Pharmaceuticals wastage and pharmaceuticals waste management in public health facilities of Dessie town, North East Ethiopia

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Abstract

Background
Pharmaceuticals wastes are drugs and medicines that can no longer be used. The improper disposal of unused medicines is a growing problem throughout the world. This study assessed the pharmaceutical wastage rate and pharmaceutical waste management for the year 2015 to 2017 in the public health facility of Dessie, Ethiopia.

Methodology
A cross-section study design was used to review logistic data retrospectively from health commodity management information systems and manual records in 8 health facilities. Health professionals’ (135) pharmaceutical waste management practices were assessed using the world health organization waste management checklist. Descriptive and inferential statistics were made using a statistical package for social sciences version 20.

Result
Supplies were the leading class of pharmaceuticals with an overall wastage rate of 37.1%. Tablet and injectable constituted the highest class of pharmaceuticals dosage form with the overall wastage rate of 20.78% and 16.49%. The overall pharmaceutical wastage rate was 3.68% amounting to USD 159,762.66 and expiry (92.05%) was the major reason for wastage. The pharmaceutical wastage rate of health centers was nearly twofold higher than hospitals. Pharmaceutical waste management was practiced by 105 (77%; 95% CI; 69.9%, 84.9%) health professionals. Determinants of pharmaceutical waste management were being male (P value = 0.08, AOR = 3.72), receiving training (P value = 0.01, AOR = 4.34), writing label (P value = 0.02, AOR = 5.04), storage of segregated waste in dispensing unit (P value = 0.01, AOR = 0.72) and the presence of disposal plan (P value = 0.002, AOR = 16.93).
Conclusions
Supplies and tablets constituted the highest wastage class of pharmaceuticals and dosage form. The pharmaceutical wastage rate was higher than the standard and increasing in successive years. Pharmaceutical waste management was not fully practiced. Appropriate inventory control and waste management are recommended.

Background
Pharmaceuticals wastes are drugs that can no longer be used because of being expired, unused, spilled, withdrawn, recalled, damaged, contaminated, or for any other reason [1, 2]. It also includes discarded items heavily contaminated during the handling of pharmaceuticals, such as bottles, vials, and boxes containing pharmaceutical residues, gloves, masks, and connecting tubing [3].

Pharmaceuticals are used in health care facilities to save millions of lives by preventing and treating diseases and improve the quality of life of the human population [4]. Medicines account for 20–60% of health spending in developing and transitional countries [5]. Incorrect inventory management, lengthy procurement cycles, poor storage, improper monitoring of drug expiration times, distribution problems, and irrational usage of drugs results in wastage of pharmaceuticals [6]. This resulted in wastage of financial resources, shortage of essential medicines, increase in out-of-pocket expenditure, and decline in quality of healthcare services [7].

In the United States of America, approximately 2 of 3 prescription medications were reported unused and the total estimated cost was approximately 59,264.20 USD (United States dollar) to 152,014.89 USD [8]. In Palestinian hospitals, the percentages of unused drug products that expired, or those with no clear expiry date were 32.7%, 17.7%, and 11% respectively. The most common drug categories encountered in households were alimentary, musculoskeletal, and anti-infective agents whereas the most common individual drugs encountered were: paracetamol (8.5%), ibuprofen (4.9%), and diclofenac (3.7%) [9]. A study of medicines wastage at a tertiary hospital in Dar Es Salaam showed that 730 medicines dosages were wasted. Anti-infective medicines wastage was 18.9%, cardiovascular medicines (8.9%) and the other categories were 23.7% of the total medicines dispensed [10]. Other studies in rural Ugandan hospitals revealed that expired drugs were worth 1584 USD (25 items) in 2000/2001 and 1307 USD (13 items) in 2004/2005 [11]. In Ethiopia, the average wastage rate was reported to be 1.1% in auditable pharmaceutical and transaction systems implementing hospitals and it accounted for 3,196,865 birrs by value in 2014/2015 [12]. Another study on Gonder town showed that the total loss of money due to expiry over six months was 1337.6 USD from six health facilities [13].

Waste management includes waste collection, packaging, storage, segregation, transport, treatment, and disposal [14] and needs to be done on a more scientific basis [15]. Hospital waste management is a significant environmental and social obligation, and hence requires a proper plan [16]. Pharmaceutical waste should be segregated from other wastes [17] and the amount of generated waste should be forecasted for the planning of waste management budgets and optimization of waste management practices [18].

