

RESEARCH

Open Access



Knowledge and practices on home medication storage and disposal in Syria: a population-based, cross-sectional study

Raghad Samha¹, Azmi Wali¹, Saeed Kadri², Fatima Al-Assi³, Aya Al-Khalaf¹, Aya Al-Deeb¹, Mosa Shibani^{2,4*}, Mhd Amin Alzabibi^{2,5}, Walid Issa Khaddam¹, Shahd Al-Hayek² and Data Collection Group

Abstract

Background Medications are commonly found in every household. In Syria, where healthcare infrastructure faces significant challenges, improper storage can lead to reduced medication efficacy and increased health risks. Additionally, inappropriate disposal practices pose serious environmental concerns, especially in a region already grappling with environmental degradation. This study aimed to evaluate the knowledge, and practices of Syrian individuals regarding the appropriate storage and disposal of home medications.

Method A cross-sectional study was conducted from September 22 to October 20, 2023, using an online survey distributed via social media apps (WhatsApp, Facebook, and Telegram) in Syria. The questionnaire, adapted from a similar study in Saudi Arabia, was translated to Arabic using the forward–backward translation technique. A convenience sampling technique was used. Inclusion criteria were participants over eighteen with expired or unused medications at home. Descriptive statistics, Chi-square tests, and binary logistic regression analysis were performed using SPSS version 27, with statistical significance defined as $p < 0.05$.

Results A total of 2,217 responses were analyzed, with the majority of participants being female (79%) and aged between 21–30 years (56%). The study found that 90.7% of respondents dispose of expired medications in the garbage, while 95% keep medications in their original containers. Additionally, 30% consult pharmacists for storage instructions, and 64% read storage information on medication leaflets. Logistic regression analysis revealed that males were less likely to check expiration dates before use (OR: 0.58, 95% CI: 0.40–0.84) and periodically (OR: 0.68, 95% CI: 0.54–0.85). Participants aged 31–40 years were less likely to check expiration dates periodically (OR: 0.46, 95% CI: 0.31–0.68), while those with children under six years old were more likely to do so (OR: 1.29, 95% CI: 1.01–1.67). Males were also less likely to read storage instructions (OR: 0.61, 95% CI: 0.50–0.76) but more likely to ask pharmacists about them (OR: 1.26, 95% CI: 1.01–1.57). There was no significant difference in these practices between medical professionals and the general population.

Conclusion This study reveals gaps in the practices related to the storage and disposal of medications among the Syrian public. The findings suggest a need for targeted public education and awareness programs to improve these practices and reduce the associated health and environmental risks.

Keywords Medication Safety, Medication Disposal, Home Medication Storage, Syria

*Correspondence:

Mosa Shibani

Moosa.shibani@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Introduction

Medications are an integral part of modern healthcare, frequently found in households worldwide [1]. While these pharmaceutical preparations play a vital role in preserving life and managing health conditions, they can also pose significant risks if not stored or disposed of properly. Improper storage can lead to diminished efficacy and potential harm due to accidental overdoses or misuse, while inappropriate disposal contributes to environmental contamination [2, 3]. Studies from various regions have highlighted that many patients store their medications improperly, raising concerns about the unintended consequences, such as improper self-medication and prescription drug misuse [3].

The safe disposal of unused, unwanted, or expired medications is a pressing global issue, with many developed countries implementing initiatives to address this concern. For example, projects like the National Return and Disposal of Unwanted Medicines in the United Kingdom, supported by both government and the pharmaceutical industry, are designed to mitigate the environmental and health risks associated with medication waste [4]. However, despite such efforts, medication waste—comprising both expired and unused drugs—continues to be a significant problem. Medications, including analgesics, antibiotics, and synthetic hormones, are frequently detected in freshwater environments, indicating the inefficacy of conventional wastewater treatment processes in removing these contaminants [4, 5]. The disposal of medications through sinks, toilets, or trash contributes to groundwater contamination and the broader environmental presence of pharmaceutically active compounds [4].

Regulatory bodies, such as the U.S. Food and Drug Administration (FDA), have issued guidelines on the appropriate disposal of medications. These guidelines recommend methods such as returning medications to pharmacies or burning them under controlled conditions. However, in many parts of the world, including some developed countries, improper disposal practices persist, exacerbating environmental pollution [7]. Only by implementing effective disposal procedures can the environmental impact of pharmaceuticals be mitigated [7].

In contrast to developed nations, where organized disposal programs are in place, countries like Syria face unique challenges. The healthcare infrastructure in Syria is strained, and there are no explicit national guidelines regarding the storage and disposal of home medications. Additionally, the ongoing conflict and economic instability have compounded these challenges, making it essential to understand the local practices related to medication management. The lack of prior research in

this area highlights a significant gap in knowledge that needs to be addressed to improve public health and environmental outcomes in the region.

