

Research Paper

## Development and validation of medication storage and disposal questionnaire

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### Abstract

**Objectives** Inappropriate medication storage and disposal is a global problem and has a negative impact on public health, economy and the environment. One of the main causes of this problem is the lack of knowledge among the population about medication storage and disposal. This study aimed to develop a tool to measure knowledge and practice about medication storage and disposal and measure it among the Jordanian population.

**Methods** This web-based cross-sectional study developed a tool to evaluate medication storage and disposal knowledge attitude and practice. Exploratory factor analysis, analysis of variance and *t*-test were conducted to analyze the data.

**Key findings** 1132 responses were collected. The exploratory factor analysis suggested a three-factor model, the three models are knowledge-need, patient-related, and medication-related factors. Knowledge-need factor evaluates the participants' perceptions of the need for awareness and regulations regarding medication storage and disposal. The patient-related factor evaluates medication discontinuation behaviours. Medication-related factor evaluates the handling of damaged or expired medication practices. The highest mean of all three factors was for the knowledge-need factor (mean = 4.13), while the lowest was for the patient-related factor (mean = 3.22). The education level was negatively associated with patient-related factor indicating good behaviours. The means of the three factors were significantly associated with the respondents reporting that they know the correct medication storage and disposal behaviours, and the respondents believing that there are consequences of keeping medication at home.

**Conclusion** The questionnaire was a valid and reliable tool to assess the knowledge and practice of medication storage and disposal. This study's findings suggest that the lack of knowledge is the main reason behind the inappropriate medication storage and disposal practice. There is a need for awareness-improvement, which should involve healthcare awareness campaigns and governmental regulations.

**Keywords:** medication storage; medication disposal; knowledge; awareness; expired medications

## Introduction

Drug wastage has a tremendous economic impact worldwide. In the U.S., the annual cost of waste for the health care system is estimated in the range of \$760–\$935 billion.<sup>[1]</sup> The disposal costs of medical waste were estimated to be 580 US\$/ton.<sup>[2]</sup> Also, the monthly estimated costs of disposal in northern Jordan in 2008 were between 70 and 1330 US\$/month.<sup>[3]</sup> A study was conducted in 2012 among Jordanian families showed that the total cost of unused medications was estimated at 6 326 000 JD (Jordanian Dinar; \$8 922 538), the total cost of expired medications was estimated at 1 267 000 JD (\$1 787 046), and medication wastage was estimated to be 34.7% of household medicines.<sup>[4]</sup> Drug storage and disposal habits have a significant impact on people's health, including accidental use, abuse of drugs, using expired medications, accidental ingestion of drug by children, drug misuse, overdosing of medications, repeating medication course improperly, and environmental impact of disposal.<sup>[5–7]</sup>

The Jordanian healthcare sector is undergoing rapid growth. Jordan is considered a regional leader in medical tourism as one of the best healthcare providers in the Middle East and North Africa. Because of this rapidly evolving healthcare sector, the amount of medical waste has increased, and the need for patients' education for proper drug storage and disposal is essential.<sup>[8,9]</sup> Patients usually keep their medication because they believe that they may use them in the future, they do not know how to verify the expiry date, or do not know the proper drug disposal methods.<sup>[10]</sup> In addition, medication may accumulate in households due to low adherence, termination of a particular therapy, side effects of medications, and changing of the dose.<sup>[11]</sup> Keeping medication in homes for these reasons costs the community money and limit availability of medications for other patients.<sup>[12]</sup> Recently, the disposal of unused medication has become an increasingly serious problem that has to be resolved to avoid the risk of exposure to inappropriate medications.<sup>[13]</sup> Many medication users are unaware of their proper disposal, and therefore they either flush them in the toilet or throw them away.<sup>[11]</sup>

In 2007, the Food and Drug Administration (F.D.A.) and the White House Office of National Drug Control Policy (ONDCP) announced the first guideline for medication disposal.<sup>[14]</sup> According to F.D.A. guidelines, most medications other than sharps can be disposed of safely by drug take-back programs or by using the U.S. Drug Enforcement Administration (D.E.A.) authorized collectors.<sup>[15]</sup> If these options are not available, and there are no particular guidelines for disposal, then the disposal is possible in-home trash after mixing the medication with some unappealing substance.<sup>[16]</sup>

Drugs are expected to be stored in proper conditions. For example, in the refrigerator for medications that need to be refrigerated, in protected bottles for light-sensitive medications, and protected from moisture and fluctuated temperatures.<sup>[17]</sup> Because of the absence of the ability to recognize the expiry date for medications in the households, it is believed that many medications are taken after exceeding their expiry date, which exposes the consumers to the unexpected adverse drug reactions.<sup>[18]</sup> This study aims to develop and validate a tool to study the medication storage and discarding habits among the Jordanian population and examine the population's attitudes and knowledge about the proper storage and disposal of medications.

