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# Expiry of medicine in public health facilities of Arsi Zone, Oromia Regional State, Ethiopia: a quantitative and qualitative study

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**ABSTRACT**

Medicines are one of the critical elements of a well-functioning healthcare system, but their expiry remains one of the significant challenges in the healthcare sector. This study aims in assessing the extent of the issue and identifying the expired medicine types and their underlying causes in some selected public health facilities of Arsi Zone, Oromia Regional State, Ethiopia. This study is a mixed-method, which includes both quantitative and qualitative components. The quantitative research was undertaken by retrospective data extraction of recorded medicines as expired for the specified period. At the same time, the qualitative part is a facility-based cross-sectional survey study with self-administered questionnaires and semi-structured in-depth interviews engaging the health professionals of study facilities to explore the reasons for the expiration of medicines. Fifteen health facilities were selected from the study zone. The total monetary value of expired medicines in the studied health facilities during 2017-2019 was 185,938.86 USD. In the same period, all study facilities received medicines worth 2,425,882.64 USD, resulting in an expiry rate of 7.66%. The top classes of wasted medicines through expiry in terms of value were anti-infectives (35.51%) and medicines for central nervous system (CNS) disorders (20.48%). In comparison, by dosage forms, nearly half were solid dosage forms (48.81%), followed by liquid dosage forms (41.82%). Delivery of near expiry date medicines by Ethiopia's Pharmaceuticals Supply Agency (PSA), lack of a system to exchange nearly expired medicines between facilities, and presence of overstocked medicines due to improper forecasting of need were the common perceived factors contributing to the expiry of medicines. Thus, the Policymakers should make decisions to reduce the contributing factors of medicines expiry to reduce wastage of medicines and promote appropriate utilization of finite resources.

## INTRODUCTION

Medicines are indispensable products in health care service delivery [1]. They can be used to prevent, diagnose, cure, mitigate, or treat disease. According to the World Health Organization (WHO) standards, essential drugs are those drugs that the nation must have sufficient quantities at all times for the management of the most common ailments that afflict the more significant number of its population [2]. The essential drug classification is unique to each country as what may be regarded as non-essential in one country may be critical to another country due to each country's disease patterns and level of development. An estimated one-third of the world's population lacks regular access to essential drugs, with this figure rising to over half in the poorest parts of Africa and Asia countries [3,4].

In ensuring the availability of medicines to the population, there is a possibility that these medicines may be damaged or expired and become unsafe for use. In addition, medicines leftover from patients and those identified to be defective may accumulate over time, adding to the stock of unsafe medicines. The resulting stockpiling of these unfit for use medicines is usually called 'medicines waste' [5,6]. According to WHO, medicines wastage is defined as unwanted medications which include expired, unused, spilt and contaminated medicines that are no longer required and need to be disposed of appropriately [7,8]. Medicines waste

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as defined by the Ethiopian Food, Medicine and Health care Administration and Control Authority (EFMHACA) disposal directive includes all expired, damaged, improperly sealed or labelled or stored, counterfeit, substandard and adulterated, prohibited or unauthorized medicines [9].

Although medicines comprise a significant proportion of healthcare expenditure, limited research exists on expired medicines' causality and economic impact. Some of the leading causes of the expiry of medicines include poor pharmaceutical management and lack of human resources and accountability [10]. In developing countries, where budgets for medicines are often tight, the supply cycle needs to be well-managed to prevent all types of wastage, including pilferage, misuse and expiry. This wastage reduces the number of medicines available to patients and the quality of health care they receive. The expiry of medicines leads to significant wastage of resources, resulting in a reduced availability of medicines, which may also impact the quality of healthcare provided to patients and ultimately engender loss of confidence in the health system.

