




Medication Disposal Awareness and Practices in Libya: A Study of an Online Population

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Abstract

Background Improper disposal of unused or expired medications presents a serious threat to both environmental and public health.

Aim This study aimed to conduct an initial assessment of the knowledge, attitudes, and disposal practices related to medications among an online, convenience sample of the Libyan population.

Methods A descriptive cross-sectional online survey was conducted from December 13–22, 2024, using a structured, 20-item questionnaire. The tool, adapted from a validated bilingual questionnaire, comprised four sections: demographics, knowledge, attitudes, and disposal practices. Knowledge was assessed via three items scored as correct (2 points), uncertain (1 point), or incorrect (0 points), with total scores (0–6) categorized as poor (0–2), moderate (3–4), or high (5–6) knowledge. Disposal practices were evaluated through two items, where a correct response scored 2 points and an incorrect response 0 points, categorizing a total score of 4 as positive practice and a score of 0 to 2 as negative practice. Data were analyzed using SPSS version 23, employing descriptive statistics and chi-square tests to examine associations.

Results The sample of 478 respondents was predominantly female (66.7%), young (56.9% aged 18–25 years), and highly educated (79.7% holding a university degree). Among 478 participants, 81% demonstrated a high level of knowledge about medication safety and expiration. Positive attitudes toward proper disposal were expressed by 55.6%, and were significantly associated with being female and employed. However, only 5.0% of respondents followed the recommended practice of returning expired medications to a pharmacy. No significant associations were found between disposal practices and demographic variables.

Conclusion This study highlights widespread unsafe disposal practices despite relatively high levels of knowledge. These findings highlight the urgent need for national policies that establish clear guidelines, promote public education, and provide accessible systems for safe medication disposal in Libya.

Keywords

- ▶ medication disposal
- ▶ Libya
- ▶ awareness
- ▶ environmental impact
- ▶ expired drugs

Dates of submission

November 4, 2025

revision

November 19, 2025

acceptance

December 7, 2025

DOI <https://doi.org/>

10.1055/s-0046-1815920.

ISSN 2519-139X.

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Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

ملخص المقال باللغة العربية

الوعي وممارسات التخلص من الأدوية في ليبيا: دراسة على عينة إلكترونية من المجتمع

المؤلفون: أميرة بوسويق، ندى الفرطاس، فرح الحصادي، عزة البر عصى، منية الكيلاني، إسرائ عقاب، كلية الصيدلة، جامعة درنة، الفتح، درنة، ليبيا،

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الخلفية: يمثل التخلص غير السليم من الأدوية غير المستخدمة أو منتهية الصلاحية تهديداً خطيراً لكل من الصحة العامة والبيئة. **الهدف:** هدفت هذه الدراسة إلى إجراء تقييم أولي للمعرفة والاتجاهات والممارسات المتعلقة بالتخلص من الأدوية بين عينة إلكترونية ملائمة من السكان الليبيين. **الطرق:** أُجري مسح مقطعي وصفي عبر الإنترنت خلال الفترة من 13 إلى 22 ديسمبر 2024 باستخدام استبيان منظم مكون من 20 بنداً. وتكونت الأداة، والمعدلة من استبيان ثنائي اللغة مُتحقق من صدقه، من أربعة أقسام: البيانات الديموغرافية، المعرفة، الاتجاهات، وممارسات التخلص. تم تقييم المعرفة من خلال ثلاثة بنود سُجّلت على النحو التالي: الإجابة الصحيحة (نقطتان)، غير متأكد (نقطة واحدة)، أو الإجابة غير الصحيحة (صفر نقطة). مع تصنيف الدرجات الكلية (6-0) إلى: معرفة ضعيفة (2-0)، متوسطة (3-4)، أو عالية (5-6). تم تقييم ممارسات التخلص من خلال بندين. حيث حصلت الإجابة الصحيحة على نقطتين والإجابة غير الصحيحة على صفر نقطة. مع تصنيف الدرجة الكلية 4 على أنها ممارسة إيجابية والدرجة 2-0 على أنها ممارسة سلبية. تم تحليل البيانات باستخدام الإصدار 23 من برنامج SPSS. مع استخدام الإحصاء الوصفي واختبارات كاي مربع لفحص العلاقات. **النتائج:** كانت عينة الـ 478 مستجيباً غالبيتها من الإناث (66.7%). وصغار السن (56.9% أعمارهم 18-25 سنة)، وأصحاب التعليم العالي (79.7% يحملون درجة جامعية). من بين 478 مشاركاً، أظهر 81% مستوى عالٍ من المعرفة حول سلامة الأدوية وتواريخ انتهاء الصلاحية. عبر 55.6% عن اتجاهات إيجابية نحو التخلص السليم. وارتبطت هذه الاتجاهات بشكل كبير بكون المشارك أنثى وموظفاً. ومع ذلك، اتبع 5.0% فقط من المستجيبين الممارسة الموصى بها المتمثلة في إعادة الأدوية منتهية الصلاحية إلى الصيدلية. ولم يتم العثور على علاقات ذات دلالة إحصائية بين ممارسات التخلص والمتغيرات الديموغرافية. **الاستنتاج:** تسلط هذه الدراسة الضوء على انتشار الممارسات غير الآمنة للتخلص من الأدوية على الرغم من المستويات المرتفعة نسبياً من المعرفة. وتؤكد هذه النتائج على الحاجة الملحة لسياسات وطنية تضع إرشادات واضحة، وتعزز التثقيف العام، وتوفر أنظمة يسهل الوصول إليها للتخلص الآمن من الأدوية في ليبيا. **الكلمات المفتاحية:** التوعية، الأثر البيئي، الأدوية منتهية الصلاحية، ليبيا، التخلص من الأدوية.

