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# KNOWLEDGE, ATTITUDES, AND PRACTICES RELATED TO THE DISPOSAL OF EXPIRED AND UNUSED MEDICATIONS IN HOUSEHOLD IN DUHOK CITY, KURDISTAN REGION, IRAQ

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**ABSTRACT:**

Unused, unwanted, and expired household medications can accumulate and be improperly disposed of, posing a major national and international public health and environmental concern. This problem is primarily caused by a lack of awareness and understanding of appropriate medicine disposal techniques. This study aimed to assess the knowledge, attitudes, and practices regarding the disposal of unused, unwanted, or expired household medicines among the general public in Duhok city, in the Kurdistan Region of Iraq. Between March 6 and June 6, 2023, 250 participants were interviewed in person using a pre-validated structured questionnaire for this cross-sectional study. The accuracy of the returned questionnaires was verified multiple times. Descriptive statistics were calculated for the sample population's characteristics, and the findings were presented in tables as percentages. Out of the 250 respondents included in the study, 115 (46%) were females, and 165 (66%) were married. A total of 205 (82%) of the respondents had formal education. The most commonly used disposal practice for unused medicines was throwing them in household garbage, as reported by 137 (54.8%). Interestingly, 127 (61.95%) of the participants who disposed of medicines in the garbage had formal education. About 68 (27.2%) of the participants kept unused or unwanted medicines at home for future use or until expiration, followed by giving them to friends and relatives (23, or 18.07%), while a few (12, or 9.27%) burned medicines at home. Significantly, 206 (82.4%) of the respondents did not check the expiry date before taking medicine. A majority of respondents, 155 (62%), held the government responsible for creating awareness about proper medicine disposal. Almost all participants (220, or 88%) felt that improper disposal of unused and expired medicines can affect the environment and health. This study revealed that the most common ways to dispose of unused, unwanted, and expired medication were tossing them in the trash and storing them for later use. There is an urgent need to address the fact that most study participants disposed of medicine in unsafe ways. Nonetheless, the majority of participants agreed that improper disposal of medications poses a threat to public health and the environment. Therefore, both national and local stakeholders urgently need to implement tailored interventions to address the situation.

**KEYWORDS:** Unused/Unwanted, Expired Medicines, Household medicine disposal, Environment, Duhok city

## 1. INTRODUCTION

While medications can save lives, improper use and management can have severe negative consequences (Boxall, 2004). The amount of pharmaceutical waste produced worldwide from unwanted, unused, and expired medications is a major concern (Kusturica *et al*., 2016). Due to an increase in health-seeking awareness and behavior, there is a global rise in the production and consumption of medicines (Levinson *et al*., 2015; Latunji *et al*., 2018). In England, the number of prescription drugs rose from 852 million in 2008 to over 1.1 billion in 2018. Similarly, despite a mere 21% increase in population, prescriptions in the United States of America (USA) have surged by 85% over the last ten years. Prescription sales are expected to increase by 7.4% globally by 2026 (Watkins *et al*., 2022).

The accumulation of medication in households can be caused by various factors, including adverse drug effects, dosage or regimen changes, prescription changes, recovery from illness, medicine expiration or discontinuation, manufacturer promotions, physician prescribing and dispensing practices, patient non-adherence (Kristina, 2018; Bashaar *et al*., 2017; Maeng *et al*., 2016), doubts about the continued necessity for medication, forgetfulness, fear of future shortages, and the desire to lower future healthcare costs (Insani *et al*., 2020; Kahsay *et al*., 2020; Makki *et al*., 2019; Ayele *et al*., 2018; Naser *et al*., 2021). Patients may also store medications in their homes because they believe they may need them in the future (Bettington *et al*., 2018). Due to a lack of knowledge about proper medicine disposal techniques, leftover, unused, and expired medications at home can pose risks to the environment, wildlife, human health, and the ecosystem (Vollmer, 2010; Daughton *et al*., 2008; Paut Kusturica *et al*., 2017).

