

Original Research

An assessment of the Storage and Disposal of Unused Medications in Southern Jordan: Knowledge and Socio-Demographic Influences

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Abstract

Background: Improper storage and disposal of unused medications in households raise global concerns due to environmental, health, and animal welfare impacts. **Objectives:** This study aims to investigate medication storage and disposal practices in southern Jordan while identifying socio-demographic factors contributing to household medicines' storage and evaluating the level of knowledge regarding medicines disposal. **Methods:** Between January and July 2023, a cross-sectional study was conducted in southern Jordan. In the current study, an online questionnaire was designed based on a comprehensive review of relevant literature. Data analysis was performed using Statistical Package for Social Science (SPSS) software. The Chi-Square test and logistic regression were employed to assess the relationships between socio-demographic factors and the storage of medications. **Results:** All participants stored unused medications at home, with 43.4% expired. The primary reason for storage, cited by 49.8% of respondents, was the anticipation of future use. Analgesics were the most commonly stored type and kept in kitchens and bathrooms. Logistic regression analysis revealed significant links between storage practices and socio-demographic factors such as age group more than 61 (p-value <0.001), Illiterate (p-value = 0.006), large family size (p-value = 0.012), no health insurance (p-value <0.001), and high income (p-value = 0.027), with gender having no significant effect. Half of the participants throwing medications in the garbage. The Pharmacists played a pivotal role as the primary source of information on medication disposal, yet there was a lack of knowledge concerning the consequences of improper disposal. **Conclusion:** The prevalence of storage of unused medications and improper disposal was high in southern Jordan. This study underscores the necessity for government policies regulating medicine dispensing to ensure appropriate quantities and reduce excess household storage. Furthermore, public awareness campaigns should educate individuals on safe disposal methods for unused medications at home and assist in mitigating associated risks.

Keywords: Medication storage; drug disposal; unused medication; public knowledge; southern Jordan

INTRODUCTION

Medication that patients no longer need is known as unused medication, and proper disposal is required.¹ The World Health Organization (WHO) reports that approximately 50% of patients do not take their medications as prescribed.² A high rate of medication non-adherence results in the accumulation of medications in the household. As a result of the changes in the patient's treatment plan, symptoms improve, the ineffectiveness of the medication, or medications are expired.³ By retaining medications in their homes, patients may unintentionally miss the opportunity to improve the health of others due to the limited availability of these medicines.⁵ Moreover, patients believe that they might use leftover medications for similar illnesses in the future if they store them.⁶

Householding of medications can have dangerous consequences. Including the risk of self-medication with an

improper dose regimen; self-medicating with antibiotics can increase the risk of bacterial resistance to these medications.⁷ Also, the potential for consuming expired medicines due to a patient's lack of knowledge in reading and checking expiry dates increases the potential for experiencing adverse reactions to the drugs.⁸ There is a concern regarding the unintentional consumption of unused medications by children and adolescents.⁹⁻¹¹ The accidental intake of certain medications, such as opioids, by adolescents may result in addiction.¹² In case children take medications like antihypertensive drugs mistakenly, it can lead to decreased heart rate, coma, and even death.¹³ These situations can have numerous high-risk outcomes.

Proper storage is crucial for maintaining medication effectiveness. Photosensitive, hygroscopic, and thermolabile medications should be kept away from light, protected from moisture, and refrigerated. Improper storage can cause the medication to lose its effectiveness, become unusable, and ultimately be wasted.¹⁴ A recent study in Jordan stated that inappropriate and unsafe storage of medications in householding, often not stored in their original packaging, led to 24.99% waste of the stored medications.¹⁵

In addition to health risks, the environmental impact of improper disposal is also concerning. Improper disposal of unused medications is a global concern¹⁶ as it harms

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the environment, humans, and wildlife.^{4, 17} Traces of pharmaceutical compounds have been found in drinking and surface water since the 1990s.¹⁸ The United States waterways contain acetaminophen, ethinyl estradiol, and verapamil, which harm aquatic ecosystems.¹⁹ Moreover, research has indicated that the active ingredient of contraceptives, 17- α -ethinyl estradiol, may affect the sexual development of fish.²⁰ In addition, antibiotics can infiltrate water sources used for irrigation, contaminating the soil—a significant source of human pathogens that affect human and animal health.²¹ Such practices can contribute to the long-term development of bacterial resistance.²² Improper disposal of medication can lead to a significant economic burden. Around 3.5 million tons of medical waste, including unused medications, are produced annually in the United States, the world's largest producer of medical waste, with a disposal cost of \$790 per ton.²³ In Jordan, the healthcare sector is a leading provider in Asia and North Africa, attracting numerous patients from various countries. That led to a substantial increase in medical waste generation and associated disposal costs.²⁴ In 2008, monthly expenses for medical waste disposal in northern Jordan ranged from \$70 to \$1330.²⁵ In the current study, the definition of proper disposal is returning medications to pharmacies or hospitals. However, various improper methods were identified, including flushing medicines down the toilet and throwing them in the trash.²⁶

Developed countries (The United States and Australia) have established policies and guidelines to improve good practices for storing and disposing unused medications.²⁷ These established policies underscore the significance of returning unused medicine to healthcare facilities for appropriate donation or disposal. The development of guidelines is in response to the growing worries surrounding incorrect practices related to storing unused medications and their improper disposal, which have reached alarming levels in developed countries like Canada, the United States, and Europe.¹⁵ Developing countries, such as Saudi Arabia, Kuwait, and Qatar have revealed that individuals store significant amounts of unused medications in inappropriate conditions.²⁸⁻³⁰ Like Jordan, these countries lack official guidelines for the proper disposal of unused medicine,^{30, 31} and there is a noticeable deficiency in implementing well-established policies for pharmaceutical waste management, resulting in the inadequate handling of such waste.²⁴

The consequences of improper storage and disposal of medications are crucial, highlighting the importance of enacting legislation and executing official guidelines for the proper storage and disposal of medicines in developing nations. Public awareness of suitable storage and disposal of medication is low in developing countries.²⁸ Conversely, in Germany and Sweden, there is a significant increase in the return rate (around 50%) of unused medications to pharmacies due to public awareness about proper storage and disposal of medicine.³² To the best of our knowledge, no previous studies have evaluated the practices of individuals in southern Jordan regarding the storage and disposal of medications. Therefore, this study aimed to estimate those practices and to determine socio-demographic parameters associated with the tendency to store unused medications. In addition, it assesses the level of knowledge about medication disposal.