Medicines are one of the critical elements of a well-functioning healthcare system, yet one-third of the global population does not have regular access to medicines. Moreover, more than half of the population has no regular access to essential medicines. This is especially in low-income countries [11]. One reason for the high inaccessibility of medicines is brought about from wastage due to expiry and damage [12,13], and the expiry of medicines is a serious threat to the already constrained access to medicines in developing countries.

The expiry of medicines highlights a problem with the supply chain, which includes medicine selection, quantification, procurement, storage, distribution and use. It is essential to determine the factors contributing to expiry at each stage of the supply cycle to design pragmatic strategies to reduce the problem. Medicines and their management are an important health system function in improving and maintaining health, however, the lack and wastage of essential medicine are still one of the most severe public health problems [14].

Reducing medicine expiry is therefore essential in contexts of shortages of medicine. Globally, expired medicines contribute to the poor performance of health systems, driving up costs and reducing access to quality care for patients [15]. Conversely, well-managed and controlled medicine supplies that keep wastage to a minimum may strengthen health system functioning and contribute to public health and trust in healthcare [15-17].

Medicine expiry is one of the challenges of medicine supply chain management in Ethiopia [18]. The reasons include inadequate documentation of expiry medicines due to the absence of accountability within health facilities for proper documenting and reporting of expiration, lack of tools that automatically capture expiry, and lack of a system that obligates health facilities to record and report medicine expiry in the country. All these issues result in a considerable amount of medicine expiry in Ethiopia. This problem requires urgent attention and mitigation [19].

Although there are reports that reveal the expiry of medicines in Ethiopia, there is a lack of objective evidence on the type and extent of medicines expiry and its contributing factors. So, in the view of the above facts, the study was aimed to determine the extent and to identify types of expired medicines and their underlying causes in selected public health facilities of Arsi Zone, Oromia Regional State, Ethiopia.

## METHODOLOGY

A mixed-method study, which includes both quantitative and qualitative components, was undertaken in some public health facilities of Arsi Zone, Oromia Regional States. The study area comprises around 20 Public community pharmacies, 97 Drug stores, 107 Health Centers and 9 Hospital pharmacies. The quantitative study was undertaken by retrospective data extraction of medicines recorded as expired from September 2016 to August 2019, and was conducted from September 2019 – August 2020. The qualitative part is a facility-based cross-sectional survey study with self-administered questionnaires and semi-structured in-depth interviews to explore the reasons for the expiration of medicines. The data collection was carried out from February 2020 to March 2020. Both the quantitative and qualitative studies were undertaken in selected public health facilities of Arsi Zone.

All the public health facilities found in Arsi Zone were considered to be the potential source facilities, while the health professionals and all the documents that were used for medicines expiry registration/disposal reports, as well as drug and medical supplies receiving vouchers were considered as sources of information. The health professionals involved in medicine supply management activities and all records of medicines registration/disposal reportage and drug and medical supplies reception from September 2016 to August 2019 in the sampled health facilities were contemplated as the study population.

Among the health facilities of the Arzi Zone, facilities which served more than three years in operation, with the staffs still employed in the facility from the study period (from September 2016 to date), and with the facilities maintaining expired medicines records were included in the study. Facilities that recorded expired medicines from the free price program and donations were excluded from the study.

The sample size of health facilities was calculated by applying the Logistics Indicators Assessment Tool (LIAT) [20]. Accordingly, by using multi-stage sampling techniques, 15 health facilities were selected out of 60 health facilities with more than three years of health services. Of the selected, five were hospitals and ten were health centers. For the quantitative and qualitative part of the study, health professionals engaged in the Drug and Therapeutics Committee (DTC) and other medicines supply management activities of the facilities employed during the study period and those having a willingness to participate were chosen using the purposive sampling technique. Additionally, the chief executive officers (CEOs) of health facilities or head of health facilities and pharmacy departments in selected health facilities were also purposively designated as key informants for the qualitative semi-structured in-depth interviews.

