmaceutical waste yet little information is recorded under households and community pharmacies management practices. Njenga (2008), notes that despite the guidelines being comprehensive, compliance at household and community levels is lacking. This constitutes a research gap that can shed light across the sector. This review found that many pharmacies collect waste and transport pharmaceutical waste to private hospitals for incineration services. Many of these incinerators are in bad working conditions whereas others are located in inaccessible areas (Njenga, 2008).

In addition, there is little knowledge of adequate pharmaceutical disposal practices at community pharmacies and household levels. Njenga (2008), was keen to conclude that the PPB disposal guidelines should be in place to promote public heath safety and also ensure a friendly environment. Thus, take back programs were suggested for management of pharmaceutical waste at the household level. Chartier (2014), notes that there are initiatives which entail collection of unwanted pharmaceuticals from households to hospitals, where they are later disposed of in a safe way which cannot pollute the environment. Pharmaceutical wastes need to be given significant attention in underdeveloped nations, with the finest available technologies being

employed to provide options for proper disposal by households and community pharmacies (Kusiluka et al., 2013). According to Ritchie and Roser (2019), the world's most prominent environmental and health problem is unsafe sanitation, particularly in emerging countries. Nawaz et al. (2018), notes lack of adequate access to proper sanitation as a leading cause of diseases like cholera, diarrhea, typhoid, dysentery, polio, and hepatitis A.

The global burden of diseases study revealed that around 775 000 people died from poor sanitation by 2017 as recorded by (Beghi et al., 2019). Almost 5% of deaths were recorded in developing countries and 11% in Chad (Zunt et al., 2018). Iosue (2020), argues that there are limited studies that have been conducted to determine how pharmaceutical waste generated by community pharmacies and households is managed effectively. Therefore, there is a need to assess the pharmaceutical waste management practices by households and community pharmacies in Nkubu a town of Meru County, Kenya.

1.2 Problem Statement

Increasing disease incidence and prevalence necessitate healthcare practitioners to prescribe and dispense different medications. According to the World Health Organization (WHO) (2010), more than half of all medications are inappropriately prescribed and sold, which causes unnecessary storage in community pharmacies and households creating environmental threats that jeopardize efficiency of sanitation service chain. WHO also notes that the consumer (patients) and households are not able to use all the dispensed medications from community pharmacies because of several reasons

including; adverse effects, alteration of dosage, feeling healthy, expiry, promotional practices by manufacturers', physicians' prescribing practices, dispensers' practices.

Notably, almost 5% of deaths were recorded in developing countries and 11% in Chad (Zunt et al., 2018). For instance, poor management of pharmaceutical waste, especially the sharp related objects have been associated with 33800 HIV infection cases as well as 31500 hepatitis C infections (Zunt et al., 2018).

Giusti (2009), notes that public health and the environment are at risk when pharmaceutical waste from the community pharmacies and households are handled improperly. When pharmacies and households dispose this pharmaceutical waste into the sinks, drains, sewers and toilets, they pose a great challenge to animal and human health (Giusti, 2009). In addition, disposal of the pharmaceutical waste such as disinfectants, antibiotics, antiseptic improperly into sewerage systems leads to ineffective treatment of sewage (Orina, 2018). Furthermore, there is possibility of drug toxicity/addiction resulting from open dumping of pharmaceutical waste from community pharmacies and households (Jones et al., 2001). Burning of polyvinyl chloride based pharmaceutical waste discharges harmful gases into the environment.

Nkubu is a growing town in terms of population and economy, which means increased volumes of pharmaceutical waste generated due to the new upcoming pharmacies and the indiscriminate over the counter purchase of

drugs. Most of this can be found in local dustbins and open pit and garbage sites.

Draining of unused suspensions and syrups down the sinks being one of the most common practice leading to these scenarios of polluted water bodies. This being the assumption of the case there is a serious and multifaceted issue that has gained both county government and national Government attention due to their various effects on both the human population and across the sanitation chain (MoH national health care waste management plan 2016-2021). It is against this background that this study was being conducted to explore the input of pharmaceutical waste management disposal in sanitation service chain in Nkubu town, Imenti south Subcounty, Meru County.

1.3 Study Objectives

1.3.1 General Objective

To explore the input of pharmaceutical waste management disposal in sanitation service chain among community pharmacies and households in Nkubu town, Meru-Kenya.

1.3.2. Specific objectives

1.3.2.1 To identify the commonly disposed drugs among the community pharmacies and those found in households across the sanitation service chain in Nkubu town.

1.3.2.2 To determine the availability of sanitation infrastructure that

supports sound pharmaceutical waste management disposal in sanitation service chain in Nkubu town.

1.3.2.3 To determine the proportion of community pharmacy managers and households with knowledge of pharmaceutical waste management disposal in sanitation service chain Nkubu town

1.3.2.4 To determine the common methods of pharmaceutical waste management disposal across the sanitation service chain in Nkubu town among community pharmacies and households.

1.4 **Research Questions**

1.4.1 What are the commonly disposed drugs among household and community pharmacies across the sanitation value chain in Nkubu town?

1.4.2 What sanitation infrastructures that supports sound management of pharmaceutical waste across the sanitation value chain that are available among community pharmacies and households in Nkubu town?

1.4.3 What proportion of the community pharmacy managers and households have the pharmaceutical waste disposal knowledge in sanitation chain service in Nkubu town?

1.4.4 What are the common methods on pharmaceutical waste management being practiced across the sanitation service chain among community pharmacies and households in Nkubu town?

1.5 Justification of the Study

All hospitals have a formal plan for pharmaceutical waste management developed by the National Health Care Waste Management plan in 2015. However, there are no management standards/strategies stipulating how community pharmacies and households should manage pharmaceutical waste (MoH, Health care waste management plan 2016-2021). Several studies have been done in Kenya on management of pharmaceutical waste in healthcare facilities (Wepukhulu, 2011; Orina, 2018). However, these studies did not focus on the households and community pharmacies, thus creating a knowledge gap. Mugumura (2015), reports that there is limited data on pharmaceutical waste management among the community pharmacies and households.

As such pharmaceutical waste needs to be managed sustainably to reduce sanitation contamination, secondary disease transmission and mitigate potential health effects. In addition, the study may aid the Joint monitoring programs to make reports on safe management of pharmaceutical waste as efforts towards improved Water and Sanitation management.

Findings of this study may help contribute to development of policies for pharmaceutical waste management at household and community pharmacy level in Kenya. The study will be of importance to pharmaceutical waste managers, sanitation and environmentalist stakeholders as it will provide scientific evidence that can guide disposal of pharmaceutical waste at the community level.

The study findings may help achieve the SDGs 6.3 that focuses on improving the water quality through pollution reduction, illegal dumping elimination and minimizing the release of hazardous chemical and material into water sources by 2030. More so the SGDs goal 3.9 focuses on reduction of mortalities and illnesses from hazardous chemicals, water, soil, air pollution and contamination by 2030. The study findings will provide information that also aid in attaining the Kenya's Vision 2030 that aims at regulating pollution and waste management, providing clean and secure environments to match vision 2030 blue print.

1.6 Limitations of the Study

The community pharmacy managers did close the premises for the fear of a crackdown that was ongoing during the week of data collection, while on the expiry of commodities most original containers and packaging materials were not available hence, the expiry dates could not be adequately verified. Similarly, it was possible that a large number of participants who declined to take part in the study were more likely to have had adequate knowledge of pharmaceutical waste management practices as well as the ones with appropriate sanitation infrastructure in sanitation value chain. Finally, the study was limited to Nkubu town in Meru County thus it would be inappropriate to generalize the findings to other towns/counties without empirical data from those counties.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Orina (2018), alights the importance of management of pharmaceutical waste as a critical matter for public health and sanitation. Pharmaceuticals become waste when they are not in use for the intended reasons, being discarded due to expiration or contamination. Unsafe disposal of pharmaceutical waste form households and community pharmacies finds its way into garbage bins and water points, not sufficiently equipped to handle this kind of waste (Pollo et al., 2019). There is a huge threat being posed on public health and environment due to presence of harmful pharmaceutical compounds in water systems and environment; thus, interfering with water treatment processes (Ruhoy, I. S., & Daughton, C. G, 2008). (Ruhoy, I. S., & Daughton, C. G,2008), indicates that pharmaceutical waste has immense impacts on non-target organisms as it causes antibiotic resistance in human, increasing mortalities and morbidities due to poisoning.

Globally, more than half of the patients do not take medication as per doctors/physician prescription thus generating more pharmaceutical waste (Holloway, K. 2011). There is also a global challenge of patients adhering to their medication, accounting for about 50% for developed countries (Pollo et al., 2019). Many patients find it difficult to complete their medication as prescribed making it a big burden of unwanted pharmaceuticals among households (WHO, 2004). For instance, the commonly disposed pharmaceuticals worldwide include controlled substances such as narcotics and psychotropic substances, anti-infective drugs, anti-cancer drug,

antineoplastic, cytotoxic-, disinfectants and antiseptics. These pharmaceuticals can be in form of solids, semi-solids or powders (WHO, 2013). Pharmaceuticals to be disposed can further be categorized by dosage form that is solids, liquids, semi solids and powders. They include capsules, powders, gels, creams, suppositories, tablets, mixtures, and granules. Others are in liquid form such as solutions, suspensions, syrups and ampoules. They can also be in aerosol canisters, which include propellant driven sprays and inhalers (WHO, 2015).

A cross section descriptive study was done on 25 community pharmacies, Hurling ham, central business district and Downtown area of Nairobi (Njenga, 2008). The study focused on disposal and handling of pharmaceutical waste by community pharmacies outlets. The findings revealed that 95% of the community pharmacies generate a substantial amount of pharmaceutical waste comprising of 53% expiries, 32% damaged, spillage and contamination, and returns accounted for 9%. Out of the total waste generated, 71% were solids, powder and semisolids, 62% liquid, 52% packaging and containers, 38% ampoules, and antineoplastic, controlled substances and disinfectants accounted for less than 15% each. In addition, about 90% of the community pharmacies disposed their pc waste offsite.

The pharmacies depend on 43% segregated waste room, 5% pharmacy backyard and store, the other half had no specific point for waste storage. Furthermore, most of the disposal method applied were environmentally hazardous. (Mugumura, J. R. 2015), noted that 36% of the community

pharmacies did not know how to dispose the generated pharmaceutical waste. The other third relied on high and medium temperature incineration, and nearly 34% practices open dumping, sewer disposal and open burning. The researcher therefore concluded that the disposal policy awareness, methods and guidelines is poor. Most of the applied disposal methods poses an immense threat to the ecosystem and sanitation.

The author added that about 65% of the pharmacy outlet operators were unqualified (Mugumura, J. R. 2015). The sanitation crisis caused by unsafe disposal of pharmaceutical products from households and community pharmacies (CPs) is complex. The pharmaceutical waste from households and community pharmacies varies in different ways, but they have great potential for contamination. Pharmaceutical waste management need to be recognized and understood in order to prevent contamination across the sanitation value chain.

2.2 Pharmaceutical Waste Disposal Infrastructure across the Sanitation Service Chain

Ghosh (2020), keenly prescribes after all other procedures have been taken, the final stage of waste management is disposal. The method of disposing of PW or any other form of waste depends on various factors such as the availability of infrastructure. (Simons, T. 2010), study on assessment of pharmaceutical waste management programs in Canada for the public revealed that there are no national wide disposal programs in Canada. However, Holloway (2011), notes the post-consumer pharmaceutical

stewardship association supports the territories to respond to unused/expired medication form households and Community pharmacies. The returned expired pharmaceutical is buried in landfills or incinerated. Each province in Canada has the authority to have their guidelines for the pharmaceutical waste disposal. Some community pharmacies are expected to accept the returned pharmaceutical from households for safe disposal. However, pharmacies fear the cost of the pick-up fee and disposal mostly when they have dispensed the drugs.

For instance, Manitoba City has a formal program for management of pharmaceutical waste from households. Households return expired/extra medication to community pharmacies or to periodic collection depots for proper disposal. Consequently, New Brunswick and Nunavut lacks the formal wide programs for pharmaceutical waste disposal. However, majority of residents dispose waste safely. The households return expired medication to health centers and community pharmacies. The collected pharmaceutical waste is sent back to Baffin Regional Hospital pharmacy for incineration. From the study findings, the cities are developing programs to manage pharmaceutical waste, however, further consultation and study are required in to establish how to optimize the management of pharmaceutical waste best. (Simons , 2010).

Harhay et al., (2009), depicts that each institution is responsible for handling the waste on site if there is no acceptable disposal infrastructure nearby. Harhay et al. (2009), has also conducted a meta-analysis of all known health

care waste management (HCWM) literature from around the world. In many cases, they reported, current incinerators were obsolete or defective, resulting in pharmaceutical waste being disposed of in municipal rubbish, open burning, or simply burying within hospital compounds. Matiko (2012), has provided a good example for this and it can be found in Dar es-Salaam, Tanzania, where 40 percent of medical store administrators in government health facilities (HFs) mentioned a shortage of incinerators as one of the issues with PW disposal, resulting in accumulation (Matiko, 2012). This poll, however, was limited to government-owned institutions.

A government-sponsored evaluation of public and private pharmacies in Kenya revealed a severe problem with HCW disposal infrastructure. The study cited by Orina (2018), with an indication that the majority of HFs relied solely on incinerators, with approximately 25% of them being dysfunctional, either under repair or non-functional. More so, only 20% of hospitals had alternative waste treatment infrastructure such as shredders. Since Community pharmacies were not assessed, it was not known whether they had access to PW disposal infrastructure (Orina, 2018).

2.3 Commonly Disposed Drugs Found Across the Sanitation Service Chain

As disease incidence and prevalence rise, healthcare providers must prescribe and administer a wider range of medications. Because of unpleasant effects, dose changes, feeling well, medications approaching their expiration dates, promotional practices by manufacturers, physicians' prescribing procedures, or dispensers' practices, consumers (patients) are unable to use all of the

prescribed medications (Seehusen & Edwards, 2006; Ruhoy & Daughton, 2008).

More than half of all medication is inappropriately prescribed, wrongly prescribed and sold, according to the World Health Organization (WHO, 2004). This causes wasteful storage and an environmental threat. In some cases, patients take under-dose of their prescribed medication leaving part of the collected drugs at home. The world medicine situation report reveals that 50% of patients incorrectly take the medicine prescribed to them (WHO, 2004).

As a result, it is common for families and patients to have unused or expired prescriptions, and the concerns have attracted global attention (Ananth et al., 2010). When it comes to storing unwanted or expired medications, patients and family members need clear instructions on how to dispose of them. The existence of such unused and expired pharmaceuticals in containers, boxes, cabinets and cupboards poses risk to individuals, the environment, and wildlife (Vollmer, G. 2010).

Jasim (2010), in his study conducted in Basrah of Iraq, found out that antibiotic (26.43%) are the commonly disposed medications followed by 19.58% of analgesics and Non-Steroidal Anti- Inflammatory Drugs (11.45%). Out of the total pharmaceutical waste, the mentioned drugs contribute to about 57% of medication disposed. Nearly 31% of the disposed medicine were in use, the other 45% were unused medication or leftovers and those that were kept for future use accounted for 23%. More so, 13% of the medications were expired

(Jasim, 2010).

While Arkaravichien et al. (2014), in correspondence to medical research conducted in Thailand, realized that 89.4% of people have some type of narcotic in their homes. The most common class of medications was neuromuscular pharmaceuticals. The survey also demonstrated that unused medicines were found in houses and that they were thrown when they were no longer needed. The most usual way of getting rid was dumping in the trash. This approach was responsible for 81.4 % of solid dosage forms, 64.6% of liquid dosage forms, and 66.6 percent of pharmaceuticals for external use. Liquid dose forms (7.4%) were also inserted into the drainage system (Arkaravichien et al., 2014).