Globally, all health care services generate 3% of pharmaceuticals waste [19, 20]. Today their disposal is alarming as they generate large quantities of waste and by-products [21]. The improper disposal of unused medicines is a growing problem throughout the world [22]. In developing countries, proper disposal of hazardous wastes is still a significant challenge [23] and there were no established medication waste management programmers [24]. A study in
Jordan showed that the handling, storage, and disposal of generated wastes have less appropriate practices as compared to the developed world, and management of hazardous or general wastes is below acceptable medical waste standards [25].

Pharmaceutical wastes are potentially generated through a wide variety of activities in the health care system [21]. However, their increased consumption has entailed a health risk due to the increased loading of pharmaceutical discharge and waste into the environment during consumption and disposal [26]. Poor management of health care waste can cause serious problems to health care personnel, waste workers, patients, and the general public [19]. Higher risk of medical wastes associated with lower knowledge about waste separation compromised the health care delivery [27]. A study conducted in Jordan showed that there is a statistically significant impact between environment and efficiency and effectiveness of medical waste separation, waste classification, waste collection, and storage in hospitals [28].

Taking the aforementioned issues into consideration, this research was attempted to provide an answer to the following basic questions. What was the pharmaceuticals wastage rate of public health facilities of Dessie town for the year 2015 to 2017? How was the pharmaceutical waste management practice of public health facilities of Dessie town? In the attempt of answering the research’s questions, the following hypothesis was constructed and was tested for its significance: Is there an increment in the annual pharmaceuticals wastage rate. Is there a statistically significant relationship between pharmaceuticals waste management and socio-demographic characteristics of professionals.

There was no similar study conducted in Dessie town. Despite few studies were done elsewhere in the world, they can’t be applied to the local context due to differences in study settings. This study would help health institutions and decision makers’ effort on proper ways of pharmaceuticals waste reduction and management to optimize scarce resources and safeguarding the health of healthcare providers, clients, and the general population. Therefore, this study assessed pharmaceuticals wastage rate and pharmaceuticals waste management in public health facilities of Dessie town.

**Methods**

**Study area and period**

A study was conducted from November 2018—February 2019 in the public health facility of Dessie town, Ethiopia. Dessie (Fig 1) is located in the South Wollo zone of Amhara National Regional State, 401 kilometers away from Addis Ababa, the capital city of Ethiopia. According to the 2017 national census, Dessie has a total population of 151,174 [29]. In Dessie town, there are 8 public health centers, one referral hospital, and a district hospital serving Dessie town and the surrounding nearly 8 million populations.

**Study design**

Cross-sectional study design which required retrospective data collection was used to review logistic data from bin cards, stock cards, and health commodity management information systems. It was also used to administer questionnaires for all professionals working in pharmacy stores and dispensing units.

**Study population**

All received and wasted revolving drug fund pharmaceuticals in public health facility of Dessie town between 2015–2017 and all professionals working in pharmacy store and dispensing units. A total of 10 public health facilities (2 hospitals and 8 health centers) were surveyed but
2 health centers were excluded due to incomplete data on the extent of pharmaceutical wastage. Wasted pharmaceuticals recorded as free price such as program and donation medicines and outside the stated years were excluded from the study.

A total of 145 self-administered questionnaires were distributed to health professionals who engaged in pharmaceutical store management and dispensing units and the overall response rate was 93%.

Data collection instruments

A structured checklist adopted from Logistics Indicator Assessment Tool (LIAT) [30] and world health organization (WHO) waste management checklist [31] was used to collect data on pharmaceutical wastage rate and contributing factors, and waste management respectively. Pharmaceutical wastage data were abstracted by the principal investigators by reviewing receiving the voucher, health commodity management information system, bin cards, and stock cards. Two pharmacists who had no working relation to the health institutions used a self-administered questionnaire to collect the data under the supervision of the principal investigators.

Data management and analysis

Data were entered and analyzed using Microsoft Excel 2010 and Statistical Package for Social Sciences version 20. Forward binary logistic regressions were used and crude and adjusted odds ratio was calculated with 95% confidence intervals and variables with p-value < 0.05 were taken as statistically significant. Pharmaceuticals were classified according to their pharmacotherapeutic classes using the classification of medicines adopted from the Ethiopian national essential medicine list [32]. The structured data collection tools were properly designed for the assurance of data quality. All data were examined for completeness and consistency during data collection, analysis, and interpretation.