## Methods

### Study design

This cross-sectional web-based study was conducted between February and August 2020. A questionnaire was developed after reviewing the literature. The questionnaire was formulated in the

English language, translated into Arabic, and back-translated by different translators. The two versions were compared and found to be similar. Face validity was conducted by interviewing 50 participants, and the questionnaire was modified according to their feedback. The final version of the questionnaire was circulated online by email and social media. The consent form was included in the online questionnaire, and ethical approval was obtained from the ethical committee of the Al-Zaytoonah University of Jordan.

### The participants and sample size

The study participants were 18 years old and above Jordanians who had medications in-home and agreed to participate in the study. Exploratory factor analysis (EFA) is a statistical method used to evaluate the presence of an underlying factor structure for a wide array of observed variables without predetermining the structure of the outcome model.<sup>[19]</sup> Many suggestions were placed to determine the appropriate sample size required for EFA. Some studies focus on the participants' number to statements ratio, others focus on the total number of participants. The suggested total number of participants ranges from 50<sup>[20]</sup> to 1000<sup>[21]</sup> to achieve an adequate sample size, and one of the frequently used ratios in guidelines is 20:1.<sup>[22]</sup> Accordingly, this study's sample size was more than 1000 participants to satisfy the two settings suggested by the two approaches.

### Study instruments

The questionnaire (Appendix A) included four sections. The consent form was in the first section. The next section included demographic-related questions. This section included questions about age, sex, number of family members, education level, and average income. Those with primary school, secondary school or high school education were considered to have a low education level, while those with bachelor's degrees or postgraduate degrees were considered to have a high education level. The third section gathered general knowledge about medication storage and usage habits. The last section consists of 12 statements of five-Likert type scale response (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree) divided into three factors; these factors included the following: the knowledge-need factor, which evaluates the participants' beliefs about the need for more awareness and regulations. This factor included the following statements: (1) There is a lack of knowledge among the population about the appropriate ways to store and discard medications (Q21), (2) Doctors and healthcare providers must take a more active role in counselling the patients about the correct methods of storing and discarding medications (Q22), (3) The government is responsible for the enactment of strict policies on the returning of unused medications to its sources and providing a suitable place to discard unused medications (Q23), (4) There is a need for more awareness and orientation about the proper ways to store and discard medications (Q24), (5) I would discard my medications in a suitable place if it were available (Q25).

The second and third factors were adopted partly from the Return and Disposal of Unused Medications (ReDiUM) questionnaire.<sup>[23]</sup> The second factor was the patient-related factor, which measures the medication discontinuation patterns among the participant. The statements in this factor were: (1) I have unused medications because I stop taking the medications when I feel better (Q26), (2) I have unused medications because I experience unwanted side effects (Q28), (3) I have unused medications because I do not feel better as I have expected (Q30), (4) I have unused medications because I have not taken the medications as instructed/prescribed (Q32).

The third factor, the medication-related factor, studied handling damaged or expired medication habits among the participants. It contained

the following statements: (1) I dispose my medications when the medications have expired (Q27), (2) I dispose my medications when they smell bad, taste bad, or look bad (Q29) and (3) I dispose my medications when I have not stored them correctly, and my medications turned bad (Q31).

### Statistical analysis

Statistical analysis was conducted using SPSS version 26.<sup>[24]</sup> Categorical variables were presented as frequencies and percentages, continuous variables were presented as means, and standard deviations (SD). *P*-value of <0.05 was considered to be significant.

EFA was conducted, and its suitability for the study data was confirmed using the Kaiser–Meyer–Olkin value (KMO) and Bartlett's test of sphericity. Parallel Analysis and scree plot (Figure 1) were examined to determine the appropriate number of factors to extract. The pattern matrix was first developed using the direct oblimin rotation, and the highest *r* value was only 0.13 indicating acceptable discriminant validity, and because of low correlations, varimax rotation method was adopted and examined to identify the proper pattern matrix. Internal consistency for each factor was evaluated by calculating Cronbach's alpha; Cronbach's alpha above 0.5 was considered acceptable. The mean of each factor was computed, and the association between these means and different sample characteristics were evaluated using *t*-test or one-way analysis of variance.