The authors collected the data using data abstraction formats and self-administered questionnaires, and the

***Table 1.*** The value of medicines (received and expired) and estimation of total medicines expiry rate in the facilities (2017-2019), Arsi Zone, Ethiopia

| S.No | Health Facilities | Year 2017 | | | Year 2018 | | | Year 2019 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Received (USD) | Expired (USD) | % | Received (USD) | Expired (USD) | % | Received (USD) | Expired (USD) | % |
| 1. | Facility 1 | 320545.61 | 30902.15 | 9.64 | 506022.52 | 35664.37 | 7.05 | 393266.25 | 35292.52 | 8.97 |
| 2. | Facility 2 | 54431.53 | 3026.45 | 5.56 | 57585.38 | 3064.76 | 5.32 | 46624.41 | 3589.41 | 7.70 |
| 3. | Facility 3 | 70374.32 | 3285.57 | 4.67 | 73180.14 | 3701.88 | 5.06 | 83690.30 | 3740.18 | 4.47 |
| 4. | Facility 4 | 31345.04 | 2455.94 | 7.84 | 35660.44 | 2864.55 | 8.03 | 46542.24 | 3027.26 | 6.50 |
| 5. | Facility 5 | 61635.75 | 2906.22 | 4.72 | 67115.74 | 3139.61 | 4.68 | 45500.28 | 2608.05 | 5.73 |
| 6. | Facility 6 | 21225.92 | 1717.39 | 8.09 | 22009.78 | 1747.38 | 7.94 | 22392.15 | 1792.90 | 8.01 |
| 7. | Facility 7 | 17236.22 | 1593.12 | 9.24 | 17106.04 | 1587.45 | 9.28 | 18970.57 | 1638.19 | 8.64 |
| 8. | Facility 8 | 15772.82 | 1496.31 | 9.49 | 16150.30 | 1438.87 | 8.91 | 15397.59 | 1519.87 | 9.87 |
| 9. | Facility 9 | 17273.76 | 1350.13 | 7.82 | 17102.78 | 1417.85 | 8.29 | 17206.78 | 1446.18 | 8.40 |
| 10. | Facility 10 | 14951.24 | 1488.87 | 9.96 | 15889.52 | 1519.88 | 9.57 | 15209.97 | 1442.99 | 9.49 |
| 11. | Facility 11 | 16900.78 | 1551.44 | 9.18 | 16716.90 | 1701.53 | 10.18 | 16152.18 | 1294.82 | 8.02 |
| 12. | Facility 12 | 20463.67 | 1664.00 | 8.13 | 18703.60 | 1662.53 | 8.89 | 16902.66 | 1480.32 | 8.76 |
| 13. | Facility 13 | 18367.95 | 1709.81 | 9.31 | 18591.22 | 1668.13 | 8.97 | 17586.42 | 1447.20 | 8.23 |
| 14. | Facility 14 | 19529.29 | 1742.42 | 8.92 | 19149.93 | 1670.01 | 8.72 | 18703.78 | 1480.49 | 7.92 |
| 15. | Facility 15 | 17086.14 | 1442.99 | 8.45 | 16151.42 | 1405.47 | 8.70 | 17461.33 | 1551.39 | 8.88 |
| Total | | 717140.04 | 58332.83 | 8.13 | 917135.70 | 64254.26 | 7.01 | 791606.90 | 63351.77 | 8.00 |

1 USD=26.65 Birr, average conversion rate has been used

principal investigator conducted the qualitative semi-structured in-depth interviews. Records of medicines wastage and disposal reports were reviewed to abstract secondary data value and types of wasted medicines. For medicines wastage value, a data collection sheet was developed [20], and for medicines expiry, the data collection sheet was prepared based on the EFMHACA medicines waste management and disposal directive [9]. The following formula was used to calculate the medicine expiration rate in percentage.

**Medicines Expiration Rate** =
(Values of medicines expired in a year)/
(Total values of medicines received in the same year).