Despite the global recognition of the importance of proper medication management, there is a paucity of research focused on the Middle East, particularly in Syria, regarding how medications are stored and disposed of at home. This gap is critical given the potential health and environmental risks associated with improper medication practices. Addressing this gap is essential for developing effective public health interventions tailored to the Syrian context.

This study aims to fill this knowledge gap by evaluating the attitudes and practices of Syrian individuals concerning the storage and disposal of medications. Specifically, the study seeks to identify common practices, assess the level of awareness about proper medication management, and explore the factors influencing these practices. The findings from this research are intended to inform the development of targeted public health interventions and policies in Syria. Additionally, the study could lay the groundwork for establishing national guidelines and educational programs that promote safe medication practices, ultimately improving public health outcomes and reducing environmental harm in the region.

Methods

Study design and sample size

During the period from 22 September to 20 October 2023, we conducted a cross-sectional study by distributing an online-based survey across Syria using social media platforms (WhatsApp, Facebook, and Telegram). Participants were recruited through both group-based and individual contact methods. Specifically, the survey link was shared in various community and health-related groups on these platforms, as well as through direct messaging to individuals who were identified as potential participants based on the inclusion criteria. This dual approach aimed to maximize reach and ensure a diverse sample. The survey questionnaire was adapted from a prior study conducted in Saudi Arabia [1], and was translated from English to Arabic using the forward-backward translation technique, prioritizing conceptual translation over literal translation to ensure cultural relevance and clarity.

All responses were anonymous and contained no identifying information; the data was only accessible to the main investigator. A convenience sampling technique was employed to select the sample population. Before full dissemination, the questionnaire's usability and technical functionality were assessed through an experimental survey with 30 participants. Following this, a pilot study involving 50 participants was conducted to confirm the questionnaire's validity. Data from the pilot study were

not included in the final analysis. Calculator.net's sample size estimator, accessible at "<https://www.calculator.net/sample-size-calculator.html>", was used to determine the sample size. Based on UN estimates, the population of Syria is predicted to surpass 18 million in 2019. We used that information to undertake an analysis of statistical power in order to determine the sample size. A sample size of 385 with a 50% design effect, a 0.05 margin of error, and a 95% confidence level was recommended. Our sample size was 2217 in total.

Inclusion and exclusion criteria

The inclusion criteria required participants to be over eighteen years old and to have expired or unused medications in their residences. The recruitment targeted individuals in various regions of Syria, and participants were encouraged to share the survey link within their networks, thereby expanding the pool of respondents using a chain-referral method. To ensure that the questionnaire was delivered particularly to the targeted study group, we included screening questions at the beginning of the survey. These questions were designed to confirm that respondents met the inclusion criteria of the study. The questions are: "Are you 18 years of age or older?" and "Do you currently have any expired or unused medications in your residence?" Only respondents who answered "Yes" to both questions were allowed to proceed with the rest of the survey.

Measures

The questionnaire consisted of 22 questions divided into 2 sections:

1. Socio-demographic characteristics: This covers 9 questions about age, gender, the governorate of origin, living place (urban or rural), employment status, financial status, educational level, having kids < 6 years, is the respondent work or study in the healthcare field.
2. Knowledge and practice towards storing and disposing of medications: This section includes 13 questions about the way/place in which drugs are stored at home, whether the original containers of the prescriptions are changed or not, and whether the expiry date is written on the new container. Participants were questioned in certain questions if they are aware of the kinds of pharmaceutical preparations or dosage forms that need to be refrigerated, as well as whether they check the expiration date of the medications they have stored before using them and on a regular basis. They were also questioned about how they dispose of both unused, unexpired and expired drugs. The full Arabic and English version of the

questionnaire can be found in the Supplementary file. 1

Ethical approval

This study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval for this research was obtained from the Ethics Committee of Syrian Private University and Al-Baath University. Prior to participation, all respondents were provided with detailed information about the study's purpose, and their rights as participants. Informed consent was obtained electronically from all participants before they began the survey. Participation was voluntary, and participants could withdraw from the study at any time without any consequences. All responses were anonymous, and no identifying information was collected. The data was stored securely and was accessible only to the main investigator.

Statistical analysis

The statistical analysis for this study involved multiple steps to ensure a thorough examination of the data. Descriptive statistics were calculated to determine mean values and standard deviations (\pm SD) for continuous variables. Categorical variables were summarized using frequencies and percentages. To analyze variations in medication storage and disposal practices among different demographic groups, Chi-square tests were utilized. This allowed for the identification of significant differences across groups. Additionally, binary logistic regression analysis was conducted to pinpoint specific factors that predict medication storage and disposal behaviors. All analyses were performed using SPSS software, version 27. Statistical significance was defined as $p < 0.05$. Results were presented with 95% confidence intervals (CIs).