### Results

1132 participant completed this survey, almost two-thirds of them were females (65.9%), and as showed in Table 1, more than half of

the participants were aged between 18 and 25 years (57.2%), the majority of them had a bachelor's degree or a postgraduate degree (86.7%), the family members number for more than half of the participants were between 5 and 10 (56.3%), and the participants were distributed almost equally between the three categories of average income (low income 31.4%, moderate-income 37.1%, and high income 31.5%).

Kaiser–Meyer–Olkin test result (0.70) and Bartlett's test (*P*-value < 0.01) confirmed the suitability of the data for factor analysis. Scree plot and parallel analysis suggested a three-factor model composed of 12 statements. Factor names, statements, factor loadings, communalities and Cronbach's alpha for three factor mode are shown in Table 2. The first factor measured the knowledge-need, and it contains five statements. For this factor, the communalities ranged between 0.32 (for item 25) and 0.62 (for item 22), and the factor loadings vary between 0.52 (for item 25) and 0.78 (for item 22). Cronbach's alpha for this factor was 0.69, and it would not be higher if any item were deleted. The total mean for the first factor was 4.13, and the mean for each item ranged between 3.99 (for item 23) and 4.31 (for item 22).

The second factor measured patient-related habits, and it contains four statements. For this factor, the highest communality extraction was 0.61 (for item 26), and the lowest extraction was 0.33 (for item 28), and the factor loadings vary between 0.51 (for item 28) and 0.78 (for item 30). Cronbach's alpha for this factor was 0.61, and deleting any item will not improve it. The total mean for the second factor was 3.22, and the means for each item ranged between 3.05 (for item 32) and 3.5 (for item 26).