Similarly, another study in Basrah, Iraq, found that 94% of 300 households examined had medication stocked in their houses. There were 4279 different types of medicine preparations in all, ranging from one to 72 per household. According to the survey, 70% of the families retained between one and twenty things, with nearly half of the products being preserved in their homes. At the time of the visit, 45% of the medications were unopened, while 23% was for use in the future (Jasim, 2010).

Self-treatment was shown to be performed by 15% and 50% of people with perceived ailments, respectively, in studies conducted in Ethiopia's southern and central regions bay (Abay, 2010). Furthermore, in the Gonder Debark and Kola-Diba (2010), research areas in North West Ethiopia, self- medication

was found to be prevalent at 27.2%. Self-medication leads to an overabundance of undesired pharmaceuticals that are purchased but not properly utilized. As a result, substantial volumes of home pharmaceutical waste are generated, posing issues for efficient disposal (Abay, 2010).

Unwanted drugs are thrown into the trash or the toilet, burned, buried, given to a sick neighbor, or thrown into the environment, according to a study conducted in Ethiopia. Others retain them in the house for future usage since they are unsure of how to properly dispose of them (Temu et al., 2014). According to research conducted in Tanzania, 25 (8.3%) of the 300 families examined had antimalarial medications on hand (Temu et al., 2014). Another study in Tanzania found that (56%) of people hold medications due to recurrent illness in their families, followed by distance to a health facility (20%) (Temu et al., 2014).

The presence of pharmaceutical wastes and disposal in waterways and water bodies, in particular, is a great concern that has attracted attention from all spheres: public, private, and other stakeholders. In the United States, for example, Boehringer (2004), observed traces medications like acetaminophen, verapamil, and estradiol in rivers due to incorrect dumping of expired and unused pharmaceutical products. These adversely affect the aquatic wildlife. Studies have confirmed that the presence of antibiotics in water has also been shown to develop resistance to antibiotics and, in the long run, genetic repercussions in people and aquatic life (Costanzo et al., 2005; Wu et al., 2009). Discarded ampoules and vials and byproducts of a mass vaccination

against polio drive in Kabul, Afghanistan in 2008 which were disposed in the municipal dumpsite became infectious to the dumpsite workers and searchers.

Pharmaceutical waste is a component of HCW that includes expired or no longer needed drugs, defective products, or pharmaceuticals that require a specific and methodical disposal technique to mitigate their detrimental impacts. As a result, the World Health Organization's European Centre for Environment and Health, based in France, established an international taskforce to provide a practical guide, focusing on the issues of Health Care Waste Management in emerging nations. Some countries lack clear state regulations or standard procedures for disposing of unwanted or unused drugs (Tong, 2011).

In Kenya, the Ministry of Health (MOH) tasked the Pharmacy and Poisons Board (PPB) with drafting the required policies to address these concerns. This resulted in the Guidelines for Safe Management of Pharmaceutical Waste (2019). Previously, the country had no clear procedures and guideline regulating the sector. Until then, the Pharmacy and Poisons Act (2002), National Guidelines for Safe Management of Health Care Waste (2011) and the Public Health Act (2012) captured general policy statements on waste and disposal of pharmaceutical products and lacked clarity. So far, no research has been done in Nkubu, Meru County on how unused and expired medications are disposed off by the general populace.

2.4 Knowledge of Community Pharmacy Managers and Households

Musson et al. (2007), alights that in the United States of America, there is reverse distribution companies which collect unused pharmaceuticals from pharmacies and other healthcare institutions and return it to the manufacturers on their behalf, or alternatively, dispose of it in accordance with environmental regulation. Furthermore, he notes that reverse distributors may end up receiving drugs which do not meet the return criteria and therefore, the drugs have to be disposed at community pharmacies. As such, an experiment found that pharmacists in the United States were unaware of the potential environmental impact of incorrect PW disposal (Jarvis et al., 2009).

Additionally, in the United States, there are no precise PWM rules. Rather, PW was governed by a number of distinct laws (Musson et al, 2007). Jarvis and colleagues (2009), found out that a newsletter-based teaching intervention was helpful in boosting pharmacists' awareness of PWM. The response rate, on the other hand, was below 50 percent. Nonetheless, the study found that just around half of the respondents were familiar with PWM. According to studies conducted in the UK, US and New Zealand, there is a lack of public knowledge about the importance of proper and safe disposal of unwanted drugs by returning them to pharmacies or designated collection places (Cormican et al., 2010). According to research, 3.8 percent of Pakistan's population has no idea what to dispose with unwanted medications in their homes. On the other side, 80 percent of respondents expressed concern that unsafe disposal of pharmaceutical waste is life threatening. Cormican et al. (2010), indicates also that despite the availability of environmentally

acceptable pharmaceutical waste disposal solutions, the majority of homes dispose of unneeded medications in the sewer system or trashcans. These procedures are frequently favored due to worries about unintentional poisoning of children and pets. Many individuals feel that disposal of unneeded medications in the sewer or municipal waste does not result in hygienic conditions (Cormican et. al., 2010).

A cross-sectional study revealed that the situation in Pakistan is much worse, with nearly half of the Community Pharmacy attendants (45%) in various stages of secondary school (Aslam et al., 2012). Only 9.5 percent had a pharmacy degree, and another 16% had completed a dispensing course. Furthermore, (Khojah et al.,2013) carried out a cross-sectional study in Saudi Arabia that revealed that nearly all CP managers had earned a degree, including B. Pharm., Pharm. D, MSc, and even a PhD (Khojah et al., 2013). A survey in Tanzania, pharmacists accounted for only 8% of medicine dispensers in CPs (Mugoyela et al., 2002), while pharmaceutical technicians accounted for 23%, clinical officers (15%), nurses (27%), and school leavers made up the balance of the group (27 percent). Similarly, In Kenya, one must be properly registered with the Pharmacy and Poison Board (PPB) in order to lawfully practice pharmacy (PPB). Pharmacists with a Bachelor's degree in pharmacy and pharmaceutical technologists; a diploma is recognized by the PPB (Mugumura, J. R., 2015). However, unlicensed drug stores with unqualified staff are frequent in Kenya, especially in rural area (Mugumura, J. R., 2015).

Consequently, according to the Tanzania study, one of the causes of PW buildup in government HFs is a lack of pharmaceutical management skills, which was highlighted by 40% of medical shop supervisors. Furthermore, Tong et al. (2011), recommended the creation of awareness on the topic among community pharmacists in New Zealand, even though they did not specifically study knowledge of PWM. Similarly, Abahussain et al. (2012), study in Kuwait, Matiko (2011) study in Tanzania recommended the same. More so, Abahussain et al., (2012) made the conclusion after studying PW disposal habits among pharmacists working in government HFs. However, Insufficiency of knowledge of PWM and the environmental risk it poses was a more serious concern in other countries. There is inadequate information on handling of pharmaceutical waste at household level.

Further, knowledge on environmentally-friendly and sustainable disposal methods for pharmaceuticals is lacking (Osho, 2016). A study conducted in Nakuru demonstrated that improperly disposed pharmaceuticals can cause adverse effects on human such as medicine resistant, accidental poisoning of children and pets (Kahenda & Wagema, 2016). This can also happen in the study area if the pharmaceutical waste is not properly disposed.

Almost half of all adults in the United States have low functional literacy skills. Poor drug adherence and health outcomes are linked to low patient literacy. However, little is known about how pharmacies respond to consumers' literacy-related needs. Patient-centered care communication is stressed as a critical component in developing a strong and suitable

interpersonal contact with the patient, ensuring the effectiveness of the consultation process, and enhancing the pharmacist's expertise in community pharmacy (Praska et al., 2005).

2.5 Pharmaceutical Waste Management Practices

Pharmaceutical waste continues to constantly grow. Expired and unused pharmaceutical waste are mostly disposed into sewer system. (Musson, S.E. Townsend, T.G. 2008) carried out a 2-case study on household pharmaceutical waste practices in Poland. The first survey focused on identification of the consumption scale of pharmaceuticals and disposal of pharmaceutical waste. The second survey aimed at identification of attitudes on managing expired pharmaceutical among patients at home.

The findings from the first survey indicated that around 74% of the pharmaceutical waste comprised of analgesics which were acquired over the counter, 65 % were medication for flu treatment. Furthermore, 68% of the participants reported to be disposing the household pharmaceutical waste by flushing them into toilet and sinks. Survey 2 reported that 35% of the population disposed waste into toilets, less than 30% practiced returns of expired medication to pharmacies. The general study concluded that the local government are not obliged to work by law or compensate community pharmacies in collection, transport, and disposal of expired pharmaceuticals.

Return to donor/manufacturer, incineration, immobilization, landfill, sewage, chemical decomposition, burning in open containers, and fast-flowing

watercourses are the eight techniques for disposing of pharmaceutical waste (Nyaga et al., 2020). There is no universally accepted procedure for dealing with pharmaceutical waste. In the United States, there are differences in several features of PWM between states. For examples, some type of reuse or resale of returned drugs are considered to be safe, but only under certain conditions (Lin et al., 2008, Gualtero 2005).

Pharmaceutical waste (PW) coming from pharmacies, hospitals, and clinics was handled by reverse distribution businesses. As a result, only non-returnable PW, such as restricted chemicals, would be available for disposal at these locations. For an instance, in affluent nations like Canada, Australia, Italy, France, and Spain, reverse logistics for the collection of household pharmaceutical waste has been established (Bellan et al., 2012).

One interesting approach that can be cited is such as that of Makki et al. (2019), where patients in New Zealand are routinely instructed to return leftover drugs to pharmacists, but there was insufficient information on how pharmacies disposed of them. In addition, the study finding revealed that the respondents' most popular disposal techniques were not environmentally friendly. Only 53% of the original study sample participated in the research (Makki et al., 2019). The authors noted that this could be a source of bias because individuals who responded may have been more interested in the topic. To elaborate further, a study in Kuwait revealed that, government pharmacies were compelled to submit their PW to central medical shops, which then disposed of it under the supervision of the environmental agency

(Abahussain et al., 2012).

Mugumura (2015), cites poor practices of disposing unwanted/expired pharmaceuticals in households and community pharmacies are responsible for a large portion of pharmaceuticals in water. The majority of consumers flush unexpired drugs into sinks, toilets or dispose then into garbage bins. This was demonstrated in a number of investigations in Tacoma, Washington.

According to the report sampled by Ghosh (2020), 54% of participants kept medications in homes and 35% flushed drugs into the sink or toilet. Studies conducted in Southern California revealed that 45% of the participants were disposing expired drugs in the trash and 28% in sinks or toilet. In King County, Washington, 52% of people threw away unneeded medications, while 20% flushed expired drugs in sinks and toilet. Pollo et al. (2019), indicates that only 1% of people practices returns of expired/unused drugs to pharmacists. Another 12- study in United States showed about 2% of the population finish their prescription, and that a large number of medications as much as 50% of many prescriptions and 80% of antibiotics went unused (Wu et al., 2009).

Residents in Washington return unused/uncompleted drugs/dosages to designated pharmacy facilities, where they will be disposed of as hazardous trash. Since 1996, a very successful take back program has operated in British Columbia, Canada, with 93 percent approval by pharmacies (Wu et al., 2009). While pharmacists in Lithuania are required to collect household medical

waste, pharmacies in Italy do so on a voluntary basis Boehringer, S. K. (2004).

Many countries have devised safer methods of dealing with the problem in response to the lack of adequate medication disposal choices available to homes. In the United States, for example, a huge number of take return programs have been launched, collection boxes developed and special envelops have been issued to households expected to take extra/expired drugs back (Siler & Brown, 2009). Prüss-Üstün, A., & Townend, W. K. (1999), on his study on pharmaceutical waste management assessment in some pharmaceutical industries from Nigeria using a sample size of 50 pharmaceutical businesses. About 34 of the 50-sample comprising of manufacturers, medicine importers, community pharmacies were selected and interviewed by questionnaires to collect information on waste management policies practices and knowledge of waste management. Prüss-Üstün, A., & Townend, W. K. (1999), also went on and revealed that the pharmaceutical industries produce both non-hazardous and hazardous wastes. However, 91.2% of the waste is poorly managed, only 58.8% of the health personnel had minimal knowledge on waste management practices.

Furthermore, about 74% of the participants were aware of the policies on waste management but less adherence was noted. More so, most of the manufacturers (79.4%) discharged pharmaceutical waste into wastewater, others flushed down the waste into drains, burnt by NAFDAC or buried within premises. The study found minimal information about households and

community pharmacies, therefore the study highlighted that there is urgent need to offer training to pharmaceutical personnel for a planned, sustained, documented and implemented waste management practices.

In addition, information on management of pharmaceutical waste in emerging countries is very scarce (Tong et al., 2011). However, Tanzania is one of the few African countries with PWM guidelines. Tanzania's Food and Medicines Authority (TFDA), which is similar to Kenya's Public Procurement Board, developed the guidelines. However, enforcement and compliance with the requirements was low, especially for government HFs (Matiko, 2011). According to the study, 72.4 percent of respondents buried their PW at the Dar es Salaam dumpsite, while 31% burnt it. Only 37.9% of respondents mentioned incineration as a PW disposal option. Except for a few defined circumstances, the study's findings contradicted TFDA rules, which required PW to be either land-filled or cremated (Matiko, 2011). More so, Matiko (2011) and colleagues, stated that most of the facilities investigated did not have copies of the recommendations. However, some lower-level facilities, on the other hand, were not responsible for disposing off their own PW, which was supposed to be collected by regional pharmacists and disposed in larger facilities.

It's also worth noting that the institutions surveyed were not of the same size and didn’t have the same staff levels, making comparisons difficult. The study's failure to include private HFs for comparison was a key flaw. Similarly, waste in Nakuru is not segregated and pharmaceutical wastes have

ended up at the dumpsite- both from households and health facilities. This has brought about rising cases of medical waste which have been carelessly disposed in the Nakuru Gioto dumpsite (Kahenda & Wagema, 2016). Generally, pharmaceutical waste in most households is not handled properly. For instance, a study conducted at Kenya's Embakasi Division community pharmacies by Oboyo & Mutai (2014), shows that pharmaceutical waste generated at the pharmacy level was 34 percent solids and 59 percent liquid forms, which were disposed of by waste disposal businesses. Approximately 19.2 percent of semisolid pharmaceutical waste was disposed of by sewage and incinerator.

2.6 Theoretical Framework

The Health Belief Model (HBM) was one of the earliest theories that focused on health behaviors (Raheli et al., 2020). HBM is an effective model for dealing with behavioral that causes health problems. According to the known paradigm that a person's health-related behavior is influenced by their perceptions. HBM is used to address concerns such as patient compliance and preventive health care practices (Raheli, 2020). It deals with the connection between a person's beliefs and their actions. The practices of pharmaceutical waste management will depend on people’s perception, knowledge and presence of necessary infrastructures.

2.7 Conceptual Framework

The components critical for any Community pharmacy and Households to practice sound PWM are availability of infrastructures, knowledge on

common disposal practice methods and availability of disposal options.