Results

Sociodemographic characteristics of the respondents

A total sample size of 2217, 1753 (79%) were female. Most respondents 1246 (56%) were in the 21–30 years age group. 798 (35.9%) lived in northern Syria. The majority of the participants lived in cities 1805 (81%). Regarding the respondents' educational levels, 1767 (80%) were University students. Participants who work or study in the healthcare system were 1090 (49%). Only 464 (21%) reported that they have children under 6 years old. 1051 (47%) participants reported their financial status as moderate. 925 (42%) participants were students who were unemployed, 347 (16%) participants

were unemployed, and 337 (15%) participants worked full-time jobs (Table 1).

Knowledge and practices of participants regarding medications storage

Among study participants, 2102 (95%) kept medications in their original container, 2073 (94%) said that they check the expiration date before using the medications, 1596 (72%) check the expiration date periodically, 1414 (64%) read the storing instructions of medications written on the leaflet, 672 (30%) asked the pharmacist about the storing instructions and 869 (39%) wrote the expiration date on the new container (Table 2).

Table 1 Participants’ sociodemographic characteristics

Item		N (%)
Gender	Female	1753(79)
	Male	464(21)
Age groups	18–20 years	487(22)
	21–30 years	1246(56)
	31–40 years	265(12)
	40 years or older	219(10)
Living area	Eastern Syria	34(1.5)
	Northern Syria	798(35.9)
	Middle Syria	641(28.9)
	Southern Syria	602(27.1)
	Western Syria	142(6.4)
Area of living	Urban	1805(81)
	Rural	412(19)
Education level	No formal education	12(1)
	Primary school	28(1)
	Secondary school	61(3)
	High school	198(9)
	University	1767(80)
	Postgraduate	151(7)
Work	Part time job	265(12)
	Full-time job	337(15)
	Student	925(42)
	Student + part-time job	259(12)
	Student + full-time job	84(4)
	Unemployed	347(16)
Do you belong to the medical field	Yes	1090(49)
	No	1127(51)
Do you have any kids < 6?	Yes	464(21)
	No	1753(79)
Income	Low	342(15)
	Moderate	1051(47)
	Good	741(33)
	High	83(4)

Table 2 Participants’ medication storage behaviors

Behavior		N (%)
Keeping medication in original container	Yes	2102(95)
	No	115(5)
Checking the expiration date before using the medications	Yes	2073(94)
	No	144(6)
Checking the expiration date of stored medications periodically	Yes	1596(72)
	No	621(28)
Reading the storing instructions of medications written on the leaflet	Yes	1414(64)
	No	803(36)
Asking the pharmacist about the storing instructions	Yes	672(30)
	No	1545(70)
Writing the expiration date on the new container	Yes	869(39)
	No	1348(61)

The most common classes of medications that participants kept at home were painkillers and antipyretics 2107 (95%). When they were asked about the ways they dispose unused medications, the most common answers were storing it for future use and throwing it in the garbage, as reported by 986 (44.4%) and 974 (43.9%) participants, respectively. The main way to dispose expired medications was throwing it in the garbage, as reported by 2012 (90.7%) participants.

Regarding places where medications were stored, 622 (28%) were stored in bedroom, 570 (25.7%) in kitchen and 1231 (55.5%) in cabinet. When participants were asked about the way they carried medications in case of traveling, more than half of them reported that they carry it in handbag 1495 (67.4%). Regarding dosage forms that should be stored in the refrigerator, suppository was the most commonly reported by 1716 (77.4%) participants (Table 3).

Correlations between participants characteristics and their practices regarding the storage of medications

Using chi-square test, results showed a statistically significant difference between males and females in checking the expiration date before using the medications, of which 1653 (94%) females answered “yes” (*p*-value < 0.01), checking the expiration date of stored medications periodically, of which 1291 (74%) females answered “yes” (*p*-value < 0.001), reading the storing instructions of medications written on the leaflet, of which 1159 (66%) females answered “yes” (*p*-value < 0.0001), asking the pharmacist about the storing instructions, of which 158 (34%) males answered “yes” (*p*-value < 0.05) and writing

Table 3 Participants' knowledge and practices regarding the storage of medications

Item		N (%)
Common classes of medications in the house	Pain killers + antipyretics	2107(27)
	Cough syrups	1072(14)
	Vitamins and supplements	1419(18)
	Antibiotics	943(12)
	Antiacids	625(8)
	Antidiabetic agents	331(4)
	Antihypertensive	522(7)
	Anti-hyperlipidemic	242(3)
	Others	419(5)
	The way of disposing unused medications	Keep it at home until expiration
Store it for future use		986(36)
Throw it in the garbage		974(36)
Give it to a friend or relative		427(16)
Return it to the pharmacy		313(11)
The way of disposing the expired medications	Throw it in the garbage	2012(87)
	Throw it in the toilet	118(5)
	Return it to the pharmacy	81(3)
	Buried in the soil	90(4)
	Burn it	25(1)
	Others	424(16)
Store medications in	Cabinet	1231(46)
	No box	131(5)
	Open box	303(11)
	Bag	206(8)
	Locked box	407(15)
	Others	424(16)
	Refrigerator	490(31)
Place for storing medications	Bedroom	622(21)
	Kitchen	570(19)
	Living room	488(16)
	Car	14(0.4)
	Others	373(12)
	Suppositories	1716(27)
	Insulin	381(6)
Syrups	887(14)	
Eye drops	591(9)	
Injectable medication	365(6)	
Ear drops	245(4)	
Ointments	497(8)	
Antibiotics	290(5)	
Tab + caps	6(0.1)	
Hormones	102(2)	
Creams	367(6)	
Iron and folic acid tablets	157(2)	
Vitamins tablets	315(5)	
Others	320(5)	
The way of carrying the medications in case of traveling	In handbag	1495(67)
	With luggage	290(13)
	In a bag inside the airplane cabin	51(2)
	I do not carry medications during travel	217(10)
	Buy new medications from designated country	164(8)