Introduction

Improper disposal of unused or expired medications presents significant risks to public health and the environment.¹⁻³ These practices can result in contamination of water and soil, harming vital microorganisms and wildlife, while also contributing to the spread of antibiotic resistance. Consequently, they not only impact human and animal health but also increase morbidity, mortality, and medical expenses.^{4,5}

Globally, the consumption of both prescription and over-the-counter medications is on the rise. By 2020, an estimated 4.5 trillion doses were projected to be consumed, a 24% increase over the preceding 5 years.^{6,7} However, a substantial portion of these medications goes unused or expires before they are consumed. The relative magnitude of this portion is influenced by various factors, including patient behavior, health care practices, and the shelf life of the medications.^{6,8}

The persistence of pharmaceutical waste in aquatic environments is particularly concerning. Medications released from wastewater treatment plants have been detected in rivers, groundwater, and seawater, causing ecological harm, spreading antibiotic resistance, and disrupting endocrine systems.^{9,10} The Mediterranean Basin, due to its semi-enclosed geography and diverse socioeconomic conditions, is especially vulnerable.^{11,12}

Despite growing global awareness of pharmaceutical waste, many regions continue to struggle with challenges such as low public awareness, weak policy frameworks, and inadequate disposal systems.^{13,14} Many people continue to store unused or expired medications at home,

which increases the risk of misuse and accidental overdoses, and diminishes drug effectiveness due to improper storage.^{15,16} Lack of public knowledge regarding safe disposal methods exacerbates these problems, contributing to poisoning, rising health care costs, water pollution, and degradation of the environment.^{17,18} This study aimed to conduct an initial assessment of the knowledge, attitudes, and disposal practices related to medications among an online, convenience sample of the Libyan population.

Methods

Study Design and Setting

This cross-sectional study evaluated public knowledge, awareness, and proper disposal of medications in Libya. Data were collected during December 13–22, 2024, and covered the northeastern, northwestern, and southern regions of the country. Participants were recruited through an electronic survey link posted on various social media platforms. The purpose and objectives of the study were clearly explained to the respondents before the beginning of the questionnaire.

Sample Size

Sample size was calculated with the Raosoft online calculator (<http://www.raosoft.com/samplesize.html>) for a confidence level of 95% and a 5% error margin, which yielded 385 as the minimal sample size. To ensure an adequate safety margin, a total of 504 responses were collected.

The Study Tool

A structured, self-administered questionnaire was prepared in Google Forms. We adapted the English version of a bilingual, validated questionnaire,⁴ and had it reviewed by pharmacy experts. It consists of 20 items assembled with yes/no or multiple-choice questions grouped in four sections.