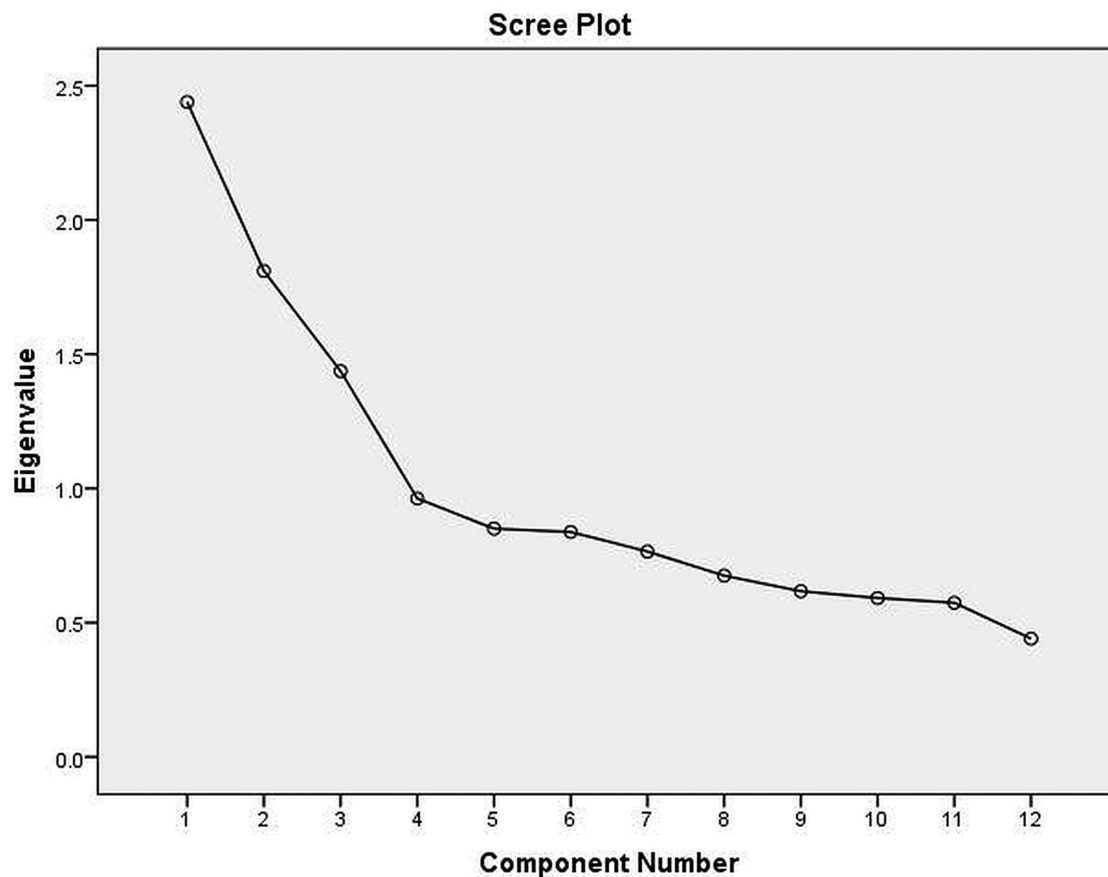


Figure 1 Scree plot

Table 1 Study sample demographics

Variable		Frequency	Percentage
Sex	Female	746	65.9%
	Male	386	34.1%
Age group	18–25 years	647	57.2%
	26–35 years	199	17.6%
	36–45 years	137	12.1%
	46–55 years	103	9.1%
	Older than 55 years	46	4.1%
Education level	Low education	151	13.3%
	Higher education	981	86.7%
Number of family members	1	50	4.4%
	2–4	421	37.2%
	5–10	637	56.3%
	More than 10	24	2.1%
Average income	Low income	268	31.4%
	Moderate income	317	37.1%
	High income	269	31.5%

Finally, the third factor measured medication-related habits. The communalities for this factor ranged between 0.44 (for item 29) and 0.63 (for item 31), and the factor loadings vary between 0.62 (for item 29) and 0.78 (for item 31). Cronbach's alpha for this factor was 0.51 and would not improve if any item were deleted. The total mean for the first factor was 3.85, and the mean for each item ranged between 3.75 (for item 29) and 3.95 (for item 27).

As Table 3 shows, all the participants had medications either prescribed by a doctor or Over the Counter (OTC) medications, almost one-third of the participants had expired medications in their homes (31.5%). The number of medications that participants had at their homes vary in a wide range as almost a third of them had 1–5 medications (30.4%), a fifth of them had 6–10 medications (20.8%), another third had more than 10 medications (29.9%), and the rest did not know the exact number of medications they had at their homes (18.9%). Regarding the number of expired medications that the participants had, a fifth of those who reported having expired medication had 1–5 medications (18.6%), and 8.4% of them did not know the number of expired medications they had. Most participants kept unused medications because they believe that they may need them in the future (71.3%). The most kept type of medications were analgesics (91.7%) followed by vitamins (60.6%), allergy, cough, and cold medications (59.8%), antibiotics (59%), and lower percentages of participants kept the other types of medications. A considerable percentage of participants (76.3%) acknowledged that they discard the unused/expired medications by throwing them in the garbage. The majority of the participants were interested to learn how to properly store medications or discard unused or expired medications (87.9%), and more of half of them think that there are consequences to keeping unused or expired medications at home (57.1%). The leading cause reported by the participants for stopping the medications is that their medical condition improved (72.3%), and the second common cause was that the participants forgot to take their medications (36.2%). Other important reasons for stopping taking the medication included the change in the treatment plan (35.2%), and extra amounts are prescribed (31.7%).

Regarding places that participants use for medication storage, the most used places were custom cabinet (53%) and fridge (46.5%). A small percentage of participants reported that they know how to discard unused/expired medications (31.5%). The most mentioned source of information about discarding medication was pharmacists

Table 2 Factors names, statements, factor loadings, communalities and Cronbach's alpha for three-factor mode

Factor name	Question number	Communalities	Factor loadings min-max	Cronbach's Alpha	Cronbach's Alpha if item deleted	Mean	Total mean
Knowledge-need	Q21. There is a lack of knowledge among the population about the appropriate ways to store and discard medications	0.32–0.62	0.52–0.78	0.69	0.69	4.00	4.13
	Q22. Doctors and healthcare providers must take more active role in counselling the patients about the correct methods of storing and discarding medications						
	Q23. The government is responsible to the enactment of strict policies on the returning of unused medications to its sources and providing a suitable place to discard unused medications						
	Q24. There is a need for more awareness and orientation about the proper ways to store and discard medications						
Patient-related	Q25. I will discard my medications in a suitable place if it was available	0.33–0.61	0.51–0.078	0.61	0.68	4.14	3.22
	Q26. I have unused medications because I stop taking the medications when I feel better						
	Q28. I have unused medications because I experience unwanted side effects						
	Q30. I have unused medications because I do not feel better as I have expected						
Medication-related	Q32. I have unused medications because I have not taken the medications as instructed/prescribed	0.44–0.63	0.62–0.78	0.51	0.53	3.05	3.85
	Q27. I dispose my medications when the medications have expired						
	Q29. I dispose my medications when they smell bad, taste bad, or look bad						
	Q31. I dispose my medications when I have not stored them correctly and my medications turned bad				0.49	3.75	
					0.20	3.85	