Bold: the recommended answers

the expiration date on the new container, of which 711 (41%) females answered “yes” (p -value < 0.05) (Table 4).

Results showed a statistically significant difference between different age groups in checking the expiration date of stored medications periodically, of which 221 (83%) participants in the age group 31–40 years old answered “yes” (p -value < 0.0001), reading the storing instructions of medications written on the leaflet, of which 188 (71%) participants in the age group 31–40 years old answered “yes” (p -value < 0.01), asking the pharmacist about the storing instructions, of which 165 (34%) participants in the age group 18–20 years old and 90 (34%) participants in the age group 31–40 years old answered “yes” (p -value < 0.05) and writing the expiration date on the new container, of which 104 (47%) participants in the age group above 40 years old answered “yes” (p -value < 0.0001) (Table 5).

Results showed a statistically significant difference between different educational levels in reading the storing instructions of medications written on the leaflet, of which 148 (75%) participants in high schools answered “yes” (p -value < 0.01), asking the pharmacist about the storing instructions, of which 15 (54%) participants in primary schools answered “yes” (p -value < 0.0001) and writing the expiration date on the new container, of which 18 (64%) participants in primary schools answered “yes” (p -value < 0.01) (Table 6).

Results showed that there is no statistically significant difference in any variable between people who work or study in the medical field and people who do not (p -value > 0.05) (Table 7).

Logistic regression analysis revealed several significant associations. Males were less likely to engage in safe medication practices, such as checking expiration dates before use (OR: 0.58, 95% CI: 0.40–0.84) and periodically (OR: 0.68, 95% CI: 0.54–0.85). Age also played a role, with participants aged 31–40 years (OR: 0.46, 95% CI: 0.31–0.68) and above 40 years (OR: 0.55, 95% CI: 0.37–0.82) being less likely to check expiration dates periodically. In contrast, participants with no formal education (OR: 3.59, 95% CI: 1.05–12.30) and those with children under six years old (OR: 1.29, 95% CI: 1.01–1.67) were more likely to check expiration dates and read storage instructions (OR: 4.59, 95% CI: 1.28–16.42 and OR: 1.26, 95% CI: 1.00–1.58, respectively). Males were less likely to read storage instructions (OR: 0.61, 95% CI: 0.50–0.76) and ask pharmacists about them, while participants with children under six were more likely to seek pharmacist advice (OR: 1.32, 95% CI: 1.05–1.65). Additionally, participants aged 21–30 years were more likely to write expiration dates on new containers (OR: 1.41, 95% CI: 1.13–1.75), while males and those with lower education levels were less likely to do so (Table 8) (Supplementary file 0.2).

Table 4 Participants’ medication storage practices stratified by gender

Behavior	Gender		P value
	Male N (%)	Female N (%)	
Keeping medication in original container			0.354
Yes	436(94)	1666(95)	
No	28(6)	87(5)	
Checking the expiration date before using the medications			0.0033*
Yes	420(91)	1653(94)	
No	44(9)	100(6)	
Checking the expiration date of stored medications periodically			0.0007*
Yes	305(66)	1291(74)	
No	159(34)	462(26)	
Reading the storing instructions of medications written on the leaflet			<0.0001*
Yes	255(55)	1159(66)	
No	209(45)	594(34)	
Asking the pharmacist about the storing instructions			0.0487*
Yes	158(34)	514(29)	
No	306(66)	1239(71)	
Writing the expiration date on the new container			0.0107*
Yes	158(34)	711(41)	
No	306(66)	1042(59)	