The self-administered questionnaire, which contained questions about socio-demographic characteristics (age, sex, level of education and average income) and perceived contributing factors of medicines expiry, was adapted from Nakyanzi *et al.*, [3] with minor modifications. A semi-structured interview guide was prepared to explore the ideas of key informants about contributing factors, consequences and efforts in preventing or minimizing the problem.

The questionnaire for the study was pre-tested in two health centers that were not included in the study. Data collectors were trained for two days on the data collection instruments and processes before data collection. For the in-depth interviews, the interview guide was tested for its face and content validity by two experts from the public health department of our institution.

The expired medicines were also grouped into pharmacological categories and dosage form categories for better analysis of the medicine's expiry. The analysis was performed in aggregate, and descriptive parameters such as Frequency, Mean, Standard Deviation (SD) were calculated for different variables. In the case of in-depth inter-view, the data were analyzed using a thematic analysis approach. Key themes such as contributing factors, consequences and suggestion for improving medicines expiration were reviewed and handled manually.

## RESULTS

### Quantitative Findings

#### *The extent of Medicines Expiry*

The total monetary value of expired medicines in the studied health facilities during 2017-2019 was 185,938.86 USD. In the same period, all study facilities received medicines worth 2,425,882.64 USD, resulting in an expiry rate of 7.66%. In the year 2017, there was an overall expiration of 58,332.83 USD, accounting for an average of 8.13% of the total value of medicines received by all health facilities. In 2018, the expiration value was estimated to be 64,254.26 USD, indicating an annual expiration rate of 7.01% for the study facilities. In 2019, there was an overall expiration of 63,351.77 USD, in which the yearly expiration rate was estimated to be 8.00%. The monetary value of medicines received and expired in the studied facilities is tabulated in Table 1. The Birr (Local Ethiopian Currency) to USD conversion rate was used as 1 USD = 26.65 Birr on average, as on September 2017, 2018, and 2019 the rate was 23.25, 27.32, and 29.40 Birr, respectively.

#### *Classes of Expired Medicines*

Overall, 150 types of wasted medicines were recorded in all health facilities during 2017-2019. The most common pharmacological classes of expired medicines in terms of value were anti-infectives (35.51%), medicines used for the treatment of central nervous system disorder (20.48%), medicines for correcting water, electrolyte and acid-base balance (15.40%) and gastrointestinal (9.27%). The estimated value of expired medicines by pharmacological classification is shown in Table 2.

#### *Medicines Expired by Dosage Form*

All types of dosage forms (solid, semisolid, liquid and gaseous) of expired medicines were found in the studied health facilities. Out of the total value of expired medicines (185,938.86 USD), nearly half were solid dosage forms – 48.81% (90,750.62 USD), followed by liquid dosage forms – 41.82% (77,768.77 USD), semisolid dosage forms – 9.26% (17,216.62 USD) and gaseous dosage forms – 0.11% (202.85 USD). In specific, of the total value of expired medicines, 26.96% (50,126.19 USD) were found in the form of injectables, 18.85% (35,040.72 USD) were in the form of capsules, and 16.42% (30,534.56 USD) of the expired medicines were tablets. The estimated value of wastage of medicines by dosage forms is shown in Table 3.