METHODS

Study Design and Setting

This study is a cross-sectional survey conducted in southern Jordan to evaluate medication storage and disposal practices. The questionnaire was distributed online through social media platforms such as Twitter, WhatsApp, and Facebook using Google Forms. The survey was conducted between January and July 2023. Participants included in this research were 18 years or older. To ensure the quality of responses, each participant could submit only one response, and answering all questions was mandatory to save their responses and ensure data completeness. This section included information about the survey's purpose, estimated completion time, and the assurance of maintaining the confidentiality of their information.

Survey Instrument

The questionnaire consists of four sections. The initial section of the survey contained the consent form. The second section for socio-demographic information (7 questions), included variables such as gender (male, female), age (18–30, 31–45, 46–60, >61), educational level (illiterate, elementary education, secondary education, bachelor's degree, MSc or PhD), number of family members (<3, 3–6, 7–11, >11), having health insurance (Yes, No), occupation (medical career, non-medical career, unemployment), and monthly income (less than 500 JD, 501–1,000 JD, more than 1,000 JD). The third section is about the storage practice of medications (6 questions); owning unused medications (Yes, No), owning expired medications (Yes, No, I do not know), number of unused medications (1–5, 6–10, more than 10, I do not know), number of expired medications (1–5, 6–10, more than 10, I do not know), types of unused medications that stored at home (antibiotics, analgesics, vitamins, antacids, antidiabetic, antihypertensive, antidepressant), storage places of unused medications (custom cabinet, fridge, different places in household), reasons for keeping unused medications (prescription of large doses, symptoms of the disease have improved, medication is of bad smell or the taste, the doctor changes the treatment plan, the possibility of using them again). The fourth section of the survey evaluates the knowledge of the public regarding the appropriate disposal of unused medications (5 questions); the methods for disposing of unused medications (returning them to the pharmacy, giving them to friends or relatives, throwing them in the trash, flushing them down into the toilet), are there any consequences for improper disposal of medications? (Yes, No, I do not know), have you ever received advice on the proper disposal of unused medications? (Yes, No), are you interested in learning how to dispose of unused medications safely? (Yes, No), source of knowledge regarding the proper disposal methods of unused medications (social media, physician, pharmacist, university courses, friends).

Reliability and validity

Previously published studies served as a guide for developing this questionnaire.^{15, 33, 34} Questions were adapted from these studies and refined through collaborative discussions within



the research team. Initially created in English, the questionnaire was later translated into Arabic, the native language in Jordan, to ensure that all participants could understand and respond effectively. The questionnaire underwent evaluation for content validity by three faculty members at Al-Balqa Applied University. These faculty members are pharmacists with postgraduate degrees in pharmacy and expertise in the relevant field. Based on their valuable feedback, the research team made revisions to enhance the quality of the survey and its effectiveness. To evaluate the content validity index of the current survey instruments, we sought input from four faculty members. The content validity index (CVI) of 1 indicates that the experts considered each item highly relevant to the research objectives. The questionnaire content is valid based on this high CVI score.

The instrument's validity was assessed using principal component analysis (PCA). The Kaiser-Meyer-Olkin (KMO) value, which exceeded the cutoff point at 0.5 with a value of 0.7, confirmed an adequate sample size for the study. The suitability of factor analysis was confirmed by Bartlett's test of sphericity (p -value = 0.001). Scree plots were used to identify four factors aligned with survey domains, which was the optimal number of factors. These components explained 57.1% of the overall variation. We assessed the internal consistency of each factor using Cronbach's alpha, resulting in a value of 0.72, considered acceptable based on Taber's criteria³⁵. A pilot distribution with a small sample of 25 individuals was conducted to assess the questionnaire's accuracy and clarity. The pilot findings showed that participants could complete all questions within 10 minutes, and they found the questionnaire clear and easily understandable. It's important to note that the results of this experimental distribution were not included in the overall data analysis.

Sample size calculation

The minimum required sample size was estimated using an online sample size calculator Raosoft®.³⁶ The sample size generated by the software was 384 individuals based on a margin of error of 5%, a confidence interval of 95%, and an estimated 3,500,000 adults³⁷ who are 18 years of age or older in Jordan.

Statistical analyses

The practices in storing and disposing of unused medications were analyzed using standard statistical methods. Data analysis was performed using Statistical Package for Social Science Version 25 software. Descriptive statistics, including frequency tables, were used to analyze participant characteristics. To establish significant associations between socio-demographic variables and medication storage practices, we utilized inferential analyses like the Pearson Chi-Square test (χ^2) and logistic regression. A significance level of $\alpha \leq 0.05$ was set for all analyses, indicating the threshold for statistical significance.

Ethics approval statement

The Al-Balqa Applied University institutional review board

approved the research, and ethical clearance was granted (ethical approval reference number: 26/3/2087). Participants were given access to the survey after providing voluntary consent, which was obtained in the initial section of the survey. Any participant can withdraw from the study at any time, and those who did not provide consent will not be able to complete the survey.