Table 5 Participants’ medication storage practices stratified by age

Behavior	Age				P value
	18–20 N (%)	21–30 N (%)	31–40 N (%)	> 40 N (%)	
Keeping medication in original container					0.132
Yes	465 (95)	1170 (94)	257 (97)	210 (96)	
No	22 (5)	76 (6)	8 (3)	9 (4)	
Checking the expiration date before using the medications					0.845
Yes	458 (94)	1165 (94)	248 (94)	202 (92)	
No	29 (6)	81 (6)	17 (6)	17 (8)	
Checking the expiration date of stored medications periodically					< 0.0001*
Yes	334 (69)	870 (70)	221 (83)	171 (78)	
No	153 (31)	376 (30)	44 (17)	48 (22)	
Reading the storing instructions of medications written on the leaflet					0.0049*
Yes	313 (64)	761 (61)	188 (71)	152 (69)	
No	174 (36)	485 (39)	77 (29)	67 (31)	
Asking the pharmacist about the storing instructions					0.0197*
Yes	165 (34)	344 (28)	90 (34)	73 (33)	
No	322 (66)	902 (72)	175 (66)	146 (67)	
Writing the expiration date on the new container					< 0.0001*
Yes	214 (44)	433 (35)	118 (45)	104 (47)	
No	273 (56)	813 (65)	147 (55)	115 (53)	

Discussion

This research investigated the Syrian public’s awareness and practices regarding the proper disposal and storage of medications. Our major findings indicate that while a high percentage of participants keep medications in their original containers (95%) and regularly check expiration dates before use (94%), there is a significant gap in consulting pharmacists for proper storage instructions, with only 30% doing so. Additionally, improper disposal practices, such as throwing expired medications in the garbage (90.7%), were prevalent among the participants. Females, individuals older than 30 years, and those with secondary or high school education were more likely to engage in safer medication storage practices.

Despite the widespread awareness of the importance of checking expiration dates, our study highlighted that only a minority consult pharmacists for proper storing instructions. This practice should be reinforced and encouraged among the public, as pharmacists play a crucial role in educating people about medication safety. Previous studies have shown that many pharmacists do not provide adequate instruction on medication disposal [8, 9]. Therefore, it is essential for healthcare providers, especially pharmacists, to take a more active role in educating the public about proper medication storage and disposal practices.

The high rate of participants opting to throw away medications when expired (87%) is consistent with findings from other studies conducted in the Middle East [3,

Table 7 Participants’ medication storage practices stratified by whether they work in the medical field

Behavior	Do you have any work in the medical field		P value
	Yes N (%)	No N (%)	
Keeping medication in original container			0.105
Yes	1025 (94)	1077 (96)	
No	65 (6)	50 (4)	
Checking the expiration date before using the medications			0.512
Yes	1023 (94)	1050(93)	
No	67 (6)	77 (7)	
Checking the expiration date of stored medications periodically			0.195
Yes	771 (71)	825 (73)	
No	319 (29)	302 (27)	
Reading the storing instructions of medications written on the leaflet			0.074
Yes	675 (62)	739 (66)	
No	415 (38)	388 (34)	
Asking the pharmacist about the storing instructions			0.292
Yes	319 (29)	353 (31)	
No	771 (71)	774 (69)	
Writing the expiration date on the new container			0.064
Yes	406 (37)	463 (41)	
No	684 (63)	664 (59)	

Table 6 Participants’ medication storage practices stratified by education level

Cases	Education level N (%)						P value
	No formal education	Primary school	Secondary school	High school	University	Postgraduate	
Keeping medication in original container							0.479
Yes	12 (100)	28 (100)	59 (97)	189 (95)	1668 (94)	146 (97)	
No	0 (0.00)	0 (0.00)	2 (3)	9 (5)	99 (6)	5 (3)	
Checking the expiration date before using the medications							0.545
Yes	12 (100)	27 (96)	55 (90)	185 (93)	1649 (93)	145 (96)	
No	0 (0.00)	1 (4)	6 (10)	13 (7)	118 (7)	6 (4)	
Checking the expiration date of stored medications periodically							0.203
Yes	6 (50)	20 (71)	49 (80)	151 (76)	1260 (71)	110 (73)	
No	6 (50)	8 (29)	12 (20)	47 (24)	507 (29)	41 (27)	
Reading the storing instructions of medications written on the leaflet							0.0037*
Yes	4 (33)	17 (61)	43 (70)	148 (75)	1108 (63)	94 (62)	
No	8 (67)	11 (39)	18 (30)	50 (25)	659 (37)	57 (38)	
Asking the pharmacist about the storing instructions							<0.0001*
Yes	5 (42)	15 (54)	31 (51)	79 (40)	505 (29)	37 (25)	
No	7 (58)	13 (46)	30 (49)	119 (60)	1262 (71)	114 (75)	
Writing the expiration date on the new container							0.0011*
Yes	4 (33)	18 (64)	30 (49)	97 (49)	664 (38)	56 (37)	
No	8 (67)	10 (36)	31 (51)	101 (51)	1103 (62)	95 (63)	

6, 8, 10, 11]. Additionally, the practice of keeping medications for later use, observed in a significant portion of our sample, may be attributed to the prevalent practice of self-medication in the region [12, 13].

Our study also found that females, participants over the age of 30, and those with secondary or high school education were more likely to verify expiration dates and read medication storage instructions. This tendency could be explained by the fact that many of these participants are likely mothers, who may be more attentive to details related to their children’s health, as observed in similar studies conducted in Turkey [14, 15].