Ethical considerations

Ethical approval was obtained from the Ethics Review Committee of the college of medicine and health sciences, Wollo University (phar 037/11), and Dessie town health bureau. Then, the study was conducted after getting permission from each respective public health facility. Study
participants were informed about the purpose of the study and verbal informed consent was obtained from study participants. In this study, verbal informed consent was approved by the ethics review committee and confidentiality of study participants’ data was maintained throughout the study.

Results

The magnitude of pharmaceutical wastage

Public health facilities of Dessie town received United States Dollar (USD) 1,860,116.76 in 2015 and the annual wastage rate was 2.7% amounting to USD 50,269.90 (Table 1).

The three-year pharmaceutical wastage analysis revealed that the overall wastage rate was 3.68% (2.70%, 4.29%, and 4.53% in 2015, 2016, and 2017 respectively) amounting to USD 139,762.66. Excluding hospitals from analysis, 7.92% of the wastage rate was found in six health centers amounting to USD 18,204.59. The major reasons for wastage of pharmaceuticals were expiry (92.05%), damage (9.94%), and lost (0.02%) amounting USD 128,151.04, 11,047.28 and 23.11 respectively.

A total of 449 pharmaceuticals were assessed and supplies were the leading class of pharmaceuticals with the overall wastage rate of 37.1% accounting for USD 51,937.43 while the list was recorded in vaccine with a wastage rate of 0.01% amounting to USD 20.40 (Table 2).

Tablet and injectable constituted the highest class of pharmaceuticals dosage form with the overall wastage rate of 20.78% and 16.49% amounting to USD 29,056.58, and 22,960.64 respectively (Table 3). Examination glove medium size, clarithromycin 500 mg tablet, and chloramphenicol 250 capsule took the highest wastage value amounting to USD 10,496.02, 7627.54, and 6712.39 with the wastage rate of 7.54%, 5.48%, and 4.82 respectively from the total received pharmaceuticals.

Pharmaceutical waste management

There were 53.3% male respondents. The respondents consisted of 20 up to 56 years of age with a mean age of 29.36 (±6.37). With regards to the level of education, 44.4% were diploma while the rest 55.6% had the degree. Their work experience ranged from beginner to 31 years with a mean work experience of 6.28 (±5.44) (Table 4).

Pharmaceutical waste management was practiced by 105 (77%; 95% CI; 69.9%, 84.9%) health professionals. Segregated pharmaceuticals stored in 35.6% dispensing units waiting for removal and 68.1% used cartons as a sort of container for segregation. Moreover, 66.7% of respondents revealed that pharmaceuticals wastes were disposed of within health facilities compounds and the usual (63.7%) methods of disposal were burning in the open air (Table 5).

Forward binary logistic regression showed that male health professionals (P value = 0.08, AOR = 3.72) and health professionals who received training on pharmaceutical waste management (P value = 0.01, AOR = 4.34) have a statistically significant association on pharmaceutical waste management (Table 6).

The adjusted model indicated that health professionals who wrote a label on segregated waste (P value = 0.02, AOR = 5.04), storage of segregated of waste in dispensing unit (P value = 0.01, AOR = 0.72), and the presences of disposal plan (P value = 0.002, AOR = 16.93) has a statistically significant effect on pharmaceutical waste management (Table 7).

Discussion

Pharmaceuticals are used to prevent, treat and improve the quality of life of the human population in health facilities [4]. Because of their health value, about one-third of the budget is spent
on purchasing various materials and supplies including medicines, and forty percent of the budget is spent on procurement & management of stores [33]. In Ethiopia, the total drug expenditure grew over years still now [12, 34].

The present study revealed that the overall wastage rate was 3.68% amounting to USD 159,762.66. The finding was 3.34 and 1.42 fold higher than the average wastage rate (1.1%) and value (USD 108,002) in auditable pharmaceutical and transaction systems implementing hospitals [12]. But the current study finding was lower than the South West Shoa Zone health facilities wastage rate (7.5%) [35].