The majority of the households that wish to get rid of medicines in their homes do so using inappropriate disposal methods (Insani *et al*., 2020; Ayele *et al*., 2018; Alnahas *et al*., 2020). Inappropriate disposal of unused and expired medication harms the environment (Bashaar *et al*., 2017), increases the risk of accidental poisoning and abuse, wastes healthcare resources, prevents access to medical treatment, and raises the risk of antimicrobial resistance in aquatic life and wildlife (Sahoo *et al*.,

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2010; Kusturica *et al*., 2012). The most popular disposal methods are throwing medicines in garbage cans and flushing them down toilets (Bashaar *et al*., 2017; Insani *et al*., 2020; Kahsay *et al*., 2020; Ayele *et al*., 2018; Azmi Hassali *et al*., 2020; Manocha *et al*., 2020; Angi'enda *et al*., 2016). Inappropriate drug disposal has led to trace amounts of numerous medications being detected in drinking water, surface water bodies, and groundwater (Vollmer, 2010; Kotchen *et al*., 2009; Smith, 2002). The active pharmaceutical ingredients in improperly disposed medicines significantly contribute to soil and water pollution (Glassmeyer *et al*., 2009). Studies show that the most common methods to dispose medications are pouring liquid dosage forms down the sink or sewer system and tossing solid dosage forms in the trash (Bashaar *et al*., 2017; Abahussain *et al*., 2012; AlAzmi *et al*., 2017; Ariffin *et al*., 2019). The best method for disposing of medications is incineration, although it is not practical at the household level (Vollmer, 2010).

Numerous medications, including acetaminophen, verapamil, ciprofloxacin, estriol, paracetamol, sulfamethoxazole, and estradiol, have been detected in waterways in the United States and Africa (Bashaar *et al*., 2017; Mahlaba *et al*., 2022). Traces of ethinyl estradiol, an active ingredient in many oral contraceptives, have been found to hamper fish sexual development and cause feminization (Jobling *et al*., 2006; Zeilinger *et al*., 2009). A study from Pakistan reports a significant decrease in the vulture population due to diclofenac exposure (Oaks *et al*., 2004). Renal tubular damage has also been reported as a result of exposure to expired or degraded tetracycline (Frimpter *et al*., 1963).

Research indicates that the presence of antibiotics in water can lead to antibiotic resistance and, over time, have a genetic impact on both marine life and humans (Wu, 2009). Furthermore, improper medication disposal raises the risk of drug abuse by teenagers, particularly when the medications are habit-forming, and can inadvertently poison young children (Al-Shareef *et al*., 2016; Ross-Durow *et al*., 2013). In addition to the detrimental effects on the environment and public health, wasting medication has significant financial ramifications (Abou-Auda, 2003; Zargarzadeh *et al*., 2005). Therefore, the issues surrounding the inappropriate disposal of unwanted, unused, and expired medications must be addressed immediately.

Customers must understand how to properly dispose of expired, unwanted, and unused medications to address the issue of pharmaceutical waste. Consumers need support and education on appropriate disposal methods to prevent environmentally harmful practices, such as flushing medications down the toilet, garbage disposal, or sink (Seehusen *et al*., 2006). When disposing of unused or expired medications at home, it is best to carefully contain the drugs with other inert materials before bringing them to a facility that handles pharmaceutical waste (Smith, 2002; McCullagh *et al*., 2012).

The World Health Organization's European Centre for Environment and Health, located in France, has established several initiatives, including the Dispose of Unwanted Medication Properly (DUMP) campaign in New Zealand (Braund *et al*., 2009) and the ENVIRx disposal program in Canada (Gagnon, 2009). The UK and most EU nations recommend returning unwanted medications to a pharmacy to reduce the amount of Active Pharmaceutical Ingredients (API) that end up in wastewater treatment plants (Vollmer, 2010). However, some nations lack formal policies or procedures for disposing of unused and unwanted pharmaceuticals (Götz *et al*., 2007; Abahussain *et al*., 2007; Tong *et al*., 2011).

Furthermore, no research has been conducted or published on household knowledge, attitudes, and practices regarding the proper disposal of unused and expired medications in the Kurdistan Region of Iraq. As a result, the purpose of this study is to evaluate this issue.

## 2. MATERIAL AND METHODS

**Study Area:**

The study was carried out in Duhok City, in Kurdistan Region of Iraq, from March to July 2023, involving 250 respondents from 250 households. Approximately 450,000 people live in the city of Duhok, which is situated at latitudes 36°85′ N and longitudes 42°97′ E. Duhok is located at an elevation of 430–450 meters above sea level (Hassan *et al*., 2023). The region has an average annual temperature of 19.2°C and an average annual rainfall of 533.7 mm (Najmaldin, 2023). The climate is semi-arid, with hot, almost rainless summers and chilly to cold, wet winters, typical of Upper Mesopotamia (Hassan, 2023).