Participants aged 21–30, mostly university students, were less likely to seek storage instructions or note expiration dates, possibly due to confidence in their education. In contrast, those with only primary education were more inclined to seek professional advice, recognizing its importance.

Refrigerators were commonly used for storing medications, particularly suppositories, and most participants carried medications in handbags while traveling, consistent with practices observed in Saudi Arabia [1].

Our study also revealed a significant gap in proper medication disposal in Syria, with only 11% returning medications to pharmacies compared to 73% in Sweden [16]. This indicates a need for better awareness and pharmacist involvement in educating the public. Additionally, 36% of participants stored medications for future

use, citing convenience and economic concerns, which is lower than the 47.2% reported in Sudan [17].

Our survey found that 87% of participants disposed of expired prescriptions in the garbage, a higher percentage than the 75.2% reported in Northern Ethiopia [18]. This may reflect a lack of awareness about the environmental and health risks of improper disposal, underscoring the need for better public education on this issue. Only 3% returned medications to the pharmacy, and 1% burned them.

In contrast to a Saudi Arabian study where antibiotics (26%) were the most commonly stored drugs, 95% of our participants reported storing painkillers and antipyretics, likely due to self-medication practices driven by economic challenges [19, 20]. Additionally, 31% of our participants stored medications in the refrigerator, compared to 42% in the Saudi study, possibly due to better storage facilities and awareness in Saudi Arabia. Notably, 77.4% of participants in our study stored suppositories in the refrigerator, which is appropriate given their sensitivity to heat.

A significant 94% of participants in our study checked medication expiration dates, much higher than the 59.2% and 59.5% reported in Ethiopia and Nepal, respectively [2, 21]. This difference may be attributed to varying levels of awareness regarding the risks associated with expired medications.

Table 8 Predictors of different medication storage practices

Item	Keeping medication in original container	Checking the expiration date before using the medications	Checking the expiration date of stored medications periodically	Reading the storing instructions of medications written on the leaflet	Asking the pharmacist about the storing instructions	Writing the expiration date on the new container
Gender						
Female	1	1	1	1	1	1
Male	0.81 (0.52–1.26)	0.58 (0.40–0.84)*	0.68 (0.54–0.85)*	0.61 (0.50–0.76)*	1.26 (1.01–1.57)*	0.75 (0.60–0.93)*
Age group						
18–20	1	1	1	1	1	1
21–30	1.38 (0.84–2.27)	1.46 (0.73–1.79)	0.93 (0.73–1.17)	1.09 (0.87–1.37)	1.23 (0.98–1.56)	1.41 (1.13–1.75)*
31–40	0.72 (0.30–1.68)	1.31 (0.68–2.49)	0.46 (0.31–0.68)*	0.77 (0.55–1.09)	1.11 (0.79–1.55)	1.00 (0.73–1.37)
>40	1.09 (0.49–2.44)	1.45 (0.77–2.75)	0.55 (0.37–0.82)*	0.70 (0.49–1.01)	1.16 (0.81–1.67)	0.90 (0.65–1.27)
Education level						
No formal education	1.11 (0.00–0)	2.31 (0.00–0)	3.59 (1.05–12.30)*	4.59 (1.28–16.42)*	0.47 (0.13–1.61)	1.57 (0.44–5.55)
Primary school	1.13 (0.00–0)	0.89 (0.10–7.80)	1.38 (0.55–3.48)	1.35 (0.57–3.16)	0.28 (0.12–0.67)*	0.40 (0.17–0.94)*
Secondary school	1.08 (0.20–5.84)	2.70 (0.82–8.86)	0.73 (0.35–1.54)	0.77 (0.40–1.47)	0.34 (0.18–0.65)*	0.68 (0.37–1.25)
High school	1.52 (0.48–4.73)	1.90 (0.69–5.23)	0.79 (0.47–1.31)	0.58 (0.36–0.93)*	0.53 (0.33–0.86)*	0.69 (0.44–1.07)
University	1.65 (0.65–4.16)	1.86 (0.79–4.36)	0.90 (0.61–1.33)	0.90 (0.63–1.28)	0.81 (0.55–1.21)	0.95 (0.67–1.07)
Postgraduate	1	1	1	1	1	1
Do you have any kids < 6 years						
Yes	0.94 (0.58–1.52)	1.38 (0.86–2.21)	1.29 (1.01–1.67)*	1.26 (1.00–1.58)*	1.32 (1.05–1.65)*	0.98 (0.79–1.22)
No	1	1	1	1	1	1
Do you have any work in the medical field						
Yes	0.75 (0.51–1.11)	1.25 (0.88–1.78)	0.92 (0.76–1.13)	0.89 (0.74–1.07)	0.99 (0.81–1.21)	0.88 (0.73–1.06)
No	1	1	1	1	1	1

* $P < 0.05$

Surprisingly, we found no significant differences between medical field workers and the general population in terms of proper medication storage practices. This unexpected result could be due to the general population’s access to online medical information and their concern for family health increasing their overall health literacy [22], which may compensate for their lack of formal medical training.