- Section 1 was for demographic information: gender, age, educational level, region of residence, and occupational status.
- Section 2 covered knowledge of proper medication disposal practices, verification of expiration date before use, opinions on the use of expired medications, and beliefs regarding the variability of expiration periods among different medications. Knowledge regarding medication safety and expiration was assessed with three yes/no/not sure response options. A correct response was scored 2, an incorrect response 0, and an uncertain response as 1. Thus, the maximum total score ranged from 0 to 6. Scores of 0 to 2 indicated poor knowledge, 3 and 4 moderate knowledge, and 5 and 6 high knowledge.
- Section 3 addressed attitudes toward medication disposal, including whether the participant had received information on safe disposal methods, perceived environmental impact of improper disposal, or perceptions of responsibility for raising public awareness.
- Section 4 addressed medication storage and disposal practices at home, including locations, presence of expired or unused medications, types of medications kept, and methods used for disposal. Medication disposal was assessed through two questions with yes/no response options. A correct answer was scored as 2 and an incorrect answer as 0, giving a maximum total score from 0 to 4. Scores of 0 to 2 indicated negative practice, while a score of 4 indicated positive practice.

Data Quality Control

To ensure accuracy of responses and attentiveness of participants, the questionnaire included a multiple-choice attention-check question placed among the main study items. The heading of this question read: *“Leave this Question Unanswered.”*

All other items in the survey were mandatory; participants could not submit the form unless every question was completed, except for this particular item, which was deliberately left optional. Although the answer options were relevant to the study topic, respondents were instructed not to choose any of them. Those who selected an answer were excluded from the final dataset. After applying this criterion, 478 valid responses were retained for analysis.

Data Analysis

Data were cleaned, coded, and organized in Microsoft Excel. They were analyzed descriptively in Statistical Package for the Social Sciences (SPSS version 23). Associations between variables were analyzed with the chi-square test or Fisher's exact test, as appropriate. A p -value of < 0.05 was considered statistically significant.

Results

Out of the total responses collected, 26 responses (5.15%) were excluded because the control question was answered, indicating inattentive or random completion. The final analysis was therefore based on 478 valid responses.

Most respondents (66.7%) were females and more than half (56.9%) were aged 18 to 25 years. Most (79.7%) held a university degree, and 0.4% had no formal education. Participants were geographically distributed across Libya, with 41.6% residing in the northwestern region, 31.6% in the northeastern region, and 26.8% in the southern region; 46.7% were students and 44.4% were employed (►Table 1).

Based on the scoring of knowledge items (►Table 2), only 1 participant (0.2%) demonstrated low knowledge, 90 participants (18.8%) showed a moderate level, while the majority, 387 participants (81.0%), exhibited high knowledge. Specifically, 79.9% knew that medication shelf-life depends on the drug identity, and 74.9% reported regularly checking expiration dates before use. However, 11.1% believed that expired medications are safe or were unsure about the associated risks.

Females had significantly more knowledge about medication safety and expiration than males ($p < 0.008$). Knowledge scores varied significantly by region ($p < 0.013$), with the southern region (71.9% high knowledge) scoring lower than the northwestern (84.9%) and northeastern (83.4%) regions. Knowledge showed no significant association with age, education, or employment status (►Table 3).

Positive attitudes to proper disposal were expressed by 55.6% of the respondents. Over half of the participants (55.6%) agreed that improper medication disposal could negatively affect the environment, while 33.7% were uncertain, and 10.7% did not perceive any environmental risk.

When asked who is responsible for raising awareness, the most common single choices selected by participants were health care institutions (29.5% of the total sample), the media (10.5%), and pharmacies (10.5%). However, a combined 46.7% of participants selected either two or three options from the list, indicating divided or overlapping perceptions of responsibility (►Table 4).

Males and employed individuals showed more positive attitudes compared with other participants ($p = 0.041$ and $p = 0.002$, respectively), but no significant associations were found with age, education, or region (►Table 5).

Most participants (77.6%) stated that they did not keep expired medications at home, whereas 22.4% did. Half (51%) reported keeping unused medications at home (►Table 6). When asked how they disposed of expired medications, most participants (76.6%) reported using more than one method, combining both appropriate and inappropriate practices. Among those who selected a single method, unsafe behaviors were common: 8.2% disposed of medications in the toilet, 4.2% kept them at home, 2.9% used them until finished, 1.7% threw them in household trash, and 1.5% gave them to others. Only 5.0% of respondents returned expired medications to a pharmacy, the recommended and safe practice

Table 1 Demographic characteristics of participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	159	33.3
	Female	319	66.7
Age group (y)	18–25	272	56.9
	26–35	111	23.2
	36–45	51	10.7
	> 45	44	9.2
Educational level	No formal education	2	0.4
	Less than high school	13	2.7
	High school diploma	46	9.6
	University degree	381	79.7
	Master's or Doctorate	36	7.5
Region of residence	Northeastern Libya	151	31.6
	Northwestern Libya	199	41.6
	Southern Libya	128	26.8
Employment status	Student	223	46.7
	Employed	212	44.4
	Retired	3	0.6
	Unemployed	40	8.4

(→ **Table 6**). No significant associations were found between disposal methods and demographic variables (all $p > 0.05$).