RESULTS

Socio-demographic Data of the Respondents

The participants from various regions of southern Jordan who completed the survey were 1019. As shown in Table 1, nearly two-thirds of the participants were females (61.8%), and 44.0% were in the 18–30 age category. Additionally, 44.2% of the participants had 3–6 family members. 45.7% of respondents had a bachelor's degree, the largest educational group. Among the participants, 62.5% had health insurance, and the employees in non-medical careers with a monthly income exceeding 1000 JD were 70.6%.

Table 1: Socio-demographic features of the study sample. N=1019

Variables		All participants
		Number (Frequency %)
Gender	Male	389 (38.2%)
	Female	630 (61.8%)
Age	18–30	448 (44%)
	31–45	263 (25.8%)
	46–60	118 (11.6%)
	>61	190 (18.6%)
Education level	Illiterate	27 (2.6%)
	Elementary education	311 (30.5%)
	Secondary education	125 (12.3%)
	Bachelor's degree	466 (45.7%)
	MSc Or PhD	90 (8.8%)
Number of family members	<3	155 (15.2%)
	3–6	450 (44.2%)
	7–11	311 (30.5%)
	> 11	103 (10.1%)
Health insurance	YES	637 (62.5%)
	NO	382 (37.5%)
Occupation	Medical career	260 (25.5%)
	Non-medical career	719 (70.6%)
	Unemployment	40 (3.9%)
Monthly income	Less than 500 JD	160 (15.7%)
	501–1,000 JD	309 (30.3%)
	More than 1,000 JD	550 (54%)



STORAGE PRACTICES OF THE MEDICATIONS

Prevalence of Storing Medications

As shown in Table 2, all survey participants had unused medications in their homes, and 17.8% had expired medications. Among participants with expired medications, over half had one to five expired medications (55.8%), and approximately a quarter were uncertain about the exact number of expired medications in their homes (22.6%). Regarding the number of unused medications, approximately half had six to ten medications (43.4%), one-third had one to five medications (30.3%), around one-fifth had more than ten medications (19.1%), and the rest were unsure of the exact number of unused medications (7.2%).

Storage Rate of Specific Medications

As depicted in Figure 1, participants most commonly stored analgesics (97.9%), followed by antibiotics (86.8%), antacids (63.5%), and vitamins (34.7%). About 24% of participants also stored antidiabetic and antihypertensive medications, while the storage rate for antidepressants did not exceed 0.4%.

Sources of information about the proper storage of unused medications

Figure 2 illustrates that pharmacists play a significant role

Variables		Number (frequency %)
Storing unused medications	Yes	1019 (100%)
	No	0 (0%)
Storing expired medications	Yes	181 (17.8%)
	No	736 (72.2%)
	I do not know	102 (10.0%)
Number of unused medications	1–5	309 (30.3%)
	6–10	442 (43.4%)
	More than 10	195 (19.1%)
	I do not know	73 (7.2%)
Number of expired medications	1–5	101 (55.8%)
	6–10	26 (14.4%)
	More than 10	13 (7.2%)
	I do not know	41 (22.6%)

in providing information about proper conditions to store medication (31.7%). In contrast, the internet and social media, physicians, and university courses play fewer roles, represented by 22.1%, 17.1%, and 18.5%, respectively. Friends and family were the least selected category as a source of information (10.6%).