Strengths and limitations of the study

This study is the first of its kind in Syria, serving as a critical starting point for increasing awareness about proper medication disposal and storage practices. The findings could catalyze future research and public health initiatives aimed at addressing medication management in Syria. Furthermore, the study’s large sample size of 2,417 participants is significantly larger than similar studies conducted in the region, enhancing the reliability and generalizability of the results [16–19].

However, there are several limitations to consider. The sample is heavily skewed, with 79% of participants being female, which could introduce gender bias in the analysis and interpretation of the results. Additionally, the demographic breakdown reveals that 80% of the sample consists of young students, with 50% belonging to the medical field. This overrepresentation of students, particularly those in the medical field, may not accurately reflect the broader population’s knowledge and practices, potentially limiting the generalizability of the findings.

Moreover, the inclusion of multiple members from the same household may have introduced bias, as their responses could be influenced by shared experiences and knowledge. The study was also conducted online, excluding individuals without internet access, which could result in a sampling bias toward more educated or urban populations. Finally, the sample was predominantly drawn from three governorates, which may not capture the full diversity of practices across Syria.

Conclusion

This study provides novel insights into the medication storage and disposal practices among the Syrian population, highlighting both strengths and areas needing improvement. Notably, while a majority of participants demonstrated awareness of checking expiration dates, there is a prevalent lack of knowledge regarding proper medication disposal methods. The widespread practice of discarding unused and expired medications in household garbage or down the sink poses significant risks to both environmental and public health.

The study's findings underscore the urgent need for targeted awareness campaigns to educate the public on safe disposal practices. Moreover, pharmacists are positioned to play a crucial role in this educational effort, bridging the knowledge gap and guiding proper practices. Implementing drug take back programs in local pharmacies, alongside sustained awareness campaigns, could be an effective strategy in addressing these issues. Future research should focus on evaluating the effectiveness of such interventions and exploring additional measures to reduce self-medication practices, particularly among younger populations and students.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-19981-x>.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

We would like to thank Theqa team for their support and assistance throughout the study.

Data Collection Group:

Mahmoud Salem Aloudat¹, Manar Bassam Omaira¹, Rabah Suhail Baghdadi¹, Hala Jafa², Tuka Hamasho³, George Moayad Hneino⁴,

¹ Faculty of Medicine, Damascus University, Damascus, Syria.

² Faculty of Medicine, University of Aleppo, Aleppo, Syria.

³ Faculty of Medicine, Hama University, Hama, Syria.

⁴ Faculty of Medicine, Tishreen University, Latakia, Syria.

Authors' contributions

R.S, A.W, F.A, M.S conceived and designed the study, and drafted the manuscript. S.AQ analyzed the data and created the tables. A.AK, A.AD contributed to the interpretation of the results and the literature review. M.S, M.A.A provided critical feedback and helped shape the research, analysis, and manuscript. W.I.K contributed to the manuscript revision. S.AH supervised the research project, provided guidance throughout the study, and critically reviewed the manuscript. All authors contributed to the writing of the manuscript, read, and approved the final manuscript.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethics approval was obtained from ethics boards in Syrian Private University and Al-Baath University. All participants provided written informed consent prior to their participation in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Faculty of Medicine, Al-Baath University, Homs, Syria. ²Faculty of Medicine, Syrian Private University, Damascus, Syria. ³Faculty of Medicine, University of Aleppo, Aleppo, Syria. ⁴School of Health and Wellbeing, University of Glasgow, Glasgow, UK. ⁵Department of Medical Biochemistry and Microbiology, Uppsala University, Uppsala, Sweden.

