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Types of pharmaceuticals in homesteads in Eswatini: knowledge level of dangers of storage and disposal, and description of practices among home-dwellers in urban and rural settings

Dlamini Sabelo V[1*], Mndzebele Welile[2], Hlope Londiwe D[1], Masuku SKS[3], Nkambule Stanley J[1], Lukhele Lungile P[1], Nxumalo Sihle[1]

[1]*Department of Environmental Health Sciences, Faculty of Health Sciences, University of Eswatini, Eswatini*
[2]*Harzadous Materials (HAZMAT), Matsapha, Eswatini*
[3]*Department of Community Health Nursing, Faculty of Health Sciences, University of Eswatini, Eswatini*

Correspondence

Dr Sabelo V. Dlamini

University of Eswatini, Department of Environmental Health, P.O. Box 369, Mbabane
Tel: +268-25170718
Fax: +268-246241
Email: dlaminisv@uniswa.sv; svdlamini2705@ymail.com

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Abstract

The dramatic increase in chemical production and trade during the past three decades has raised both public and official concern about the potential risks posed by hazardous chemicals pesticides and medicines. With increased threat from HIV infection, many householders find themselves needing to access and keep a complex and diverse variety of pharmaceuticals. A cross-sectional, explorative and qualitative survey was carried out among 329 households involving in-depth interviews and observation to investigate types of pharmaceuticals found in rural, peri-urban and urban areas in Eswatini, the level of knowledge of householders and disposal practices of unused and expired pharmaceuticals. Eswatini does not have any laws that regulate the management of household pharmaceuticals. The results of the survey suggested that a majority of homesteads (85%) stored unused, often expired and left-over pharmaceuticals mainly for future use. The level of knowledge of risks associated with presence of pharmaceuticals was found to be very low among householders and that no programmes were initiated by the local health authority or the municipal councils to enhance the knowledge levels. Eighty-two different types of pharmaceuticals were identified including analgesics (38%), antibiotics (27%), supplements (21%) and others (14%). In urban areas, respondents reported that they disposed waste pharmaceuticals into the normal bins which are collected and disposed into landfills and dump sites while peri-urban and rural areas reported that they burn their pharmaceuticals in backyards. The findings in this study suggest the need for further research to determine availability of the variety of pharmaceuticals in surface, ground and drinking water around the country. Guidelines for management and safe disposal of pharmaceuticals need to be urgently developed and programmes to educate householders should be initiated in Eswatini.

Introduction

Significant interest has translated into intensive research on the input and presence of active pharmaceutical ingredients and their fate in the environment in many countries and among many communities. Modern medical research has resulted in the addition of a wealth of medications that can improve health and extend both the length and quality of life but when they are no longer needed, they have to be disposed and disposed safely. Due to population increases and emergence of diverse health conditions that require continued reliance on a variety of medicines, pharmaceuticals are now produced and used in increasingly large volumes every year [1]. Increasing medication use often results in an abundant supply of medications in some households [2]. The unintended consequences of disposal of unwanted medicines present an emerging concern for the environment and public health. The potential long-term effects of even low concentrations of pharmaceuticals in the environment, including potential combination effects should be investigated in any country in order to strengthen the fact base and to advocate for drafting of appropriate policies and guidelines that are likely to derive long-term protective measures to life and the environment [3]. Health facilities (hospitals and clinics) are known to be major producers and sources of general medical waste including pharmaceuticals that reach households. The increase in number of ill persons mainly due to high communicable diseases such as HIV/AIDS, TB, other upper respiratory infections (and recently, COVID-19) and non-communicable

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diseases has resulted to an increase in number, types and use of pharmaceuticals in homesteads [4]. These global epidemics have also resulted in a significant increases of over-the-counter medicines in general. For example, in the United States, over-the-counter medicines increased by 60% since the 1990s. In 2008, total sales for prescription medicines in the United States reached $291.5 billion, a 1.4 percent increase from 2007 [5]. With these increases comes concern about the fate and effects of these compounds in households and the environment.