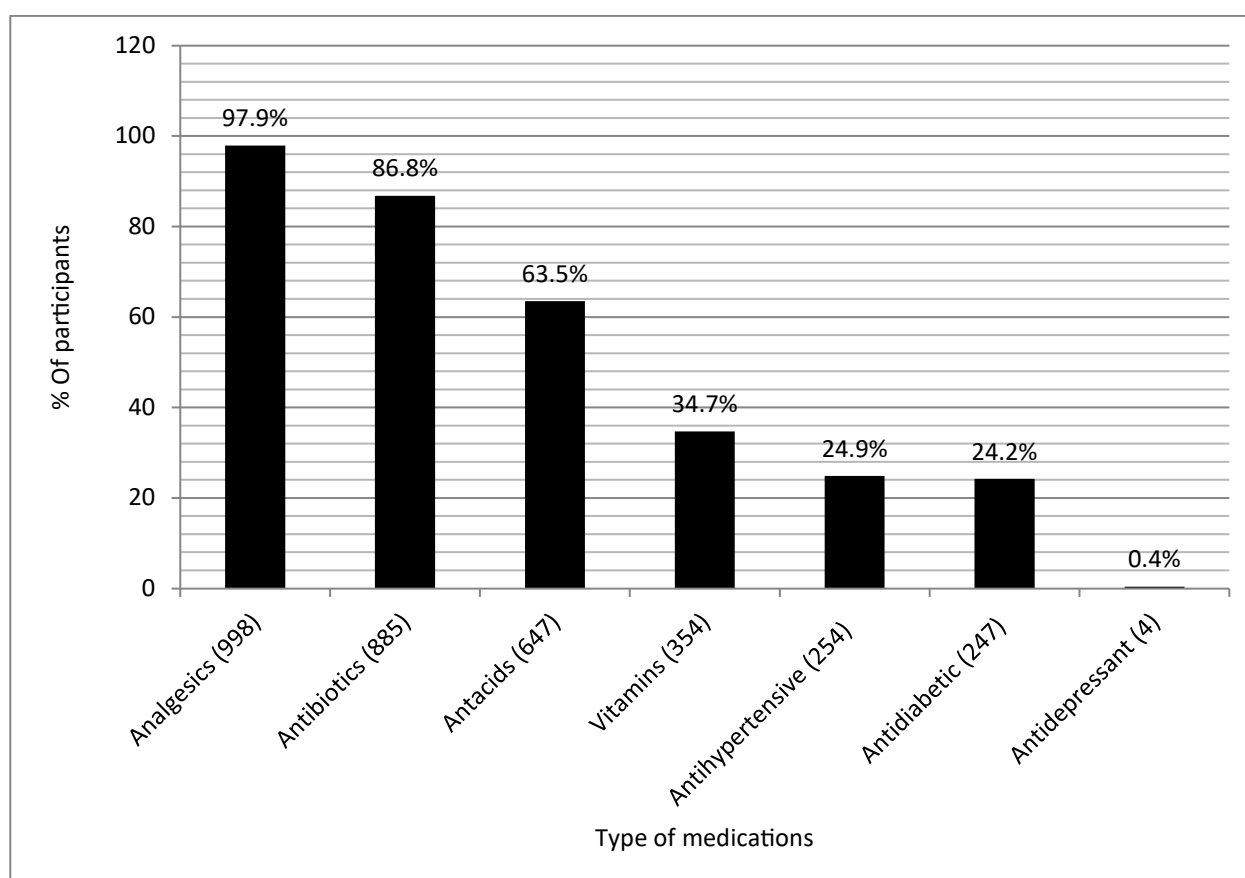


Figure 1. Storage rate for specific medications



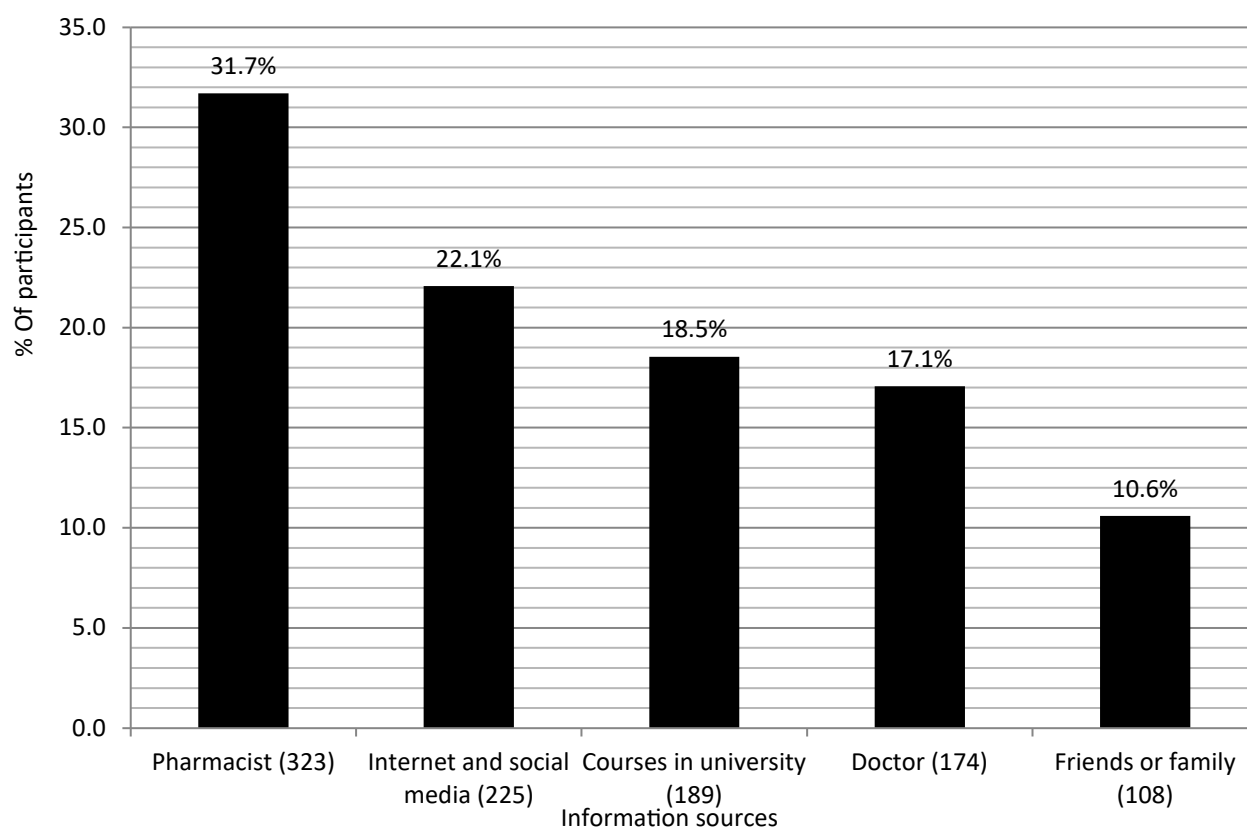


Figure 2. Participants' sources of information about storing unused medications properly

Places of storage the unused medications

According to Figure 3, 51.4% of participants stored unused medications in their bedrooms, bathrooms, and kitchens. A smaller percentage reported using a custom cabinet (16%). Nearly one-third of participants reported storing medications in their refrigerators (32.6%).

Reasons for storage of unused medications

In response to the question of why they kept medications at home, almost half the participants (49.8%) cited positive past experiences with the medication. Nearly twenty percent of participants (20.4%) had unused drugs because they had discontinued them on their own, either because their disease symptoms had improved or because the medications weren't effective. For detailed reasons, see Table 3.

Participants' Practices of Medication Disposal

Participants' answers about how they dispose of unused medications are in Table 4. Approximately half of the participants reported throwing medications in the garbage (46.6%), while a quarter disposed of them by flushing them down the toilet (24.3%). About one-fifth gave the unused medications to family and friends (20.6%), and only 8.4% returned drugs to the pharmacy.