***Table 2.*** Estimated value of expired medicines by classes in the study facilities (2017-2019), Arsi Zone, Ethiopia

| S.No | Class of Medicines | Value of Medicines Expired USD (%) |
|---|---|---|
| 1. | Anti-infectives | 66020.01 (35.51) |
| 2. | Central Nervous System | 38082.46 (20.48) |
| 3. | Water, Electrolyte and Acid-Base balance | 28658.33 (15.41) |
| 4. | Gastrointestinal | 17243.45 (9.27) |
| 5. | Cardiovascular | 9939.77 (5.35) |
| 6. | Anaesthetics | 6233.59 (3.35) |
| 7. | Respiratory | 4074.96 (2.19) |
| 8. | Vitamins and Minerals | 3090.53 (1.66) |
| 9. | Obstetric/Gynecological | 2065.14 (1.11) |
| 10. | Endocrine | 1882.84 (1.01) |
| 11. | Ophthalmic agents | 1862.31 (1.00) |
| 12. | Dermatological agents | 1807.00 (0.97) |
| 13. | Musculoskeletal | 1401.34 (0.75) |
| 14. | Water for injection | 1180.08 (0.63) |
| 15. | Anti-histamines | 995.69 (0.54) |
| 16. | Immunological preparation | 719.11 (0.39) |
| 17. | Ear-Nose-Throat preparations | 682.23 (0.37) |
| Total | | 185938.86 (100) |

***Table 3.*** Estimated value of wastage of medicines by dosage forms in the study facilities (2017-2019), Arsi Zone, Ethiopia

| S.No | Types of Dosage Forms | Value of Expired Medicines USD (%) |
|---|---|---|
| 1. | Solid Dosage Forms | |
| | Capsules | 35,040.72 (18.85) |
| | Tablets | 30,534.56 (16.42) |
| | Powders | 25,175.34 (13.54) |
| 2. | Liquid Dosage Forms | |
| | Injections | 50,126.19 (26.96) |
| | Suspensions | 19,250.69 (10.35) |
| | Syrups | 6,398.89 (3.44) |
| | Drops | 1,622.87 (0.87) |
| | Elixirs | 370.13 (0.20) |
| 3. | Semisolid Dosage Forms | |
| | Ointments | 9,884.46 (5.32) |
| | Suppositories | 3,901.83 (2.10) |
| | Creams | 2,250.25 (1.21) |
| | Gels | 1,180.08 (0.63) |
| 4. | Gases Dosage Forms | |
| | Aerosols/inhalations | 202.85 (0.11) |
| Total | | 185,938.86 (100) |

## Qualitative Findings

### *Socio-Demographic Characteristics of Respondents*

A total of 50 health professionals aged 21-42 years (mean ± SD = 28.08±5.54 years) were engaged as respondents during the study. Among the 50 respondents, 25 (50%) were pharmacy professionals (pharmacists/druggists), 8 (16%) were nurses, 7 (14%) were health officers, and 5 (10%) were medical doctors and laboratory technologists. Most of the respondents, 28 (56%), had 5-10 years of work experience, as shown in Table 4.

***Table 4.*** Socio-demographic characteristics of health professionals working in the study facilities (2017-2019), Arsi Zone, Ethiopia (n=50)

| Variables | N (%), n=50 |
|---|---|
| Age | |
| 21-30 Years | 35 (70) |
| 30-40 Years | 13 (26) |
| >40 Years | 2 (4) |
| Sex | |
| Male | 30 (60) |
| Female | 20 (40) |
| Profession | |
| General Practitioners | 5 (10) |
| Pharmacists | 15 (30) |
| Druggists | 10 (20) |
| Health Officers | 7 (14) |
| Nurses | 8 (16) |
| Laboratory Technologists | 5 (10) |
| Level of Education | |
| Diploma | 13 (26) |
| First Degree/Graduates | 37 (74) |
| Work Experience | |
| <5 Years | 20 (40) |
| 5-10 Years | 28 (56) |
| >10 Years | 2 (4) |

N=Number, %-Percentage

### *Perceived factors contributing to medicine expiry*

A total of 16 factors, which were believed to influence medicine expiry, were given as questionnaires to all the respondents, and the responses were assessed using a 5-point Likert scale. The most common perceived factors contributing to medicine expiry were "Delivery of near expiry medicines to the health facilities" – 4.36±0.91 (Mean ± SD), «Poor stock management such as using neither FIFO nor FEFO in stock management» – 4.24±0.81, «Presence of overstocked medicines due to improper forecasting in the facilities» – 4.00±1.08, and «Absence of functional DTC in the health facility» – 3.94±1.17. The mean score of all the responses on different contributing factors is shown in Table 5.