A wastage rate of 7.92% was found in six health centers of Dessie town amounting to USD 18,204.59. The result was higher than the lost money from a similar number of health facilities

| Sr. no | Code of health facilities | 2015 | 2016 | 2017 |
|--------|---------------------------|------|------|------|
|        | Received USD | Wastage USD | % wastage | Received USD | Wastage USD | % wastage | Received USD | Wastage USD | % wastage |
| 1      | DHC           | 33,830.15 | 4,490.09 | 13.27 | 32,678.79 | 2,450.80 | 7.50 | 29,200.43 | 487.08 | 1.67 |
| 2      | SGHC          | 15,183.69 | 435.42 | 2.87 | 16,610.66 | 562.92 | 3.39 | 16,656.51 | 3,128.18 | 18.78 |
| 3      | BHC           | 5,888.73  | 136.48  | 2.32 | 8,128.56  | 288.73  | 3.55 | 8,701.83  | 734.10  | 8.44 |
| 4      | KHC           | 5,925.17  | 1,220.38 | 20.60 | 8,430.60  | 587.90  | 6.97 | 9,501.35  | 268.29  | 2.82 |
| 5      | GHC           | 9,718.33  | 167.76  | 1.73 | 9,043.96  | 585.45  | 6.47 | 9,915.43  | 1,215.39 | 12.26 |
| 6      | MHC           | 3,507.54  | 241.88  | 6.90 | 3,507.54  | 452.45  | 12.90 | 3,507.54  | 751.29  | 21.42 |
| 7      | BMH *         | 100,754.72 | 1,159.49 | 1.15 | 210,562.53 | 8,383.74 | 3.98 | 272,074.50 | 17,845.76 | 6.56 |
| 8      | DRH *         | 1,685,308.43 | 42,418.40 | 2.52 | 845,764.62 | 35,349.86 | 4.18 | 994,303.66 | 36,400.83 | 3.66 |
| Average|              | 1,860,116.76 | 50,269.90 | 2.70 | 1,134,727.27 | 48,661.83 | 4.29 | 1,343,861.25 | 60,830.92 | 4.53 |

Average

| Sr. no | Classes of pharmaceuticals | Wasted value USD | % wastage |
|--------|----------------------------|-----------------|----------|
| 1      | Anti-infectives            | 32,415.73       | 23.28    |
| 2      | Anesthesia medicine        | 5,865.04        | 4.21     |
| 3      | Anti-histamines            | 911.59          | 0.65     |
| 4      | Blood products/ Anti-anemic| 4,056.68        | 2.91     |
| 5      | Central nervous system     | 10,242.78       | 7.36     |
| 6      | Cardiovascular             | 3,375.18        | 2.42     |
| 7      | Dermatological agents      | 930.25          | 0.67     |
| 8      | Endocrine                  | 4,145.50        | 2.98     |
| 9      | Ear-Nose- Throat preparations| 4,534.47      | 3.26     |
| 10     | Gastrointestinal           | 3,434.44        | 2.47     |
| 11     | Obstetric/ Gynecological   | 1,728.23        | 1.24     |
| 12     | Musculoskeletal            | 176.70          | 0.13     |
| 13     | Respiratory                | 2,135.32        | 1.53     |
| 14     | Vaccine                    | 20.40           | 0.01     |
| 15     | Vitamins                   | 2,490.69        | 1.79     |
| 16     | Water for injection        | 544.18          | 0.39     |
| 17     | Water, electrolyte, and acid-base balance correcting| 2,526.36 | 1.81 |
| 18     | Laboratory reagents and chemical | 7,750.45 | 5.57 |
| 19     | Supply                     | 51,937.43       | 37.31    |
| Total  |                           | 139,221.44      | 100.00   |

* Hospital.

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in Gonder town (USD 1337.6) [13]. The present study result was slightly lower than the average rate of wastage (8.5%) in nine health centers amounting to USD 11,906.23 in health facilities of South West Shoa Zone [35]. The difference might be attributed to the number and type of health facilities and length of reviewed time included in the study.

On the other hand, wastage in two hospitals of Dessie town was USD 141,558.07 with an overall 3.45% wastage rate. This was 1.73 times lower than the wastage rate in one hospital of South West Shoa Zone (6%) with a value of USD 5,003.2 [35] but higher than rural Ugandan hospitals where expired drugs worth USD 1584 in 2000/2001 and USD 1307 in 2004/2005 [11]. The difference was due to the number of pharmaceuticals included in the study and the volume of hospitals.