Recent studies have identified a wide range of pharmaceutical chemicals in rivers, streams, and ground waters [6-8], and it has also been shown that some of these compounds are potentially harmful to aquatic organisms, affecting reproduction and development even at very low concentrations in some cases [9]. Anti-retroviral drugs (ARVs) currently prescribed to millions of HIV/AIDS patients have been found in both surface water bodies and wastewater treatment plants [10,11]. A recent study conducted by Vumazonke and colleagues (2020) in surface waters of the Western Cape, South Africa, reported that Carbamazepine and erythromycin were detected in high concentrations ranging from 81.8 to 36 576.2ng/L and 11.2 to 11 800 ng/L respectively, while clarithromycin and sulfamethoxazole were detected at moderate concentrations ranging from 4.8 to 3280.4 ng/L and 6.6 to 6968 ng/L, respectively [8]. The presence of unused or expired pharmaceuticals in surface water poses toxicological effects in humans and animals even at trace concentrations. Most pharmaceutical substances are, by nature, biologically active and hydrophilic, in order that the human body can take them up easily, and persistent, to avoid degradation before they have a curing effect.

While the number of pharmaceuticals continue to increase in homesteads, disposal facilities or guidelines are commonly unavailable or unknown by household dwellers. As such, several studies have demonstrated a variety of pharmaceutical compounds dispersed in the environment and that the origin of such waste is not only due to manufacturing operations but mainly due to consumer use and actions [12]. Consequently, pharmaceuticals have been recovered from river waters, stream sediment ground water, soils, plant and animal tissue [13] (Kümmerer 2009). Pharmaceuticals are typically transported to wastewater treatment works, where, depending on their molecular structure and physicochemical properties, can be either degraded by biological treatment processes or released to the environment in effluents or sorb to sludge [14-18]. Because of detection of pharmaceuticals in soils, concerns have been raised over the potential for these substances to be taken up into human food items and to pose a risk to human health [19,20]. A number of studies have demonstrated the uptake of pharmaceuticals used in human and veterinary medicine into plants [21-25].

In a majority of cases, pharmaceuticals are used and the therapy succeeds before all the medication (particularly tablets) have been used up [26]. The patient then finds no need to continue using the medication and often stores it for future use or to share with members of the family and relatives who may develop similar symptoms. While studies to quantify the amount of pharmaceuticals in homesteads have increased among many overseas countries, such studies remain limited or absent in many Sub-Saharan countries. No study has been conducted to determine the storage and disposal practices of unused medicines in Eswatini. Consequently, the long-term impacts of medicine disposal on the health of Emaswati and on the status of the environment are not known. Studies to determine the range and quantity of these waste medicines in ground water sources have also not been conducted. As long as this information is not available and guidelines are absent, the quantity of medicines reaching water sources and the general environment will increase as pharmaceutical usage also increases.

Pharmaceuticals have been detected in the soil environment where there is the potential for uptake into crops. A study conducted by Carter and Colleagues (2020) explored the fate and uptake of pharmaceuticals (carbamazepine, diclofenac, fluoxetine, propranolol, sulfamethazine) and a personal care product (triclosan) in soil−plant systems using radish (*Raphanus sativus*) and ryegrass (*Lolium perenne*). Five of the six chemicals were detected in plant tissue. It therefore may be important to question previous assumptions on plant uptake, and specific models may be required to accurately predict plant uptake which account for species differences, distribution of chemicals in the plant, chemical properties, and the fate of the pharmaceutical in different soil matrices including effects of the pharmaceuticals following uptake of these plants by humans and animals [27]. A study conducted in Mezquital Valley, Mexico sampled a chronosequence of soils that were variously irrigated with wastewater from zero up to 100 years reported the accumulation of ciprofloxacin, enrofloxacin, sulfamethoxazole, trimethoprim, clarithromycin, carbamazepine, bezafibrate, naproxen, diclofenac, as well as the occurrence of Enterococcus spp., and *sul* and *qnr* resistance genes [28]. Given the logistical and ethical complexities of research in this area, several papers focus on techniques for prioritizing which compounds are most likely to harm wildlife and how modelling approaches can make predictions about the bioavailability, metabolism and toxicity of pharmaceuticals in non-target species [29]. The purpose of this research is to determine the prevalence of unused and expired drugs in households, the knowledge level, attitudes and how these influence storage and disposal practices.