### *Qualitative semi-structured in-depth interview findings*

In-depth interviews were conducted with CEOs and Pharmacy heads. All the key informants (a total of 15) were males with the age range of 35-42 years. Their work experiences ranged from 3-14 years. The interview was held with three patterns of responses: factors that contribute to medicines wastage, the consequence of medicines' wastage on service delivery, and suggestions for improving medicines' wastage.

### *Factors that contribute to medicines wastage*

The key informants mentioned several reasons as contributing factors. Among these are the provision of medicines

***Table 5.*** Perceived factors contributing to medicines expiry by health professionals in the study facilities (2017-2019), Arsi Zone, Ethiopia (n=50)

| S.No | Contributing Factors | Frequency (%) | | | | | Mean | SD |
|---|---|---|---|---|---|---|---|---|
| | | Disagree Strongly | Disagree | Neutral | Agree | Strongly Agree | | |
| 1. | Near expiry medicines (< 6 months) are being delivered to the health facility | 1 (2) | 3 (6) | 0 (0) | 19 (38) | 27 (54) | 4.36 | 0.91 |
| 2. | Lack of system to move near expiry medicines between facilities | 2 (4) | 8 (16) | 6 (12) | 14 (28) | 20 (40) | 3.84 | 1.22 |
| 3. | Presence of over stocked medicines due to poor quantification in the facility | 2 (4) | 3 (6) | 8 (16) | 17 (34) | 20 (40) | 4.00 | 1.08 |
| 4. | Lack of electronic stock management tools in the health facility | 4 (8) | 7 (14) | 9 (18) | 18 (36) | 12 (24) | 3.54 | 1.22 |
| 5. | The shortage of pharmacy human resources in the facility | 3 (6) | 10 (20) | 3 (6) | 20 (40) | 14 (28) | 3.64 | 1.25 |
| 6. | Poor communication with key stake holders (health bureau, suppliers, NGO's) | 4 (8) | 6 (12) | 2 (4) | 20 (40) | 18 (36) | 3.84 | 1.25 |
| 7. | Weak or no mechanisms for expiry monitoring and evaluation in the health facility | 4 (8) | 9 (18) | 7 (14) | 19 (38) | 11 (22) | 3.48 | 1.24 |
| 8. | Poor stock management, i.e. using neither FIFO nor FEFO in stock management | 0 (0) | 2 (4) | 6 (12) | 20 (40) | 22 (44) | 4.24 | 0.81 |
| 9. | No accurate data available in the health facility to facilitate quantification | 4 (8) | 10 (20) | 15 (30) | 16 (32) | 5 (10) | 3.16 | 1.10 |
| 10. | Absence of functional DTC in the health facility | 2 (4) | 7 (14) | 3 (6) | 18 (36) | 20 (40) | 3.94 | 1.17 |
| 11. | Lack of accountability for stock-outs and expiry of medicines in the facility | 5 (10) | 11 (22) | 12 (24) | 17 (34) | 5 (10) | 3.12 | 1.16 |
| 12. | Medicines are purchased without procurement plan/policy in the facility | 0 (0) | 6 (12) | 12 (24) | 19 (38) | 13 (26) | 3.78 | 0.97 |
| 13. | Selection of medicines are not based on available EML in the health facility | 1 (2) | 8 (16) | 10 (20) | 13 (26) | 18 (36) | 3.78 | 1.15 |
| 14. | Nonparticipation of prescribers in medicine selection & quantification of the facility | 2 (4) | 3 (6) | 14 (28) | 15 (30) | 16 (32) | 3.80 | 1.08 |
| 15. | Lack of knowledge and skills of pharmacy professionals in supply management | 3 (6) | 15 (30) | 22 (44) | 5 (10) | 5 (10) | 2.88 | 1.01 |
| 16. | Abrupt changes of treatment practices results in medicines expiry within the facility | 8 (16) | 14 (28) | 11 (22) | 10 (20) | 7 (14) | 2.88 | 1.29 |