**Sample Methods and Data Collection:**

A pre-validated structured questionnaire was used for in-person interviews in this descriptive, cross-sectional survey (Bashaar *et al*., 2017; Ayele *et al*., 2018; Mahlaba *et al*., 2022; Husain *et al*., 2017). According to Leslie Kish, only one member from each selected household was randomly chosen for an interview to prevent information duplication (Kish, 1949). The study population included individuals of both genders (male and female) and local residents of Duhok city over the age of 18, regardless of race or employment status. To enhance comprehension, the questionnaire was provided in both Kurdish and English and was back-translated for accuracy. On average, it took about ten to fifteen minutes to complete.

**Study Instrument:**

The questionnaire was divided into three sections. The first section collected sociodemographic information about the study participants, including their gender, age, marital status, level of education, employment status, and monthly income. Part II explored the relationships between participants' demographic traits and their practices for disposing of unused, unwanted, or expired medications. The third section assessed participants' knowledge about expired, unwanted, and unused medications.

**Data Analysis:**

After double-checking each completed questionnaire for accuracy, the data were entered into an Excel spreadsheet and confirmed by a second person. After cleaning, the data were transferred to SPSS for examination. We computed descriptive statistics, such as means, standard deviations, frequencies, and percentages, based on the sample characteristics.

**Ethical Consideration:**

The Environmental Sciences Department Ethics Review Committee at Zakho University granted ethical approval. Before the commencement of the survey, each respondent provided informed consent. The identity of the participants was kept confidential.

## 3. RESULTS AND DISCUSSIONS

The study gathered data from 250 respondents in Duhok City, Kurdistan Region of Iraq. All 250 individuals approached consented to take part in the study, resulting in a 100% response rate. Table 1 displays the sociodemographic details of the participants. Among the participants, 46% were male, and 54% were female, with 56% being over the age of 30. The majority of respondents (66%) were married, and 82% had completed formal education. Employment status varied, with 26.4% working part-time or full-time, 21.6% self-employed, 21.2% students, 19.2% unemployed, and 11.6% retired. Most participants (84%) had a monthly income greater than $300 (Table 1).

**Table 1:** Participants' Social-Demographic Characteristics

| Variable | | Number (%) |
|---|---|---|
| Gender | Male | 115 (46%) |
| | Female | 135 (54%) |
| Age | < 30 | 110 (44%) |
| | ≥ 30 | 140 (56%) |
| Marital status | Single | 85 (34%) |
| | Married | 165 (66%) |
| Educational status | None | 45 (18%) |
| | Formal education | 205 (82%) |
| Employment | Student | 53 (21.2%) |
| | Self-employed | 54 (21.6%) |
| | Working part or full-time | 66 (26.4%) |
| | Unemployed | 48 (19.2%) |
| | Retired | 29 (11.6%) |
| Monthly income | < 300$ | 40 (16%) |
| | 300-499$ | 128 (51.2%) |
| | 600-899$ | 44 (17.6%) |
| | ≥ 900$ | 38 (15.2%) |

Table 2 presents the results of participants' attitudes regarding the relationships between demographic characteristics and the disposal practices of unused, unwanted, or expired medications. The table shows the following distribution of participants who store medications at home for later use or until they expire: females 43 (31.85%), males 25 (21.74%); age < 30: 8 (7.27%), age ≥ 30: 36 (25.71%); single: 9 (10.59%), married: 35 (21.21%); no education: 2 (4.44%), formal education: 44 (21.46%). In contrast to previous research (Kristina, 2018; Bashaar *et al*., 2017; Insani *et al*., 2020; Bettington *et al*., 2018; Mahlaba *et al*., 2022; Kampamba *et al*., 2021; Vellinga *et al*., 2014; Hassali *et al*., 2020; Okoro *et al*., 2020; Gidey *et al*., 2020; Wieczorkiewicz *et al*., 2013; Al-Shareef *et al*., 2016; Gupta *et al*., 2019), fewer participants in our study kept their medications in storage for future use. Household members in the Kurdistan Region lack knowledge about safe medication disposal techniques. Therefore, the media, physicians, pharmacists, and other professionals should be primary sources of education on this issue. Men in our study were less inclined to return medications to collection facilities and less motivated to figure out how to properly dispose of them, similar to findings by Al-Shareef *et al*. (Al-Shareef *et al*., 2016). Females were more likely than males to give unwanted medications to others, as seen in research by Shaaban *et al*. (Shaaban *et al*., 2018). The main reasons for having unused or expired medications were switching to different medications after experiencing side effects, discontinuing medications after feeling better (unfinished treatment), noncompliance, and excess quantity supplied (Wieczorkiewicz *et al*., 2013; Ruhoy *et al*., 2007). No pharmacy in Kurdistan provides advice on how to dispose medications after treatments are completed. Therefore, doctors, pharmacists, and other medical professionals should guide patients on the safe disposal of household medications that are no longer needed or have expired.