Methods

The study employed a cross-sectional, explorative qualitative design that involved in-depth interviews of key representatives of homesteads and observatory methods.

Study setting

Three areas were purposively selected to represent rural (Mahlangatsha), peri-urban (Eteni, located 9km from Manzini) and urban (Zakhele a suburban part of Manzini).

Sampling and Sample Size

According to the 2007 Eswatini Population Census, Mahlangatsha had 1 602 homesteads and Manzini had 7 156 homesteads. The *Raosoft* sample size calculator (www.raosoft/samplesize.com) was used to attain sample sizes of 214, for Mahlangatsha, and 238 for Manzini (Eteni and Zakhele) at the 95% confidence level and allowing a margin error of 5% and to observe a response distribution of 20%. However, at some homesteads, no residents were found on the days of the survey and the final number of homesteads that participated were 164 (77%), 71 (60%) and 94 (79%) respectively for Mahlangatsha, Eteni and Zakhele. Therefore, a total of 329 homesteads formed the sample size.

Data Collection Methods

An observation checklist was used to identify pharmaceuticals in bedrooms, kitchens and bathrooms of homesteads. Face-

to-face interviews with key informants found in homesteads were conducted guided by a questionnaire that consisted of items with the ability to probe for in-depth information about knowledge levels and practices. All participants that represented households consented without problems to the survey. The questionnaire and observation checklist were pre-tested at Motshane (5), Msunduza (4) and Thembelihle (4) and then adjusted accordingly to enhance reliability.

Results

Out of the 329 homesteads surveyed, 281 (85.41%) had stored pharmaceuticals. This result suggests that a majority of homesteads in Eswatini are likely to store pharmaceuticals. It is not immediately clear whether those without pharmaceuticals had actually finished them or had never had them. The distribution of pharmaceuticals suggested that a majority of homesteads in the rural areas (73%) were more likely to keep pharmaceuticals compared with those in the peri-urban (63%) and urban (54%) areas. Nonetheless, these findings still suggest abundance of pharmaceuticals stored in all the three sections of the country. The rural homesteads were found to keep a wider variety of pharmaceuticals (58) compared to the peri-urban (34) and urban (28). By far, the majority of drugs were analgesics or those meant to relieve pain e.g. panado or paracetamol, Stop pain, Go-pain, ibruprofen, aspirin, Tylenol, indocid, etc., followed by antibiotics which included sulphamethaxazole, amoxycil, flutex, cloxacilin, cotrimoxazole, and flustat, followed by supplements such as Ferrous sulphate, Calcium, Multivitamins, Vitamin C, and B complex. (Figure 1).

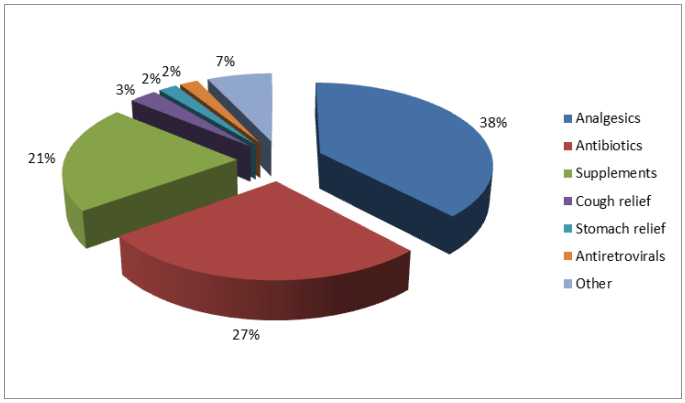

Figure 1. *Types of pharmaceuticals found in homesteads*

Storage

A majority of households were found to store pharmaceuticals in a non-lockable cupboard located in the kitchen or bathroom (particularly in urban and peri-urban areas) but in rural areas, most pharmaceuticals were found in the kitchen and in bedrooms or sleeping units. The participants further reported to store these unused medicines in non-lockable cupboards, on the table, inside or on top of the refrigerators or on a shelf built on the wall (Figure 2). Worth noting is that most of these storage areas were within easy reach of children and disabled persons. The knowledge level of the dangers of storage of pharmaceuticals differed between urban (72%), peri-urban (59%) and rural (38%).