**Table 3** Medications storage and disposal habits

Variable	Frequency (%)
Owning medications	Yes 1132 (100)
	No 0 (0)
Presence of expired medications at home	Yes 357 (31.5)
	No 536 (47.3)
	I do not know 239 (21.1)
Knowledge about how to discard medications	Yes 357 (31.5)
	No 775 (68.5)
Interest in learning about how to store medications and discard unused or expired medications	Yes 995 (87.9)
	No 137 (12.1)
Are there any consequences of keeping medications?	Yes 646 (57.1)
	No 239 (21.1)
	I do not know 247 (21.8)
Number of medications at home	1–5 344 (30.4)
	6–10 235 (20.8)
	More than 10 339 (29.9)
	I do not know 214 (18.9)
Number of expired medications at home	1–5 210 (18.6)
	6–10 27 (2.4)
	More than 10 25 (2.2)
	I do not know 95 (8.4)
Causes of keeping medications	Because I may need them again 807 (71.3)
	To give them to whoever needs them 87 (7.7)
	Because I do not know how to discard them 38 (3.4)
	Because doctors prescribe them in large amounts 54 (4.8)
	Because pharmacies do not sell medications in a small amount 30 (2.7)
	Because usually, I do not count my medications 116 (10.2)
How do you discard unused/expired medications?	Return them to the hospital or pharmacy 38 (3.4)
	Bury them 10 (0.9)
	Throw them in the garbage 864 (76.3)
	Throw them in the toilet and pour water on them 47 (4.2)
	Give them to other people 57 (5)
	Burn them 2 (0.2)
	Do not discard them at all 38 (3.4)
	Do not know how to discard them 76 (6.7)
Types of medications that you keep	Antibiotics 668 (59)
	Contraceptive pills 61 (5.4)
	Analgesics 1038 (91.7)
	Vitamins 686 (60.6)
	Bronchodilators 182 (16.1)
	Diabetic medications 232 (20.5)
	Antacids 476 (42)
	Eye preparations 394 (34.8)
	Allergy, cough, and cold medications 677 (59.8)
	Other medications 207 (18.3)
Causes of not using medications	Change in the treatment plan 398 (35.2)
	There is a change in the smell or the taste of the medications 60 (5.3)
	My medical condition improved 818 (72.3)
	The medications are ineffective 217 (19.2)
	I change to lower doses 67 (5.9)
	Medications have been expired 144 (12.7)
	Concerns about side effects 221 (19.5)
	The medications have a bad smell or taste 60 (5.3)
	Extra amounts are prescribed 359 (31.7)
	Troubles in following doctor instructions 133 (11.7)
	I forget taking my medications 410 (36.2)
	Instructions are unclear 42 (3.7)
The place that you keep your medications	Fridge 526 (46.5)
	Kitchen 194 (17)
	Custom cabinet 600 (53)
	Bathroom 11 (1)
	Bedroom 375 (33.1)
	Other places like the living room 120 (10.6)



Table 3 Continued

Variable		Frequency (%)
Source of knowledge about storing and discarding medications	Brochures	49 (4.3)
	Nurses	18 (1.6)
	Pharmacists	185 (16.3)
	Doctors	82 (7.2)
	Mobile applications	25 (2.2)
	T.V.	27 (2.4)
	Internet and social media	113 (10)
	Courses in university or college	179 (15.8)
	Education campaigns	25 (2.2)
	Family member	63 (5.6)
The preferred source of knowledge about storing and discarding medications	Doctors	459 (40.5)
	Nurses	102 (9)
	Pharmacists	818 (72.3)
	Mobile applications	195 (17.2)
	Brochures	208 (18.4)
	Internet and social media	419 (37)
	TV	126 (11.1)
	Family member	123 (10.9)

(16.3%), followed by courses that the participants took in the university or college (15.8%). Moreover, the majority of the participants' (72.3%) preferred source of information about discarding unused/expired medications is the pharmacist (72.3%), followed by the doctors (40.5%), and the internet and social media platforms (37%). There were significant differences in the patient-related habits between the different age groups ( $P$ -value 0.03) and as shown in Table 4, the oldest age groups (those between 46–55 years and those who are older than 55 years) had a highest mean, while the youngest age group (18–25 years) had the lowest mean (mean 3.17).