This study revealed that the pharmaceutical wastage rate of health centers was nearly two-fold higher than hospitals. This was in line with the study conducted in Serbia where tertiary healthcare level hospitals produced statistically significantly larger quantities of healthcare waste than secondary level hospitals [36]. The differences in wastage rate across various studies might be due to differences in duration of the study, assessed types, number and characteristics of health facilities, number of items, and inflation of the currency.

The overall wastage rate in the successive years was increasing and it was higher than the national standard (2%) wastage rate [37]. The amount of waste generated was increased as the number of patient flow increased [38]. The mean pharmaceutical waste generation was 0.017kg/day in the health centers of West Gojjam Zone [39] and 1.17 kg/day in Mizan Tepi University teaching hospital [40]. This results from a loss of scarce financial resources and extra resources needed for handling, processing, and disposal of pharmaceutical waste which impose a financial burden for health facilities as well as the country [7]. Further wastage resulted in a shortage of essential medicines, an increase in out-of-pocket expenditure, and a decline in the quality of healthcare services.

### Table 3. Pharmaceuticals wastage rate by dosage form in public health facilities of Dessie town, Ethiopia, (n = 8).

| Sr. no | Dosage form          | Wasted value USD | % wastage |
|-------|----------------------|------------------|-----------|
| 1     | Aerosols/ inhalation | 584.29           | 0.42      |
| 2     | Capsule              | 9,958.38         | 7.15      |
| 3     | Cream                | 848.07           | 0.61      |
| 4     | Drop                 | 5,774.84         | 4.15      |
| 5     | Elixir               | 223.02           | 0.16      |
| 6     | Jell                 | 101.38           | 0.07      |
| 7     | Injection            | 22,960.64        | 16.49     |
| 8     | Tablet               | 29,056.58        | 20.87     |
| 9     | Lotion               | 108.38           | 0.08      |
| 10    | Ointment             | 993.26           | 0.71      |
| 11    | Pessary              | 154.32           | 0.11      |
| 12    | Powder               | 5,367.42         | 3.86      |
| 13    | Solution             | 277.88           | 0.20      |
| 14    | Syrup                | 1,162.46         | 0.83      |
| 15    | Suppository          | 864.78           | 0.62      |
| 16    | Suspension           | 1,097.85         | 0.79      |
| 17    | Supply               | 51,937.43        | 37.31     |
| 18    | Laboratory reagents and chemical | 7,750.45 | 5.57 |
|       | **Total**            | **139,221.44**   | **100.00** |

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In the present study, the reasons for pharmaceuticals wastage were expiry (92.05%), damage (9.94%), and loss (0.02%). The result was nearly in line with the value of expired (95.7%), while three times higher in damaged value (3.1%) and no observed record of obsoleted (1.2%) [35]. Even though the magnitude of loss is minimal, pilferage was attempted. Wastage of 26.5% because of pilferage at a tertiary Hospital in Dar Es Salaam were factors contributing to medicines wastage [10]. This requires effective and efficient inventory management for the prevention of pilferage and damage [41, 42].

Anti-infectives (23.28%), central nervous system (7.36%), and anesthesia (4.21%) took a greater share of wastage value in the present study. Anti-infective medicines and cardiovascular medicines wastage was 18.9% and 8.9% in tertiary Hospitals in Dar Es Salaam [10] and Sweileh et al. study in Palestinian hospital showed that alimentary, musculoskeletal, and anti-infective agents were the most common categories [9]. The University hospital pediatric units of Brazil showed that 22.7% antimicrobials, 14.8% electrolytes, 14.6% analgesics/pain killers, 9.5% diuretics, and 6.7% antiulcer agents were wasted [43]. This might be attributed to health facilities in developing countries like Ethiopia were more prone to infectious disease as they demand more anti-infective. On the other hand, the reason for the inflated wastage rate of injectable might be due to perceived superior efficacy which letter increases purchase volume resulted from deviation in prescribing practices from the standard recommended by WHO [44]. Delivery of near expiry date drugs was also the main reason [45].

Nearly two-thirds of respondents did not take training on pharmaceutical waste management and having training increases pharmaceutical waste management by 4.34. The proportion of respondents who had received specific training was 11.5% in Nigeria [46], 40% in Khartoum state hospital [47], and low in Bangladesh [48]. Continuous training should be conducted and for further improvement, a larger number of trained specialists in the field is mandatory [36].