Response scores ranged from Strongly agree (5) to Disagree Strongly (1)

without needs and requisition, lack of electronic stock management tools, absence of functional DTC, poor storage facilities, lack of communication between the *Pharmaceuticals Supply Agency* (PSA) and health facilities, insufficient pharmacy personnel and weak monitoring systems. Inadequate availability of pharmacy professionals was also mentioned as a reason, which in turn resulted in a high available staff workload. At this juncture, some clinical nurses were employed in medicine management, which contributed to medicines wastage.

According to the key informants, the poor attitude of health facility administrators to the pharmacy service, absence of medicines wastage controlling mechanisms such as reporting and auditing, weak supervision of inventory management, lack of accountability for wasted medicines and lack of regular discussion with key stakeholders on issues were responsible for medicines wastage.

### *The consequence of medicine wastage on service delivery*

Key informants were asked for their opinion on the effect of medicines wastage on their service provision. Financial burden (budget constraint) and shortage of storage size (space limitation) were among the consequences mentioned by key informants. All key informants revealed that the major challenge in medicines wastage was congested storage. According to the key informants, a large proportion of the storage space is occupied by wasted medicines.

### *Suggestions for improving medicines wastage*

The respondents were asked to provide suggestions on how to improve medicine wastages in public health facilities. Employing additional pharmacy professionals, conducting regular discussions on medicines supply management with key stakeholders and enhancing communication of the health facility with other health facilities and supplier were among the suggestions made to improve medicines wastage. They also suggested that there should be an electronic medicine supply management tool to allow for the monitoring of stock levels and expiry dates. Based on the need to overcome supply challenges, all respondents recommended PSA should provide medicines with long expiry dates.

## DISCUSSION

In this study, the medicines expiration rate was 7.66%, which is slightly lower than the nationally reported figure of 8.3% [21]. However, this result is higher than the study conducted in Addis Ababa, which was 4.8% [19]. This variation could be due to differences in the level of health facilities included, such as considering only hospitals. The study also showed that the average rate of medicine expiry was higher than the national target of below 2% set within the Health Sector Development Program (HSDP IV) [22]. In contrast to our results, Auditable Pharmaceutical Transactions and Services (APTS) practice in Ethiopia reported much lower figures of 0.27% and 1.1% expiry rate [23,24]. The higher figure of medicine expiration rate in the present study might be due to the non-implementation of APTS practice in public health facilities of Arsi Zone. An overall increase in the average expiry rate was observed for all selected health facilities. The key informant interview revealed the absence of Integrated Pharmaceutical Logistics System (IPLS) implementation, which would be the reason for an increase in the rate of medicines expiry. Impact evaluation report showed that IPLS is improving the loss of medicines due to expiration [25].

This study showed that delivery of near expiry medicines (<6 months) to the health facilities by the suppliers, lack of a system to move near expiry medicines from one facility to another, presence of overstocked medicines due to improper forecasting of need in the facilities, absence of electronic stock management tools and shortage of pharmacy staffs in the health facilities as major contributing factors for medicines expiration. Similar study findings such as short shelf life, improper forecasting of need leading to overstock and poor inventory control as significant factors for high wastage rates of medicines was also reported [3]. In contrast to the above findings, a study conducted in developed countries showed that poor compliance of medicines, stop or change of medication, side effect and patient death were the major contributing factors for medicines expiration [26,27].