Discussion

This study assessed the Libyan public's knowledge, attitudes, and practices in medication use, storage, and disposal. Although awareness of medication shelf life and the risks of expired drugs was relatively high, important deficiencies were evident in disposal practices and risk perception. These findings are consistent with observations from other countries in the region.^{4,13,19} For example, in the United Arab Emirates, knowledge and practices were not significantly

influenced by gender or education, though occupational differences were noted.⁴ By contrast, our results demonstrate a significant association with gender and geographic region, with females and respondents from the northwestern area generally having better knowledge. This pattern may reflect unequal access to health care services across Libya, suggesting the need for interventions tailored to specific regions.

Attitudes toward the environmental risks of improper disposal were mixed. Just over half of respondents (55.6%) recognized the potential harm, but one-third was unaware. Comparable findings have been reported elsewhere, such as in an Indonesian study, in which more than half of the

Table 2 Participants' responses regarding medication safety and expiration

Statement	Response	Frequency (n)	Percentage (%)
Do you believe that some medications have a longer shelf life than others?	No	19	4.0
	Not sure	77	16.1
	Yes	382	79.9
Do you check the expiration date before taking a medication?	No	17	3.6
	Sometimes	103	21.5
	Yes (always)	358	74.9
Can medications be used after their expiration date?	Yes	22	4.6
	I do not know	31	6.5
	No	425	88.9

Table 3 Association between sociodemographic factors and knowledge levels

Demographic characteristic	Participant group	Frequency (n)	Percentage (%)	Knowledge level 1	Knowledge level 2	Knowledge level 3	p-Value
Gender	Male	159	33.3	1	40	118	0.008 ^a
	Female	319	66.7	0	50	269	
Age (y)	18–25	272	56.9	1	55	216	0.103
	26–35	111	23.3	0	22	89	
	36–45	51	10.7	0	11	40	
	> 45	44	9.2	0	2	42	
Educational level	No education	2	0.4	0	1	1	0.456
	Less than high school	13	2.7	0	1	12	
	High school	46	9.6	0	8	38	
	University degree	381	79.7	1	70	310	
	Master's or doctorate	36	7.5	0	10	26	
Region of residence	Northeast Libya	151	31.6	0	25	126	0.013 ^a
	Northwest Libya	199	41.6	0	30	169	
	South Libya	128	26.8	1	35	92	
Employment status	Student	223	46.7	1	47	175	0.687
	Employee	212	44.4	0	37	175	
	Retired	3	0.6	0	0	3	
	Unemployed	40	8.4	0	0	34	

^aStatistically significant.

participants were unaware of the environmental consequences.¹⁹ These results point to a broader global challenge: public awareness remains insufficient to drive environmentally responsible behavior.

In this study, a clear gap was observed between knowledge and practice. Although most participants were aware of safe disposal methods, only 5.0% returned expired medications to pharmacies, whereas 76.6% reported using multiple disposal practices that included both correct and incorrect methods. The tendency of many participants to select more than one disposal method indicates inconsistent or uncertain behavior, reflecting a lack of clear understanding of proper disposal practices. This finding aligns with a study conducted

in Saudi Arabia, where 79.7% of respondents acknowledged the risks of improper disposal yet only a few followed the correct procedures.¹³

Evidence from Libya supports this pattern: a study conducted in Sebha, in the southwest region, found that more than half of participants (52.2%) considered disposal in household garbage to be appropriate, and more than 80% reported discarding unused or expired medicines in this way.²⁰ Despite widespread recognition of environmental risks, both studies reveal that safe disposal practices remain uncommon.