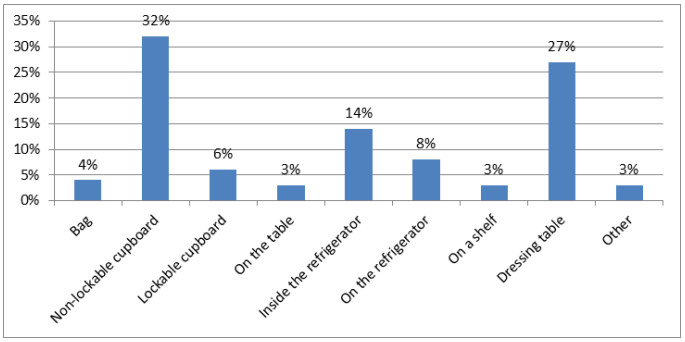

Figure 2. *Storage areas used by householders for pharmaceuticals*

Participants were asked if they kept the pharmaceuticals safely and 92% responded that they thought their storage methods were safe and the remainder (8%) said that they were not sure. When participants were asked to explain what they understood by 'safe storage of pharmaceuticals', a majority (58%) mentioned that "they were out of reach of children", others mentioned that "they were kept in lockable cupboards" (13%), while others claimed that "they were stored safe because there were no children". When asked if they had experienced an accident from the pharmaceuticals, 16% claimed they had experienced accidents. The accidents cited included the following:

- *"An old lady who accidentally drank wrong tablets and lost sanity for some hours"*
- *"An overdose of some tablets plus a bleaching solution taken by a woman following a misunderstanding with her husband"*
- *"A child that drank tablets and suffered diarrhoea"*
- *"A dog that was killed after eating medicines from the garbage bin"*
- *"Tablets that were swept from the flow and taken by chickens with no noted immediate side effects"*

However, most of the pharmaceuticals (97%) were in their original containers (envelopes for tablets and bottles for medicines) and were clearly labelled with name of medicine, owner and regimen for taking medicine or dosage. Those few that were unlabelled or in wrongly labelled containers commonly involved DPH or cough medicine and supplements such as Vitamin C. It was not immediately clear how these medicines ended up in unlabelled containers but a small percentage of respondents mentioned that they were shared by relatives into the unlabelled containers.

Reasons for storing pharmaceuticals

The participants were asked why they kept medicines at their homes. The majority of the respondents (57%) claimed that their illnesses had resolved and that they did not see the need to continue taking the medication. When asked if the doctor issued instructions that they may stop taking these drugs when the illness resolved only 3.9% agreed and the rest claimed they were never given any instructions to such. A smaller proportion of respondents (21%) claimed to have consulted another healthcare facility when they did not see any improvement where they were provided with a different prescription. When asked if they told the healthcare worker that they had been to another facility where they were given a prescription that didn't improve the condition or illness, only 2.4% said they did.

The distribution of the responses are shown in Figure 3 below.