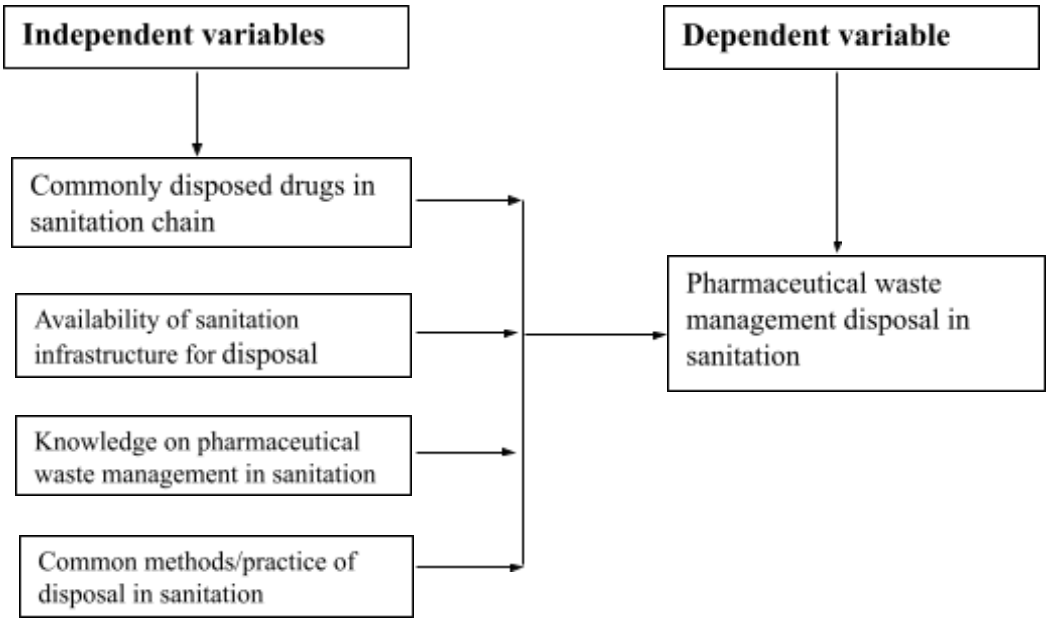

Figure 2.1 Conceptual framework

3.0 CHAPTER THREE: METHODOLOGY

3.1 Study Area

The study was undertaken at Nkubu town, Imenti South Sub-County of Meru County. It has a population of 20,000 inhabitants comprising of 7675 households (KNBS Report, 2019). The town borders River Thingithu and Mikumbune town, Meru and Chuka as shown on the map

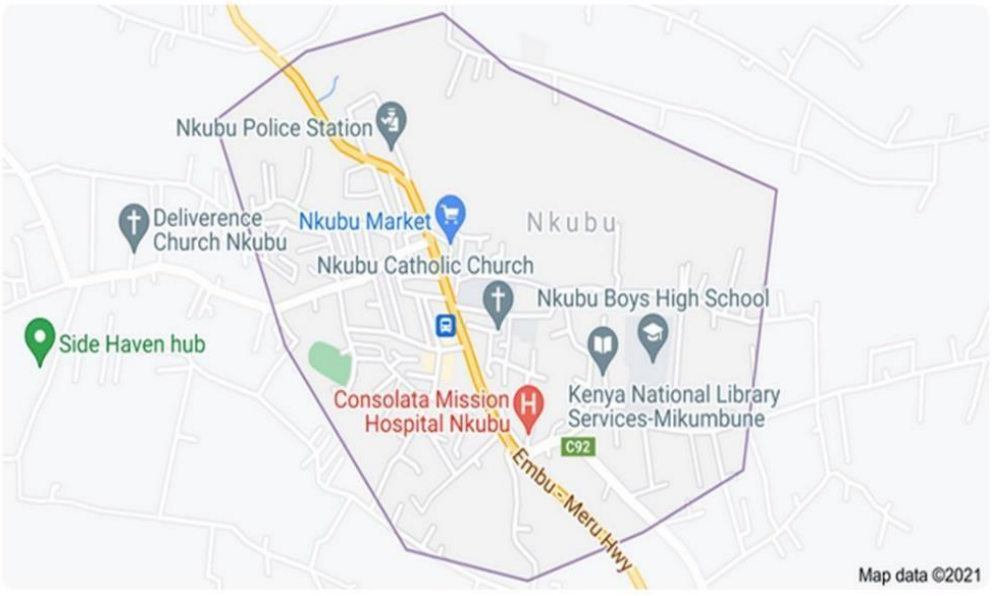

Figure 3.1 Nkubu Town Map

The area has two main hospitals i.e. the Kanyakine sub county hospital and Nkubu Consolata Mission Hospital. The area has fertile soils for farming. Inhabitants practices dairy, coffee and tea farming.

3.2 Study Design

A descriptive cross-sectional study design was utilized. This design was ideal because data on pharmaceutical waste management disposal practices was collected at one point in time.

3.3 Study Population

There are 7675 households located within Nkubu town (KNBS, 2019). The

heads of the household were included in this study while for the 21 community pharmacies included in this study, widely varied in terms of premise size, inventory size and variety depending on owners' capabilities and local economic circumstances (Sub County Pharmacist annual report, 2020).

3.4 Eligibility Criteria

3.4.1 Inclusion Criteria

A community pharmacy met the following criteria to be included in this study:

- Was privately owned
- Was providing retail pharmacy services to the community
- Was located within the boundaries of Nkubu town
- The manager must have consented to take part in the study

Household heads met the following criteria:

- Household heads were aged 18 years and above
- Given consent to participate in the study
- Were located/residing within Nkubu Town

3.4.2 Exclusion Criteria

3.4.2.1 Any household or community pharmacies managers that did not meet the inclusion criteria will was excluded

3.4.2.2 The Community pharmacy managers or households' heads who did not consent to participate in the study

3.4.2.3 Any households without house heads e.g. those headed by minors were not included in the study.

3.5 Sample Size Determination

The sample size was calculated following the Slovin's formula (Slovin, 1960) as shown below $n = N/ (1+Ne^2)$

Where

n is the sample size required,

N is the total population size

e is the tolerance error (at a confidence level of 95%).

Community pharmacies (Sample size A)

Total pharmacies = 21

$21/ (1+ 21(0.05)^2 = 19$

21/ (1+21 X 0.03 X 0.05)

Community households (Sample Size B)

Total households (N) = 7675

Sample size (B) = $7675/ (1+7675 (0.05)^2 = 380$

Therefore, the sample size will include 19 community pharmacies and 380 households

3.6 Sampling Techniques and Procedures

Simple random sampling technique was used, which is a probability sampling technique that helps in saving time and resources.

Here every household and community pharmacy of the population was chosen merely by chance.

The selected households and pharmacies were visited for investigation. Nkubu town comprises one ward (Nkuene ward) and a part of (Mitunguu ward). These two wards are comprised of seven villages Namely; Kigumone, Kigane, upper Mikumbune, lower Mikumbune, upper Taita, lower Taita and Muguru villages.

To calculate the number of households and community pharmacies to be sampled from each ward and village, proportion to size allocation will be applied as follows; (Village A population/Total population) * sample size as shown in table 3.6 below;

Ward	**Villages**	**No. of CPs**	**No. of CPs samples**	**No. of House holds**	**No. of households to be sampled**
Nkuene	Kigumone	3	3	750	37
	Kigane	3	3	789	39
	Upper Mikumbune	2	2	625	31
	Lower Mikumbune	4	3	2050	102
	Upper Taita	4	3	1800	89
Mitunguu	Lower Taita	2	2	544	27
	Muguru	3	3	1117	55
	Total	**21**	**19**	**7565**	**380**

Table 3.1 Population distribution of Nkubu town

3.7 Data Collection Tools and Procedures

Questionnaires both for household heads and community pharmacy managers (Appendix III and IV) were used for data collection. The questionnaire had both close-ended and open- ended questions. The questionnaires were administered by the principal researcher and one research assistant. The tool was self-administered for respondents who are literate and interviewer-administered for those who could not read and write. The questionnaire was administered to the selected Community pharmacies and households. In addition, the tool comprised of five components namely the demographic information, commonly disposed pharmaceutical drugs, the current pharmaceutical waste management methods, available management infrastructures and knowledge of pharmaceutical waste management among households and community pharmacies.

The Research assistant was trained for two (2) days on study objectives and research protocols that were applicable to this study before commencement of data collection.

For community pharmacies the questionnaires were administered in their respective premises while for households were administered at their respective homes.

Once the informed consent form (appendix 1) had been signed by the participant and the researcher, the participant was given the questionnaire to fill in. The filled questionnaires were collected. If the participant needed more

time to fill in the questionnaire, the researcher requested to collect it later and proceeded to the next pharmacy or household. On getting the completed questionnaire, the researcher thanked the participant and left. Completed questionnaires were handed in to the principal researcher at the end of each day.

3.8 Pretesting of the Data Collection Tool

To ensure reliability and validity of the tool, the questionnaire was pre-tested at Imenti North Sub County using 15% of the sample size (3CPs and 57 households). This helped to determine if the tool was suitable for the intended purpose. In addition, once the pre-test was completed, necessary amendments were made to address identified errors and limitations. The data collected was processed and taken through analysis.

3.9 Training Procedure

Upon recruitment, the research assistant was taken through a short training programme by the principal researcher for two days. The purpose was to familiarize them with the data collection tool, the informed consent form, the recruitment of participants and data collection procedures. The principal investigator conducted the training.

3.10 Quality Assurance Procedures

Upon receiving completed questionnaires, the principal researcher read through each questionnaire to confirm completeness. The principal researcher undertook to contact some of the respondents to ensure they were actually

visited by the researcher assistants. Wherever necessary and practicable, participants were revisited to obtain missing information or to seek clarifications.

3.11 Minimization of Errors and Biases

To help minimize errors and biases, research assistants were trained to understand content of data collection tool and procedures to make the exercise as uniform as possible. Data collection was closely supervised by the principal researcher. Secondly, a pilot test was undertaken prior to actual data collection to identify and correct any ambiguities in the data collection tool. All the persons assigned data collection took part in the pilot test exercise. Filled questionnaires were reviewed daily to ensure completeness and minimize spoilt questionnaires as much as possible. Clarifications were sought whenever possible, if necessary.

3.12 Data Analysis and Management

The collected data was cleaned to ensure data correctness, validation and removal of errors. This was to help eliminate the effects of data inconsistences such as missing values. Statistical package for social studies (SPSS) version 22 was used for data analysis. Quantitative data was analyzed using descriptive statistics. Descriptive statistics was used for data analysis, since it provides simple summaries about the samples and measures. The descriptive statistics comprised of the measures of central tendency and measures of dispersion. The measures of central tendency used for this analysis include arithmetic mean and median. The measures of dispersion include the standard deviation and the

range. The study findings were presented using figures, graphs, pie charts and tables.

The inferential statistics is used to define the characteristics of the variables and also to show the relationship between the variables. The inferential statistics is used to analyze parametric data. Regression analysis was used to define the relationship and impact of the independent variables on the dependent variable. The coefficient of correlation is used to measure the strength and direction of the relationship between the variables. The correlation coefficient is computed using the Pearson product moment. The confidence level used for this analysis is 95%. This statistical analysis helped simplify the large data in a simple way. R-squared will measure the coefficient of determination and it helped in measuring the amount of variation between the independent variable and the dependent variable. The regression analysis was used to estimate the regression coefficients and determine the prediction line. Analysis of Variance (ANOVA) was used to test the significance of the overall regression equation. For this test the F-test value and Critical F value was used. Multiple regression model was used in the analysis of the impact between the dependent variable and independent variable. Qualitative data that was generated through open ended questions in the questionnaire was classified and organized into thematic framework based on themes and concepts.

3.12.1 Data Transformation

The questionnaire was used to collect the nominal measurement scale data and it was important to transform the data for the purposes of the analysis. The

transformation of the data was guided by the following formula;

Mean = $\frac{\sum FX}{\sum F}$ where f is the frequency associated with the responses while X is the weight.

3.12.2 Regression Analysis Model

The study has adopted the multiple regression model of the following form;

$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + e$

Where;

Y = Pharmaceutical waste management disposal in sanitation

X_1 = Community disposed drugs in sanitation chain

X_2 = Availability of sanitation infrastructure for disposal

X_3 = Knowledge of pharmaceutical waste management in sanitation

X_4 = community methods or practices of disposal in sanitation.

β_0 = is the constant or the Y intercept showing the value of Y when X = 0

β_i = is the coefficients for the independent variables.

e is the residual value or error term. It is assumed the residual values are independent and normally distributed with a mean of 0 and variance of 1.

3.13 Ethical Considerations

The research permit was obtained from the National Commission for Science, Technology & Innovation (NACOSTI, appendix III) and a letter of authorization was obtained from Meru University of Science and Technology (appendix II) that enabled the research to get approvals from the local authorities. Permission and approval were also sought from Imenti South Sub

County health department.

This study was non-clinical and data collection did not expose the participants to any risk of harm. The study findings were expected to be beneficial to the communities and the participants by contributing to improvement in pharmaceutical waste management. The participants were allowed to opt freely to participate or not without being coerced. They reserved the right to withdraw at any stage without incurring any consequences. Full disclosure of the nature of the study was made to potential participants including the title, introduction, objectives and expected benefits. Informed consent was sought from each respondent that was willing to participate in the study. Confidentiality and privacy of the respondent's information was maintained at all times. The identity of the participants was protected in that no names or any identifying information was solicited in the questionnaires. After collection of data, data was stored safely in locked cabinets to maintain security and prevent access by unauthorized persons.

4.0 CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the findings from the questionnaires that were administered to the respondents. The research sought to explore the pharmaceutical waste disposal management practices among community pharmacies and households across sanitation service chain in Nkubu town, Meru County.

4.2 Response Rate

Response rate is the number of properly filled questionnaires expressed as percentage of the total number of respondents (Mugenda, 2013). The study targeted a sample size of 380 households and 19 community pharmacy managers. Response Rate is determined as follows;

$$\text{Response rate} = \frac{\text{properly filled questionnaires X 100\%}}{\text{Total number of respondents}}$$

Out of the targeted 380 households, 370 were properly filled giving a response rate of 97.3% while all the 19 community pharmacy managers filled the questionnaires properly giving a response rate of 100%. This was an excellent response as it surpasses that of Fincham (2008) recommended rate of at least 80% and Kothari (2010) recommended rate of above 50%. These rates are therefore adequate representation for generalization of the target population.

4.3 Model Diagnostic Tests

It was important to test the collected data to determine whether it is fulfilling

the assumptions of good regression estimator under parametric data analysis. A good regression estimator is assumed that residual values are normally distributed, there is no multicollinearity, and no serial correlation and the data should have homoscedasticity. When the test was carried for all the characteristics, the results showed the absence of multicollinearity, autocorrelation and heteroscedasticity. It also showed that the residuals are normally distributed.

4.4 Socio-demographic information of the respondents

The results of the socio-demographic information of the respondents are represented in form of frequency tables and pie chart. It shows the summary of the descriptive statistics in form of the frequency distribution. The data is grouped into age, education level, gender and the size of the household.

4.4.1 Age of the Households

Table 4.1 Age of the Households

Classification	Frequency (n)	Percentage (%)
Below 30	85	23
30-39	166	45
40-49	75	20
50-59	32	9
60 and above	12	3
Total	370	100

For household heads age, the highest number of 166 were aged between 30 and 39 years. This contributed to the largest percentage of the sample size of 45%. The age group with the least respondents were the people of 60 years and

above. The household heads within the age bracket below 30 years were 23% of the total sample size while those aged between 40 and 49 years old were 20%. The second age group which had least correspondents were aged between 50 and 59 years and it had 9% of the sample size.

4.4.2 Gender of the Households

The interviewees were grouped into male and female. The following table 4.2 shows the compositions of the male and female of the respondent households.

Table 4.2 Gender of the Household

Classification	Frequency (n)	Percentage (%)
Male	196	53.0
Female	174	47.0
Total	370	100

Out of the total sample size (370), 53% were male while 47% were female. It means that the male gender had the highest response and the female had the lowest. The increase of the response in males is likely to be caused by the high number of idle men in Nkubu town.

4.4.3 Level of Education of the Households

The level of education of the household was grouped into primary education, secondary education and tertiary education. The interviewees were to answer the level of certificate they have acquired and this would make the summary of

the level of education of the respondent. The following pie chart has explained the summary of the number of respondents in each level of education.