Participants' Knowledge of Medication Disposal In Figure 4A, participants answers about the effects of improperly disposing

of medications. It revealed that 48% did not believe there were harmful effects, while 27% were aware of potential harm. Figure 4B indicates that most participants (60%) had not previously received advice on how to dispose of medications, but 74%

Table 3: Reasons for storing unused medications among participants. N=1019

Reasons	Frequency	Percentage (%)
The physician prescribed large doses of medication.	124	12.20%
Symptoms of the disease improved, or the medications were not working.	208	20.40%
Medication is of bad smell or taste.	84	8.20%
The physician altered the treatment plan.	96	9.40%
It is possible to reuse these medications in the future.	507	49.80%

Table 4: Methods for disposing of unused medications among participants. N=1019

How do you dispose of unused medications?	Number (Frequency %)
I was returning them to the pharmacy.	86 (8.4%)
I was giving them to friends or relatives.	210 (20.6%)
I was throwing them in the trash.	475 (46.6%)
I was flushing them down into the toilet.	248 (24.3%)

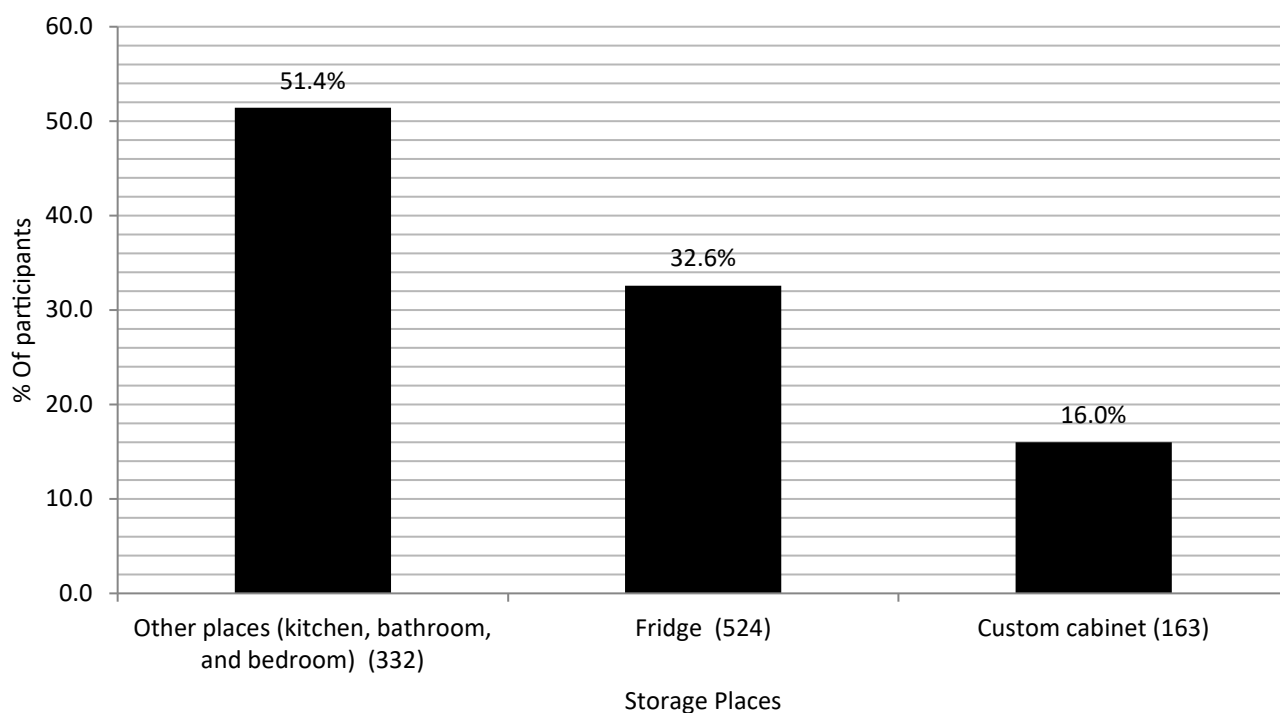


Figure 3. Places where participants store unused medications

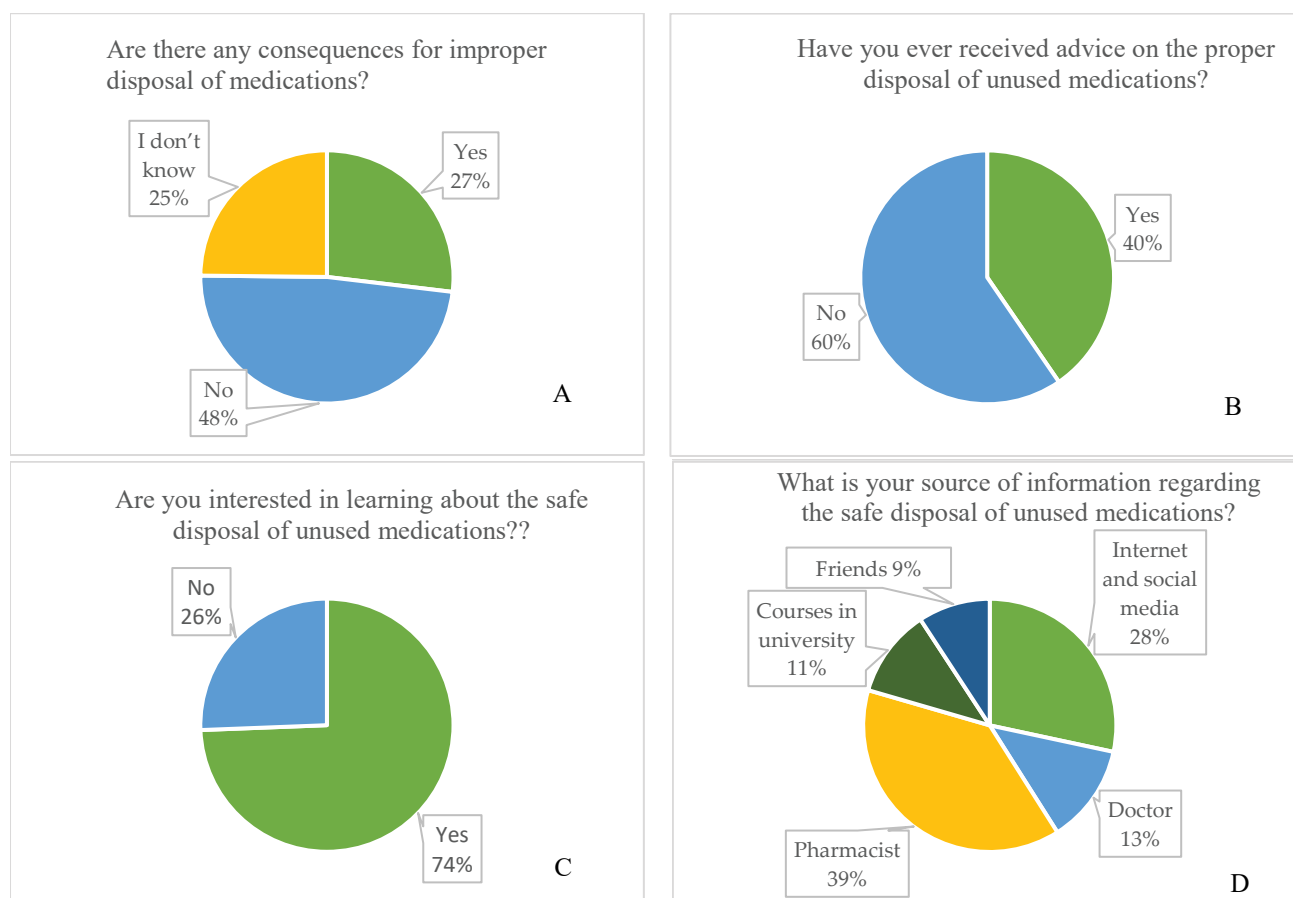


Figure 4. Responses to the questions assessing participants' knowledge of disposal of medications

expressed interest in learning the correct methods (Figure 4C). For information on the preferred source for learning proper disposal methods, full details are in Figure 4D, where 39% of participants chose pharmacists.

Association between demographic factors and storing medications

Data from 784 participants who had used various medications within the past year was analyzed out of 1019 participants. Among these individuals, 434 (55.4%) practiced medication storage, while 350 (44.6%) did not. Table 5 presents the results of the chi-square analysis, examining the association between socio-demographic variables and medication storage. Table 6 displays a logistic regression model investigating the predictive significance of socio-demographic variables for medication storage, represented by odds ratios and 95% confidence intervals.

Table 5 indicates that the relationship between gender and medication storage was not statistically significant ($P=0.11$). As shown in Table 5, chi-square analysis revealed a substantial variation in medication storage frequency across different age groups ($p < 0.001$). The lowest proportion of participants storing medications (48.1%) was in the 18–30 age group.