Significant differences were found in the patient-related and the medication-related habits between the different education level groups ( $P$ -values < 0.01 for both factors). For the patient-related factor, the mean was higher for the low education group (mean = 3.34) when compared to the higher education group (mean = 3.20). In contrast, the higher education group participants had a higher mean in medication-related habits (mean = 3.88) when compared with the low education group (mean = 3.67).

Also, significant differences were found in patient-related habits ( $P$ -value < 0.01) between the average income groups. The participants whose income falls in the moderate-income group had the highest mean (mean = 3.34), while those with the highest income had the lowest mean (mean = 3.11).

Additionally, significant differences in patient-related and medication-related habits were found in relation to the presence of expired medications ( $P$ -values < 0.01 for both factors). Regarding the patient-related factor, the participants who did not know if they had expired medications at their homes had the highest mean (3.39), and the participants who denied having an expired medication had the lowest mean (3.07). On the other hand, the participants who did not know if they had expired medications had the lowest mean in medication-related habits (3.66), and those who denied having an expired medication had the highest mean (3.98).

Significant differences in all three factors were found between those who responded that they received information about how to discard unused/expired medications and those who did not; the  $P$ -value was 0.01 for knowledge-need factor, and <0.01 for both patient-related and medication-related factors. The means were higher for those who did not receive information in both knowledge-need and patient-related factors (4.15 and 3.27, respectively). In

contrast, in medication-related factor, the mean was higher in the participants who received information about discarding unused/expired medications (mean = 3.98).

Likewise, significant differences were found in both knowledge-need and medication-related factors between those who were interested in learning about how to discard the medication and who were not interested ( $P$ -value < 0.01 for both). In both factors, the participants who were interested in learning about how to discard medication had higher means (means were 4.17 for knowledge-related factor and 3.88 for medication-related factor).

Finally, there were significant differences in all three factors regarding the participants' beliefs about the consequences of keeping unused/expired medications at home ( $P$ -value < 0.01 for the three factors). The participants who believe that there are consequences of keeping medications had the highest mean for the knowledge-need factor (4.19) and medication-related factor (3.92). While for the patient-related factor, the highest mean was for those participants who did not know if there are any consequences of keeping unused/expired medications at home (3.35), and the lowest mean was for those who did not think that there are consequences of keeping unused/expired medications at home (3.71).

## Discussion

This study's objectives were to develop and validate the storage and disposal of unused medications questionnaire, explore the medication storage and discarding habits among the Jordanian population, and understand the attitudes and knowledge of the population about the proper discarding of medications. Hazards that arise from medical waste have generally been of great concern to those who are in charge of environmental health preservation in the developing countries,<sup>[8]</sup> and with the rapidly growing health sector in Jordan, it is well-known now that Jordan has an increasing amount of medical waste.<sup>[8]</sup> Accordingly, waste management must get more recognition among the general population and stakeholders to prevent any hazards produced wastage.<sup>[8]</sup> To the best of the authors knowledge, this study is the first one to discuss medications storage and discarding habits among the Jordanian population.

To achieve these objectives, an Arabic questionnaire was designed based on issues identified in the literature and has been divided into

**Table 4** Association between the means of knowledge-need, patient-related, and medication-related factor and sample characteristics