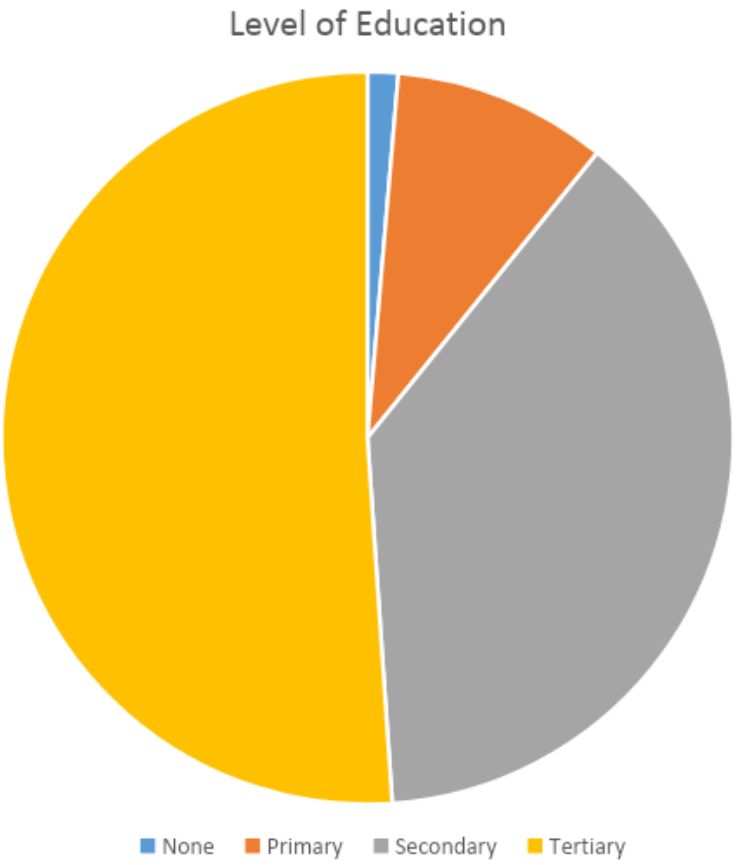

Figure 4.1 Level of education of the Household

From the chart above, 51.08% (n=189) of the household heads had tertiary level of education, 38.11% (n=141) had secondary education, 9.46% (n=35) had primary education while notably, 1.35% (n=5) had no formal education. This shows that most of the respondents in the town are holding tertiary education certificate and they are likely to understand the questionnaire. There are people not holding any education certificate but this makes the least number of the sample size.

4.4.4 Size of the Households

The size of the household is defined as the number of people per household. The size of the households was classified into 1 member to more than 10 members as shown by the following result table 4.3.

Table 4.3 Size of the Household

Classification	Frequency (n)	Percentage (%)
1	19	5.14
2	50	13.51
3	85	22.97
4	102	27.57
5	72	19.46
6-10	38	10.27
>10	4	1.08
Total	370	100

The distribution was as follows 27.57% (n=102) of the households had four people, 22.97% (n=85) had three, 19.46% (n=72) had five, 13.51% (n=50) had two, 10.27% (n=38) had between six to ten members. Only 1.08% (n=4) of the households had over 10 people.

4.5 Socio-demographic Information of Community Pharmaceutical Managers

4.5.1 Age of Community Pharmaceutical Managers

The results shows that the respondent pharmaceutical managers are aged

between 30 years to 49 years. From the sample size of 19 managers 10 of them were aged between 30 to 39 years, 7 were aged between 40 to 49 years while only 2 were below 30 years. This is an indication that most of the managers are young. The following frequency table shows the result of the study.

Table 4.4 Age of Community Pharmacy Managers

Classification	Frequency	Percentage (%)
Below 30	2	10.53
30-39	10	52.63
40-49	7	36.84
50-59	0	0.00
60 and above	0	0.00

4.5.2 Gender and Workforce of Community Pharmaceutical Managers (CPM)

From table 4.3.2, 58% of the CPMs were male while the 42% were female. Majority of the PCM, 45% (n=9), had a workforce of 2 people dispensing, 41% (n=7) had 1 person, 9% (n=2) had 3 while 5% (n=1) had 4 persons. None had 5 or more workforce as shown in table 4.5 and 4.6.

Table 4.5 Gender of Community Pharmacy Managers

Classification	Frequency	Percentage (%)
Male	11	58.00
Female	8	42.00

Table 4.6 Workforce of the Community Pharmacy Managers

Classification	Frequency	Percentage (%)
1	7	41.00
2	9	45.00
3	2	9.00
4	1	5.00
5 and above	0	0.00

4.6 Objective 1 Commonly Disposed Drugs in Nkubu Town

4.6.1 Medicine/Drugs in Households

From the households, 65% confirmed that they have a collection of over-the-counter medicines in their household which they currently don't use. Only 35% had none.

On the other hand, over 70% of the households' respondents had at least more than one class of over-the-counter drugs in their houses, 29.7% were antibiotics and closely followed by Analgesics such as Paracetamol or Panadol maramoja/ sona moja and hedex at 25.7%, suspensions and syrups at 19.7%, Antidiabetics at 7.0 %, creams and ointments at 4.9% cardiovascular drugs at 2.7 % and other types not categorized in the list were 0.8%. This is explained by the following table;

Table 4.7 Commonly Stocked and Disposed OTC Drugs among the Households

Characteristics	Classification	Frequency (n)	Percentage (%)
OTC drugs in the house	Yes	241	65.00
	No	129	35.00
	1	102	27.56

OTC not in use	2	98	26.49
	0	95	25.68
	3	46	12.43
	>3	29	7.84
Most commonly disposed OTC drugs	Analgesics	103	19.62
	Others	83	15.81
	Antibiotics	55	10.48
	Antihistamines	53	10.10
	Antihypertensive	46	8.76
	Syrups/suspensions	35	6.67
	Cardiovascular drugs	33	6.29
	Antifungals	30	5.71
	Anti-psychotropic	26	4.95
	Creams and ointments	23	4.38
	ant diabetics	22	4.19
	Don’t have	16	3.05

The commonly disposed drugs were antibiotics at 29.7%, closely followed by Analgesics like Paracetamol or Panadol maramoja/ sona moja and hedex at 25.7%, suspensions and syrups at 19.7%, Ant diabetics at 7.0%, creams and ointments at 4.9% cardiovascular drugs at 2.7% and Others mentioned at 0.8% as shown in the chart below.

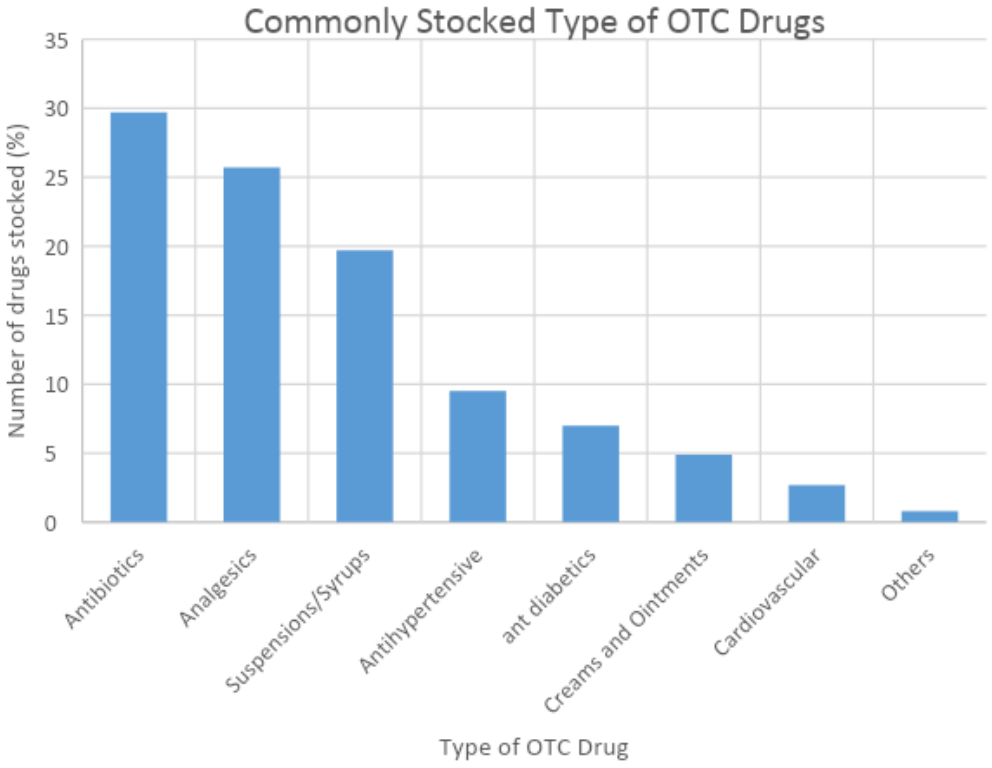

Figure 4.2 Commonly Stocked Type of OTC Drugs

4.6.2 Medicines in pharmacies

The summary of the data showed that 78.9% of the pharmacies do not keep a record of disposed drugs once they expire from their stock. Only 21.4% confirmed to keep such a record. 73.68% of the pharmacies had expired medicine in their stores.

Only 26.32% did not have. 36% of the commonly disposed drugs from the pharmacies in Nkubu town were antibiotics, 27% were antihypertensive, 9% suspensions/syrup, cardiovascular drugs, and other types not listed in the categories were 9% each. Analgesics and creams/ointments were each 5%.

Table 4.8 Most Commonly Disposed Class of Drugs from the Community Pharmacies

Status	Classification	Frequency (n)	Percentage (%)
Keep a register of disposed drugs	Yes	4	21.10
	No	15	78.90
Stock expired drugs	Yes	14	73.68
	No	5	26.32
Most commonly disposed drugs (N=22)	Antibiotics	8	36.00
	Antihypertensive	6	27.00
	Suspensions/syrup	2	9.00
	Cardiovascular drugs	2	9.00
	Others (not listed)	2	9.00
	Analgesics	1	5.00
	Creams/Ointment	1	5.00

4.7 Objective 2 Availability of Sanitation Infrastructure that Supports Sound Pharmaceutical Waste Management in Nkubu Town

4.7.1 Households Connected to a Means of Waste Collection and the Type of Drainage

To understand the current status of the sanitation infrastructure in Nkubu town, the study respondents were asked to confirm if their houses were connected to a means of pharmaceutical waste disposal e.g. The soak pits, sewers, open drains or municipal sewarage.72% (n=268) are connected to a means of pharmaceutical waste disposal. 28% (n=102) of the households' respondents were not connected to any means of waste disposal. They were further asked to specify the type of drainage they use. 32.4% (n=120) use soak pit, the households using sewer were 28.1% (n=104), 25.9% (n=96) use open drain while 13.5% depend on municipal collection.

Table 4.9 Status of Household's Connection with Sanitation Facility/ Infrastructure

Characteristics	Classification	Frequency	Percentage (%)
Connected	Yes	268	72
	No	102	28
Type of drainage	Soak pit	120	32.4
	Sewer	104	28.1
	Open drain	96	25.9
	Municipal	50	13.5

4.7.2 Availability of Sanitation Infrastructures that Supports Sound Pharmaceutical Waste Management for Community Pharmacies in Nkubu Town

From the survey, 84% of the CPMs confirmed to have their facility connected to either a municipal sewerage system or piped water. Notably, 16% had none. 36.8% of the pharmacies reported to depend on the municipal collection. 31.6% use sewer, 21.1% use soak pit while 10.5% use open drain. The form of sanitation available was reported as follows: pit latrines and municipal collections were 29.6% each, compost pit was 25.9% while 14.8% use water closet. 57.1% of the CPMs disposed their pharmaceutical wastes by burning, 33.3% disposed by composting, 4.8% disposed by emptying them into the sink while another 4.8% had no method of disposal as shown on table 4.10.

Table 4.10 Sanitation Status of the Community Pharmacies

Characteristics	Classification	Frequency (n)	Percentage (%)
Connected	Yes	16	84.0

	No	3	16.0
Type of drainage	Municipal	7	36.8
	Open drain	2	10.5
	Soak pit	4	21.1
	Sewer	6	31.6
Form of sanitation available	Pit latrine	8	29.6
	Municipal collection	8	29.6
	Compost pit	7	25.9
	Water closet	4	14.8
Method of PW disposal	Burning	12	57.1
	Composting	7	33.3
	Pouring in the sink	1	4.8
	None	1	4.8

4.8 Objective 3 Knowledge of Community Pharmacy Managers and Household heads on Pharmaceutical Waste Management Practices

4.8.1 Household Heads Response

The research sought to find out whether the households heads had ever received information or have knowledge about pharmaceutical waste management, risks of storing unwanted pharmaceuticals in the house and the understanding of the household heads on expiry of the drugs and the most appropriate person to inform about unused or expired medicine in the house.

The study results showed that 66.2% of the household heads had no knowledge about waste management while 33.8% are informed. 52.7% are informed about safe waste disposal of expired and unused medicine. 54.9% of the household head respondents trust that a medicine expires by the doctor's-indicated date. From the survey results, 28.6% argued that medicine does not expire, 7.3% notably claimed that medicine does not expire, 6.2% believe that medicine expires a week after opening while 3% thought that medicine expires at a different date from the ones listed. 68.4% of the CPMs have never engaged a licensed hazardous waste handler. 52.6% does not have any pharmaceutical waste collection tool while the rest only have a litter bin.

The table shows the results as described above:

Table 4.11 Knowledge of Household Heads on Sanitation

Status	Classification	Frequency (n)	Percentage (%)
Informed about waste management	Yes	245	66.20
	No	125	33.80
Informed about safe disposal of expired or unused medicines	Yes	195	52.70
	No	175	47.30
Medicine expiry date	Date indicated by the doctor	203	54.90
	Six months after opening	106	28.60

	Medicine does not expire	27	7.30
	A week after opening	23	6.20
	Any other (specify)	11	3.00
	Don't know	0	0.00
The most appropriate person to report to on expiry of a medicine	A pharmacist	292	78.9
	A community health worker	30	8.1
	A Doctor	28	7.6
	A Nurse	8	2.2
	Others	12	3.2
Return expired/unused medicine	Yes	347	93.80
	No	23	6.20

4.8.2 Knowledge of the Risks associated with Storing Expired Medication

When asked about the risks associated with storing unwanted pharmaceutical wastes in the house, 48.4% of the household's heads respondents confirmed that they were knowledgeable. Out of these, majority (35.4%) mentioned wrong prescription as the major risk. Other risks identified are wrong dosage (26.0%), poisonous (15.1%), and danger to children (13.5%), as shown in the table below.

Table 4.12 Knowledge on the Risks of Storing Unwanted/Expired Medication

Status	Classification	Frequency (n)	Percentage (%)
Know the risks	Yes	179	48.4

	No	191	51.6
Type of risks listed	Wrong prescription	68	35.4
	Wrong dose	50	26.0
	Poisonous	29	15.1
	Danger to children	26	13.5
	Can cause Death	15	7.8
	Other risks not listed	4	2.1

4.8.3 Community pharmacy managers

The results of the survey indicated that 57.89% of the CPM respondents considered expired drugs as the definition of a pharmaceutical waste. 21.05% defined it as unused drugs while 10.53% defined it as unwanted drugs and another 10.53% confessed that they don't know the definition.

After the survey 42.11% of the CPMs couldn't define the term pharmaceutical waste management (PWM). 26.32% viewed PWM as a proper disposal of drugs, 21.05% defined it as disposal of expired drugs while 10.53% perceived it to be proper use of drugs. On expiry of the drugs, 59.1% held the view that a medicine expires by the labelled date of expiry on the medicine while the rest considered the date indicated by the manufacturer as the expiry date.

68.4% of the CPMs respondents said that a drug inspector is the most appropriate authority to report to on proper disposal of unused or expired medicine. 26.3% considered a government authority as the right person to report to while 5.3% chose a fellow pharmacist or pharmaceutical technologist.

94. 74% of the CPM respondents confirmed that they had not been trained on safe pharmaceutical management. Only 5.26% of the CPM respondents had been trained, who identified quarantine as the safe method of handling pharmaceutical wastes. 78.9% of the CPM respondents consider inventory management as part of sound pharmaceutical management while 21.1% view it otherwise. The table below summarizes the data above.