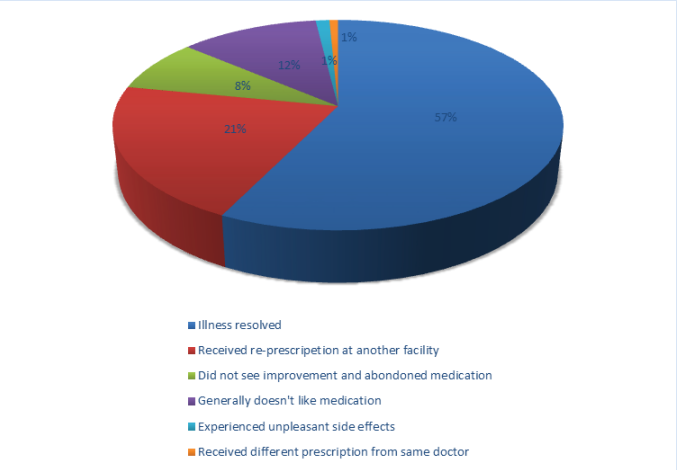

Figure 3. *Reported reasons for storing unused or expired medicines*

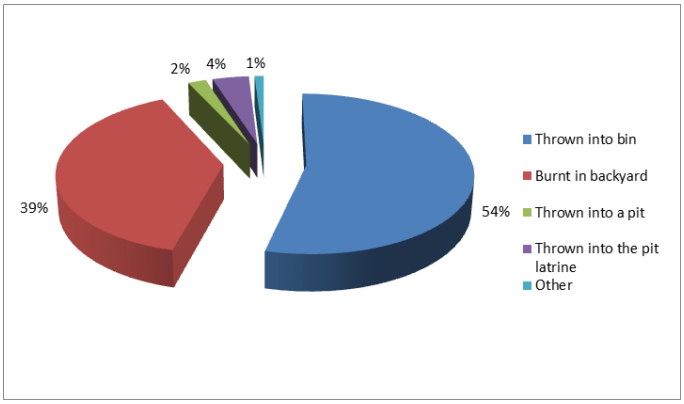

Figure 4. *Types of disposal methods of pharmaceuticals used by home-dwellers*

Some respondents cited lack of resources and time to return to hospital for the same illness.

"It is a waste of money to travel to hospital and return with the same medication you have at home", one added.

Some respondents said that they kept pharmaceuticals in the house in case they or other members of the household or neighbourhood would develop the same symptoms and need the same treatment. None of them said that they make attempts to re-sell them to another householder or neighbour. This practice suggests that the respondents performed prescriptions to members of the household who may be given wrong medication because they do not have the knowledge required to make a diagnosis or the legal right to make a prescription. These practices poses great danger to the recipient of un-prescribed medicines. Only 14% (n=46) claimed to dispose remaining medicines following 'healing' or disappearance of symptoms.

Methods of Disposal

A majority of the participants revealed that they dispose the pharmaceuticals either in solid waste bins (54%) or burn them in a backyard pit (39%). However, some mentioned that they disposed their waste pharmaceuticals into the pit latrines (4%) or into an open pit near the homestead yard (2%) (Figure 4).

It was also noted that a majority (98%) of those that said they disposed of their pharmaceuticals in solid waste bins are those in the urban areas yet a significant percentage of urban (24%), peri-urban (33%) and rural (42%) claimed to burn their pharmaceuticals, suggesting that burning was practiced at almost all the settings. Participants in peri-urban and rural tend to burn or throw their waste pharmaceuticals in pit latrines. A smaller proportion of urban-dwellers (14%) reported that they disposed liquid medicines into the toilet and/or sink and that none of these were solid pharmaceutical waste.

Discussion

Improper disposal of medications potentially poses a significant environmental risk and storage of expired and unused medications in households provides an increased risk of accidental childhood poisonings. The absence of such crucial information on the types, storage and disposal processes of unused and expired medicines among householders in Eswatini denies decision-makers, policy-makers and practitioners the evidence required to support decision processes.

Supporting Legislation

The pharmaceutical industry contributes to ensuring the right to combat pain as a human right, because article 11 of the 1966 International Covenant on Economic, Social, and Cultural Rights affirms that health is a human right. The committee on economic, social, and cultural rights, the monitoring body of the convention, decided that states should provide and facilitate access to adequate quantities of public health, health care, goods, services, and programs [30]. Furthermore, the local pharmaceutical industries help countries to control epidemics and pandemics because they provide countries with medicines and medical supplies quickly and without the complications of importing. This makes it easier for countries to deal with health emergencies quickly and effectively. In the Kingdom of Eswatini, the Ministry of Health has powers in the area of the supply of pharmaceuticals and medical supplies. The ministry prepares the registration and certification policy and ensures its development and implementation, particularly in its targeting of high-value-added items from national production. However, the existing legislation in Eswatini does lacks the existence of a substantive body that can lead the development of policies on pharmaceutical use and management as support for local governments and authorities. In Great Britain, for example, the Royal Pharmaceutical Society is a body established to support the development of policy and good practice on handling and security of medicines within local arrangements. General guidelines may then be drawn following developed policies to contextualize practices to best serve each locality. A reference list that may be used to guide home-dwellers which pharmaceuticals are hazardous and which ones are not does not exist in Eswatini. This finding is consistent with early reports from some developed countries [31]. The Ministry of Health in Eswatini must also facilitate the establishment of a data bank and the preparation of periodic and circumstantial reports on the evaluation of the pharmaceutical industry. The Ministry has to devise legislation compelling private pharmaceutical companies to develop management guidelines for unused medicines including take-back strategies and disposal.