Proper management of pharmaceutical wastes requires separating and storing wastes at the point of generation. In the present study, nearly two and one-third of the respondents label
and store (AOR = 0.72) on pharmaceutical wastes respectively, and this was significantly associated with pharmaceutical wastes management. The finding was better than hospitals in Addis Ababa [38], health centers in West Gojjam Zone [39], and low-level health facilities in Tanzania [49] where waste separation and treatment practices were poor. So, all healthcare facilities are obligated to separate, label, and safely put away and limit access to wastes from unauthorized personnel [36]. The storage area should be enclosed, labeled, and separated from other waste storage area [17].

The commonly used container or bag for segregation was a carton in the health facilities of Dessie town. Similarly, normal waste bins used for over 75% disposed of pharmaceuticals in selected hospitals of Ghana [50]. In the University hospital of Brazil, sharps’ disposable box with a yellow bag, sink drain, sharps box with orange bag, and infectious waste/bin with a white bag was used [43]. When planning storage of waste, the characteristics of the specific chemicals to be stored and disposed of must be considered [17] and all waste-bag seals should be in place and intact until they are transported to disposal sites [51].

This study found that the presence of a pharmaceutical waste disposal plan (AOR = 16.93) was statistically associated with waste management. There were no specific regulations or guidelines used for waste management in health centers in West Gojjam Zone [39], Ghana [50, 52], and most of the developing countries including Asia [24]. Similarly, 55% of hospitals in Khartoum state have no clear policy of waste management and only 20% have a waste disposal plan.

### Table 5. Pharmaceutical waste management practices in public health facilities of Dessie town, Ethiopia, (n = 135).

| Sr. no | Descriptions                           | Number | Percentage |
|--------|----------------------------------------|--------|------------|
| 1      | Container or bag used for segregation  | Carton | 92         | 68.1       |
|        |                                        | Plastic bag | 19 | 14.1       |
|        |                                        | Wastebasket | 24 | 17.8       |
| 2      | Writing label on segregated waste      | Yes    | 81         | 60         |
|        |                                        | No     | 54         | 40         |
| 3      | Recording of segregated waste          | Yes    | 90         | 66.7       |
|        |                                        | No     | 45         | 33.3       |
| 4      | Storage of segregated waste awaiting removal | Dispensing unit | 48 | 35.6       |
|        |                                        | Pharmacy store | 63 | 46.7       |
|        |                                        | Both   | 24         | 17.8       |
| 5      | Waste disposal guideline                | Yes    | 87         | 64.4       |
|        |                                        | No     | 48         | 35.6       |
| 6      | Waste disposal plan                     | Yes    | 79         | 58.5       |
|        |                                        | No     | 56         | 41.5       |
| 7      | Waste disposal team                     | Yes    | 89         | 65.9       |
|        |                                        | No     | 46         | 34.1       |
| 8      | Place of disposal                       | Municipal land | 45 | 33.3       |
|        |                                        | Health facility compound | 90 | 66.7       |
| 9      | Frequency of disposal                   | Annually | 103    | 76.3       |
|        |                                        | Quarterly | 17    | 12.6       |
|        |                                        | Every six month | 15    | 11.1       |
| 10     | Method of disposal                      | Incineration | 27    | 20         |
|        |                                        | Burning | 86    | 63.7       |
|        |                                        | Landfill | 22    | 16.3       |
| 11     | Impact of waste disposal on the environment | Yes    | 92    | 68.1       |
|        |                                        | No     | 43    | 31.9       |

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management plan [53] while 9% and 47% of the healthcare facilities in Ilala and Kinondoni, respectively do not have the standard operating procedures [49]. As a result, waste management practice in Mizan Tepi University teaching hospital [40] and different hospitals of Jordan [25] was not coherent with the WHO guideline. Burning was a widely practiced method of disposal. Hospitals of Addis Ababa dispose of through incineration [38], while health centers in West Gojjam Zone used local types of incinerators and open burn [39]. Most of the pharmaceuticals in the present study were disposed of within the health facilities compound. This was in line with the disposal practice of hospitals of Addis Ababa [38] while most of the low-level facilities have no specific disposal sites in Tanzania [49]. Nowadays, pharmaceutical waste disposal generates large quantities of waste and by-products [21]. The explosion of toxic air pollutants due to open burning and dumping on uncontrolled sites may contaminate the environment or increase the chance of diversion of products to the market for resale and misuse [4] and proper disposal is still a significant challenge in developing countries [23].