Table 4.13 Community Pharmacy Managers' Knowledge on Pharmaceutical Waste Disposal

Characteristics	Classification	Frequency (n)	Percentage (%)
Definition of pharmaceutical waste	Expired drugs	11	57.89
	Unused drugs	4	21.05
	Unwanted drugs	2	10.53
	Don't know	2	10.53
	Don't know	8	42.11
Definition of Pharmaceutical Waste Management	Proper disposal of drugs	5	26.32
	Disposal of expired drugs	4	21.05
	Proper use of drugs	2	10.53
Medicine expiry date	Labeled date of expiry	13	59.10
	Date indicated by the manufacturer	9	40.90
The most	Drug inspector	13	68.40

appropriate person/authority to report to on proper disposal of unused or expired medicine	County/National Gov't authorities	5	26.30
	Fellow pharmacist/pharmaceutical technologist	1	5.30
Trained on safe PW management	No	18	94.74
	Yes	1	5.26
Consider inventory management to be part of sound pharmaceutical management	Yes	15	78.9
	No	4	21.1

4.8.4 Knowledge of Associated Risks of Storing Expired Medicine

From the survey, 84.21% of the CPM respondents confessed that they don't know any risks of storing unwanted/expired medicine in their premises. Only 15.79% of them had the knowledge. Out of these, all of them identified wrong dispensing as an associated risk of such action, 33% listed probable misuse of the unused/expired medicine while 17% stated spillage as a risk.

It has also shown that, 57.1% of the CPM respondents listed burning as their commonly used method of PW disposal, 33.3% mentioned composting, and 4.8% poured the PW into the sinks while another 4.8% didn't know any method of PW. 31.6% of the CPM respondents held the view that there is no effect of PW on sanitation, 26.3% notably did not know any effects, 15.8% clogging, 10.5% blockage, 10.5% rusting, while 5.3% mentioned possible water contamination as an effect of PW on sanitation as shown in the table 4.14.

Table 4.14 CPM Knowledge on Associated Risk of PW

Status	Classification	Frequency (n)	Percentage (%)
Know the risks	No	16	84.21
	Yes	3	15.79
Type of risks listed	Can be wrongly dispensed	3	50.00
	Can be misused	2	33.00
	Can cause spillage	1	17.00
Effects of pharmaceutical waste on sanitation	None	6	31.60
	Don't know	5	26.30
	Clogging	3	15.80
	Blockage	2	10.50
	Rusting	2	10.50
	Water contamination	1	5.30

4.9 Methods of Pharmaceutical Waste Management

4.9.1 Type of Drainage

The study showed that 32.4% of the households use soak pit as a type of drainage, 28.1% sewer, 25.9% use open drain while 13.5% depends on garbage

municipal collection, as shown in the table 4.9.1.

Table 4.15 Households Drainage types

Type of drainage	F	%
Soak pit	120	32.4
Sewer	104	28.1
Open drain	96	25.9
Municipal	50	13.5

4.9.2 Storage of expired or unused drugs in your house

From the study, 24% of the households reportedly store expired or unused drugs in cabinets, 23% in boxes, 22% in cans, 9% dispose the wastes immediately, 8% store in cupboards, 5% never specified the storage place while rest store in tins (4%), shelves (3%), containers (2%), cartons (1%) as shown in the table below.

Storage of expired or unused drugs in your house	**Frequency**	**Percentage of Frequency**
Cabinet	89	24%
Box	85	23%
Cans	82	22%
Dispose immediately	34	9%
Cupboard	30	8%
Not specified	17	5%
Tins	13	4%
Shelves	12	3%
Container	6	2%
Carton	2	1%

Table 4.16 Drugs in the Households Either Expired or not in use

4.9.3 Method of PW Disposal

The study showed that 23.8% of the households use pit latrines as a method of pharmaceutical waste disposal, 20.4% burn the wastes, 17.3% use a sewer, 9.9% dump the wastes in the nearby bushes, 9.7% bury the wastes, 5.5% use compost pit, 4.5% collect them in litter bins, 4.2% use toilets, 1% pour the wastes in the sink while the rest, 3.7% never specified which method of waste disposal. The following graph shows the summary of the information above;

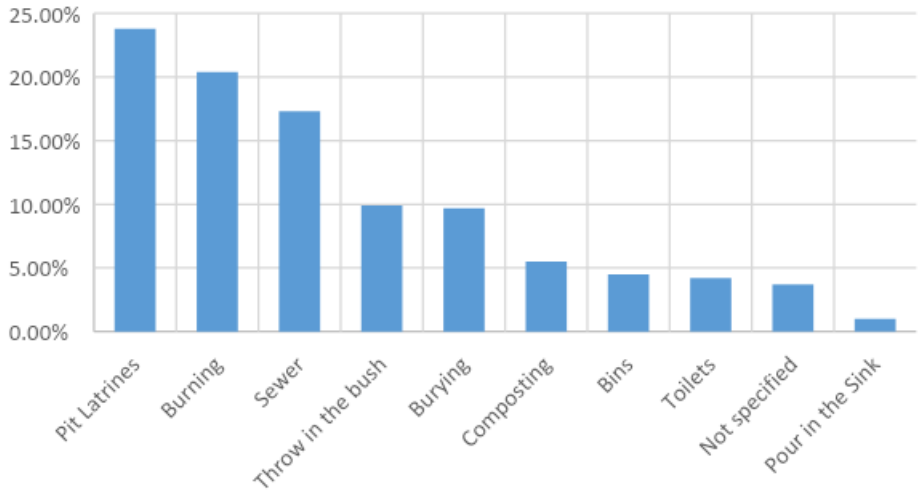

Table 4.17 Methods of PW Disposal

4.9.4 Best Ways of Properly Disposal of Unwanted Drugs

The respondents provided different methods of disposing the unwanted drugs. The table below shows the summary of the average number of respondents and their preferred disposal method;

Table 4.18 Suggested Proper disposal methods of unwanted drugs

Suggested best ways to properly dispose of unwanted drugs	**F**	**Percentages of frequency**
	10	
Pit Latrines	5	27.8%
Burning	93	24.6%
Sewer	59	15.6%
Burying	37	9.8%
Throw	22	6.8%
Toilets	16	4.2%
Compost	14	3.7%
Return	12	3.2%
Bins	12	3.2%
None	3	0.8%
In sink	1	0.3%

From the table above the results of the survey were as follows; 27.8% of the household's heads respondents suggested disposal in pit latrines as the best method, 24.6% of the respondents proposed burning, 15.6% supported disposal in a sewer, 9.8% burying, 6.3% throwing in the bush, 4.2% (n=16) in toilets,

3.7% in compost, 3.2% returning to the pharmacy, 3.2% disposing in litter bins, 0.8% did not propose any method of unwanted drugs while 0.3% proposed emptying in the sink.

4.9.5 Unwanted Practices of Pharmaceutical Disposal

From the study the respondents described several methods that are unwanted practices of disposing pharmaceutical material. The following table shows the summary of the unwanted practices and the number of respondents;

Table 4.19 Common unwanted pharmaceutical waste disposal practices among households

Unwanted practices of pharmaceutical disposal	**F**	**Percentage of frequency**
Burning	93	38.1%
Pit latrine	65	26.6%
Throwing away in the environment	24	9.8%
Toilet	16	6.6%
Compost	14	5.7%
Bins	12	4.9%
Careless dumping	7	2.9%
Storing in the house	6	2.5%
Reuse	4	1.6%
None	3	1.2%

The study revealed that 38.1% of the household head respondents consider

burning as a major unwanted practice in pharmaceutical wastes disposal. 26.6% listed disposal in the pit, 9.8% identified throwing in the bush, 6.6% listed disposal in the toilet, 5.7% mentioned disposal in compost pits, 4.9% collecting the PW in litter bins, 2.9% careless dumping, 2.5% storage in the house, 1.6% viewed re-use as the worst practice of PW disposal while 1.2% didn't see any.

4.9.6 Community Pharmacies

CPM respondents 10.5%listed quarantine as their preferred method of separating/storing expired and unused medicine in their pharmacies. Interestingly, 63.2% agreed that they do separate or store unused drugs while 26.3% confessed they don't separate them neither do they store. 75% of the CPM respondents use burning as their preferred method of disposing pharmaceutical wastes, 15% compost, and 5% pit latrine while 5% rely on municipal collection.

The respondents viewed the best methods of proper disposal of unwanted drugs as follows: 45.5% burning, 22.7% collection by authority, 18.2% composting, and 9.1% quarantine while 4.5% didn't know any of the methods.

The most common unwanted practices according to the CPM respondents were as follows: 42.1% draining in the sink, 21.1% dispensing unused drugs, 21.1% emptying in the pit latrine, and 10.5% had none while the remaining 5.3% did not know any of the methods. The following table summarizes the results above;

Table 4.20 CPM Pharmaceutical Waste Management

Characteristics	Classification	Frequency (n)	Percentage (%)
	Yes	12	63.2
	No	5	26.3
	Quarantine	2	10.5
Methods of PW disposal	Burning	15	75.0
	Composting	3	15.0
	Pit latrine	1	5.0
	Municipal collection	1	5.0
Best disposal method	Burning	10	45.5
	Composting	4	18.2
	Collection by authority	5	22.7
	Quarantine	2	9.1
	Don't know	1	4.5
Unwanted practices	Dispensing unused drugs	4	21.1
	Draining in the sink	8	42.1
	Emptying in the pit latrine	4	21.1
	Don't know	1	5.3
	None	2	10.5

4.10 Regression and Correlation Analysis

Pearson Product Moment correlation analysis was conducted to measure the relationship between the commonly disposed drugs in sanitation chain, availability of sanitation infrastructure for disposal, knowledge of pharmaceutical waste management disposal, practices of disposal in sanitation and pharmaceutical waste management disposal in sanitation. The results of the analysis are presented in the table 4.21.

Table 4.21 Correlation Coefficient Matrix

	Commonly disposed drugs in sanitation chain	**Knowledge on pharmaceutical waste management in sanitation**	**Practice of disposal in sanitation**	**Availability of sanitation infrastructure for disposal**	**Pharmaceutical waste management disposal in sanitation**
Commonly disposed drugs in sanitation chain	1				
Knowledge on pharmaceutical waste management in sanitation	0.354	1			
Practice of disposal in sanitation	0.466	0.414	1		
Availability of sanitation infrastructure for disposal	0.544	0.454	0.527	1	
Pharmaceutical waste management disposal in sanitation	0.483	0.438	0.415	0.474	1

From the results above, the variables have different degrees of correlation. Most of the variables indicate that they have weak positive correlation because correlation coefficient is below 0.5. However, the correlation coefficient between the availability of sanitation infrastructure and waste management shows a strong relationship.

Multiple regression analysis will fit in modelling this scenario because waste management is a policy which is affected by several factors. The management has to consider the effect of the factors on the waste management. The following table 4.22 shows the summary of obtained regression results.

Table 4.22 Regression Output

	Unstandardized Coefficients		**Standardized Coefficient**		
Model	**Beta**	**SE**	**Beta**	**t**	**Sig.**
Constant	-2.619	0.429		-5.603	0.000
Community Disposed Drugs	0.097	0.108	0.047	0.893	0.000
Availability of Sanitation	0.308	0.105	0.208	3.978	
Knowledge of pharmaceutical waste mgt.	0.543	0.106	0.184	3.437	0.001
Common methods	0.515	0.110	0.265	5.061	0.000

The model will be accepted because the adjusted R-square coefficient shows that most of the values will be explained by the model. The study recommends linear regression model as follows;

Pharmaceutical waste management = -2.619 +0.097* community disposed drugs + 0.308* availability of Sanitation + 0.543* Knowledge of pharmaceutical management + 0.515 * Common methods.

The coefficients indicate the amount of pharmaceutical waste management will change when the independent variable changes in one unit.

When community disposed drugs changes by 1%, pharmaceutical waste management is expected to improve by 0.097% while a unit increase in sanitation availability will cause 0.308 increase in pharmaceutical waste management. A unit increase in knowledge of pharmaceutical management and common methods will lead to 0.543 and 0.515 increase in waste management respectively. Since the t values large than the significance values, the coefficients of the regression are statistically significant.

CHAPTER FIVE: DISCUSSION, CONCLUSION, RECOMMENDATIONS AND PUBLICATION

5.1 Discussion

The main objective of the study was to explore the input of pharmaceutical waste management disposal in sanitation service value chain among community pharmacies and households in Nkubu town, Meru-Kenya. This was achieved by assessing the most commonly disposed drugs in households and community pharmacies that end up in the sanitation value chain, the availability of any sanitation infrastructure that supports sound pharmaceutical waste management, the proportion of community pharmacy managers and households with knowledge of pharmaceutical waste management in regards to sanitation, the common methods of pharmaceutical waste management disposal affecting sanitation among community pharmacies and households in Nkubu Town.

There is growing public concern over presence of active pharmaceutical ingredients in water and the environment. This pharmaceutical waste also includes antimicrobials which interfere with water treatment process since most depend on biodegradation. Pharmaceuticals have immense effects on non-target organisms, such as medicine resistance in humans, increases in morbidity and mortality of the population due to unintentional poisoning.

In Nkubu town (68%) of the household heads are aged below 40 years old. with slightly more men than women. This study revealed that almost half of the households are headed by women. Majority (51.08%) of the household heads

have tertiary education. However, there are few (1.35%) with no formal education. Over 81% of the households have three or more members. There are households with over ten members. This supposedly implies that the households consist of at least the father, mother, and the children. The result is in tandem with the 2019 population census of Meru County that revealed an average household's size of 3.6 (KNBS, 2019). This could have an impact on volume of waste effluents released from households

All the community pharmaceutical managers are aged below 50 years. The number of male is slightly higher than the female by 16 percent. It is encouraging to note that all the community pharmacy managers have tertiary education, an indication that majority of the pharmacies have undergone training and qualified to dispense drugs. And for this study it focused on those community pharmacies that were registered by the regulatory body the pharmacy and poisons board and belonged to their respective associations the Kenya Pharmaceutical Association (KPA) and Pharmaceutical Society of Kenya (PSK). Majority (86%) of the community pharmacies in Nkubu town employ either one or two attendants. And none of the sampled employed more than 4 people. This is an indication that most of the pharmacies operate on small-scale, thereby managed mostly by the owners assisted by few attendants. As disease incidence and prevalence rise, healthcare providers must prescribe and administer a wider range of medications. Because of unpleasant effects, dose changes, feeling well, medications approaching their expiration dates, promotional practices by manufacturers, physicians' prescribing procedures, or dispensers' practices, consumers (patients) are unable to use all of the prescribed medications (Seehusen & Edwards, 2006; Ruhoy & Daughton,

2008). Thus, this medications from these community pharmacies find their way in the households.

5.1.1 Objective 1 Commonly Disposed Drugs Among Household and Community Pharmacies

There is indiscriminate purchase of antibiotics from this pharmacy outlets that more often end up in the households as unfinished doses. On analgesics, they are readily available in local shops and most of time one doesn't need to have a prescription to purchase them. From the study it was found out that this community pharmacies do not keep records of disposed drugs but had many expired commodities within their premises.

This is in line with Jasim (2010) in his study conducted in Basrah of Iraq, found out that antibiotic (26.43%) are the commonly disposed medications followed by 19.58% of analgesics and Non-Steroidal Anti- Inflammatory Drugs (11.45%). Out of the total pharmaceutical waste, the mentioned drugs contribute to about 57% of medication disposed. Nearly 31% of the disposed medicine were in use, the other 45% were unused medication or leftovers and those that were kept for future use accounted for 23%. More than half of all medication is inappropriately prescribed, wrongly prescribed and sold, according to the World Health Organization (WHO, 2004). This causes wasteful storage and an environmental threat. In some cases, patients take under-dose of their prescribed medication leaving part of the collected drugs at home. The world medicine situation report reveals that 50% of patients incorrectly take the medicine prescribed to them (WHO, 2004). As a result, it is

common for families and patients to have unused or expired prescriptions, and the concerns have attracted global attention (Ananth et al., 2010).