Received: 10 July 2024 Accepted: 4 September 2024

Published online: 06 September 2024

References

- Hassan EWE, Taisan AAA, Abualhommos AK. Knowledge and practices concerning the storage and disposal of home medications among people in the eastern region of Saudi Arabia: a cross-sectional study. *Saudi Pharmaceutical journal*. 2022;30(2):172–9. <https://doi.org/10.1016/j.jsps.2021.12.010>.
- Woldeyohanins AE, Adugna M, Mihret T, Kifle ZD. Knowledge, attitude, and practices of unused medications disposal among patients visiting public health centers in Gondar Town, Ethiopia: a cross-sectional study. *J Environ Public Health*. 2021;2021: 5074380. <https://doi.org/10.1155/2021/5074380>.
- AlAzmi A, AlHamdan H, Abualezz R, Bahadig F, Abonofal N, Osman M. Patients' knowledge and attitude toward the disposal of medications. *J Pharm*. 2017;2017:8516741. <https://doi.org/10.1155/2017/8516741>.
- Paut Kusturica M, Tomas A, Sabo A. Disposal of unused drugs: knowledge and behavior among people around the world. *Rev Environ Contam Toxicol*. 2017;240:71–104. https://doi.org/10.1007/398_2016_3.
- Corre KSL, Ort C, Kateley D, Allen B, Escher BJ, Keller J. Consumption-based approach for assessing the contribution of hospitals towards the load of pharmaceutical residues in municipal wastewater. *Environ Int*. 2012;45:99–111. <https://doi.org/10.1016/j.envint.2012.03.008>.
- Banwat SB, Auta A, Dayom DW, Buba Z. Assessment of the storage and disposal of medicines in some homes in Jos north local government area of Plateau State, Nigeria. *Tropical Journal of Pharmaceutical Research*. 2016;15(5):989. <https://doi.org/10.4314/tjprv15i5.13>.
- Amoabeng JA, Otoo BA, Darko G, Borquaye LS. Disposal of unused and expired medicines within the Sunyani Municipality of Ghana: a cross-sectional survey. *J Environ Public Health*. 2022;2022: 6113346. <https://doi.org/10.1155/2022/6113346>.
- Al-Shareef F, El-Asrar SA, Al-Bakr L, et al. Investigating the disposal of expired and unused medication in Riyadh, Saudi Arabia: a cross-sectional study. *Int J Clin Pharm*. 2016;38:822–8. <https://doi.org/10.1007/s11096-016-0287-4>.
- Al Ruwaili N, Al Balushi A, Alharf A, AlShaharani H, Eldali A. Do parents in Saudi Arabia store medications safely? *Int J Pediatr Adolescent Med*. 2014;1(1):21–5. <https://doi.org/10.1016/j.ijpam.2014.09.003>.
- Ristic' G, Đorđević' A, Hristov S. A regional model for household pharmaceutical waste management. *Proc Inst Civil Eng Waste Resource Manage*. 2016;169(4):191–9.
- Naser AY, Amara N, Dagash A, Naddaf A. Medications disposal and medications storage in Jordan: a cross-sectional study. *Int J Clin Pract*. 2021;75:1–8.

12. Jafarzadeh A, Mahboub-Ahari A, Najafi M, Yousefi M, Dalal K. Medicine storage, wastage, and associated determinants among urban households: a systematic review and meta-analysis of household surveys. *BMC Public Health*. 2021;21(1): 1127. <https://doi.org/10.1186/s12889-021-11100-4>.
13. Abdelwahed RNK, Jassem M, Alyousbashi A. Self-medication practices, prevalence, and associated factors among Syrian adult patients: a cross-sectional study. *J Environ Public Health*. 2022;2022:9274610, 7. <https://doi.org/10.1155/2022/9274610>.
14. Farid S. Fertility patterns in the Arab Region. *Int Fam Plan Perspect*. 1984;10(4):119–25. <https://doi.org/10.2307/2948061>.
15. *Int J Caring Sci*. 2022;15(1):478. <https://www.internationaljournalofcaringsciences.org>. Accessed May 2024.
16. Persson M, Sabelström E, Gunnarsson B. Handling of unused prescription drugs — knowledge, behaviour and attitude among Swedish people. *Environ Int*. 2009;35(5):771–4. <https://doi.org/10.1016/j.envint.2008.10.002>.
17. Yousif MA. In-home drug storage and utilization habits: a Sudanese study. *East Mediterr Health J*. 2002;8(2–3):422–31 PMID: 15339133.
18. Kahsay H, Ahmedin M, Kebede B, Gebrezihar K, Araya H, Tesfay D. Assessment of knowledge, attitude, and disposal practice of unused and expired pharmaceuticals in community of Adigrat City, Northern Ethiopia. *J Environ Public Health*. 2020;2020:1–11. <https://doi.org/10.1155/2020/6725423>.
19. Koshok MI, Jan TK, Al-Tawil SM, Alghamdi EA, Ali A, Sobh AHM, Gamal MEM. Awareness of home drug storage and utilization habits: Saudi study. *Medicine Science | International Medical Journal*. 2017;6(4):1. <https://doi.org/10.5455/medscience.2017.06.8687>.
20. Abdelwahed RNK, Jassem M, Alyousbashi A. Self-medication practices, prevalence, and associated factors among Syrian Adult patients: a cross-sectional study. *J Environ Public Health*. 2022;2022:1–7. <https://doi.org/10.1155/2022/9274610>.
21. Jha N, Kafle S, Bhandary S, Shankar PR. Assessment of knowledge, attitude, and practice of disposing and storing unused and expired medicines among the communities of Kathmandu, Nepal. *PLoS ONE*. 2022;17(8):e0272635. <https://doi.org/10.1371/journal.pone.0272635>.
22. Tennant B, Stelfefon M, Dodd V, Chaney B, Chaney D, Paige S, Alber J. eHealth literacy and Web 2.0 health information seeking behaviors among baby boomers and older adults. *Journal of medical Internet research*. 2015;17(3): e70. <https://doi.org/10.2196/jmir.3992>.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.