Occurrence and Types of Pharmaceuticals

Subratty and Haseed-Nathire (2005) state that medical waste in the developing world can be classified into two broad categories: non-hazardous waste and hazardous waste-pharmaceuticals fall under hazardous waste [4]. About 82 different kinds of pharmaceuticals were found in the sampling populations. This finding confirms reports from previous studies in Africa [32]. The shift towards increasing home care service has resulted in generation of larger amount of pharmaceuticals in households [33]. In a study conducted by Bound and colleagues (EFPIA, 2002) results showed that around half of respondents (52.8%) finished their medication [34], which suggests that the other half either store or dispose their medication. Findings from our study reported a proportion of 52% of urban households that store unused medicines at their household, which is in agreement with findings from a study conducted in Adigrat City, Ethiopia [35] which reported that about 52.4% of householders kept unused medicines at their homes. Contrary to the findings in our study, where rural households (73%) were more likely to keep pharmaceuticals compared with those in the peri-urban (63%) and urban (54%) areas, a study conducted in Serbia reported no difference between urban (10.3%) and rural (11.8%) [36]. Besides that fewer households kept pharmaceuticals in both urban and rural households in Serbia, the absence of a significant difference could be due to interventions implemented in both urban and rural areas which influenced the practices of many householders. Therefore, implementation of strategies at all settlement areas in Eswatini are likely to reduce the discrepancies in the practices between urban, peri-urban and rural households.

Our study reported analgesics (38%), antibiotics (27%) and supplements (21%) as the common types of pharmaceuticals found in households. This finding is in line with findings reported in the study conducted in Adigrat City, Ethiopia [35], where it was reported that analgesics (41.5%) and antibiotics (36.7%) were the most common types. The large proportions of antibiotics suggest that some householders would not finish their prescribed dose and stop after recovering. Such a practice has a high probability of enhancing the development of resistance against these drugs either among those that do not finish the prescribed dose or among family members and friends that inherit and use the incomplete dose.

Studies conducted in Brazil [37] suggested that the most common medicines storage place was the kitchen (58.4%), while our study reported 38% because of the diversity of backgrounds surveyed i.e. urban, peri-urban and rural. The findings suggest that some members of households use pharmaceuticals that are leftover from relatives or they purchase them from pharmacies. This finding suggests that there was a tendency to use unprescribed medicines among residents of all settings i.e. rural, peri-urban and urban residents. Unprescribed contact with some pharmaceuticals can pose safety hazards to users [31].The absence of a pharmaceutical controlling body in Eswatini has led to a number of pseudo-pharmacies opening up and with unregulated capacities and lack personnel with adequate competency to make legal prescriptions. However there are those homesteads (6) that reported no medication. Four homesteads that did not have pharmaceuticals were at Eteni and the participants were young (between 21-27 yrs) and they lived alone.

Storage

The knowledge level in our study (72%) was comparable with that reported by Magagula and colleagues (2022) in the city of Johannesburg (77%) [38]. Despite the relatively high knowledge of the dangers associated with the storage of pharmaceuticals in the urban areas, storage practices did not suggest that precautions were taken to ensure safety of household dwellers and the environment. Most homesteads at urban, peri-urban and rural settings in Eswatini were found to practice unsafe storage methods of excess pharmaceuticals. These findings were consistent with reports of a study conducted in urban (89.0%) and rural (89.0%) where the storage practices were not different between urban and rural householders [39]. Even though the participants claimed that they were out of reach of children, these drugs may still be intentionally taken by suicidal members of families. Even then, a majority of them could be accessed by children, hence reports of accidental poisoning of children, the elderly and illiterate are well documented.

Nonetheless, the reports suggested by householders that they kept drugs for re-use suggest lack of knowledge of that pharmaceuticals are no longer pure and safe following prescription to a patient due to uncertainty of the storage, handling and condition [31].