Globally, more than half of the patients do not take medication as per doctors/physician prescription thereby generating pharmaceutical waste more Holloway (2011). There is also a global challenge of patients adhering to their medication, accounting for about 50% for developed countries (Collins, 2011). Many patients find it difficult to complete their medication as prescribed making it a big burden of unwanted pharmaceuticals among households (WHO, 2003). For instance, the commonly disposed pharmaceuticals worldwide include controlled substances such as narcotics and psychotropic substances, anti-infective drugs, anti-cancer drug, antineoplastic, cytotoxic-, disinfectants and antiseptics. These pharmaceuticals can be in form of solids, semi-solids or powders (WHO, 2012).

Remigios, (2010) indicates that pharmaceutical waste has immense impacts on non-target organisms as it causes antibiotic resistance in human, increasing mortalities and morbidities due to poisoning. Cormican et al., (2010) has also highlighted the issue of drug mismanagement in Households. He reiterates that possession of unused or expired medications pose great risks to sanitation and have gained global attention in the recent past.

5.1.2 **Objective 2 Sanitation infrastructure in households and community pharmacies.**

From the study (72%, n=268) of the households are either connected to a piped water of a municipal sewerage system and use soak pit, sewers, open drains, while and the municipal collection as means of sanitation infrastructure. Similarly, 84% of the community pharmacies are either connected to a municipal sewerage system or piped water and depend on municipal collection, use sewer, use soak pit, open drain for pharmaceutical waste disposal. The forms of sanitation available were pit latrine and municipal collections (29.6%, n=4) each, compost pit (25.9%, n=7) while the rest use water closet (14.8%). It is worth to note that there is no structured method of disposal, as every household depends on the available facility and method for their disposal.

Giusti (2009) notes that Public Health and the environment are at risk when pharmaceutical waste from the community pharmacies and households are handled improperly. When pharmacies and households dispose the pharmaceutical waste into the sinks, drains, sewers and toilets, they pose a great challenge to animal and human health (Giusti, 2009). In addition, disposal of the pharmaceutical waste such as disinfectants, antibiotics, antiseptic improperly into sewerage systems leads to ineffective treatment of sewage (Orina, 2018).

Ghosh (2020) keenly observes after all other procedures have been taken, the final stage of waste management is disposal. The method of disposing of pharmaceutical waste or any other form of waste depends on various factors such as the availability of infrastructure. A government-sponsored evaluation of public and private pharmacies in Kenya revealed a severe problem with

HCW disposal infrastructure and several studies have been done in Kenya on management of pharmaceutical waste in healthcare facilities (Wepukhulu, 2011; Orina, 2018). However, these studies did not focus on the households and community pharmacies, thus creating a research gap. Since Community pharmacies were not assessed, it was not known whether they had access to pharmaceutical waste disposal infrastructure (Orina, 2018).

5.1.3 Objective 3 Knowledge of the households and CPMs on sanitation

The research sought to find out whether the households heads had ever received information or have knowledge about pharmaceutical waste management, risks of storing unwanted pharmaceuticals in the house and the understanding of the household heads on expiry of the drugs and the most appropriate person to inform about unused or expired medicine in the house. The study results showed that 66.2% (n=245) of the household heads had no knowledge about waste management while 33.8% (n=125) are informed. 52.7% (n=195) are informed about safe waste disposal of expired and unused medicine. Only 5.26% (n=1) of the CPM respondents had been trained, who identified quarantine as the safe method of handling pharmaceutical wastes. 7 CPM respondents consider inventory management as part of sound pharmaceutical management. Proper inventory management ensures minimal expires of drugs, thus less of the drugs are disposed of in the sanitation service chain.

On the other hand, 35.4% (n=134) household heads Mentioned wrong prescription as the major risk to health of the people. This can lead to use of

expired medicine by patients in the households. Other risks identified were wrong dosage, poisoning, and danger to children. Wrong dosage can arise through sharing over the counter the drugs without a doctor's prescription with other patients. According to CDC reports, over 50,000 children in the world end up into emergency rooms annually for accidentally taking wrong medicines, without an adult's supervision. This lack of knowledge leads to poor disposal of unwanted pharmaceuticals and this might pollute the sanitation chain and even lead to accidental poisoning of to both children and pets. Community pharmacy managers confirmed to have never contracted a licensed hazardous waste handler, do not have any special pharmaceutical waste collection tool apart from a litter bin. Hence those outlets without the litter bins could possibly expose the pharmacists to the dangerous pharmaceutical wastes during waste segregation.

5.1.4 Objective 4 Common Methods of disposal for households and community Pharmacies

The study showed that 23.9% (n=91) of the households use pit latrines while 73.5% (n=14) of the community pharmacies use burning as the common methods of pharmaceutical waste disposal.

The common method of pharmaceutical waste disposal being practiced in community pharmacies therefore, was burning while for households was emptying in the pit latrine. Disposal of unwanted pharmaceutical products through unsafe methods along the sanitation chain was prevalent among the respondents.

On the other hand, some of the unwanted practices included dispensing and reuse of unused drugs, draining in the sinks, emptying in the pit latrines. Nkubu is a growing town in terms of population and economy, which means increased volumes of pharmaceutical waste generated due to the new upcoming pharmacies and the indiscriminate over the counter purchase of drugs. Most of this is observed in local dustbins and open pit and garbage sites. Rogowska et al. (2019), carried out a 2-case study on household pharmaceutical waste practices in Poland. The first survey focused on identification of the consumption scale of pharmaceuticals and disposal of pharmaceutical waste. The second survey aimed at identification of attitudes on managing expired pharmaceutical among patients at home. Furthermore, 68% of the participants reported to be disposing the household pharmaceutical waste by flushing them into toilet and sinks. Survey 2 reported that 35% of the population disposed waste into toilets, less than 30% practiced returns of expired medication to pharmacies.

A cross-sectional study conducted in the Republic of Serbia on management of pharmaceutical waste in pharmacies revealed that 76.5% of the assessed pharmacies collect and dispose expired medicines brought by the community people, while the other 23.5% of pharmacies do not collect expired drugs from households (Manojlović et al., 2014). Additionally, Manojlovic (2014), concludes that community pharmacies need to instill obligations of pharmaceutical waste collection and disposal legally.

WHO (1999) recommends nine methods of pharmaceutical waste disposal.

They include: returning to the pharmacists/vendor/supplier/manufacturer. Return to donor/manufacturer, incineration, immobilization, landfill, sewage, chemical decomposition, burning in open containers, and fast-flowing watercourses are the eight techniques for disposing of pharmaceutical waste (Nyaga et al., 2020). Glassmeyer (2010) and hinchey (2017), indicate that the Geology survey of USA records that 80% of the pharmaceutical waste is found in water consequently contaminating drinking water

The WHO Guidelines for Safe Disposal of Unwanted Pharmaceuticals (1999) notes that the dangers of expired medicine can be experienced in four ways: contamination of water such as from landfills, killing of bacteria necessary for sewage treatment such as by non-biodegradable antibiotics and antineoplastic, toxic air pollution from burning of expired medicine, diversion of expired drugs for resale, and access and use by children.

Pharmaceutical waste continues to constantly grow due to increase in population Expired and unused pharmaceutical waste are mostly disposed into sewer system through the sinks.

The WHO (1999) guideline outlines key steps that should be taken when disposing unwanted pharmaceuticals. Each end user must decide immediately to act on unwanted pharmaceutical products in their custody. This need to be under the approval of the relevant authority, either from the county or national government.

5.2 Conclusion

Nkubu is a growing town in terms of population and economy, which means increased volumes of pharmaceutical waste generated due to the new upcoming pharmacies and the indiscriminate over the counter purchase of drugs. Most of this can be found in local dustbins and open pit and garbage sites. Draining of unused suspensions and syrups down the sinks being one of the most common practices leading to these scenarios of polluted water bodies. This being the assumption of the case there is a serious and multifaceted issue that has gained both county government and national Government attention due to their various effects on both the human population and across the sanitation chain (MOH national health care waste management plan 2008-2012).

Both from households and community pharmacies, the household's data confirmed that they usually stock over the counter (OTC) drugs in their houses. The Most common classes of the drugs were antibiotics (29.7%, n=110), analgesics (25.7%, n=95), while from the community pharmacies 36% (n=8) of the commonly disposed drugs from the pharmacies in Nkubu town were antibiotics, 27% (n=6) were antihypertensive, 9% suspensions/syrup hence a large number of antibiotics find their way in various stages of sanitation service chain from containment, collection, transportation and treatment. Furthermore, majority of households and community pharmacies are connected to a piped water or a sewerage system. Improperly disposed pharmaceuticals end up in garbage collection centers and water purification systems which are not sufficiently equipped to manage this form of waste.

From objective three on the proportion of community pharmacy managers and household heads with sound knowledge on pharmaceutical waste disposal across the sanitation service chain, it was found out that the majority do not have any knowledge on how to dispose of the pharmaceutical waste. Improperly disposed pharmaceuticals thus end up in garbage collection centers and water purification systems which are not sufficiently equipped to manage this form of waste.

From objective four the study sought the various common methods of pharmaceutical waste management disposal being practiced in community pharmacies and households, among the responses burning, composting, collection by local authorities (municipal), pouring in the sinks for syrups and suspensions among others. Burning has its effects on the environment due to the inhalation of carbon monoxide. Most significant for this study was in regards to sanitation was composting and draining in the in the sinks. Draining of unused suspensions and syrups down the sinks being one of the most common practices of disposal. This draining in the sinks could have effects on the water systems as it leads to at times clogging of pipes hence can't flow down the drain. And rusting of metal systems. Leading to these scenarios of polluted water systems and at various sanitation value chains. Nkubu is a growing town in terms of population and economy, which means increased volumes of pharmaceutical waste generated due to the new upcoming pharmacies and the indiscriminate over the counter purchase of drugs. Most of this can be found in local dustbins and open pit and garbage sites.

5.3 Recommendations

From the conclusions above, the following recommendations were made;

There is need to establish public awareness, educational programs regarding management and handling of unwanted pharmaceuticals among households, that would highlight their effects both on human beings and across the sanitation chain if poorly disposed.

Sensitization of the both the public and premise owners on the provision and availability of licensed hazardous handlers and their collection points for proper disposal is recommended especially within the town. The county government can provide litter color coded bins so that drugs being disposed of can be handled differently from other wastes, making waste segregation easy and thus minimizing of the indiscriminate disposals of pharmaceutical wastes at various stages of sanitation value chain.

Training of pharmacists/pharmaceutical technologists who are the focal people in handling, dispensing and the eventual counselling of patients on rational drug use and disposal practices. Effective and efficient sanitation programs like recycling of wastes and hygienic disposal need to be introduced to cushion the general population on the best management practices.

A detailed national study is recommended to investigate the magnitude of pollution with pharmaceutical waste across the sanitation chain in Kenya. As it was established in the study that pharmaceutical waste is evident across the sanitation service chain.

The pharmacy and poisons board the regulatory authority for pharmacies should discourage the establishment of community pharmacies before verifying the pharmaceutical waste disposal sanitation infrastructure available to them. This requirement should be a prerequisite for every pharmacy outlet before license approval. Since the study showed a lot of gaps in the infrastructure provision.

5.4 Publication

Gitobu, K., Kaimuri, M., & Karani, C. (2022). Methods of pharmaceutical waste management disposal practiced in sanitation value chain by community pharmacies and households in Nkubu Town. *African Journal of Science, Technology and Social Sciences*, *1*(1). https://doi.org/10.58506/ajstss.v1i2.13

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APPENDICES

Appendix I: Informed Consent Form

ICF FOR HOUSEHOLD HEADS AND COMMUNITY PHARMACY MANAGERS

Study Title: Exploring the Input of Pharmaceutical Waste Management Disposal in Sanitation Service Value Chain: A case Study of Nkubu town, Meru-kenya

Principal Researcher: Kenneth Muriungi Gitobu

Institution: Meru University of Science and Technology

PART 1: INFORMATION SHEET

My name is Kenneth Gitobu, a Master of Science in Sanitation student at Meru University of Science and Technology. I am carrying out research on assessment of pharmaceutical waste management practices among community pharmacies and household's in Nkubu town. I am inviting you to take part in this research study which will form part of my assessment for award of my Master degree. You have been selected to take part for this study in a Simple random sampling process. However, the decision to participate or decline is absolutely yours.

On confidentiality your personal details and those of your pharmacy will be handled with strict confidentiality. The information you provide will be

identified by a number rather than name. The study will be conducted within a period of two weeks. During this time, we may revisit you to seek any clarifications if necessary.

Contact Person: You may ask questions now or later. If you need to ask questions later, you may contact the Principal researcher using the following contact details.

Kenneth Muriungi Gitobu

Mobile No. **0720460242**

Email: **gitobu_kenneth@yahoo.com**

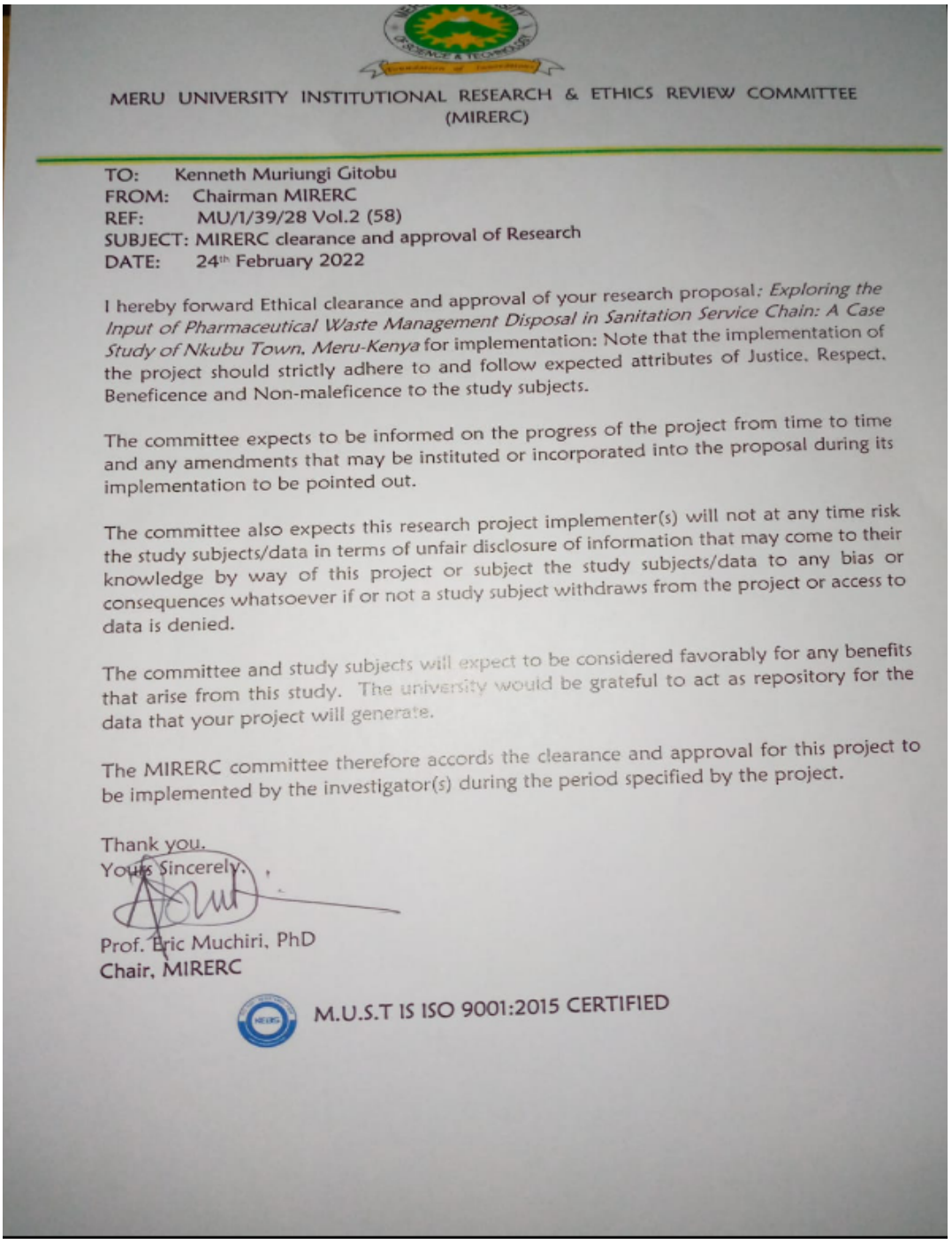
PART 2: CONSENT STATEMENT BY THE PARTICIPANT

I have read the foregoing information. I have had the opportunity to ask questions about it and any questions I have asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Signature: …….. Date: ……

Name of Participant: …….