This study recognized delivery of near expiry medicines to the health facilities by the suppliers as one of the contributing factors for medicines expiration. The results of this study are similar to the study conducted in Uganda, where almost half of the expired medicines was due to the provision of medicines that were about to expire [14] and in Ethiopia, where delivery of near expiry medicines is a key driver for the medicines wastage in public health facilities [28]. This study also made evident that the presence of overstocked medicines due to improper forecasting of need in the health facilities was the primary cause of medicines expiry. The key informant interview showed that provision of medicines without requirements by suppliers also resulted in the overstocking of medicines. Similarly, a study done in Uganda and Tanzania showed that overstocking of medicines was a major contributing factor for the expiry of medicines [3,29]. Overstocking of medicines usually produces a high number of expired medicines and a high cost of storing excess stock [30]. Therefore, there is a need to have a proper quantification and forecasting of medicine requirements using reliable consumption data from health facilities and provision of medicines through a demand-based approach from suppliers.

The other identified factor for medicines wastage was the lack of electronic stock management tools in the health facilities. An effective inventory control system provides timely, accurate information. This helps to reduce the incidence of stock-outs and controlling wastage [31]. Electronic logistic management information systems are more reliable systems in generating accurate information than paper-based systems. [31]. However, it is highly recommended to apply both computerized and paper-based systems for excellent reconciliation of stock data. When used effectively, automation eases the tediousness of medicine inventory management, saves personnel time, and promotes the quality of services [32]. Therefore, emphasis should be made to ensure that the use of electronic tools and other systems of stock recordings are well established and applied effectively.

Shortage of pharmacy staffs in the facilities was cited as one of the contributing factors for medicines wastage, both in the survey and in the in-depth interview. This finding was similar to what was found in the assessment report undertaken in South Africa, where inadequate availability of pharmacists in the facilities was identified as possibly contributing to medicines wastage [33]. Human resources are a key performance driver within medicine supply chains. Shortage of human resources could play a role in medicines' wastage due to increased workload, decreased stock level monitoring and limitations in the application of other medicine management tools [34]. Thus, the number of pharmacy staff should be increased to reduce workload and improve medicine supply management.

A certain amount of medicines wastage is inevitable, but it is also estimated that about 50% of all medicines wastage is likely to be preventable [26]. All the key informants suggested that having an adequate number of pharmacy professionals, strengthening DTC, conducting regular supervision, having regular discussion on medicines supply management activities with key stakeholders and improving the communication of the health facility with other health care actors and with suppliers, were among the suggestions made to improve medicines wastage.

### Strength and Limitation of the Study

The strengths of this study include that the study used both quantitative and qualitative methods to supplement each other. The limitations include that the study covered only wasted medicines with a price list, and it did not show the wastage rate of program and donation medicines due to the absence of price records.

## CONCLUSION

The study revealed that the extent of medicines expiry in public health facilities of Arsi Zone was high. The medicines expiry rate was estimated to be 7.66%. The top classes of wasted medicines through expiry in terms of value were anti-infectives and medicines for central nervous system (CNS) disorders. Delivery of near expiry date medicines by PSA, lack of a system to exchange nearly expired medicines between facilities, presence of overstocked medicines due to improper forecasting of need in the facilities, lack of electronic stock management tools and shortage of pharmacy professionals in the health facilities were identified as major contributing factors for medicines wastage. Thus, the Policymakers should make decisions to reduce the contributing factors of medicines expiry to reduce wastage of medicines and promote appropriate utilization of finite resources. These are major challenges requiring regulation, learning good drug distribution practices from developed countries, and applying responsible logistics management. In view of the long-time drug supply chain problem, an increased oversight of drug distribution is required, for which international public health organizations can be invited for assistance.

## ETHICAL CONSIDERATIONS

The Institutional Ethical Review Committee approved the study (Approval Reference Number: COHS/R/0057/2019/20). Permission to conduct the research at the respective health facilities was secured from the respective heads of study facilities. Written informed consent from each study participant was obtained. All the data collected from participants in the study was kept confidential by not using personal identifiers. Moreover, for confidentiality and ethical issues, names of study health facilities were identified as codes.

## COMPETING INTERESTS

All authors declare that they have no competing interests.

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