Sixty-eight percent (68%) of respondents believed that the current pharmaceutical waste management and disposal had an impact on the environment. A study conducted in Jordan showed that there is a statistically significant impact between environment and efficiency and effectiveness of medical waste separation, waste classification, waste collection, and storage in hospitals [28]. Contamination of wastewater by antibiotics or other pollutants can lead to the rise of drug resistance [54]. As a result, pharmaceutical waste can harm patient’s or medical

Table 6. Socio-demographic factors associated with pharmaceutical waste management in public health facilities of Dessie town.

| Sr. no | Socio-demographic profile | Pharmaceutical waste management | COR (95% CI) | AOR (95% CI) |
|--------|---------------------------|---------------------------------|--------------|--------------|
|        |                           | Yes vs No                        |              |              |
| 1      | Sex                       |                                 |              |              |
|        | Male                      | 61(84.7) 11(15.3)               | 0.38(0.16–0.89) | 3.72(1.4–9.85) |
|        | Female                    | 43(68.3) 20(31.7)               | 1            | 1            |
| 2      | Age                       |                                 |              |              |
|        | 20–29                     | 67(80.7) 16(19.3)               | 1.57(0.37–6.59) | 2.27(0.24–21.06) |
|        | 30–39                     | 29(70.7) 12(29.3)               | 0.90(0.20–4.01) | 1.03(0.14–7.3) |
|        | ≥40                       | 8(72.7) 3(27.3)                | 1            | 1            |
| 3      | Work experience           |                                 |              |              |
|        | <5                        | 41(78.8) 11(21.2)               | 1.97(0.69–5.62) | 1.54(0.32–7.45) |
|        | 10–May                    | 46(80.7) 11(19.3)               | 2.21(0.78–6.27) | 2.34(0.56–9.77) |
|        | >10                       | 17(65.4) 9(34.6)                | 1            | 1            |
| 4      | Level of education        |                                 |              |              |
|        | Diploma                   | 48(80) 12(20)                  | 0.73(0.32–1.67) | 3.44(0.54–21.59) |
|        | Degree                    | 56(74.7) 19(25.3)             | 1            | 1            |
| 5      | Profession                |                                 |              |              |
|        | Pharmacy                  | 34(81) 8(19)                   | 1.49(0.55–4.04) | 1.77(0.52–5.99) |
|        | Druggist                  | 33(76.7) 10(23.3)              | 1.15(0.44–2.99) | 0.26(0.37–1.83) |
|        | Other*                    | 37(74) 13(26)                  | 1            | 1            |
| 6      | Training on pharmaceutical waste management | | | |
|        | Yes                       | 36(90) 4(10)                   | 0.28(0.09–0.86) | 4.34(1.28–14.69) |
|        | No                        | 68(71.6) 27(28.4)             | 1            | 1            |

Other* Midwifery, health officer, nurse, laboratory technology.

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employee’s health, as well as the environment [36] and it is more beneficial to educate and improve practice regarding disposal of pharmaceutical waste [55].

A large number of pharmaceuticals are used every day and their use is on the rise. Effective and efficient pharmaceutical management in health institutions is a crucial factor for reducing waste and plays a greater role in the environmentally responsible disposal of pharmaceutical waste. Therefore, the study pinpointed to health institutions and decision-makers the extent of