Appendix II: MIRERC Clearance Letter



MERU UNIVERSITY INSTITUTIONAL RESEARCH & ETHICS REVIEW COMMITTEE
(MIRERC)

TO: Kenneth Muriungi Gitobu
FROM: Chairman MIRERC
REF: MU/1/39/28 Vol.2 (58)
SUBJECT: MIRERC clearance and approval of Research
DATE: 24th February 2022

I hereby forward Ethical clearance and approval of your research proposal: *Exploring the Input of Pharmaceutical Waste Management Disposal in Sanitation Service Chain: A Case Study of Nkubu Town, Meru-Kenya* for implementation: Note that the implementation of the project should strictly adhere to and follow expected attributes of Justice, Respect, Beneficence and Non-maleficence to the study subjects.

The committee expects to be informed on the progress of the project from time to time and any amendments that may be instituted or incorporated into the proposal during its implementation to be pointed out.

The committee also expects this research project implementer(s) will not at any time risk the study subjects/data in terms of unfair disclosure of information that may come to their knowledge by way of this project or subject the study subjects/data to any bias or consequences whatsoever if or not a study subject withdraws from the project or access to data is denied.

The committee and study subjects will expect to be considered favorably for any benefits that arise from this study. The university would be grateful to act as repository for the data that your project will generate.

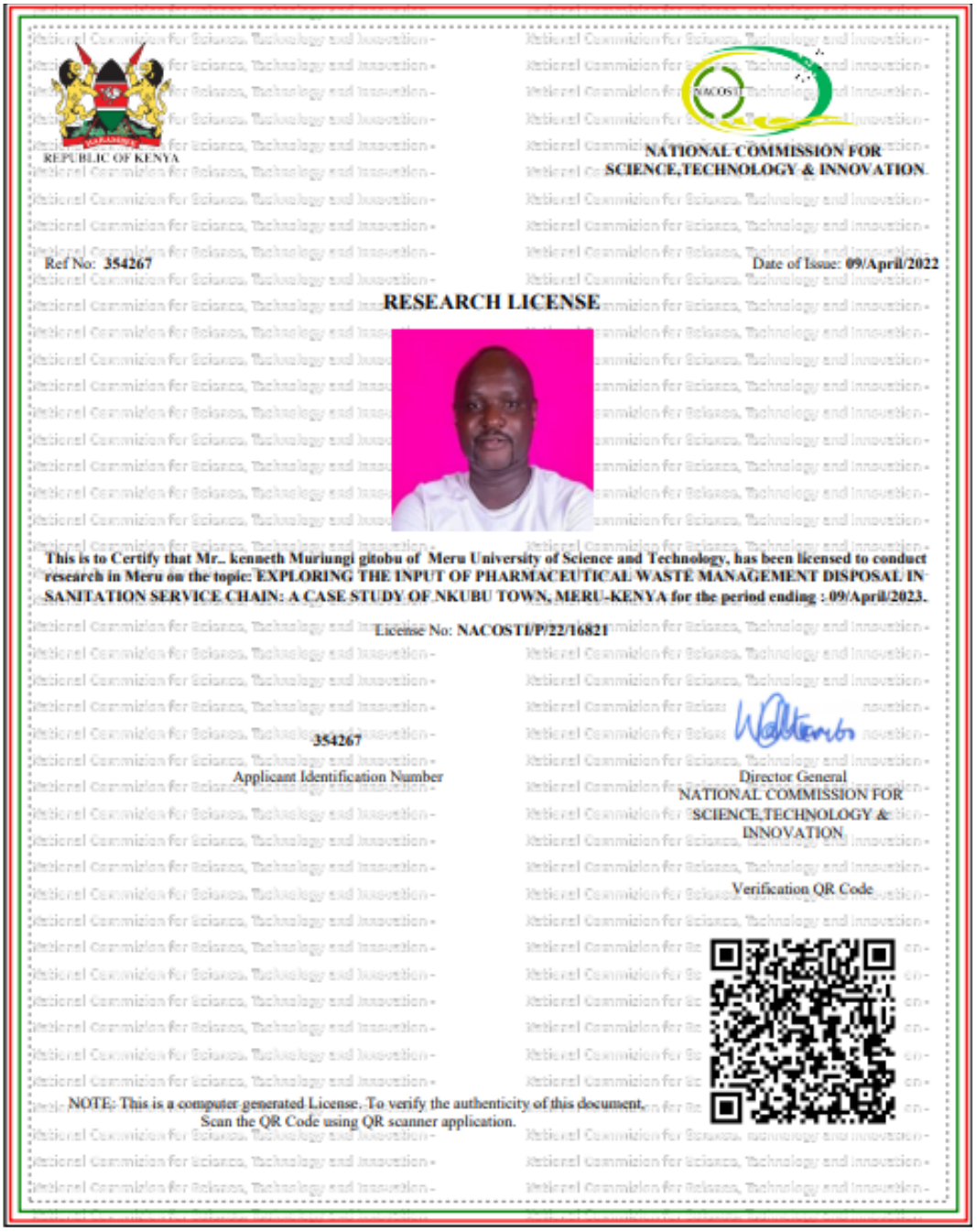
The MIRERC committee therefore accords the clearance and approval for this project to be implemented by the investigator(s) during the period specified by the project.

Thank you.
Yours Sincerely,

Prof. Eric Muchiri, PhD
Chair, MIRERC

M.U.S.T IS ISO 9001:2015 CERTIFIED

Appendix III: NACOSTI Research Permit



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **354267**

Date of Issue: **09/April/2022**

RESEARCH LICENSE

This is to Certify that Mr.. kenneth Muriungi gitobu of Meru University of Science and Technology, has been licensed to conduct research in Meru on the topic: EXPLORING THE INPUT OF PHARMACEUTICAL WASTE MANAGEMENT DISPOSAL IN SANITATION SERVICE CHAIN: A CASE STUDY OF NKUBU TOWN, MERU-KENYA for the period ending : 09/April/2023.

License No: **NACOSTI/P/22/16821**

354267

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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Appendix IV: Questionnaire for Community Pharmacy Managers

Part 1: DEMOGRAPHIC INFORMATION

1. Age of respondent (years):

2. Gender of the respondent: Male ☐ Female

Education level:

☐ None

☐ Primary

☐ Secondary

☐ Tertiary

3. How many people do actual dispensing in your premise?

PART 2: THE COMMONLY DISPOSED PHARMACEUTICALS

1. Do you keep any register for drugs disposed of from your pharmacy?

Yes ☐ No ☐

2. Are drugs generally or often disposed without proper laid down procedures from your pharmacy?

☐ Yes ☐ No

3. Which class of drugs do you mostly disposed off?

a. Antihypertensive ☐

b. Analgesics ☐

c. Antibiotics ☐

d. Cardiovascular drugs ☐

e. Ear/eye/Nose preparations ☐

f. Creams and ointments ☐

g. Suspensions/syrup ☐

4. Do you have any expired medicines stored in your pharmacy currently?

Yes ☐ ☐ No

5. If yes to Q4 above, which class of drugs?

i. Antihypertensive ☐

j. Analgesics ☐

k. Antibiotics

l. Cardiovascular drugs ☐

m. Ear/eye/Nose preparations ☐

n. Creams and ointments ☐

o. Suspensions/syrup ☐

p. Others ……

PART 3: AVAILABILITY OF SANITATION INFRASTRUCTURE THAT SUPPORTS SOUND PHARMACEUTICAL WASTE MANAGEMENT

1. Is your premise connected to a municipal sewerage system or piped water?

2. What type of drainage is available for waste water in your pharmacy?

   Soak Pit ☐ Open Drain ☐ Municipal Sewer ☐

3. Is your pharmacy connected to a septic tank?

   Yes ☐ No ☐

4. What form of sanitation is available for your premise?(tick appropriately)

A. Pit latrine ☐

B. Water closets ☐

C. compost pits ☐

D. Correction by Municipal ☐

E.others……

……..

5. Have you engaged the services of a licensed hazardous waste handler?

   ☐ Yes ☐ No

6. List any type of pharmaceutical waste management collections equipment's used within your premise?

   ……

   ……

7. How do you dispose expired/unwanted PW?

   ……

   …

PART 4: KNOWLEDGE ON PHARMACEUTICAL WASTE MANAGEMENT

1. What do u understand by the term pharmaceutical waste?

2) What do you understand by the term pharmaceutical waste Management?

3. Have you ever received information or training on safe and proper ways to dispose expired or unused medicines?

☐ Yes No ☐

4. If yes in question 3 which ways of safe disposal were you taught?

.....

5. Are you aware of any risks associated with storing unwanted pharmaceuticals in your premise?

Yes ☐ No ☐

If yes to question 5 above, list any two risks
A……..
B…….

6. What are the effects of pharmaceutical waste on sanitation?

7. Do you consider inventory management to be part of sound pharmaceutical management?

Yes ☐ No ☐

8. When can you say your medication is expired? [Tick appropriately]

a) After the labelled date of expiration ☐
b) A week after opening ☐
c) Six months after opening ☐
d) Medicine does not expire ☐
e) Date indicated by the manufacturer ☐

f) Don't know ☐

g) Any other (specify)……

8. As a pharmaceutical practitioner, who is the most appropriate person/Authority to report to on proper disposal of unused or expired medicine?

A. County/National Government authorities……

B. Fellow pharmacist/pharmaceutical technologist…….

C. Drug inspector…….

E. others (specify)…….

PART 5: COMMON METHODS OF PRACTICE

1. How do you separate /store of expired or unused drugs in your pharmacy?

…….

2. How do you dispose of pharmaceutical waste from your pharmacy?

… ……..…… …… ……..

4. In your opinion list the best ways to properly dispose of unwanted drugs?

……

5. In your opinion list any unwanted practices of pharmaceutical disposal?

……

END OF QUESTIONNAIRE, THANK YOU

Appendix V: Questionnaire for Households Heads

PART 1: DEMOGRAPHIC DATA

1. Age of respondent (years):

2. Gender of the respondent: ☐ Male ☐ Female

3. Education level

None ☐

Primary ☐

Secondary ☐

Tertiary ☐

4. How many people are leaving in your household?

PART 2: THE COMMONLY DISPOSED PHARMACEUTICALS-

1. Do you have any medicines in the house that you/family member are not using?

☐Yes ☐ No

4. If yes to question 2 above, why do you keep unused medication? (Tick appropriately)

a) Do not want to waste them ☐

b) I don't keep them, I dispose of them ☐

c) For future use ☐

d) Not sure how to dispose them ☐

e) To give them away ☐

f) To keep a stockpile in case of shortages ☐

g) Others

(specify)……

…..

5. How many different prescription/over the counter medications do you currently have?

Prescribed Over the counter

6. Do you have any expired medicines stored in your home?

☐Yes No☐

7. List any drugs you may be having at home.

……..……..

……..……
…

……
……

……..……
…

PART 3: AVAILABILITY SANITATION INFRASTRUCTURE THAT SUPPORTS SOUND PHARMACEUTICAL WASTE MANAGEMENT

1. Is your house connected to a municipal sewerage system, piped water or any means of solid waste disposal?

……

……

……

……

……

2.What type of drainage is available for waste water in your house?

Soak pit ☐ Open Drain ☐ Municipal Sewer ☐

3.Is your house connected to a septic tank?

Yes ☐ No ☐

4.What informed the current form of sanitation infrastructure in your house?

PART 4: KNOWLEDGE ON PHARMACEUTICAL WASTE MANAGEMENT

1. Have u ever heard / received any information about pharmaceutical waste management?

Yes ☐ No ☐

2. Have you ever received any information about safe disposal of expired or unused medicines?

☐ Yes No ☐

3. Have u ever heard / received information about pharmaceutical waste?

☐ Yes No ☐

4. Are you aware of any risks associated with storing unwanted pharmaceuticals in the House?

Yes ☐ No ☐

5. If yes to question 4 above, list any two risks?

……

……

6. When can you say your medication is expired? (Tick appropriately)

a) A week after opening ☐

b) Six months after opening ☐

c) Medicine does not expire ☐

d) Date indicated by the doctor ☐

e) Don't know ☐

f) Any other (specify)……

7. Who is the most appropriate person to inform about unused or expired medicine that are in your house?

a. Doctor ☐

b. pharmacist ☐

c. Nurse ☐

d. community health worker ☐

e. Others (specify)

……

……

PART 5: COMMON METHODS OF PRACTICE

a. How do you store/separate expired or unused drugs in your house?

……

……

……

b. Do you regularly return unused drugs to your supplier /pharmacy outlet/ doctor/hospital?

Yes ☐ No ☐

c. How do you dispose of pharmaceutical waste?

……

……

…….

d. In your opinion list the best ways to properly dispose of unwanted drugs

……

……

……

e. In your opinion list any unwanted practices of pharmaceutical disposal

……

…….

END OF QUESTIONNAIRE, THANK YOU

Appendix VI: Journal Article Publication

Gitobu, K., Kaimuri, M., & Karani, C. (2022). Methods of pharmaceutical waste management disposal practiced in sanitation value chain by community pharmacies and households in Nkubu Town. *African Journal of Science, Technology and Social*

Sciences, *1*(1). https://doi.org/10.58506/ajstss.v1i2.13

Methods of pharmaceutical waste management disposal practiced in sanitation value chain by community pharmacies and households in Nkubu town

Kenneth Gitobu*, MaryJoy Kaimuri[1], Erastus Mwangi[1] and Caroline Karani[1]

[1] *Meru University of Science and Technology*

ARTICLE INFO

KEY WORDS

community pharmacies

Household

pharmaceutical waste

pharmaceutical waste management (PWM)

Sanitation, sanitation value chain

ABSTRACT

Introduction: Pharmaceutical Waste Management (PWM) has emerged as a challenging issue, with both health and environmental negative impacts. The study assessed thecommonmethodsofpharma-ceutical waste management disposal in Nkubu town among communi-ty pharmacies and households in the sanitation service chain.

Methods: The study area was Nkubu town, where datawascollect-ed byuseof structured questionnaires.Thesample size was 19 commu-nity pharmacies and 380 households. Descriptive statistics were used for data analysis. Results are presented in tables.

Results: The study showed that 23.9% (n=91) of the households use pit latrines while 73.5% (n=14) of the community pharmacies use burning as the common methods of pharmaceutical waste disposal.

Conclusion: The common method of pharmaceutical waste dis-posal being practiced in community pharmacies was burning while for households was emptying in the pit latrine. Disposal of unwanted pharmaceutical products through unsafe methods along the sanitation chain was prevalent among the respondents.

Recommendation: There is need to create public awareness and establish educational programs regarding management and handling of unwanted pharmaceutical wastes among community pharmacies and households in Nkubu town.