Participants who gave medicines to friends or relatives were as follows: females 15 (11.11%), males 8 (6.96%); age < 30: 4 (3.64%), age ≥ 30: 9 (6.43%); single 2 (2.35%), married 21 (12.73%); no education 11 (24.44%), formal education 28 (13.66%). As indicated by Table 2, the majority of participants disposed of expired or unused medications by throwing them in the garbage: females 61 (45.19%), males 76 (66.09%); age < 30: 88 (80%), age ≥ 30: 83 (59.29%); single 63 (74.12%), married 67 (40.6%); no education 16 (35.56%), formal education 127 (61.95%). The most common method of medication disposal in this study was throwing unused medications in household trash, which is not an appropriate way to dispose of pharmaceuticals. These results are consistent with those reported in the United States, Kuwait, Malaysia, Serbia, and other countries (Bashaar *et al*., 2017; Ayele *et al*., 2018; Kusturica *et al*., 2012; Manocha *et al*., 2020; Kotchen *et al*., 2009; AlAzmi *et al*., 2017; Ariffin *et al*., 2019; Gidey *et al*., 2020; Wieczorkiewicz *et al*., 2013; Marwa *et al*., 2021; Al-Naggar *et al*., 2010). When recycling was less popular, more unused medications might have been discarded with the garbage. Regrettably, disposing of medications in this way opens the door for misuse and potential harm (Okoro *et al*., 2020). Medication reimbursement programs provided by pharmacies encourage individuals to retain their medications rather than discard them. Such programs can help reduce the burden on both the community and the government.

Only six participants—one married, five singles, and five with formal education—returned medications to a medical store or pharmacy. Studies by Watkins *et al*. (27%) (Watkins *et al*., 2022), Okoro and Peter (10.3%) (Okoro *et al*., 2020), and Kampamba *et al*. (4.4%) reported higher (Kampamba *et al*., 2021) and lower return rates to pharmacies compared to the current study (4.7%). This percentage may reflect a lack of knowledge about proper medication disposal. Research from Sweden, Portugal, New Zealand, and the United States shows that most participants in those studies returned unwanted medications to pharmacies (Dias-Ferreira *et al*., 2016; Kozak *et al*., 2016). The observed difference might result from effective mechanisms promoting proper disposal of unused medication. Pharmacies and medical stores in Kurdistan do not accept unwanted or unused medications from the public. Consequently, we recommend implementing legal and administrative regulations to address this issue.

Of the participants, only 12 (9.27%) burned medications at home. Among them, 9 were married, 3 were single, and 9 were female. None had formal education. Our findings align with studies conducted in Tanzania and Ethiopia (Gidey *et al*., 2020; Marwa *et al*., 2021), but our result was higher than the Nigerian study (4.2%) (Okoro *et al*., 2020). High-temperature incineration is the most ecologically friendly method for disposing of drug waste, but this requires returning medications to pharmacies (Smith, 2002). Despite other disposal options, incineration requiring third-party collection of unwanted medications is the best choice for secure disposal of pharmaceutical waste (Smith, 2002). For example, the US Environmental Protection Agency-approved high-temperature incineration method is used by community pharmacies in Australia's Return of Unused Medication Service to collect and destroy medications (Tong *et al*., 2011).

Only three individuals, all with no education (one married and two singles; one male and two female), flushed or sank medications into their toilets. This is significantly fewer than the number of participants in studies from other countries such as Sweden, India, Malaysia, South Africa, Germany, Tanzania, Zambia, and Nigeria, where a higher percentage of people are concerned about the effects of pharmaceuticals (Makki *et al*., 2019; Alnahas *et al*., 2020; Azmi Hassali *et al*., 2020; Mahlaba *et al*., 2022; Braund *et al*., 2009; Kampamba *et al*., 2021; Okoro *et al*., 2020; Gidey *et al*., 2020; Marwa *et al*., 2021; Persson *et al*., 2009; Shivaraju *et al*., 2017). This concern has been linked to awareness-raising campaigns (Persson *et al*., 2009). It is conceivable that the Kurdistan Region has not yet seen any well-publicized national campaigns regarding the disposal of medical waste. Flushing pharmaceuticals down the toilet or washbasin is one of the least suitable methods of disposal, as this leads to the transfer of drugs into water sources (Daughton, 2003). Providing consumers with clear instructions on how to dispose of unused or expired medications could reduce the potentially harmful effects of improper disposal. We propose that the government focus on managing free medications provided at public hospitals, as research indicates a higher rate of medication waste when medications are provided at no cost.