Disposal methods

The study revealed that a majority of homesteads in the urban areas dispose their pharmaceuticals in waste bins together with general solid waste that is periodically collected and disposed in landfills and dump sites by the local municipal authority. This findings confirms earlier reports that described methods of disposal at global level as garbage, toilet or sink [40]. A recent study conducted among the public in Lagos State, Nigeria reported that 73.2% of respondents disposed their unused medicines in garbage [41], while our study reported 54%, probably because our study participants included rural households. The study conducted in the Ethiopia by Kahsay and colleagues (2020) reported that around three-quarters (75.2%) and 63% of the respondents discarded unused and expired medicines in the garbage bins, respectively [35]. The difference would probably not be significant compared to responses from urban residents from our study. Our study further identified burning and disposal in pit latrines as common methods particularly among rural and peri-urban dwellers. Due to the lack of knowledge or the absence of systems for the proper disposal of unused medicines, householders in different settings may utilize different methods to dispose unused medicines. The study conducted by Kahsay and colleagues in Ethiopia (2020) suggested that about half of the respondents (50.14%) had good knowledge concerning the disposal of unused and expired pharmaceuticals [35]. The study also reported that most (82.2%) of the respondents had a positive attitude towards the disposal of unused and expired pharmaceuticals [35]. However, the varying percentages between knowledge, attitudes and practices suggest that both knowledge and attitudes had no bearing on the practices. In many low and middle-income countries such as Ethiopia and Eswatini, support in the development of proper and adequate disposal systems from institutions such as municipal councils is often lacking to transform knowledge and attitudes into positive actions.

A study conducted in Malaysia identified discarded drugs in the waste stream ranging from expired vitamins, expired prescribed drugs and others [42]. Besides the drugs, used syringes were

also found, which create risks to the waste collectors especially if it is disposed in inappropriate manners where waste collectors could accidentally step on syringes or even badly cut themselves when the sharp point punctured the conventional house-garbage bags. This not only risked injuries to the charged collectors but also expose them to various infectious diseases transmitted from the contacts. These accidents are possible to occur and it would be extremely serious with transmission of diseases like HIV through drug-users' syringes [42].

Depending on the pharmacology of a medical substance, a pharmaceutical is excreted as a mixture of metabolites, as unchanged substance, or conjugated with an inactivating compound attached to the molecule into the environment, which adds to loads disposed as unused medicines that both enter surface water and water treatment plants. Work has been done in the field of risk assessment and risk management strategies to eliminate pharmaceuticals from wastewater or from the effluent of sewage treatment plants [13]. As a result, tremendous amounts of literature can now be found describing technical management measures such as oxidative or photolytic effluent treatment, filtering techniques, and application of charcoal [13], and recently, through the use of ultrasound [43] and dielectric barrier discharge [44] or membrane bioreactors [45]. However, a majority of the treatment methods described are not without shortcomings of their own. These methods are also too expensive to run for developing countries such as Eswatini. Therefore, additional approaches such as involvement of the people handling and using pharmaceuticals, and focusing on the properties of the compounds should come into focus. Sewer disposal of pharmaceuticals could potentially be legal for certain pharmaceuticals (those not hazardous) but wastewater treatment plants recommend against sewer discharge of pharmaceuticals [46,47]. For example, disinfectants disposed into sewer systems may kill the bacteria necessary for biological treatment of the sewer. Highly concentrated disinfectants released into watercourses may also kill aquatic life. A wide range of pharmaceuticals have been discovered in fresh and marine waters and it has recently been shown that even in small quantities these compounds have the potential to cause harm to aquatic life. In a study conducted in surface waters in the south East of England, ibuprofen, paracetamol and salbutamol were detected and quantified in all locations sampled. Ibuprofen was consistently found at the highest concentrations (up to 3 µg/l) [48]. The main pathway of these drugs into the environment is through household use, and the disposal of unused or expired pharmaceuticals as manufacture is well-regulated (EFPIA, 2002). Another alternative method that is often considered by many pharmaceutical management authorities is incineration (heating pharmaceuticals to temperatures above 1 200oC. Although the volume of waste pharmaceuticals is small relative to other wastes currently incinerated at hazardous and medical waste incinerators, pharmaceutical incineration has the potential to contribute to unwanted air pollution emission. Incinerators equipped with adequate emission controls have been developed but these have not received adequate distribution to developing countries like Eswatini. As such, many communities in Eswatini do not have access to basic incineration facilities or mechanisms to collect waste pharmaceuticals for incineration. A few homesteads were found with used aerosols or inhalers such as those used by asthma patients. Aerosols are likely to explode resulting in injury to those operating the incinerator or damage to property. This is particularly true for peri-urban and rural communities that reported to regularly burn such waste in rubbish pits within the household compounds. Waste is burnt only when the rubbish pits are full, suggesting that the waste may remain 'stored' within pit latrines for uncertain periods during which they may be ingested by children or pets or be washed off during rainstorms. Many developed countries have developed schemes for removal of waste pharmaceuticals through return programmes or reverse distribution. For example, some European member states [49], Australia, Canada and the USA have developed systems where residents drop off unwanted pharmaceuticals at pharmacies for collection by manufacturers. While these measures can provide adequate safety levels of disposal, they have not yet been considered by many developing countries because of the high costs associated with regular collection programmes. However, if appropriately implemented and monitored, such programmes are most likely to provide adequate solutions to the accumulation of unwanted pharmaceuticals in homesteads and the contamination of water and the environmental following their disposal. These programmes have to offer convenience, safety and privacy in order to be preferred over garbage bins, pit latrines and garbage pits. Strict security measures would have to be put in place to prevent pseudo-pharmacies from re-selling the returned pharmaceuticals.