Variable		Knowledge		Patient		Medication	
		Mean (SD)	P-value	Mean (SD)	P-value	Mean (SD)	P-value
Sex	Female	4.14 (0.48)	0.24	3.20 (0.71)	0.11	3.87 (0.68)	0.16
	Male	4.10 (0.51)		3.27 (0.70)		3.81 (0.66)	
Age group	18–25 years	4.12 (0.50)	0.82	3.17 (0.71)	0.03	3.83 (0.68)	0.38
	26–35 years	4.12 (0.51)		3.30 (0.72)		3.94 (0.67)	
	36–45 years	4.16 (0.47)		3.20 (0.68)		3.83 (0.71)	
	46–55 years	4.13 (0.45)		3.36 (0.71)		3.83 (0.59)	
	Older than 55 years	4.07 (0.49)		3.34 (0.67)		3.88 (0.50)	
Education level	Low education	4.11 (0.51)	0.73	3.34 (0.70)	<0.01	3.67 (0.66)	<0.01
	High education	4.13 (0.49)		3.20 (0.71)		3.88 (0.67)	
Average Income	Low income	4.11 (0.45)	0.75	3.29 (0.66)	<0.01	3.82 (0.64)	0.98
	Moderate income	4.13 (0.55)		3.34 (0.65)		3.83 (0.66)	
	High income	4.14 (0.47)		3.11 (0.73)		3.83 (0.72)	
Presence of expired medications at home	Yes	4.14 (0.49)	0.49	3.33 (0.67)	<0.01	3.79 (0.67)	<0.01
	I don't know	4.09 (0.51)		3.39 (0.63)		3.66 (0.71)	
	No	4.13 (0.48)		3.07 (0.74)		3.98 (0.63)	
Knowledge about how to discard medications	Yes	4.07 (0.52)	0.01	3.13 (0.74)	<0.01	3.98 (0.63)	<0.01
	No	4.15 (0.47)		3.27 (0.69)		3.79 (0.68)	
Interest in learning about how to discard medications	Yes	4.17 (0.47)	<0.01	3.22 (0.72)	0.41	3.88 (0.67)	<0.01
	No	3.81 (0.52)		3.27 (0.66)		3.61 (0.64)	
Are there consequences of keeping medications?	Yes	4.19 (0.49)	<0.01	3.18 (0.73)	<0.01	3.92 (0.67)	<0.01
	I don't know	4.12 (0.48)		3.35 (0.66)		3.71 (0.69)	
	No	3.97 (0.49)		3.20 (0.70)		3.81 (0.63)	

knowledge-need, patient-related, and medication-related, in addition to demographic information. An online version of the questionnaire was created to gather the data, and 1132 responses were collected. EFA results confirmed the originally intended three factors: knowledge-need, patient-related, and medication-related storage habits.

### Knowledge and awareness

Almost half of the participants reported that they had expired medications at home, but less than one-third of the participants had received any knowledge about the appropriate ways to discard medications. Of all participants, only 16.3% had gained knowledge about the appropriate ways of storing and discarding medications from pharmacists. This is a similar percentage to the one reported in a study conducted in the United States.<sup>[25]</sup> This implies the need to activate pharmacists' role in this aspect, which is the same conclusion derived from a Saudi study about the awareness of home medication storage and utilization habits.<sup>[26]</sup> The pharmacist role's importance was also confirmed when the participants were asked about their preferred source of knowledge, as the pharmacist was the choice of 72.3% of the participants.

The results of the study imply the importance of knowledge about storing and discarding medications in many aspects. Those who had received knowledge had better patient-related and medication-related behaviours. Another important contributor to these behaviours was the awareness of keeping medication consequences as the participants who were aware of the consequences of keeping medications acknowledged that more awareness is needed and had better patient-related and medication-related behaviours.

Those who had not received knowledge previously about storing and discarding medications had significantly higher means in knowledge-need factor, indicating that they felt that there's a need for more healthcare providers' contribution in increasing the awareness about storage and disposal of medications.

Also, universities and colleges must activate their roles as sources of information about medication storage and discarding, as only 15.8% of the participants reported that they had obtained information about medication storage and disposal during their education. This is important as previous studies have shown that the involvement of education in population awareness about medication storage and disposal is essential.<sup>[23]</sup>

### Regulations

Despite that 57.1% of the participants believe that there are consequences of keeping medications, only 47.3% knew that they did not have expired medications at home and the rest either acknowledged that he/she had expired medications at home or did not know. This suggests that awareness of consequences is insufficient, and laws must be enacted to regulate medications' storage and disposal. Moreover, many of the respondents (mean = 4.14) indicated their willingness to discard the unused/expired medication in a suitable designated service once such service is available. This confirms previous studies<sup>[27–29]</sup> that reported that increasing awareness of these services' presence will increase its utilization among the general population.