| Sr. no | Descriptions                                      | Yes          | No          | COR (95% CI)   | AOR (95% CI)   |
|-------|--------------------------------------------------|--------------|-------------|----------------|----------------|
| 1     | Container or bag used for segregation             |              |             |                |                |
|       | Carton                                           | 67(64.4)     | 25(80.6)    | 0.38(0.1–1.39) | 0.3(0.04–2.08) |
|       | Plastic bag                                       | 16(15.3)     | 3(9.7)      | 0.76(0.13–4.28) | 0.31(0.02–3.5) |
|       | Wastebasket                                       | 21(20.3)     | 3(9.7)      | 1              | 1              |
| 2     | Writing label on segregated waste                 |              |             |                |                |
|       | Yes                                               | 73(90.1)     | 8(9.9)      | 0.14(0.06–0.36) | 5.04(1.28–19.7) |
|       | No                                                | 31(57.4)     | 23(42.6)    | 1              | 1              |
| 3     | Recording of segregated waste                     |              |             |                |                |
|       | Yes                                               | 76(84.4)     | 14(15.6)    | 0.3(0.13–0.69) | 1.36(0.4–4.63) |
|       | No                                                | 28(62.2)     | 17(37.8)    | 1              | 1              |
| 4     | Storage of segregated waste awaiting removal      |              |             |                |                |
|       | Dispensing unit                                   | 34(70.8)     | 14(29.2)    | 0.81(0.26–2.46) | 0.72(0.01–0.57) |
|       | Pharmacy store                                    | 52(82.5)     | 11(17.5)    | 1.57(0.5–4.87) | 0.2(0.02–1.51) |
|       | Both                                              | 18(75)       | 6(25)       | 1              | 1              |
| 5     | Waste disposal guideline                          |              |             |                |                |
|       | Yes                                               | 77(88.5)     | 1011.5      | 0.16(0.17–0.39) | 1.3(0.34–4.98) |
|       | No                                                | 27(56.3)     | 2143.8      | 1              | 1              |
| 6     | Waste disposal plan                               |              |             |                |                |
|       | Yes                                               | 74(93.7)     | 5(6.3)      | 0.07(0.02–0.22) | 16.93(2.71–105) |
|       | No                                                | 30(53.6)     | 26(46.4)    | 1              | 1              |
| 7     | Waste disposal team                               |              |             |                |                |
|       | Yes                                               | 80(89.9)     | 9(10.1)     | 0.12(0.05–0.3) | 1.89(0.44–8.02) |
|       | No                                                | 24(52.2)     | 22(47.8)    | 1              | 1              |
| 8     | Place of disposal                                 |              |             |                |                |
|       | Municipal land                                    | 29(64.4)     | 16(35.6)    | 2.75(1.2–6.29) | 0.27(0.07–1.01) |
|       | Health facility compound                          | 75(83.3)     | 15(16.7)    | 1              | 1              |
| 9     | Frequency of disposal                             |              |             |                |                |
|       | Annually                                          | 77(74.8)     | 26(25.2)    | 0.21(0.02–1.68) | 0.68(0.04–10.3) |
|       | Quarterly                                         | 13(76.5)     | 4(23.5)     | 0.23(0.02–2.35) | 0.25(0.01–4.7) |
|       | Every six month                                   | 14(93.3)     | 1(6.7)      | 1              | 1              |
| 10    | Method of disposal                                |              |             |                |                |
|       | Incineration                                       | 15(55.6)     | 12(44.4)    | 0.19(0.04–0.82) | 0.11(0.01–1.39) |
|       | Burning                                           | 70(81.4)     | 16(18.6)    | 0.69(0.18–2.62) | 0.89(0.14–5.47) |
|       | Landfill                                          | 19(86.4)     | 3(13.6)     | 1              | 1              |
| 11    | Impact of waste disposal on the environment       |              |             |                |                |
|       | Yes                                               | 73(79.3)     | 19(20.7)    | 0.67(0.29–1.55) | 0.47(0.11–2.01) |
|       | No                                                | 31(72.1)     | 12(27.9)    | 1              | 1              |

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pharmaceutical wastage and waste management to optimize scarce resources and safeguarding the health of healthcare providers, clients, and the general population. The study utilizes recorded data from health facilities and the information management systems in health institutions may introduce bias to the study. Moreover, the cross-sectional nature of this study might make it harder to establish a temporal relationship.

**Conclusion**

Supplies constituted the leading class of pharmaceuticals wastage. Tablet and injectable had the highest class of pharmaceuticals dosage forms wastage. The pharmaceutical wastage rate was higher than the standard wastage rate. The wastage rate was increasing in successive years and the expiry of pharmaceuticals was the major reason. The pharmaceutical wastage rate of health centers was nearly twofold higher than hospitals.

More than two-thirds of health professionals had practiced pharmaceutical waste management. Cartons were used as a sort of container for segregation and pharmaceuticals waste disposed of within health facilities compound and the usual method of disposal were burning in the open air. Determinants of pharmaceutical waste management were the sex of health professionals, receiving training on pharmaceutical waste management, writing a label on segregated waste, storage of segregated waste in dispensing unit, and the presence of disposal plan. Appropriate inventory management and the development and adoption of clear health facility-specific health care waste management plans and policies are recommended. The finding of this study will be used as input for researches. It will also help policymakers for developing interventional measures for reducing pharmaceutical wastage and execute proper pharmaceutical waste management practices.

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