None of the participants buried any medications. Only one educated female participant under the age of thirty donated medication to a hospital. Furthermore, according to a Turkish online survey, 34.0% of participants returned unused medications to the hospital (Akici *et al*., 2018). This finding is consistent with a prior Ethiopian study (Gidey *et al*., 2020). One possible explanation for the lower rate of donation in this study could be a lack of knowledge about the proper disposal of unused or expired medications. In contrast, other studies conducted in Europe and various regions have reported higher rates of unused and expired medications being returned to healthcare facilities (Braund *et al*., 2009; Dias-Ferreira *et al*., 2016; Kozak *et al*., 2016; Persson *et al*., 2009). Increasing government and organizational involvement in educational initiatives and mass media campaigns may help prevent improper medication disposal in Kurdistan. Consequently, the country needs a formal, mandatory procedure for the disposal of medications.

Consistent with Turkish and Irish studies, our study found no significant gender-based differences in the methods used to dispose of unwanted or unused medications (Vellinga *et al*., 2014; Akici *et al*., 2018). In line with other published studies (Akici *et al*., 2018; Rogowska *et al*., 2019), we found a significant correlation between age and the methods used for disposal. Specifically, older participants (over thirty) were more likely than younger participants to burn, give away, or throw away unwanted or unused medications. The majority of participants disposed of medications in various ways. Since reducing improper disposal is the goal of any intervention, it is crucial to understand the motivations behind these behaviors. It is also important to recognize that transitioning from inappropriate disposal to a more labor-intensive method requires different strategies than simply increasing pharmacy disposal options. We recommend creating a national policy, a legislative framework, and implementing staff training to ensure the effective management of pharmaceutical waste.

**Table 2:** The Relationships Between the Unused, Unwanted, and Expired Medicine Disposal Practices and Participant Demographic Features

| Variable | Gender | | Age | | Marital status | | Educational status | |
|---|---|---|---|---|---|---|---|---|
| | Female | Male | < 30 | ≥ 30 | Single | Married | None | Formal education |
| Keep at home for future use/ until expiration | 43 (31.85%) | 25 (21.74%) | 8 (7.27%) | 36 (25.71%) | 9 (10.59%) | 35 (21.21%) | 2 (4.44%) | 44 (21.46%) |
| Give to friends/relatives | 15 (11.11%) | 8 (6.96%) | 4 (3.64%) | 9 (6.43%) | 2 (2.35%) | 21 (12.73%) | 11 (24.44%) | 28 (13.66%) |
| Throw in garbage | 61 (45.19%) | 76 (66.09%) | 88 (80%) | 83 (59.29%) | 63 (74.12%) | 67 (40.6%) | 16 (35.56%) | 127 (61.95%) |
| Return to medical store/pharmacy | 4 (2.96%) | 2 (1.74%) | 3 (2.73%) | 3 (2.14%) | 5 (5.88%) | 1 (0.6%) | 1 (2.22%) | 5 (2.44%) |
| Burn at home | 9 (6.67%) | 3 (2.6%) | 4 (3.64%) | 8 (5.71%) | 3 (3.53%) | 9 (5.45%) | 12 (26.67%) | 0 (0%) |
| Flush into toile/sink | 2 (1.48) | 1 (0.87%) | 2 (1.82%) | 1 (0.71%) | 2 (2.35%) | 1 (0.6%) | 3 (6.67%) | 0 (0%) |
| Donate to hospital | 1 (0.74%) | 0 (0%) | 1 (0.9%) | 0 (0%) | 1 (1.18%) | 0 (0%) | 0 (0%) | 1 (0.49%) |
| Bury underground | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Total (100%) | 135 (100%) | 115 (100%) | 110 (100%) | 140 (100%) | 85 (100%) | 165 (100%) | 45 (100%) | 205 (100%) |

Results regarding participants' knowledge about the disposal of unused, unwanted, or expired medicines are presented in Table 3. The majority of the respondents (220; 88%) stated that improper disposal of these medicines can impact human health and the environment (Table 3). These results align with previous research, which found that over half of participants were aware of the harm caused by improper disposal of unused and expired medications (Kristina, 2018; Bashaar *et al*., 2017; Insani *et al*.,

2020; Ayele *et al*., 2018; Gidey *et al*., 2020; Vellinga *et al*., 2014; Shamim, 2018). However, our findings contradict those of Mahlaba *et al.* (Mahlaba *et al*., 2022).