Furthermore, the results have shown that the percentage of the participants who return the expired medications to the pharmacies or hospitals was low (3.4%), indicating the importance of imposing regulations that involves the more active participation of pharmacists and healthcare providers in handling medical waste. The usefulness of such regulation can be emphasized by the much higher percentage of Americans (22.9%) who return their unused/expired medications to the pharmacies in states with such regulations.<sup>[25]</sup>

### Patient-related factor

Older participants (between 46 and 55 years of age and older than 55 years) showed worse patient-related behaviours. This may be explained by the increasing number of medications needed with age,<sup>[30]</sup> which may lead to poorer medication adherence.<sup>[31]</sup>

The education level of the participants had a significant effect on their patient-related behaviours. These findings are consistent with a study that evaluated the association between education level and medication adherence among the Jordanian population.<sup>[32]</sup>

In our study, the average income had an unclear effect on patient-related behaviours as no consistent improvement or decline in medication adherence was observed with the increase in the average income. This result contradicts other studies that found a positive correlation between the average income and medication adherence<sup>[33, 34]</sup> and other studies that did not find a significant association between income level and medication adherence.<sup>[35]</sup> However, patient-related factor evaluated medication discontinuation and did not directly assess adherence.

### Medication-related factor

Education level was a significant contributor to medication-related factors as those with low education levels had worse practices in handling damaged or expired medications. Similar findings were mentioned in a Chinese study about the factors influencing the attention to home storage of medications.<sup>[36]</sup>

The most common type of medication that participants retain was analgesics, which is expected as they are indicated as needed. The percentage of the participants who responded that they keep antibiotics was 59%, and a similar percentage was reported in a study conducted in Kabul.<sup>[11]</sup> These results indicate the misuse of antibiotics among different populations, which may increase antibiotic resistance.<sup>[37]</sup>

### Storage and disposal practices

In our study, all the participants had at least one medication at home, and almost one-third of them had more than ten medications, which indicates the high rates of household medication storage among the Jordanian population. These findings are similar to those mentioned in studies conducted on the Saudi population.<sup>[38,39]</sup> This storage behaviour may lead to unfortunate consequences like the accidental poisoning of children.<sup>[17]</sup>

The leading reason for keeping medications among the participants was to reuse them in the future. The same cause was reported in many other studies as the most common reason for keeping medications.<sup>[11,40,41]</sup> This attitude can be a cost-saving measure<sup>19</sup> or due to concerns over occasional medication shortage in some hospitals or pharmacies.

Only 1% of the participants keep their medications in the bathroom, and more than half of them store their medications in a custom cabinet, indicating good medication-storage habits.<sup>[42]</sup> However, 76.1% of the participants respond that they discard the unused/expired medication in the garbage, which is higher than the percentages reported in other studies.<sup>[40, 43]</sup> This discarding method's popularity is explained by its ease,<sup>[40]</sup> but it may result in environmental and health hazards like medication abuse, toxicity and death.<sup>[44]</sup>

### Study limitations

This study has several limitations. First, only those who can read and have internet access could fill the questionnaire. Also, those interested in medication storage and disposal could be more encouraged to complete the questionnaire, leading to selection bias. The questionnaire was also self-reported, leading to recall bias, and the answers were not independently verified.

### Recommendation and challenges

Establishment of a system to collect expired and unwanted drugs from the general consumers could be hard to imply, particularly in the short-term.<sup>[28]</sup> Therefore, as indicated by the study results, it is recommended to exert more efforts to increase the awareness of the general population about the importance of safe storage and disposal of medication and its impact on the public health, economy, and environment

### Conclusion

This study validated a tool to measure knowledge and practice about medication storage and disposal. The study's results indicate the significance of knowledge and awareness of medication storage and disposal behaviours among the general population. Therefore, healthcare providers, especially pharmacists, must have an active role as the most trusted source of knowledge about medications by counselling their patients about the proper medication storage and disposal methods. Moreover, the government can serve a critical role in this aspect by enactment of regulations and increasing knowledge by organizing education campaigns and awareness programs.

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### Author Contributions

W.A.Q.: methodology, formal analysis, writing-original draft, supervision. M.M.H.: conceptualization, methodology, investigation, writing-original draft. E.S.G.: investigation, writing-review and editing. A.S.J.: investigation, writing-review and editing.

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### Conflict of Interest

None declared.

### Data Availability Statement

The datasets generated and analyzed during the current study are available on Mendeley data doi: 10.17632/6jzc9yx2c5.1.

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