Conclusion

Despite the fact that management of unused medicines is a well-documented problem worldwide, developing countries such as Eswatini have not conducted such studies to inform policy development processes at improving handling, segregation, storage and disposal practices. While many participants in this study were aware of the ability of the pharmaceuticals to negatively affect the natural environment, this awareness did not translate to appropriate behaviour required for proper management of unused medications. A small number of medicines that may be especially harmful and, in some cases, fatal with just one dose if they are used by someone other than the person for whom the medicine was prescribed, exist in many households. To prevent accidental ingestion by children, pets, or anyone else, a few medicines have specific disposal instructions indicating that they should be flushed down the sink or toilet as soon as they are no longer needed, and when they cannot be disposed of through a medicine take-back programme. However, many developing countries including Eswatini, have not established the medicine take-back programme and while disposal remains the sole method of getting rid of them, safe and efficient methods and guidelines have not been established to assist populations in rural, peri-urban and urban households. Developed countries such as the United States of America have established a list through the FDA that explain which expired, unwanted, or unused medicines should be flushed down the sink or toilet to help prevent danger to the environment, people and pets. The absence of a body established to periodically review the medicines available to homesteads and offer advice and guidelines on their safe storage and disposal is also a major challenge in Eswatini. However, existence of such a body without strong consumer awareness programmes that would shed knowledge to householders on safe storage, management and disposal of pharmaceuticals would be a futile exercise. Overall, there is a need to develop programmes and guidelines for management of household pharmaceutical wastes for urban, peri-urban and rural parts of the country. Development of such programmes should involve householders in order to improve buy-in and ownership. Studies to determine the presence and

quantities of pharmaceuticals in soil and water bodies should be conducted to estimate the impact the long-term disposal of pharmaceuticals in these ecosystems and probably quantify the impact of human poisoning because many families still rely on untreated water for domestic use in Eswatini..

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Competing interests

The author would like to report no competing interests in the study areas or the issues discussed in this study.

Author's Contributions

The first and second author put together the research concept note (proposal) which was reviewed by all authors. All authors were involved in data collection. The first and second author analysed the findings and then put together the first draft which produced several drafts leading to the final draft following inputs from the rest of the authors. All the authors have accepted this as the final draft and have approved its onward transmission to this journal for publication.

Consent

All respondents signed a written consent before each was engaged in the in-depth interview and observation of the homestead. An information statement was read to the respondents after which time was allowed for consideration and the decision to participate. The consent statement also included a statement allowing the publication of the findings of the study including all the figures that would be derived from the contributed information. A copy of the consent form may be forwarded if so required by the reviewers.

Ethical Clearance

The study was cleared by the Ethics and Scientific Committee of the Ministry of Health following recommendation from the UNESWA (Faculty of Health Sciences) Research Ethical Review Committee.

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