The probability of medication storage was 2.4 times greater in the >61 age group and 1.7 times higher in the 31–45 age group compared to the 18–30 age group. The association between educational level and the rate of medication storage is with a p -value = 0.001. Illiterates had the highest storage rate of 73.1%. As education levels increased, storage rates progressively declined. Participants with elementary education had a rate of 63.7%, those with secondary education had 54.2%, bachelor's degree holders had 51.7%, and individuals with an MSc or PhD had the lowest storage rate at 38.3%. The relationship between the number of family members and medication storage behavior was statistically significant ($p = 0.003$). As the number of family members increased, storage rates also increased. Participants with fewer than three family members had a storage rate of 40.3%, while those with more than eleven members had a storage rate of 60.3%. Table 5 demonstrates a statistically significant relationship between occupation and medication storage behavior, with a p -value of 0.038. The logistic regression model in Table 6 reveals that unemployed participants had a significantly higher tendency to store medication (p -value = 0.017; AOR = 3.060; 95.0% C.I.: 1.226-7.638). This result indicates that unemployed participants had about three times more tendency than those in medical careers to store medication. Participants with non-

Table 5: The relationship between socio-demographic characteristics and storage using chi-square analysis. N=784.

Variables		Total	Stored medications	Un-stored medications	χ^2	P-value
		N (%)	N (%)	N (%)		
Gender	Male	336 (42.9%)	175 (52.1%)	161 (47.9%)	2.55	0.11
	Female	448 (57.1%)	259 (57.8%)	189 (42.2%)		
Age	18–30	318 (40.6%)	153 (48.1%)	165 (51.9%)	19.609	<0.001
	31–45	197 (25.1%)	107 (54.3%)	90 (45.7%)		
	46–60	96 (12.2%)	55 (57.3%)	41 (42.7%)		
	>61	173 (22.1%)	119 (68.8%)	54 (31.2%)		
Education	Illiterate	26 (3.3%)	19 (73.1%)	7 (26.9%)	19.24	0.001
	Elementary education	240 (30.6%)	153 (63.7%)	87 (36.3%)		
	Secondary education	96 (12.2%)	52 (54.2%)	44 (45.8%)		
	Bachelor's degree	362 (46.2%)	187 (51.7%)	175 (48.3%)		
	Postgraduate	60 (7.7%)	23 (38.3%)	37 (61.7%)		
Number of family members	<3	124 (15.8%)	50 (40.3%)	74 (59.7%)	13.703	0.003
	3–6	350 (44.6%)	201 (57.4%)	149 (42.6%)		
	7–11	237 (30.2%)	139 (58.6%)	98 (41.4%)		
	>11	73 (9.3%)	44 (60.3%)	29 (39.7%)		
Occupation	Medical career	189 (24.1%)	95 (50.3%)	94 (49.7%)	6.537	0.038
	Non-medical career	564 (71.9%)	316 (56.0%)	248 (44.0%)		
	Unemployment	31 (4.0%)	23 (74.2%)	8 (25.8%)		
Health insurance	Yes	296 (37.8%)	141 (47.6%)	155 (52.4%)	11.474	0.001
	No	488 (62.2%)	293 (60.0%)	195 (40.0%)		
Monthly income	Less than 500 JD	123 (15.7%)	54 (43.9%)	69 (56.1%)	9.646	0.008
	501–1,000 JD	225 (28.7%)	121 (53.8%)	104 (46.2%)		
	More than 1,000 JD	436 (55.6%)	259 (59.4%)	177 (40.6%)		