To prevent further environmental harm, it is crucial to reduce the improper disposal of medications by ensuring they are disposed of appropriately and safely (Peake *et al*., 2015). Our study indicates that disposing of unused or expired medications via sinks, toilets, or garbage bins negatively affects the environment, potentially harming aquatic life, contaminating drinking water, and posing risks to human health (Boxall, 2004; Tong *et al*., 2011). Expired or unused medications can damage ecosystems, harm wildlife, and may be inadvertently ingested by small children. Research suggests that the release of expired and unused medications, such as antibiotics, into the environment may contribute to the rise in antimicrobial resistance (AMR) (Bashaar *et al*., 2017).

Furthermore, 155 (62%) out of 250 respondents stated that it was the government's duty to raise awareness regarding the appropriate disposal of outdated and unused medications. Notably, over 97% of participants reported that someone in their family had accidentally taken medication . Only 21 respondents checked the expiration date in both situations, whereas the majority did not check it before taking the medication (206; 82.4%) or before buying it at the pharmacy (218; 87.2%) [Table 3]. Our findings closely resemble those published by Mahlaba in South Africa (Mahlaba *et al*., 2022).

It is crucial to check the expiration date on any medication before using it or purchasing it, as failure to do so could have serious consequences. The Kurdistan Region currently lacks established policies for disposing of unused medications and does not have provisions for pharmacies to accept unused medicines. Therefore, suitable plans for the collection and disposal of unused medications are urgently needed. Many doctors collaborate with pharmacies and prescribe a large number of medications. We recommend that the government thoroughly investigate this issue and take appropriate measures to address it.

**Table 3:** Knowledge of Respondents Regarding the Disposal of Expired, Unwanted, and Unused Medicines

| Variable | Number (%) |
|---|---|
| Improper disposal of unused/unwanted/expired medicine can affect the environment and well-being | |
| Yes | 220 (88%) |
| Do not know | 27 (10.8%) |
| No | 3 (1.2%) |
| Who is responsible for creating awareness the proper disposal of unused/unwanted/expired medicines? | |
| Government | 155 (62%) |
| Pharmacist | 34 (13.6%) |
| Pharmaceutical industries | 38 (15.2%) |
| Public | 16 (6.4%) |
| Media | 7 (2.8%) |
| Had in your family ever taken a medicine by mistake? | |
| Yes | 243 (97.2%) |
| Do not know | 5 (2%) |
| No | 2 (0.8%) |
| Do you check the expired medicine before taking it? | |
| Yes | 21 (8.4%) |
| Do not know | 23 (9.2%) |
| No | 206 (82.4%) |
| Do you check the expiration date at the pharmacy before taking the medicine? | |
| Yes | 21 (8.4%) |
| Do not know | 11 (4.4%) |
| No | 218 (87.2%) |

## CONCLUSION

Expired or unused medications are frequently disposed of improperly in Duhok City. Most research participants discarded unused and expired medications in toilets, washbasins, household trash, or stored them for later use or until they expired. These practices may contribute to pollution and public health issues. It is the government's responsibility for establishing a robust, safe, and affordable pharmaceutical waste management program and launching a comprehensive media campaign to educate the public about the risks of using expired medications. Decision-makers must develop a formal, mandatory procedure for disposing of unwanted, unused, and expired medications. The way medications are prescribed and disposed of has a significant environmental negative impact. It is crucial to address both prevention and resolution of the problem by utilizing knowledge through training programs and ongoing education.

Improper waste disposal techniques remain prevalent among residents of Duhok. Therefore, there is a need for education and other strategies. Finally, disposing of pharmaceuticals at home poses a serious risk to the environment and public health. This challenge can be addressed by implementing take-back programs, educating the public, promoting responsible purchasing, and providing alternatives. Furthermore, we recommend banning the sale of medications without a prescription and urge doctors to prioritize strategies to reduce overprescribing while emphasizing the importance of patient compliance.

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