These findings indicate that unsafe disposal practices represent a widespread problem in Libya and cannot be

Table 4 Participants' attitudes toward medication disposal and its environmental impact

Attitude statement	Participants' response	Frequency (n)	Percentage (%)
Do you think disposing of expired medications in the trash has negative environmental effects?	No	51	10.7
	Maybe	161	33.7
	Yes	266	55.6
In your opinion, who is responsible for raising awareness about proper medication disposal?	Media	50	10.5
	Medical institutions	141	29.5
	Pharmacies	50	10.5
	Other	14	2.9
	Selected two options	163	34.1
	Selected three options	60	12.6

Table 5 Association between demographic factors and participants' attitudes to medication disposal

Demographic characteristic	Participant response	Frequency (n)	Percentage (%)	Level 1 attitude	Level 2 attitude	p-Value
Gender	Male	159	33.3	60	99	0.041
	Female	319	66.7	152	167	
Age (y)	18–25	272	56.9	132	140	0.126
	26–35	111	23.2	44	67	
	36–45	51	10.7	22	29	
	> 45	44	9.2	14	30	
Education status	No education	2	0.4	1	1	0.608
	Less than high school	13	2.7	8	5	
	High school	46	9.6	21	25	
	University degree	381	79.7	169	212	
	Master's or Doctorate	36	7.5	13	23	
Region of residence	Northeast Libya	151	31.6	66	85	0.503
	Northwest Libya	199	41.6	94	105	
	South Libya	128	26.8	52	76	
Employment status	Student	223	46.7	113	110	0.002
	Employee	212	44.4	75	137	
	Retired	3	0.6	1	2	
	Unemployed	40	8.4	23	17	

addressed by awareness campaigns alone. Evidence from this study and the Sebha survey points to the same conclusion: the urgent need for a coordinated national strategy.²⁰ Such a strategy should integrate public education with a practical infrastructure, including pharmacy-based take-back systems, region-specific awareness initiatives, and stronger involvement of health care providers in guiding patients toward safe practices. Implementing these measures and drawing on successful experiences such as the Return Unwanted Medicines (RUM) program in Australia would offer

Libya a sustainable framework to reduce environmental risks and safeguard public health.

Limitations

The study used a convenience sampling approach through social media platforms. This method may have resulted in a higher proportion of younger and more educated participants who are accustomed to using the internet. Nevertheless, respondents represented all main regions of Libya, and

Table 6 Key medication storage and disposal practices (N = 478)

Practice variable	Category	Number	%
Storage			
Keeps expired medications at home	Yes	107	22.4
Keeps unused medications at home	Yes	244	51.0
Most common disposal methods reported ^a			
Uses multiple disposal methods		366	76.6
Disposes in toilet/sink		39	8.2
Keeps at home		20	4.2
Returns to pharmacy		24	5.0
Most common expired medication categories stored ^b			
Pain relievers		41	8.6
Antibiotics		31	6.5

^aParticipants could select multiple methods. The most prevalent single methods reported among the total sample are listed.

^b"Other medications" is the most cited category (53.8%) but is nonspecific. The most common specific categories are listed.

their distribution was generally consistent with the national population pattern, providing reasonable geographic coverage. The results should be interpreted in the context of the studied sample and are not intended to reflect the entire Libyan population. Although the use of a convenience sample is acceptable for exploratory research, future investigations should include more diverse populations to obtain findings that are more representative at the national level.

Conclusion

This study offers meaningful insight into public knowledge, awareness, and practices concerning medication use and disposal across Libya. While a majority demonstrated high awareness, particularly in relation to expiration dates and drug safety, a notable minority held misconceptions or uncertainty, underscoring the need for targeted educational efforts. Significant differences by gender and region further suggest that public health messaging should be tailored accordingly.

Although over half of the respondents expressed positive attitudes toward proper disposal and environmental risks, a considerable share remained indifferent or unsure. The lack of consensus on which institutions should lead awareness efforts reflects broader gaps in public engagement with pharmaceutical waste issues.

Medication disposal practices were generally suboptimal. The frequent retention of unused or expired medications in households, alongside the adoption of unsafe disposal methods, reflects a broader structural challenge. Importantly, these behaviors showed no significant correlation with demographic characteristics, suggesting that the issue is widespread and not confined to specific population subgroups.

Overall, the findings underscore the urgency of implementing national strategies that combine public education, regulatory clarity, and accessible infrastructure for safe disposal. Such efforts are critical to promoting responsible medication practices and mitigating potential risks to both human health and the environment.

Conflict of Interest

None declared.

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