Table 6: Socio-demographic factors associated with the storage of medications using logistic regressions.

Variable		Wald	df	P-value	Adj. OR	95.0% C.I (AOR)	
						Lower	Upper
Gender	Male				1 ^c		
	Female	2.826	1	0.093	1.308	0.942	1.79 ^a
Age	18–30	18.863	3	<0.001	1 ^c		
	31– 45	5.924	1	0.015	1.753 ^b	1.116	3.681
	46–60	8.361	1	0.004	2.394 ^b	1.325	4.325
	>61	17.68	1	0.001	2.433 ^b	1.607	3.681
Education level	Illiterate	14.592	4	0.006	1 ^c		
	Elementary education	5.214	1	0.039	1.537 ^b	0.567	0.906
	Secondary education	2.635	1	0.024	2.341 ^b	2.349	5.538
	Bachelor's degree	9.494	1	0.002	2.654 ^b	1.362	12.422
	Postgraduate	6.228	1	0.012	4.113 ^b	1.19	8.691
Number of family members	<3	13.893	3	0.003	1 ^c		
	3–6	5.494	1	0.002	1.134 ^b	0.651	0.691
	7–11	8.569	1	0.003	1.672 ^b	1.185	2.359
	> 11	6.306	1	0.012	2.225 ^b	1.192	4.154
Occupation	Medical career	7.813	2	0.02	1 ^c		
	Non-medical career	4.365	1	0.015	2.017 ^b	1.473	5.905
	Unemployment	5.739	1	0.017	3.060 ^b	1.226	7.638
Health insurance	Yes				1 ^c		
	No	13.502	1	0.001	1.787	1.311	2.436 ^a
Monthly income	Less than 500 JD	12.409	1	0.015	1 ^c		
	501–1,000 JD	9.62	1	0.003	1.878 ^b	1.415	5.206
	More than 1,000 JD	8.353	1	0.027	2.154 ^b	1.948	4.895

Adj. OR; Adjusted odds ratio; a Likelihood Ratio (LR) test; b Wald test; c reference group

medical careers were about twice as likely to store medication compared to those with medical careers. The prevalence of medication storage among participants without health insurance was 60%, which was higher than among those with health insurance (47.6%; $p = 0.001$). The logistic regression model further supported this trend, showing that the likelihood of medication storage was about 1.8 times higher for those without health insurance. The relationship between monthly income and medication storage rate is statistically significant (p -value = 0.008). Generally, as monthly income decreases, the rate of medication storage declines. Among participants with a monthly income of more than 1000 JD, the storage rate was 59.4%, while it decreased to 43.9% among participants with a monthly income of less than 500 JD.

DISCUSSION

Storing and improperly disposing of drugs at home can lead to numerous harmful consequences. The potential consequences of storing and disposing of drugs in households have raised concerns.¹⁴ Improper disposal can harm human health, water sources, animals, and the environment. Moreover, it results in

medication wastage, especially in resource-limited countries like Jordan.³⁸ This study aims to evaluate the storage and disposal of unused medications in southern Jordan and assess knowledge about proper disposal there. It also examines how socio-demographic factors influence medication storage.

All participants had unused medications in their homes. About half of them had 6–10 unused medications, similar to a study in BG Nagar.³⁹ Additionally, 17.8% of them had expired medications, mostly 1–5 in number. Surprisingly, some participants were unaware of the precise number of expired drugs they possessed. This lack of awareness could lead to accidental consumption and potential harm due to changes in chemical composition or microbial growth.⁴⁰ According to the current study, 49.8% of participants stored leftover medication and reused it for similar health conditions. However, reusing drugs without consulting a healthcare professional can be harmful.⁴¹ The patient's health conditions can change, and it's essential to consult a healthcare provider if a treatment plan update is needed.⁴² Additionally, 20.4% of participants kept leftover medication after their health improved, while 8.2% mentioned having unused medicines at home because of an unpleasant taste or smell. These results are consistent with a



previous Jordanian study.³⁴

Analgesics were the most stored medication in households among the study participants (97.9%). This prevalence may be attributed to the accessibility of analgesics as an over-the-counter (*nonprescription*) medication, making them easier to obtain and store at home.^{43, 44} Around 86.8% of individuals also stored antibiotics, indicating potentially improper use, such as not following prescribed instructions or engaging in self-medication. Such practices can contribute to the growing problem of antibiotic resistance.⁴⁵ Notably, despite legal restrictions, antibiotics are available without a prescription in Jordan.⁴⁶ However, antidepressant drugs were stored in much smaller quantities (0.4%), likely because they require a prescription for purchase. These observations suggest that medications available without a prescription are more likely to be stored in larger quantities, aligning with findings from previous studies.^{18, 44} Proper storage of medications in dry and cool conditions is crucial to maintain their effectiveness and prevent potential risks.⁴⁷ However, the survey revealed that only 16% of participants used custom cabinet storage, while 32.6% stored their drug products in the refrigerator. Around 50% of participants stored unused medications in bathrooms and kitchens, potentially causing toxic byproducts or reduced efficacy due to the varying humidity and temperature.⁴⁸