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Introduction

Globally, there lacks standard procedure for deal-ing with pharmaceutical waste disposal. In the US, there was variation among the different states in some aspects of PWM. Many states for instance allow some form of reuse or resale of returned pharmaceu-ticals considered to be safe but under varying condi-tions (Gualtero *etal et al2005).*

Pharmaceuticals wastes are drugs that can no long-er be used because of being expired, unused, spilled, withdrawn, recalled, damaged, contaminated, or for any other reason. Pharmaceutical products have been used in increasing quantities globally citation (WHO, 2013). However, studies have shown that a large number of these products eventually went unused or expired (WHO, 1999). According to World Health Or-ganization (WHO, 2013), more than half of all medica-tions are inappropriately prescribed and sold, which causes unnecessary storage in CPs and households creating environmental threats that jeopardize effi-ciency of sanitation service chain. WHO (2004) notes that the consumers (patients) and households are not able to use all the dispensed medications from com-munity pharmacies because of several reasons that may include adverse effects, alteration of dosage, feel-ing healthy, medications reaching the expiration date, promotional practices by manufacturers', physicians' prescribing practices and dispensers' practices. Non-adherence to medication canals result to storage of left over medicines at home. According to WHO (2010) 50% of patients fail to take medicine correctly, hence these medications end up as pharmaceutical wastes in the sanitation value chain. Cormicanetal., (2010) has emphasized the issue of drug mismanage-ment in Households. He reiterates that possession of unused or expired medications pose great risks to sanitation and have gained global attention in the re-cent past.

When pharmacies and households dispose the pharmaceutical waste into the sinks, drains, sewer sand toilets, they pose a great challenge to animal and human health (Giusti, 2009). In addition, dispos-al of the pharmaceutical waste such as disinfectants, antibiotics, antiseptic improperly into sewerage sys-tems leads to ineffective treatment of sewage (Orina, 2018). Furthermore, there is possibility of drug tox-icity/addiction resulting from open dumping of pharmaceutical waste from community pharmacies and households (Jones et al., 2001).

Pharmaceutical wastes calls for significant atten-tion in underdeveloped nations, with the finest availa-ble technologies being employed to provide options for proper disposal by households and community pharmacies (Khojah,H.M.J.etal.(2013) According to Harhay et al, (2019),the world's most prominent envi-ronmental and health problem is unsafe sanitation, particularly in emerging countries.

Ghosh (2020), emphasizes that Management of Pharmaceutical waste from households and commu-nity pharmacies poses a serious challenge because of the environmental damage it causes and the health concerns. Managing pharmaceutical waste is funda-mental and critical to prevent the ecosystem and public health dangers posed. Furthermore, Pharma-ceutical waste remains a serious issue in most Low and Middle-income Countries (LMIC) due to the eco-nomic, social, technological difficulties and insuffi-cient training on waste management (Ghosh (2020). Pharmaceutical waste handling should be done to promote safe sanitation system as a goal to achieve the Sustainable Development Goal (SDG) 6 (CUE, 2018).

India generates around 60 metric tons of pharma-ceutical waste from pharmacies and a household, making their disposal and sorting a great challenge. Pharmaceutical waste is usually discarded into land-fills or drains except for the chemotherapy agents which are incinerated (Hinchey,2017) Improper dis-posal and handling of unused pharmaceutical prod-ucts has become a growing problem worldwide as cited by Cormican et al.,(2010). Iosue (2020), argues that there are limited studies that have been conduct-ed to determine how pharmaceutical waste generated by community pharmacies and households is man-aged effectively

Michael et al.,(2019) cites that animals and human can be exposed to toxicities from pharmaceutical products in the environment through usage of con-taminated water, this is mainly because many com-munity pharmacies and households keep unused, unwanted and expired drugs which they frequently discard through sinks, toilets, and the municipal or garbage waste bins.

A systematic review by Iosue (2020), on compar-ing the disposal of pharmaceutical waste at industry, household and community levels Kenya, Ethiopia, Sudan and Uganda revealed that Kenya has a com-prehensive and Standard operating procedure for management of pharmaceutical waste yet little in-formation is recorded under households and com-munity pharmacies management practices. This con-stitutes a research gap that can shed light across the sector. This review found that many pharmacies col-lect waste and transport pharmaceutical waste to private hospitals for private incineration services. Many of these incinerators are in bad working condi-tions whereas others are located in inaccessible are-as (Njenga, 2008).

Generally, pharmaceutical waste in most house-holds is not handled properly. For instance, a study conducted at Kenya's Embakasi Division community pharmacies by Oboyo & Mutai (2014) shows that pharmaceutical waste generated at the pharmacy

level was 34 percent solids and 59 percent liquid forms, which were disposed of by waste disposal businesses. Approximately 19.2 percent of semi-solid pharmaceutical waste was disposed of by sew-age andincinerator.

Mugumura(2015) cites poor practices of dispos-ing unwanted/expired pharmaceuticals in house-holds and community pharmacies are responsible for a large portion of pharmaceuticals in water. The majority of consumers flushes unexpired drugs into sinks, toilets or disposes then into garbage bins. This was demonstrated in a number of investigations in Tacoma,Washington.

Information on pharmaceutical waste disposal methods and management in African is scarce.Tanzania is one of the African countries where guidelines for pharmaceutical waste manage-ment were available (titled "Guidelines for disposal of unfit medicines andcosmetic products, First Edi-tion, 2009").The guidelines were developed by the TanzaniaFood and Medicines Authority (TFDA), which is the equivalent of the Kenyan PPB.However, enforcement and compliance with the guidelines was poor, even for government HFs (Matiko, 2012).This study reported that 72.4% of the re-spondents buried their PW at the Dares Salaam dumpsite while 31% burned their PW. Only 37.9% mentioned incineration as one of the options for PW disposal.This practice was at variance with the TFDA guidelines which required PW to be either land-filled or incinerated save for a few specified excep-tions.

Nkubu is a growing town in terms of population and economy, which means increased volumes of pharmaceutical waste generated due to the new up-coming pharmacies and the indiscriminate over the counter purchase of drugs. Most of this can be found in local dustbins and open pit and garbage sites. It is against this background that this study was being conducted to determine the common methods of pharmaceutical waste management disposal in sani-tation service chain in Nkubu town, Imenti south of Meru.

Methodology

A descriptive cross-sectional study design was utilized where structured questionnaires were used for data collection. The study was conducted in Nku-bu town, Meru County-Kenya during the months of January to April 2022. The study population was community pharmacy managers and household heads above the age 18 years, who were residents of Nkubu town at the time of data collection. A total of 380 household heads and 19 community pharmacies managers were sampled to participate in this study. All questionnaires were double-checked for accura-

cy and collected data were entered into Statistical Package for Social science (SPSS) version 22 for analysis. Descriptive statistics were used for analysis and findings were presented in tabular form. Writ-ten informed consent was obtained from all the re-spondents. Participation in this research was volun-tary and the identity of respondents was kept confi-dential. .

Ethical approval and clearance was obtained from Meru University Institutional Research and Ethics Review Committee, MIRERC Number: MU/1/39/28 Vol. 2(58) and the National Commission for Science, Technology & Innovation (NACOSTI/P/22/16821). Permission was sought from Imenti South Sub coun-ty health department to carry out the study.

Results

The study findings showed that 23.9% (n=91) of the households use pit latrines as the most common methods of pharmaceutical waste disposal. Other methods used by households include burning 20.5% (n=78), sewer 17.4% (n=66), dumping the wastes in the nearby bushes 10% (n=38), burying 9.7% (n=37), use of compost pit 5.5% (n=21), disposing in litter bins 4.5% (n=17), 4.2% (n=16) use toilets) while3.2% (n=12) never specified which method of waste dis-posal as shown in table 1.

Method of PW Disposal	F	%
Pit Latrines	91	23.9%
Burning	78	20.5%
Sewer	66	17.4%
Throw in the bush	38	10%
Burying	37	9.7%
Composting	21	5.5%
Bins	17	4.5%
Toilets	16	4.2%
Not specified	12	3.2%
Draining in the Sink	4	1.1%
Total	380	100%

Table 1: *Common Methods of pharmaceutical waste disposal among the households*

On the hand, in Community Pharmacies, the most common method of pharmaceutical waste dispos-al was Burning 73.5% (n=14) followed by com-posting 15.9% (n=3)

The study results of the methods of pharmaceutical waste disposal adopted by Community Pharmacies are as summarized in table 2

Similarities were observed from the study that showed burning, composting and pit latrines were the most commonly used methods of pharmaceutical

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Frequency (n)	Percentage (%)
14	73.5
3	15.9
1	5.3
1	5.3
19	100%

Table 2: *Common Methods of pharmaceutical waste disposal among the CPMs*

waste disposal in both the households and the com-munity pharmacies.

Discussion

Currently, pharmaceutical waste management and disposal methods are issues that have gained atten-tion of major stakeholders because it has been real-ized that indiscriminate and improper disposal can contaminate the environment and pose the risk to water, air, agricultural products, food chain, even harm animals/ livestock and eventual effects on san-itation chain Harhay et al, (2019).The various meth-ods of disposal of unwanted pharmaceuticals that are practiced determine their presence in the envi-ronment and their potential to contaminate water Giusti, L. (2009). Households and community phar-macies contribute to environmental concerns relat-ed to pharmaceutical waste since they dispose the unwanted pharmaceuticals through sink, toilet or in a trash bins All of these methods have detrimental impacts on the environment and the sanitation chain Cormican et al.,(2010). Globally, the disposal meth-ods currently used are evident in various studies which have been conducted worldwide (Beckel *et al., 2055).*

Previously, it was believed that the most appro-priate disposal methods of unused or expired medi-cations was to flush them down the toilet / drain, as opposed to discarding them in the trash, where ani-mals or humans would be more likely to encounter them (Chasler, 2011). Therefore, studies have been conducted throughout the world on this significant public health and sanitation issue to find the policy

solutions. Iosue (2020) retaliates that there are limited studies that have been conducted to deter-mine how pharmaceutical waste generated by com-munity pharmacies and households are man-aged. This is the first study to be conducted at Nku-bu town in Meru County-Kenya.

The results of this study found that majority of the households disposed the pharmaceutical waste by emptying in the pit latrines. This is contrary to a study conducted in Nairobi-Kenya by Mugumura (2015) who cites poor practices of disposing unwanted/expired pharmaceuticals in households as being responsible for a large portion of pharmaceuticals in water. The majority of consumers flush expired and unexpired drugs into sinks, toilets or dispose them into garbage bins (Ghosh, 2020). According to the report by Ghosh (2020), 54% of participants kept medications in homes and 35% flushed drugs into the sink or toilet which is comparable to this study where 4.2% of the respondents flushed in the toilets and the ma-jority disposed in latrines at 23%.Studies conducted in Southern California revealed that 45% of the re-spondents were disposing expired drugs in the trash and 28% in sinks or toilets, Pollo et al, (2019). In King County Washington, 52% of people threw away unused medications, while 20% flushed expired drugs in sinks and toilet. Pollo et al, (2019) indicates that only 1% of people return people return ex-pired/unused drugs to pharmacists.

The results of this study also differ from a similar study where Rogowska et al., (2019) carried out 2-case studies on household pharmaceutical waste practices in Poland. The first survey focused on iden-tification of the consumption scale of pharmaceuti-cals and disposal of pharmaceutical waste where 68% of the participants reported to be disposing the household pharmaceutical waste by flushing them into toilets and sinks. The second survey reported that 35% of the population disposed waste into toi-lets, less than 30% practiced return of expired medi-cation to pharmacies.

Similarly, a study carried out in households, from Ethiopia found that unwanted pharmaceuticals are thrown into trash, flushed down the toilet, burnt, bur-ied, given to a sick neighbor or thrown to the environ-ment. Others keep them in the house for the next use because they don't know the right way to dispose un-wanted pharmaceuticals (Mekonnen & Fentie, 2014). Flushing pharmaceuticals in the toilets ends up in water purification systems which are not sufficiently equipped to handle them hence contaminating drink-ing water which can further contribute to develop-ment of antibiotics resistance, or exposure of popula-tions to irritant or mutagenic anticancer drugs and the possible link between endocrine disrupting com-pounds and failing fertility of the aquatic life (Mekonnen & Fentie, 2014)

Disposing unwanted pharmaceuticals using methods such as burning, burying, throwing in the bushes, dumping together with other gar-bage are undesirable in the sense that they con-tribute to environmental pollution to both hu-man and animals, for instance presence of hor-mones and steroids in water are linked to the reproductive problems and lowers immune re-sponse in fish and frogs and they may find their way into water bodies and drinking water. This is clearly shown in a 2002 study in the US geo-logical survey (Simon 2010). The results of these surveys and those of this study differ because of differences in socio economic status of the popu-lations and countries involved.

The results of this study also revealed that ma-jority of the community pharmacies practiced burning as the preferred method of pharmaceu-tical waste disposal. This results concurs with those of a cross sectional descriptive study con-ducted on 25 community pharmacies in upper hill, hurlingham, central business district and Downtown area of Nairobi- Kenya (Njenga, 2008) that focused on disposal and handling of pharmaceutical waste by community pharmacies outlets. The findings revealed that 95% of the community pharmacies generate a substantial amount of pharmaceutical waste. In the same study Njenga (2008) also noted that 36% of the community pharmacies did not know how to dispose the generated pharmaceutical waste. The other third relied on high and medium tem-perature incineration, and nearly 34% practiced open dumping, sewer disposal and open burning. Burning, sewer disposal and open dumping is thus practiced in both the urban and rural areas of the country hence contamination of the sanita-tion service chain.

Similarly, Tanzania is one of the African countries whereguidelines for PWM were available (titled “Guidelines for disposal of unfit medicines and-cosmetic products, First Edition, 2009”).The guide-lines were developed by the TanzaniaFood and Med-icines Authority (TFDA), which is the equivalent of the Kenyan PPB which is the drugs regulatory au-thority in Tanzania. However, enforcement and com-pliance with the guidelines was poor, even for gov-ernment health facilities (Matiko, 2012). Matiko (2012) , in his study in Tanzania reported that 72.4% of the respondents from community pharmacies buried their pharmaceutical wastes at the Dares Sa-laam dumpsite while 31% burned their pharmaceu-tical wastes. Only 37.9% mentioned incineration as one of the options for pharmaceutical waste disposal which was at variance with theTanzania food and medicines authority (FDA) guidelines which re-quired Pharmaceutical waste to be either land-filled or incinerated save for a fewspecified exceptions. This results differ with the findings of this study that revealed that of the community pharmacies prac-ticed burning as the preferred method of pharma-ceutical waste disposal.

In conclusion, the literature reviewed showed a generally poor state of pharmaceutical waste man-agement disposal methods in developing countries (Matiko2012, National Healthcare Waste Manage-ment Plan-2008, Mugoyela & Ally 2002, Wafula 2013). Pharmaceutical waste management disposal is a fairly recently recognized and evolving sanita-tion and environmental areas of concern. Safe dis-posal of pharmaceuticals waste plays a significant role in reduction of contamination across the sanita-tion service chain. Pharmaceutical waste manage-ment disposal is a serious issue that has gained both county government and national Government atten-tion due to their various effects on both the human population, the environment and across the sanita-tion chain (MOH national health care waste manage-ment plan 2008-2012).

Conclusion

The common method of pharmaceutical waste dis-posal being practiced in community pharmacies was burning while for households it was emptying in the pit latrines. Disposal of unwanted pharmaceutical products through unsafe methods along the sanita-tion chain was prevalent among the respondents. Moreover, community pharmacists are in an excel-lent position to educate patients on pharmaceutical waste disposal methods, therefore leveraging their knowledge through training programs and continu-ous education is of importance.

Recommendations

There is need to create public awareness and estab-lish educational programs regarding management and handling of unwanted pharmaceutical wastes among community pharmacies and households in Nkubu town. In addition a detailed national study is recommended to investigate the magnitude of pollu-tionwith Pharmaceutical waste across the sanitation chainin Kenya.

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