Many participants followed disposal practices similar to those observed in Kuwait, Britain, and the United States, involving throwing unused drug products in the trash.^{29, 49} Interestingly, around 25% of participants reported emptying unused drug products into the toilet, a method also found in a previous research study.³¹ There was a belief that flushing medications down the toilet was safer than disposing of them in the trash to protect animals from potential harm.³³ However, guidelines from the White House Office of the National Drug Control Policy (ONDCP) suggest that disposing of medications in the trash is an acceptable practice. It is advisable to mix these medications with undesirable substances like coffee grounds to prevent unintended ingestion by animals.⁵⁰ Recently, strategies like take-back programs encourage individuals to return unused drugs to pharmacies for proper disposal. These programs have succeeded in countries like Sweden and Korea.^{32, 33} Surprisingly, only 8.4% of the participants in this survey reported returning their medicines to pharmacies. This study underscores the need for awareness programs in Jordan to promote the concept of returning unused medications to pharmacies and to prevent potential harm to the environment.

The lack of knowledge regarding the harmful consequences of improperly disposing of medications affects disposal behavior.^{51, 52} According to the study findings, 48% of the participants do not perceive any harmful environmental effects resulting from improper disposal of medications. Additionally, 25% have limited knowledge about the potential ecological impacts of improperly disposing of drugs. In contrast, only 27% realized that improper disposal of unused medications could pose health risks. Additionally, 60% did not receive guidance on how to dispose of unused medications. Despite this, most participants showed an interest in learning how to dispose of

drugs safely. Regarding the preferred sources of information of the participants for the correct methods of disposing of medications, 39% indicated a preference for pharmacists as their primary source of information, but 28% preferred to rely on the Internet and social media. This preference trend aligns with findings from another study.³⁴ To address patients' inquiries regarding the safe disposal of unused medications, authorities in Jordan, including the Ministry of Health and the Pharmacist Association, should encourage pharmacists to conduct awareness campaigns on social media platforms and establish dedicated websites to address this issue.⁵³

The storage of medications was higher among older participants, maybe because of their higher incidence of chronic diseases.⁵⁴ Older individuals often keep unused medication on hand for specific purposes, such as analgesics, laxatives, and ointments treatment for skin ulcers. Additionally, cognitive decline and the complexity of treatment regimens among older individuals can contribute to non-adherence to recommended dosages, resulting in an excess of unused medications at home.⁵⁵ Moreover, individuals with higher educational levels tend to store medications in households less frequently, confirming a significant relationship between education levels and the storage of unused medications. Due to the higher level of knowledge of the risks associated with medication non-compliance and consumption of non-prescribed medications.⁵⁶ Therefore, people with a higher level of education prefer to visit physicians and acquire proper medications. However, Sharif et al. have indicated that the association between educational levels and the practice of storing medication was non-significant.⁸ On the other hand Abushanab et al. revealed the opposite trend in their study, where medication storage practice is high among individuals with higher educational levels.¹⁵ The study indicates that the storage rates of leftover medications progressively increased as the number of family members increased compared to smaller families. Larger families tend to buy larger quantities of medication and engage more in self-medication practices. Consequently, households with more members accumulate a variety of medications for self-medication as needed.^{15, 57}

Based on the findings of this study, individuals with health insurance tend to store medications less than those without health insurance because it covers the expenses of medication and physician visits. As a result, people tend to seek medical advice rather than rely on leftover medications, consistent with similar observations elsewhere.^{58, 59} As participants' monthly income decreased, their storage rates progressively declined. In addition, the tendency of participants to store medication at home is affected by their monthly income. Due to their limited financial capacity, participants of lower incomes tend to obtain medicines in smaller quantities and only when necessary. A previous study revealed a comparable trend.¹⁵

Ultimately, Many unused medicines are stored improperly at home, and disposal methods are often unsafe. This highlights the need for the government to promote proper storage and disposal through health awareness campaigns and discourage medicine accumulation at home. Additionally, strict laws



should be enforced for unsafe disposal.

There are limitations to making causal inferences and establishing causality from cross-sectional studies. Several factors affect the responses to an online questionnaire, including access to the internet and electronic devices. The sample seems likely not to represent the whole population due to a predominance of females, younger, and educated respondents. The results of this study need to be generalized by further studies.

CONCLUSIONS

This study is a novel effort to evaluate how people in South Jordan store and dispose of medication. Storage of considerable quantities of unused medications at home is under unsuitable conditions, and the methods to dispose of unused medications are unsafe. This study highlights the significance of enhancing public awareness concerning the secure storage and appropriate disposal of unused medications. It emphasizes the crucial role of healthcare providers, especially pharmacists, in educating patients directly when dispensing medications. The free educational campaigns using social media applications could encourage practicing responsible medication handling. In addition, guidelines that regulate the purchase of non-prescription medications for self-treatment are necessary

because they may help limit the habit of storing medications. The government and relevant organizations need to implement the guidelines that motivate people in southern Jordan to dispose of their medication securely. In addition, southern Jordanian authorities could use the findings of this research to understand the socio-demographic factors that could affect people's tendency to accumulate unused medications, even though they are not needed, and then employ the necessary actions to limit this practice. Extending health insurance coverage to more people is an example of an appropriate possible action. Moreover, it is crucial to establish clear guidelines that motivate residents to dispose of their unused medications responsibly and safely.

AUTHORS' CONTRIBUTIONS

AT: Conceptualization of the study, study design, collecting data, data analysis, and writing the manuscript draft.

KH: Collecting data, reviewing, writing, and editing the final manuscript, data interpretation, and organization.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest to declare.

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